

PART V

WORK ASSOCIATED WITH SEWER CONSTRUCTION

A. GENERAL INFORMATION

Any new sewerage system to be connected to the public sewer shall not be constructed until final plans are approved by the Service Authority. The Authority shall be furnished for review three (3) sets of plans and specifications prepared by a registered engineer certified to do business in the state of Virginia. Plans shall be in sufficient detail to accurately indicate all pertinent design and construction details for a comprehensive interpretation of the work to be performed. Plans shall be reviewed for compliance with the following standards as have been adopted by the Service Authority.

B. DESIGN CRITERIA

1. Slope

Sewers shall have a uniform slope and straight alignment between manholes, and be designed and constructed in accordance with these specifications.

Minimum grades shall not be less than those required to produce a velocity of approximately two (2) feet per second when the size pipe selected is flowing full and using an "n" value of 0.013 in the Manning Formula.

Minimum grades shall be as follows (however, slopes greater than these are desirable):

Sewer Size Minimum Slope in Feet per 100 Feet

8"	.50
10"	.28
12"	.22
14"	.17
15"	.15
18"	.12
21"	.10
24"	.08

Pipelines shall be sized to serve buildout of the planned development. Pipe sizes shall not be arbitrarily increased in order to take advantage of a flatter grade.

The maximum permissible velocity shall not exceed fifteen (15) feet per second. Suitable provisions shall be provided to break steep slopes to limit the velocities in the connecting sewer pipes between manholes. Where it is impractical to reduce the velocity,

the sewer main shall be ductile iron.

2. Drop Manhole Requirements

Drop manhole connections shall be constructed for sewers entering manholes at elevations greater than or equal to twenty-four (24) inches above the manhole invert. Drop connections shall be ductile iron pipe or PVC pipe backfilled in six (6) inch lifts and compacted by hand tampers. (See Part IV, Figure S-1-C, Page TD-3). Sewer lines entering a manhole less than twenty-four (24) inches above the manhole invert shall not enter the manhole greater than twelve (12) inches above the manhole invert and shall be incorporated into a smooth transition by filleting the invert.

3. Sewers Exceeding 20% Slope

Sewers on a twenty percent (20%) slope or greater shall be anchored securely with concrete anchors and be constructed of ductile iron pipe. (See Part VII, Figure S-4, Page TD-8). Anchor spacing shall be in accordance with the following table:

<u>Slope</u>	<u>Anchor Spacing</u>
20% to 35%	Not over 36'
35% to 50%	Not over 24'
50% or greater	Not over 16'

The first anchor shall be placed on the first joint upstream from the lower manhole. The location of the first anchor and the maximum spacing required shall determine the number of anchors used between manholes.

4. Sewer Junctions

At all junctions where a smaller sewer joins a larger one, the relative elevation of the inverts shall be set to maintain the same energy gradient. Two approximate methods for securing these results which may be used are: (1) positioning the water surface of each sewer flowing at 80% of its capacity at the same elevation, or (2) positioning the crown of both sewers at the same elevation.

5. Minimum Size

No public sewer shall be less than eight (8) inches in diameter, except that laterals serving six (6) connections or fewer on cul-de-sacs or as sidewalk collector lines may be six (6) inches provided that engineering calculations and justification indicate that such line size is adequate. Minimum size for each lateral connection is four (4) inch inside diameter. The Authority reserves the right to specify the size of any sewer mains.

6. Manhole Requirements

Manholes for access to sewers shall be provided at all intersections with other sewers, at all points of change in alignment, changes in pipe size or grade, and at the end of the line. The maximum distance between manholes shall be 400 feet. All sewer lines shall be straight between manholes. A manhole shall be constructed at the end of all lines, regardless of length.

Sewer manholes for sewers up to twenty-four (24) inch diameter shall not be less than forty-eight (48) inch inside diameter. Manholes for sewers larger than twenty-four (24) inches and up to forty-eight (48) inches shall have an inside diameter of not less than sixty (60) inches.

Manhole top elevations shall be above the 100-year Flood Elevation or watertight with ventilation.

Where practical manholes shall be placed on undisturbed soil. Where manholes must be installed in fill areas, the fill shall be compacted to 95% of the optimum density, as determined by AASHTO T-99 to an elevation not less than thirty-six inches (36") above the proposed invert before excavation begins. Certification of compaction at the manhole location shall be provided before setting the manhole base.

7. Ventilation

Ventilation of gravity sewers shall be provided where continuous watertight sections greater than 1000 feet in length are incurred. Vents shall be protected against the 25-year flood level either by elevation or mechanical means.

8. Depth of Cover

All sewers should be constructed in such a manner that a minimum of three (3) feet of cover is maintained between the top of the pipe and the finished grade elevation. Only under extraordinary conditions shall any sewer line be installed with less than three (3) feet of cover from the top of the pipe to finished grade. This will only be allowed by special permission from the Authority. If such a condition arises, the pipe shall be ductile iron, Class 52, and adequately protected. Greater depths may be required if deemed necessary to provide service to adjacent properties or to serve lower-lying properties. PVC pipe shall not be used when the final cover over top of the pipe exceeds fifteen (15) feet.

9. Design

The structural design of the sewer shall conform with the methods given in ASCE Manual No. 37, as amended, for the design and construction of sanitary and storm sewers.

The proposed design shall identify and adequately address the protection of all potable water supply structures within one hundred (100) feet of the proposed project.

10. Industrial Waste

Sources of waste other than domestic shall be evaluated on an individual basis and plans of all industrial or commercial pretreatment facilities shall be reviewed by the Authority in accordance with current Albemarle County Industrial Waste Ordinance.

11. Storm & Sanitary Sewer Crossings

The minimum distance where sewer lines and storm drainage appurtenances cross shall be twelve (12) inches.

C. SEWER LOCATIONS

1. General

It is understood that topographic constraints dictate the appropriate location for installation of sanitary sewers. Sewers shall be designed to accommodate gravity sewer flow whenever possible. If sewers are to be constructed within streets or highway rights-of-way, preliminary approval must be obtained from VDOT.

If sewer lines are to be constructed on private property, a permanent sanitary sewer easement shall be provided in accordance with Part II of these specifications.

Whenever possible, sewers should not be located in areas subject to flooding, or in drainage ditches, or in any location that would encourage infiltration. Structures located by necessity in areas prone to inundation shall be provided with watertight covers.

2. Stream Crossings

Sewers crossing streams shall remain fully operational during 25-year flood/wave action. Sewers shall be constructed of watertight ductile iron pipe of the same size inside diameter as the appurtenant sewer or the next size larger in ductile iron, if equal size is not available. The pipe and joints shall be tested in place, shall exhibit "0" infiltration, and shall be designed, constructed and protected against anticipated hydraulic and physical, longitudinal, vertical and horizontal loads and erosion and impact.

Where stream crossings are proposed below the channel the tops of all sewers crossing streams shall be at a sufficient depth below the natural bottom of the stream to protect the sewer line. Where less than three (3) feet of cover is available at crossings, the line shall be encased in concrete. Encasement shall be in accordance with detail shown in these specifications. (See Part VII, Figure S-7, Page TD-11).

Sewers laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no other practical alternative exists. Construction methods and materials of construction shall be such that sewers will remain watertight and free from change in alignment or grade. Pier design shall be submitted to the Authority for approval.

D. SEWER CONNECTIONS & LATERALS

Lateral connections to sewer lines eighteen (18) inches in diameter or larger shall only be made at manholes. New sanitary sewer main connections shall only be made at manholes. If necessary, a new "dog-house" manhole shall be installed on an existing sewer line to accommodate a new connection.

A sewer service lateral shall be required for each customer and/or lot, unless otherwise approved by the Authority. Sewer laterals shall be constructed to the property line and sealed until said sewer line is put in use. (See Part VII, Figure S-2, Page TD-6). All service lateral stub-outs shall be marked with a pressure treated 2" x 4" piece of lumber no less than 4' in length. The 2" x 4" shall extend approximately one foot above grade and shall be painted green. The depth to the lateral shall be noted on the 2x4. Alternate markers may be approved by the Service Authority.

The pipe between the public sewer line and the property line shall conform to the following:

All pipe from the main sewer line to the property line shall be laid in a straight line and to a minimum grade of not less than one-quarter inch per foot. In no case shall the line be less than four (4) inch inside diameter. The minimum depth of cover shall be three (3) feet

over the sewer lateral unless otherwise approved by the Authority.

Where dissimilar materials exist between a service connection and the building sewer a satisfactory adapter shall be provided in order to ensure a tight joint and smooth transition.

When it becomes necessary to tap an existing sewer line, a saddle or manhole will be required at the point of connection. Saddles shall be approved by the Authority prior to installation.

The pipe between the property line and the building shall conform to the applicable sections of the BOCA National Plumbing Code/1993, as amended.

All in-line wyes/tees or saddles shall be left exposed for visual inspection by the Service Authority so that measurements to the nearest downstream manhole can be obtained.

E. SANITARY SEWER CONSTRUCTION

1. Pipe Laying-General Requirements

Construction of sanitary sewer lines and appurtenances shall be in accordance with the approved plans and specifications. The Authority shall insist that good workmanship and standard sewer line construction principles apply in the work in order that the finished project may qualify on final inspection for acceptance into the Authority sewerage system.

Prior to the construction of any sanitary sewer, the owner's or developer's engineer shall place adequate line and grade stakes and shall also set stakes and furnish grades so that all manhole tops can be set to grade, all in accordance with the approved plans and specifications. Whenever obstructions not shown on plans are encountered during progress of the work, which interfere to such an extent that an alteration in plans is required, the Authority or its representative shall be advised.

If any deviation is contemplated in location, line or grade of any sewer line, masonry structure, or accessory from that shown on the plans approved by the Authority, details of the proposed deviation shall be submitted to the Authority for review and approval before the changes are constructed. Verbal approval may be granted for minor alterations. Major alterations will require written approval before such alterations are put into effect. The severity of the alteration and its remedial action shall be determined by the Authority.

2. Excavation and Laying of Pipe

(a) Excavation

Pipeline construction shall be made by open cut unless otherwise specified or required. During the excavation operations, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins.

All open trenches shall be adequately shored and braced to provide a safe working environment. Trench boxes shall be made available onsite and utilized in accordance with appropriate OSHA standards. It is the contractor's responsibility to comply with the requirements of OSHA pertaining to men working in an open trench.

All excavated material not suitable for back-fill shall be removed and disposed of in an acceptable manner. Grading shall be done as may be necessary to prevent water from flowing into trenches or other excavations and any water accumulating therein shall be removed by approved methods.

The trenches in which the pipe is to be laid shall be opened in accordance with the lines and grades on the approved plans and designated in the field by the developer's or owner's engineer. The exposed end of all pipes shall be fully closed by means of an approved stopper to prevent earth or other substances from entering the pipe. All sewers shall be laid true to line and grade with bells upstream. The sections of pipe shall be so laid and fitted together that, when complete, the sewer will have a smooth and uniform invert.

Where a proposed sanitary sewer system connects to an existing manhole, main line or any other sewage facility, the outlet pipe of the first manhole upstream from said existing sewer facilities shall be completely blocked with an expansion plug. This plug shall remain in place throughout the construction and testing phases of the project and shall not be removed until final approval of the project is granted by the Authority. The exposed end of all sewer pipe in the trench (particularly throughout the first reach upstream from the existing sewer facility) shall be completely blocked with an approved plug when pipelaying is not in progress in order to protect the existing sewer facility.

All trenches shall be kept free of water during the laying operations. Not more than one hundred (100) feet of trench shall be opened in advance of the completed sewer when located along streets or highways, and not more than two hundred (200) feet at other locations.

(b) Construction in Fill Areas

Where pipelines are to be installed in fill areas, the fill shall be compacted to 95% of the optimum density, as determined by AASHTO T-99, to an elevation not less than thirty-six (36) inches above the pipe bells before excavation begins for the pipe trench. Certification at intervals as directed by the Authority shall be required of all compaction in fill areas.

(c) Trench Width

The width of the trench at any point below the crown of the pipe shall be no greater than the width necessary to accommodate shoring the trench, setting and aligning the pipe. Trench walls in this area shall be kept as nearly vertical as possible. Trench walls above the crown of the pipe may be sloped or shored to meet the applicable OSHA trenching standards. Excavation at manholes and similar structures shall be sufficient to leave at least twelve (12) inches clearance between their outer surface and the embankment or sheeting. Minimum clearance between side of trench and pipe shall be eight (8) inches.

(d) Rock Excavation

Where rock is encountered in trench excavation, whether solid or in the form of loose rock or shale, or large boulders, it shall be removed by blasting or other approved methods to the extent that no projection of rock shall be nearer than six (6) inches to any part of the sewer pipe when laid, nor project beyond the lines and grades of structures. No blasting shall be done within twenty-five (25) feet of any completed work or adjacent to any other structure unless proper precautions are taken. Ends of sewer line adjacent to blasting shall be covered to avoid receiving debris. No rock or asphalt over six-inches (6") in any dimension shall be placed in the trench and in no case shall rock or asphalt be placed closer than two feet vertically to the installed pipe.

(e) Overexcavation

Where the excavation has been carried too deep the contractor shall refill the over-excavated trench with VDOT specification No. 68 stone, in order to ensure the stability of the various structures.

(f) Pipe Installation (General)

When installing pipe in the trench, proper implements, tools, and facilities satisfactory to the Authority and as recommended by the material manufacturer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe, fittings, and accessories shall be carefully lowered into the trench piece by piece by means of a derrick, ropes, slings, or other suitable tools or equipment in such a manner as to prevent damage to the sewer main materials and any protective coatings and linings (when ductile iron is used). Under no circumstances shall sewer main materials be dropped or dumped into the trench.

(g) Condition of Ductile Iron Pipe

All lumps, blisters and excess coal tar coating shall be removed from the ends of each pipe. The outside of the spigot and the inside of the bell shall be wire-brushed and/or clean and dry and free from oil and grease before the pipe is laid.

(h) Special Precautions

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. During the laying operation, no debris, tools, clothing or other materials shall be placed in the pipe. Sewer lines shall be plugged at the end of each construction day to prevent foreign matter from entering them.

3. Pipe Foundation

(a) Foundation in Good Soil

For PVC pipe the bottom of the trench shall be excavated from four (4) to six (6) inches below the bottom of the barrel of the pipe and a bedding shall be provided of No. 68 Stone, per Virginia Department of Transportation specifications. The bedding shall be shaped to the spring line of the exterior diameter of the pipe to support one-half of the circumference of the pipe for the entire length of the barrel and shall extend to the trench walls.

For ductile iron pipe, the bottom of the trench shall be scraped and compacted, and all stones shall be removed or a four (4) inch bedding of No. 68 stone shall be provided. Bell holes shall be cut to prevent the pipe from resting on the bells. (See Part VII, Figure S-3, Page TD-7).

Where excavation is made in rock or boulders a bedding of No. 68 stone with a minimum thickness of six (6) inches shall be provided for both PVC and ductile iron pipe. The bedding material shall extend evenly to the trench wall.

(b) Foundation in Poor Soil

Whenever the soil at the bottom of the trench is soft, unstable or saturated with water, a

granular fill under the bedding to a depth required to stabilize the soil shall be provided. Maximum size of gravel shall be one inch. Ductile iron pipe shall be provided in unstable soils as determined by the Authority. (See Part VII, Figure S-3, Page TD-7).

(c) Pressure Sewer

Where pressure sewers are required, all tees, bends, and plugs shall be braced, blocked, and/or anchored to prevent any movement by providing adequate reaction backing. This backing shall be a concrete thrust block with a compressive strength not less than 2500 psi. Backing shall be placed between solid undisturbed earth and the fitting to be anchored and shall be so placed that pipe and fitting joints will be accessible for repair. (See Part VII, Figure W-3, Page TD-14).

4. Backfilling and Tamping

(a) General

All trenches or excavations shall be backfilled to the original surface of the ground or to such other grades as may be shown on the approved plans.

Backfilling shall be subject to the approval of the Authority for the type of construction used. All backfilling shall be completed promptly. Backfilling around structures should be started as soon as the mortar and masonry are sufficiently set. New trenching will not be permitted when earlier trenches need backfilling or labor is needed to restore the surfaces of streets or other areas to a safe and proper condition.

(b) Materials

All material used for backfilling of trenches shall be free of excessive amounts of unsuitable materials such as all organic material, frozen clods, and sticky masses of clay and gumbo which are difficult to properly compact. Backfill material shall contain no rock or asphalt larger than six (6) inches in any dimension and in no case shall rock or asphalt be placed closer than two (2) feet vertically to the installed pipe.

(c) Backfilling

Backfilling around PVC pipe shall be carefully done by hand and tamped with suitable tools of approved weight. Backfill over all pipe to a depth of twenty-four (24) inches shall be carefully placed in layers approximately six (6) inches thick, each layer being thoroughly tamped and compacted by hand or pneumatic tamper in place. Special care shall be taken in using a mechanical tamper directly over the pipe.

Above this point, backfill shall be deposited in layer thicknesses which will permit compaction to a density of at least 95 percent of the maximum density at optimum moisture content as determined by the AASHTO standard Proctor test (AASHTO Designation T-99) under all proposed traffic areas. Backfill in existing traffic areas shall be in accordance with the Virginia Department of Transportation's standards.

(d) Compaction

Unless otherwise shown on the plans, the backfill in all trenches from two (2) feet above the top of the pipe to finish grade shall be deposited and thoroughly compacted in six (6) inch layers in traffic areas and twelve (12) inch layers in non-traffic areas. The compacting shall be done by suitable mechanical means. In all cases, special care shall be

taken to see that the spaces at the sides of the trench are thoroughly filled and compacted.

It shall be required that a minimum of one (1) compaction test will be conducted on trench backfill per 400 linear feet of sewer line. Compaction tests may be waived by the Authority on projects less than 400 linear feet in length. The contractor shall bear the expense of all compaction tests. The location of tests shall be selected in the field by the Authority and will not necessarily be limited to regular intervals.

The results of all compaction tests shall be submitted to the Authority for review and approval prior to acceptance of construction. The degree of compaction required for trenches in streets and paved areas is 95 percent of maximum density and for trenches in all other areas the required density shall be 90 percent of maximum density. If the tests indicate the required density has not been obtained, the contractor shall remove, replace and recompact the material to the specified density. Failure of any compaction tests may result in additional compaction tests being required.

(e) Protection of Pipe and Appurtenances

Backfilling shall be done in such a way as to prevent dropping of material directly on top of the pipe from more than a three (3) foot vertical distance. When placing material from a bucket it must be lowered so that the shock of the falling earth will not damage the sewer line or structure.

F. SANITARY SEWER PIPE, JOINTING AND ACCESSORIES

1. General Requirements

Unless otherwise approved in writing by the Authority all sanitary sewer lines shall be of the material herein listed. The Authority reserves the right to select the type and/or class material which shall be used from the following list:

(a) Ductile Iron Pipe & Fittings

Ductile iron pipe shall be centrifugally cast pipe manufactured in accordance with AWWA/ANSI C-151-91/A21.51-91, or current revision, Class 50, 51, or 52, as conditions require. All ductile iron pipe shall have a cement mortar lining in accordance with AWWA/ANSI C104-90/A21.4-90 or current revision. Ductile iron pipe shall be manufactured by Griffin Pipe Products Co., U.S. Pipe And Foundry Co., Atlantic States Cast Iron Pipe Co., or approved equal.

Fittings shall be standard mechanical joint fittings in accordance with AWWA/ANSI C-11093/A21.10-93, or current revision, and AWWA/ANSI C-111-90 (ANSI/A21.11-90), or current revision. All fittings shall be cement mortar lined inside in accordance with AWWA/ANSI C104-90/A21.4-90, or current revision. Cast iron or ductile iron fittings shall be manufactured by Griffin Pipe Products Co., U. S. Pipe And Foundry Co., or approved equal.

Pipe and fittings shall be coated inside and out with coal tar coatings.

No cast iron soil pipe shall be used as a public sewer.

(b) Concrete Pipe

Non-Pressure Sewer Pipe

Reinforced concrete sewer pipe shall be used only when sewer lines are twenty-four (24) inch in diameter or larger and shall be in conformance with ASTM designation C-76 or current revision, for Class II, Class III, Class IV or Class V with the exception that absorption shall be limited to five (5%) percent.

(c) Polyvinyl Chloride (PVC) Pipe

Non-Pressure Sewer Pipe

PVC gravity sewer pipe shall be manufactured of compounds conforming to ASTM D-1784-81, or current revision. Pipe and fittings shall meet and/or exceed all of the requirements of ASTM Specification D-3034-89 PSM SDR 35, or current revision, for heavy wall PVC as manufactured by Johns-Manville Corporation, Certainteed, or approved equal.

PVC pipe shall be installed in strict conformance with ASTM Designations D-2321-89 or current revision.

The maximum allowable joint length for PVC pipe is 13 feet.

PVC pipe shall be shipped and stored so that warping of pipe does not occur. PVC pipe to be stored outside should be covered to protect it against the sun's rays, per manufacturer's published recommendation.

Certificates of compliance with applicable ASTM designations and strength classifications covering the pipe, joints, gaskets, and fittings will be required directly from the pipe manufacturer as deemed necessary by the Authority.

2. Joints

Jointing of concrete, cast iron, ductile iron, and plastic pipe shall conform to the manufacturer's published recommendations and specifications.

Joints in sewer pipe shall conform to the following:

(a) Ductile Iron and Cast Iron Pipe

Gravity Sewers: Mechanical or push-on joints in accordance with AWWA/ANSI C-111-90/A21.11-90), or current revision.

Pressure Sewers: Mechanical, push-on, or flanged joints in accordance with AWWA/ANSI C-111-90/A21.11-90), or current revision, or approved rubber gasket type joint to lock against displacement.

(b) Concrete Pipe

Concrete pipe joints shall be made by the use of an "O" ring type round rubber gasket, ASTM C-443-79, or current revision. These gaskets will be furnished by the pipe manufacturer and installed in strict conformance with his published recommendations. The gasket shall be the sole element utilized in sealing the joint from either internal or external hydrostatic pressure.

(c) Polyvinyl Chloride Pipe

PVC pipe shall be joined by bell and spigot type connections. The pipe joint shall be tightly sealed against infiltration and exfiltration by means of a locked-in rubber sealing ring conforming to ASTM D-3212-89, or current revision. The connection shall also permit the thermal expansion or contraction of the pipe.

(d) Gaskets

Gaskets for sewer pipe and fittings shall be vulcanized natural or vulcanized synthetic rubber free of porous areas, foreign material or visible defects. Rubber gaskets shall conform to all applicable provisions of AWWA C111-90 or current revision.

Gaskets shall be protected from exposure to excessive heat, cold, direct sunlight, ozone (from electric motors and equipment), oil, grease, or other contaminants.

G. MANHOLES

1. General Requirements

All manholes on one project shall be constructed of the same materials. All concrete work shall be in accordance with the applicable sections of these specifications.

Sealing around all pipes entering manholes shall be done with a quick setting non-shrinking grout such as Blendcrete Patching Compound, as manufactured by Concrete Products Supply Co., or approved equal.

Height control rings may be used to adjust manhole tops to proper grade; however, a maximum of twelve (12) inches total of height control rings will be permitted.

2. Frames & Covers

(a) Materials

Manhole frames and covers shall be heavy duty, traffic resistant, gray cast iron. Frame and cover castings shall conform to the details and dimensions shown in these specifications and shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow-holes and other defects in positions affecting their strength and value for the use intended. They shall be boldly filleted on angles and the arises shall be sharp and perfect. They shall be sand blasted or otherwise cleaned or scaled so as to present a smooth, clean, and uniform surface.

Standard and watertight manhole covers shall have no pick holes. The marking "Sewer" must be cast in their body. Watertight manhole covers provided with bolts and gaskets shall be required in all low lying areas subject to flooding and as required by the Authority. Three (3) 5/8" anchor bolts shall be placed in the cone section to secure the manhole frame to the concrete on watertight cones. Standard manhole frames and covers shall be Super Cast, Inc. Model MH-RCR-2001, or approved equal. Watertight manhole frames and covers shall be Super Cast, Inc. Model MH-RCR-3000W, MH-RCR-3000SRW or approved equal. (See Part VII, Figures S-1-D and E, Pages TD-4 & TD-5).

(b) Frame & Cover Installations

Manhole frame and cover castings shall be installed so that the cover shall be exposed and flush with the existing street surface. In no case shall the existing pavement surface be raised or lowered to meet the grade of installed manhole frame and cover castings. If street surfaces are renewed or replaced by the developer or owner after the sewer system has been approved and accepted by the Authority, but while such streets are still the obligation of the developer or owner, the manhole frames and covers therein shall be readjusted to proper location relative to new street surfacing by the original developer or owner. Where frames and covers are located in off-street areas, they shall be placed flush with the finished grade. Where manholes are installed in sloped areas the finished grade of the slope shall intersect the top rim of the frame and cover on the uphill side.

The manhole frame shall be sealed to the concrete manhole section using a bed of mortar on either side of a butyl rubber sealant such as "Ramneck", or approved equal. The frame and cover shall be mortared to the outside of the concrete manhole section.

3. Pre-Cast Concrete Manholes

Pre-cast concrete manholes shall conform to the following specifications:

(a) General Information

Manholes shall be constructed of precast reinforced concrete manhole sections conforming to ASTM designation C-478-80, or current revision. Manholes will be required to have a flexible boot connection at the pipe entry to prevent infiltration. The flexible boot connections shall be cast in the manhole section such as the flexible manhole sleeve manufactured by Lock Joint Pipe, or approved equal. (See Part VII, Figure S-1-A, B, and C, Pages TD-1 through TD-3).

The minimum inside diameter of the manhole shall conform to the requirements of Section B.6, unless otherwise approved by the Authority.

The uppermost section of the manhole shall be tapered eccentrically and shall be a minimum of three (3) feet in height. Where field conditions dictate "flat top" manhole sections can be utilized with the approval of the Authority. The height of the lower section shall be at least three (3) times the inside diameter of the largest sewer pipe entering the section and in no case less than two (2) feet.

(b) Concrete

The walls of the manholes shall have a minimum thickness of five (5) inches and shall be constructed of reinforced concrete with a compressive strength of 3000 psi at 28 days. If the manhole bottom is not monolithically molded with the walls, a concrete floor slab shall be provided with a minimum thickness of twelve (12) inches and a minimum outside diameter of five feet, ten inches. The concrete shall have a minimum compressive strength of 3000 psi at 28 days. The manhole base slab, if cast in place as opposed to being furnished as a monolithic component of the precast manhole section, shall be reinforced with Style 6x6 - W5.5 welded wire fabric or equivalent area of reinforcing steel. The base slab, if cast in place, shall be poured so as to ensure a watertight seal at the joint formed by the base slab and riser section.

(c) Joints

The joints between manhole sections shall be tongue and groove with an "O" ring rubber gasket or "STEP" section with sliding flap seal ring as manufactured by Forsheda, or approved equal conforming to ASTM designation C-443-79 or latest revision. Jointing of the precast manhole sections shall conform to the manufacturer's published recommendations and specifications. A flexible joint sealant such as "Ramneck", or approved equal, may be required between precast manhole sections.

(d) Steps

Manhole steps shall be designed for installation in a sanitary sewer and shall be steel encapsulated in corrosion resistant rubber, Wedg-Lok type as manufactured by Delta Pipe Products, or M. A. Industries Model #PS1-PF, or approved equal, and shall be in accordance with OSHA standards and ASTM C-478-80 or current revision. Manhole steps shall be a minimum of ten (10) inches wide and shall project no less than five (5) nor more than seven (7) inches from the wall. Vertical spacing of manhole steps shall be uniform with a maximum of sixteen (16) inches and a minimum of twelve (12) inches.

(e) Inverts

All flow lines shall be constructed through manholes to a minimum of three-fourths (3/4) the depth of the contributing sewer. Inverts shall be true to line and grade with flow lines having a minimum drop of .2 feet and a maximum drop of 1 foot from inlet to outlet. Sides of flow lines shall be built up with low slump concrete or with masonry and plastered with mortar to provide a smooth channel and prevent solids deposition. Manhole benches shall be sloped to drain to flow lines.

4. Connection to Existing Manholes

Whenever connections are to be made to an existing manhole, care shall be taken to prevent debris from entering the sewer line. Flow into existing manholes will not be permitted until all "upstream" sewer lines have been tested, approved and thoroughly cleaned of all debris.

Pipe connections to existing manholes shall be made with flexible boot connections. Existing manholes not provided with flexible boot connections already cast in place, shall be field cored and have boots installed such as the PS-10, Press Wedge II, or PSX manufactured by Press Seal Gasket Corporation or approved equal. Drop connections shall be made in accordance with the detail in Part VII, Figure S-1-C, Page TD-3.

H. ACCEPTABLE TESTS

1. General Requirements

All sanitary sewer lines and manholes shall be subjected to the applicable tests described in this section. All labor and equipment for such tests shall be furnished by the contractor. In the event that leakage exceeds the stated allowance in any section tested, the developer or owner shall cause such repairs to be made to the line, manholes or appurtenances as may be necessary to comply with the specifications, to the satisfaction of the Authority. 48 hours notice is required prior to undertaking any tests.

2. Gravity Sewers

(a) Alignment

A light will be flashed between manholes by means of a flashlight or reflection of sunlight with a mirror or by other methods as may be adopted by the Authority. If the illuminated interior to the pipe shows poor alignment, displaced pipe, blockage or other defects, the defects shall be corrected so as to meet all standards governing the construction of sewer mains. All costs involved shall be born by the contractor.

(b) Deflection

All PVC gravity sewer lines shall be subject to vertical deflection testing as deemed necessary by the Authority. The maximum allowable deflection following completion of backfill shall not exceed five percent (5%) of the pipe's internal diameter. Deflection testing shall be conducted using a properly sized Go-No-Go Mandrell or by other methods as may be adopted by the Authority. Any sewer sections failing to meet deflection requirements shall, at the contractor's expense, be corrected so as to meet all standards governing the construction of sewer mains.

(c) Testing

1. Infiltration

Infiltration tests will be allowed when a contractor can demonstrate to the satisfaction of the Authority that the ground water table is a minimum of four (4) feet above the crown of the sewer pipe throughout the full length of the segment to be tested. Measurements shall be made using an in-line weir gauge or other method as may be approved by the Authority. A series of three measurements shall be made at not less than one hour intervals, and the results shall be reduced to an average. All such tests shall be made only under the supervision of the Authority at the expense of the contractor.

State highway restrictions may limit the use of infiltration testing in streets or future street areas. Approval of infiltration tests shall be obtained from the Authority before testing by the contractor.

The leakage allowed into the sewer shall not exceed a rate of one hundred (100) gallons per inch of diameter per day per mile for any section between successive manholes for sewers up to twenty-four (24) inches in diameter. For sewers larger than twenty-four (24) inches, leakage shall not exceed 3000 gallons per mile per day.

2. Exfiltration

The contractor shall conduct leakage tests of the completed sewers at his expense and only under the supervision of the Authority. Exfiltration testing of the lines shall be conducted between successive manholes by plugging the inlet to the lower manhole, using a plumber's expansion plug, and by plugging the outlet sewer pipe in the upper manhole using a plumber's expansion plug with a two (2) inch fill pipe through the middle. The two (2) inch fill pipe through the plumber's expansion plug shall have an ell installed in a turned up position into which a two (2) inch threaded riser pipe shall be screwed in place to form a filler pipe. Positive means shall be provided for releasing entrapped air in the sewer pipe prior to taking measurements. As an alternate, the inlet pipe or pipes to the upper manhole may be plugged and the manhole then used as a means of filling the section of pipe to be tested. Exfiltration shall be determined by measuring the amount of water added to keep the standpipe or manhole, as the case may be, filled to a depth of four feet above the barrel of the pipe.

Leakage shall not exceed one hundred (100) gallons per inch of diameter per day per mile for sewers up to twenty-four (24) inches in diameter. For exfiltration tests of sewers larger than twenty-four (24) inches in diameter the leakage shall not exceed 3000 gallons per mile per day. An allowance of an additional ten percent (10%) of gallonage shall be permitted for each additional two (2) foot head over a basic four (4) foot minimum internal head.

The contractor shall conduct either infiltration or exfiltration tests as directed by the Authority and in all cases such tests and allowable quantities for infiltration and exfiltration shall be in strict accordance with the applicable sections of these specifications.

3. Low Pressure Air Test

In lieu of the water exfiltration test, a low pressure air test may be employed under the supervision of the Authority. The testing equipment, procedure, and results will all be subject to the strict approval of the Authority. Results of the air test will be reviewed for compliance with ASTM designation C-828-80, or current revision.

The air test is to be conducted between two (2) consecutive manholes. The test equipment shall consist of two (2) plugs (one tapped and equipped for air inlet connection), a shut-off valve, a pressure regulating valve, a pressure reduction valve, and a monitoring pressure gauge having a pressure range from 0 to 5 psi, graduated in 0.10 psi with an accuracy of +.04 psi. The test equipment shall be set up outside the manhole for easy access and reading.

Air shall be supplied to the equipment slowly and shall be regulated to prevent the pressure inside the pipe from exceeding 5.0 psig. The pipeline shall be filled until a constant internal pressure of 3.5 psig is maintained. The internal pressure shall be maintained at 3.5 psig or slightly above for a five (5) minute stabilization period, after which time the internal pressure will be adjusted to 3.5 psig, the air supply shut off and the test begun. No person shall remain in the manhole while the pipe is being pressurized or throughout the test for safety reasons.

A pressure drop of 1.0 psi from 3.5 to 2.5 psig shall be allowed for the test times specified in the following table, based upon the designated pipe size and test segment length.

AIR TEST TABLE

BASED ON EQUATIONS FROM ASTM C-828-80

SPECIFICATIONS TIME (MIN:SEC) REQUIRED FOR

PRESSURE DROP

FROM 3.5 TO 2.5 PSIG

WHEN TESTING ONE PIPE DIAMETER ONLY

PIPE DIAMETER, INCHES

TEST LENGTH FEET	<u>4</u>	<u>6</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>15</u>	<u>18</u>
25	0:04	0:10	0:18	0:28	0:40	1:02	1:29
50	0:09	0:20	0:35	0:55	1:19	2:04	2:58
75	0:13	0:30	0:53	1:23	1:59	3:06	4:27
100	0:18	0:40	1:10	1:50	2:38	4:08	5:56
125	0:22	0:50	1:28	2:18	3:18	5:09	7:26
150	0:26	0:59	1:46	2:45	3:58	6:11	8:30
175	0:31	1:09	2:03	3:13	4:37	7:05	
200	0:35	1:19	2:21	3:40	5:17		
225	0:40	1:29	2:38	4:08	5:40		
250	0:44	1:39	2:56	4:35			8:31
275	0:48	1:49	3:14	4:43			9:21
300	0:53	1:59	3:31				10:21
350	1:02	2:19	3:47			8:16	11:54
400	1:10	2:38			6:03	9:27	13:36
450	1:19	2:50			6:48	10:38	15:19
500	1:28			5:14	7:34	11:49	17:01

Should the 1.0 psi drop occur in less time than that specified in the table the sewer segment shall have failed. If the time required for the pressure to drop 1.0 psi is greater than that shown in the table, the sewer segment shall have passed. For a more detailed description of the air test method refer to ASTM designation C-828-80, or current revision.

An air pressure correction shall be required when the prevailing ground water is above the sewer line being tested and shall be calculated as follows:

Ground Water Depth (ft.) + 3.5 = Starting Test Pressure 2.31

Ending Test Pressure = Starting Pressure - 1.0 psi

There is no change from time requirements established for the basic air test.

3. Manhole Testing

(a) General

Manholes shall be tested by exfiltration or vacuum. Where water exfiltration tests are performed on the sewer line, the manholes may be included in these tests in lieu of the independent manhole testing procedures outlined below.

(b) Exfiltration

If the water exfiltration test is to be used, the manholes shall be filled with water to the top, by the contractor, unless otherwise directed by the Authority. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested. The stoppers shall be positioned in the lines far enough from the manhole to assure testing of those portions of the lines not otherwise tested. Once the manhole has been filled with water to the top, a twelve (12) hour soak shall be required prior to testing. Leakage during a one-hour test shall not exceed one half gallon.

(c) Vacuum Testing

Manholes may be tested by vacuum testing only if constructed of precast concrete. Testing shall include the joint between the concrete cone section and the manhole frame, unless otherwise directed by the Authority. Stub-outs, boots, and pipe plugs shall be secured to prevent movement while the vacuum is being drawn.

Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications for which performance information has been provided by the manufacturer and approved by the VDH.

A measured vacuum of 10 inches of mercury shall be established in the manhole. The time for the vacuum to drop to 9 inches of mercury shall be recorded. Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 inches to 9 inches of mercury. The maximum allowable leakage rate shall be in accordance with the following:

<u>Manhole Size</u>	<u>Depth</u>	<u>Minimum Time for a 1" HG Pressure Change</u>
4 ft. diameter	Less than 10 ft.	60 sec.
4 ft. diameter	Greater than 10 ft. Less than 15 ft.	75
4 ft. diameter	Greater than 15 ft. Less than 25 ft.	90
5 ft. diameter	Less than 10 ft.	75
5 ft. diameter	Greater than 10 ft. Less than 15.	90

5 ft. diameter	Greater than 15 ft. Less than 25	105
6 ft. diameter	Less than 10 ft.	90
6 ft. diameter	Greater than 10 ft. Less than 15 ft.	105
6 ft. diameter	Greater than 15 ft. Less than 25 ft.	120

Manholes greater than 25 feet in depth shall be reviewed and testing requirements established on a case-by-case basis.

If the manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test or the manhole shall be tested in accordance with the standard exfiltration test and rated accordingly. If a manhole joint mastic is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced. The test shall then be repeated as specified above.

4. Pressure Sewer

(a) Hydrostatic Pressure Test

All sewer force mains shall be tested at a hydrostatic pressure of 150 psi or fifty percent (50%) above the design operating pressure, whichever is greater, for at least one hour. Leakage shall not exceed the amount given by the following formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

Where L= allowable leakage in gph

D= diameter of pipe in inches

P= test pressure in psi

S= length of pipe tested in test

The method and equipment for conducting this test and specific pressure of the test shall be subject to the approval of the Authority.

5. Acceptance

Should deflection, infiltration, exfiltration, air test, vacuum test or pressure leakage limits be exceeded as specified above, the Authority reserves the right to reject all or any portion of the facilities. Any project or portion of a project rejected by the Authority or its authorized representative shall not be permitted to discharge into any previously approved system until the rejected system or portion of system has been repaired so as to meet all standards governing the construction of sewer mains. All repair methods, other than replacement of the defective area with new sound materials, shall be subject to prior approval of the Authority. Grouted, collared, clamped or otherwise patched-up gravity

or force main sewer pipe will not be acceptable.

Upon completion of such inspection or tests as required in these specifications, all foreign matter, including sand, rock, gravel, etc. shall be removed from all sewers and manholes before final approval is granted.