

SECTION 2 - DESIGN STANDARDS FOR GRAVITY SANITARY SEWERS

2.1 General Requirements.

2.1.01 Sanitary sewers are to be provided solely for the collection and transport of sanitary waste. Under no circumstances shall any roof drains, foundation drains, or surface or subsurface drains be either directly or indirectly connected to sanitary sewers. The following design parameters include an adequate allowance for normal infiltration but will not accommodate the above prohibited connections.

2.1.02 Sanitary sewer lines are to be designed to serve the entire sewer shed of which the subdivision or development is a part. This necessitates consideration of property beyond the development or subdivision in question. The developer is required to design and construct his system, properly sized and at an appropriate location, to permit future extensions to be made at the limits of the subdivision or development in question. Elevation of the sewer system must be designed such that future extensions can serve the entire area which naturally drains towards the system.

2.2. Technical Design.

2.2.01 System Layout

- A. The overall layout and general design shall conform to the parameters set forth in the approved Engineering Report (Form F-1). The System Layout Plan shall delineate sewer shed area boundaries. The map shall clearly define the areas pertinent to interim and ultimate development of the area proposed to be served. The System Layout Plan shall show existing utilities indicating those impacted by the proposed development and shall show both proposed and future utilities based on the Comprehensive Land Use Plan or current zoning, whichever is greater. Existing and proposed ground elevations shall be shown at contour intervals not exceeding 5 feet unless otherwise approved. Proposed utilities necessary to serve adjacent properties and associated easements shall be shown.
- B. Since all sanitary sewers must be accessible for operation and maintenance:
 - (1.) Locate all sanitary sewers in legally established road rights-of-way wherever possible.
 - (2.) Where public sewers must be located on private property, the sewer shall be installed in existing or proposed permanent easements that are legally established for such purpose.
 - (3.) Sewers shall be located outside of jurisdictional wetland areas whenever possible.
 - (4.) A Stormwater BMP shall not encroach on the sanitary sewer.

- C. Construction shall be along the center line of rights-of-way or easements except when this location has been previously used by another utility, or when the width of a road right-of-way justifies the use of two sewer lines. Exception to this specified location will be allowed only when it can be established that it is not practical to adhere to the standard location.
- D. All sewers shall be on continuous grade between manholes.
- E. Where sewer depth is 10 feet or less, sewer mains and manholes shall be located a minimum of 10 feet horizontally from any part of a building, structure, or its foundation. Where the depth of sewer is greater than 10 feet, the sewer mains and manholes shall be located a minimum of 15 feet from any part of a building, structure, or its foundation.

2.2.02 System Design

- A. The overall design shall be in accordance with the provisions of the approved Engineering Report.
- B. An analysis shall be prepared that will tabulate the number of people served or proposed to be served as determined from the County Land Use Map or existing Zoning, whichever is greater. The tabulation shall be by incremental areas for evaluation purposes.
- C. Average and peak flows shall be developed for areas and sub-areas and tabulated in the report as deemed necessary or appropriate.
 - (1.) Where development is existing or proposed, average sewer flows within the sewer shed shall be calculated using actual (existing) or proposed population densities in accordance with the following table titled "Henrico Sewer Flow Rates", flow rates cited in the DEQ SCAT Regulations or other published data as appropriate.
 - (2.) For undeveloped acreage where no specific development has been proposed, flow rates from the following table should be used.

Henrico Sewer Flow Rates

Units	Use		Flow-rate	Reference	Comment
per acre	Rural Residential	RR	800 GPD/acre	Henrico Department Of Public Utilities Standards [2.2.02 C] Source: 2007 Henrico Wastewater Facilities Plan	Based on Henrico historical billing records, flow monitoring and pump station data.
	Suburban Residential 1	SR1	800 GPD/acre		
	Suburban Residential 2	SR2	1000 GPD/acre		
	Urban Residential	UR	1600 GPD/acre		
	Multi-family Residential	MFR	3000 GPD/acre		
	Suburban Mixed Use	SMX	2000 GPD/acre		
	Traditional Neighborhood	TND	2000 GPD/acre		
	Urban Mixed Use	UMU	7500 GPD/acre		
	Office	OF	1500 GPD/acre		
	Office/Service	O/S	500 GPD/acre		
	Commercial Arterial	CA	1500 GPD/acre		
	Commercial Concentration	CC	1500 GPD/acre		
	Planned Industrial	PI	2000 GPD/acre		
	Light Industrial	LI	1500 GPD/acre		
	Heavy Industrial	HI	300 GPD/acre		
	Open Space/Recreation	OS/R	100 GPD/acre		
Semi-Public	SP	600 GPD/acre			
Government	GOV	800 GPD/acre			
per unit	Single family Residential		300 GPD/unit		
	Multi-family Residential		300 GPD/unit		
per 1000 sqft	Office		175 GPD/1000 sqft	EPA Gravity Design Criteria [Collection Systems Technology Fact Sheet, Conventional Sewers, Table 1]; less 15% for difference btw gross sqft & net sqft	
	Commercial/Retail		250 GPD/1000 sqft	DEQ SCAT Regulations [9VAC25-790-460, Table 3]	"shopping centers: 200-300 gpd per 1000 sqft"
	Restaurant		1330 GPD/1000 sqft	DEQ SCAT Regulations [9VAC25-790-460, Table 3]	"restaurants: 50 gpd per seat" assumed: 4 seats per 100 sqft with 2/3 of the gross square footage attributed to seating

10/1/2008

- D. The design shall provide calculation of present and ultimate flows and demonstrate that capacity is provided in existing and proposed facilities. For existing facilities, the engineer shall provide an analysis of the downstream system to the extent determined by the Department to determine the adequacy of the system for existing and future flows.
- E. The design shall be based on ultimate development and shall present such factors as deemed necessary for a sound evaluation of the several factors used in development of the report.
- F. Where an alternate design is proposed that would incorporate interim or staged construction, the report shall develop the alternate design and shall present a thorough investigation and justification for consideration of the alternate.
- G. The design of carrying capacities of lateral, trunk, and interceptor sewers shall be based upon the total sewer shed area served by the line or lines in question. The design flow shall be based on acreage density, using these Standards and the DPU Water and Sewer Facilities Plan.
- H. Equivalent flows from motels, schools, hospitals, etc. shall be based upon the Virginia Department of Environmental Quality SCAT Regulations.
- I. In the absence of information on densities or equivalent flows, the designer shall supply sufficient information, substantiated by sound engineering judgment to verify the design. This information shall be subject to approval by the Department.

2.2.03 Capacity Design

- A. Sanitary sewers shall be designed with capacity to provide service for the ultimate tributary population using a 50 year growth projection as an upper limit.
- B. Proper allowance for peak flow, as shown on the Peak Flow Chart, Form F-2, shall be included.
- C. Computations of all lines shall be shown on a form similar to the sewer design form, Form F-4.
- D. Computations shall be accompanied by a System Layout Plan as specified in 2.2.01A.
 - (1.) The System Layout Plan shall be prepared for sewer line, sewage pumping station, sewage force main and water line projects. The scale shall be no smaller than 1 inch equals 600 feet. Show all proposed utility construction with ties to existing utilities.

- (2.) The System Layout Plan shall show entire the entire drainage area to be served with the location(s) of line(s) in the system and the points of entry of flows, including any flows being received from other areas. The plan shall be keyed to computation sheet (hydraulic analysis, Form F-4). Computations and maps shall be submitted to the Department for approval.

2.2.04 Hydraulic Design - Sewers

- A. Sewers shall be designed to give a mean velocity when flowing full of not less than two (2.0) feet per second. Pipe sizes shall not be arbitrarily increased in order to take advantage of a flatter grade.
- B. The minimum size pipe to be used in systems shall be eight (8) inches.
- C. Allowable minimum grades shall be as follows:

<u>Sewer Size (Inches)</u>	<u>Minimum Slope in Feet/100</u> <u>Feet</u>
8	0.40
10	0.32
12	0.24
14	0.20
15	0.16
16	0.16
18	0.16
21	0.10
24	0.08
27	0.07
30	0.06
33	0.06
36	0.05

- D. Computations for velocity of flows shall be based on the Manning formula, where "n" equals 0.013.
- E. In cases where the calculated depth of flow is less than pipe flowing full, the velocity at actual depth of flow shall be computed.
- F. For sewage flow depth less than 1/4 full, an allowance shall be made for increased value of "n" and in no case shall velocities of less than 1.3 feet per second be permitted. The improved velocities shall be accomplished by steeper grades and not by changing pipe diameter.

- G. Where velocities greater than 15 feet per second are expected, special provisions shall be made to protect against displacement by erosion and impact. The pipe shall conform to appropriate ASTM or AWWA specifications which provide protection against internal erosion.
- H. Sewers should intersect in manholes at deflection angles not greater than 90 degrees. The table on page 2-8 shows maximum deflection angles for various sizes of downstream and upstream pipes.
- (1.) Maximum deflection angle is determined using a minimum radius of 2 times the upstream sewer diameter for subcritical flow. If this condition can not be met, a larger diameter manhole will be required to achieve the minimum radius.
 - (2.) All PCs and PTs of connecting pipes shall be at the manhole sidewalls.
 - (3.) The designer must satisfy the Department that the minimum radius is satisfied and that adequate losses have been provided in the hydraulic analysis.
- I. Miscellaneous head losses at manholes shall be computed using the following formula:
- (1.) Manholes where radius of turn is greater than or equal to 2 pipe diameters:

$$H = 0.25 * (\text{angle}/90^\circ)^{-5} * (V^2/2g)$$

Where: angle is horizontal deflection angle
 $V^2 / 2g$ is velocity head of downstream pipe
 - (2.) Loss for straight run manhole shall be 0.05 feet. In no case shall loss less than 0.05 feet be allowed.
- J. Where pipe diameters increase at manholes, then the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation. The effluent (downstream) invert shall be lowered below the influent (upstream) elevation in addition to computed miscellaneous head loss as follows:
- Change equals $0.8 * (D_1 - D_2)$ in Feet and:
 D_1 equals downstream diameter
 D_2 equals upstream diameter
- K. Special consideration shall be given to cases where a hydraulic jump is produced within a manhole because of a change in sewage flow velocity from the upstream pipe to the downstream pipe. A hydraulic jump occurs when flow in the upstream pipe is supercritical and the flow in the downstream pipe is subcritical.
- (1.) As an approximation, a hydraulic jump can be assumed to occur if all of the following conditions are met:

- a. The diameter of the sewer entering and leaving the manhole is 24 inches or smaller;
 - b. The slope of the upstream pipe is 1.50 percent or greater;
 - c. The slope of the downstream pipe is less than 1.50 percent.
- (2.) Manholes with hydraulic jumps shall not have changes in direction between the upstream pipe and the downstream pipe unless the manhole is increased in size to allow a flow channel with a minimum radius of 4 times the upstream pipe diameter in order to allow the hydraulic jump to be contained within the channel.
 - (3.) Additional upstream pipes connecting to a manhole are identified as secondary sewers.
 - (4.) When secondary subcritical sewers discharge into manholes with hydraulic jumps, the invert elevation of the secondary sewer shall be above the peak water surface profile of the downstream sewer. This can be approximated by matching the invert of the secondary sewer to the crown of the downstream pipe. This ensures that they will be free flowing under all conditions.
 - (5.) When secondary supercritical sewers discharge into manholes with hydraulic jumps, the invert elevation of the secondary sewer shall have an invert elevation above the centerline elevation of the outlet sewer.

2.2.05 Structural Design and Location

- A. Structural requirements must be considered in the design of all sewers and appurtenances.
- B. The proper strengths shall be determined and indicated for sewer pipe materials being specified. Strength shall be based upon pipe size, proposed depth, width of trench, bedding conditions, existing ground conditions, etc. This is a matter of detail design not subject to simple generalizations. Minimum bedding shall be Class C.
- C. In deep cuts, it is generally preferable to change pipe strengths to obtain proper design rather than vary bedding conditions. However, pipe strength or class shall be shown on plans with stations to indicate the location.
- D. No change in pipe strength or material shall be made between manholes unless it can be substantiated that a considerable cost savings would result and the integrity of the system would not be jeopardized. Proper precautions shall be taken regarding correct location(s) of varying strength of pipe.
- E. The minimum manhole diameter shall be increased to 60-inches when the total depth equals or exceeds 24 feet.

MAXIMUM MH DEFLECTION ANGLES								
SUBCRITICAL FLOW								
RADIUS IS 2 TIMES DIAMETER OF U.S. PIPE								
48 INCH DIAMETER MANHOLE								
US PIPE DIA (IN)	8	10	12	15	16	18	21	24
DS PIPE DIA (IN)								
8	90							
10	90	90						
12	90	90	90					
15	90	90	90	90				
16	90	90	90	90	90			
18	90	90	90	90	90	70		
21	90	90	90	90	80	60	60	
24	90	90	90	90	80	60	60	50
60 INCH DIAMETER MANHOLE								
DS PIPE DIA (IN)								
10								
12								
15								
16					90			
18					90	80		
21					90	80	80	
24					90	80	80	70
SUPERCritical FLOW								
RADIUS IS 4 TIMES DIAMETER OF U.S. PIPE								
48 INCH DIAMETER MANHOLE								
US PIPE DIA (IN)	8	10	12	15	16	18	21	24
DS PIPE DIA (IN)								
8	73							
10	73	61						
12	72	60	52					
15	71	59	51	42				
16	71	59	51	41	39			
18	70	58	50	41	38	35		
21	70	57	49	40	37	35	30	
24	70	55	47	38	36	35	30	25
60 INCH DIAMETER MANHOLE								
DS PIPE DIA (IN)								
8	86							
10	86	73						
12	85	73	63					
15	84	72	62	52				
16	84	72	62	51	49			
18	84	71	62	51	48	43		
21	83	70	61	50	47	43	37	
24	81	70	60	49	47	42	36	32

- F. Gravity systems receiving pumped flows shall be protected against sulfide attack for a distance of 4000 feet downstream from point of pumped flow entry. This shall be accomplished by the use of acid-resistant pipe and manholes. The Department shall approve the materials and design for the conditions at each individual location.
- G. Ductile iron pipe shall be used where sewers enter or cross streams, estuaries, lakes or reservoirs; cross jurisdictional wetland areas; or as a carrier pipe within any bore or tunnel crossing.
- H. Ductile iron pipe shall be used in subdivisions for sanitary sewer lines installed in an easement along the property line between buildable areas.
- I. Ductile iron pipe shall be used in easements where, in the opinion of the Department, the sanitary sewer is not accessible from a street, parking lot, or driveway.
- J. Epoxy coated ductile iron pipe shall be used at the high point of force mains where an air / vacuum valve is required. The epoxy coated pipe shall be used a sufficient distance upstream and downstream of the air / vacuum valve to ensure that protection against hydrogen sulfide corrosion is provided.
- K. Anchor sewers on slopes of 20% or greater. Spacing of anchors will comply with requirements of DEQ SCAT Regulations.
- L. Steel casing pipe shall have minimum yield strength of 35,000 psi and a minimum internal diameter of 4 inches greater than the largest external diameter of the carrier pipe. The wall thickness of casing pipe shall be sufficient to resist loads to which it will be subjected, but in no case less than 0.250 inches. Standard installation detail shall be as shown in VDOT Road and Bridge Standards except that the leak detector pipe shall be eliminated. The thickness of the casing shall be as required by VDOT for State Roads and the DPW for County Roads. Requirements for railroads shall be as specified in a permit issued by the railroad.
- M. Minimum casing pipe sizes needed for nominal pipe diameters of ductile iron pipe are shown in the following chart.

CASING PIPE DIAMETER FOR BORED CROSSINGS	
Ductile Iron Pipe Required	
Carrier Pipe Diameter (in.)	Casing Diameter (in.)
6	16
8	18
12	24
16	30
24	36

- N. Electronic markers (ball type) shall be installed on all water mains, sewer gravity mains and sewer force mains in accordance with the following:
- (1.) Ball type electronic markers shall be passive type as manufactured by 3M or Omni and shall be rated and color coded for sewer.
 - (2.) Locations for electronic markers shall be as shown on Standard Drawings entitled Electronic Marker Placement Detail for Gravity Sewer (D-750) and Electronic Marker Placement Detail for Water Mains and Sewer Force Mains (D-740).
 - a. Minimum distance between markers shall be 6 feet. Markers shall be a minimum of 4 inches above the pipe. Markers shall have a maximum of 3 feet of cover.
 - b. When pipe joints are deflected, place markers at the pipe joint beginning and ending the deflection and at intermediate joints for every one foot (maximum) of deflection.
 - c. Locations for Markers shall be in accordance with the following:
 1. Service Tee at the main
 2. Casing ends
 3. Maximum 100 feet on metallic pipe and 50 feet for non-metallic pipe
 4. All points where sewer crosses over or under other utilities

2.2.06 Manholes

- A. Standard and drop manholes, service connections and other appurtenances shall be constructed in accordance with Standard Drawings.
- B. A flow channel shall be formed or shaped to the full height of the crown of the downstream (outlet) sewer in such a manner to not obstruct maintenance, inspection or flow in the sewers.
- C. Manholes shall be installed at the end of each line, at all grade, size, or alignment changes, and at all sewer line intersections.
- D. When manholes are located in paved areas accessible to vehicular traffic they shall

be spaced at distances no greater than 400 feet for sewer sizes up to 15 inches and 500 feet for sewer sizes 16 inch through 30 inch. When located in inaccessible areas, spacing of manholes on sewer lines 30 inch or less shall not exceed 350 feet.

- E. Spacing of up to 600 feet may be permitted in sewers larger than 30 inches.
- F. Vandal proof manhole frames and covers shall be used on all manholes not in paved streets unless watertight covers are required.
- G. Manholes shall not have stub-out sections of sewer pipe, nor bricked-up nor partially scored openings for future sewers. Manhole connections shall be in accordance with Paragraph 13.3.8 at the time the sewer is to be extended.

2.2.07 Sewer Appurtenances

- A. Sewer connections serving more than one building shall be made by construction of a manhole on the County sewer and an 8" sewer line terminating in another manhole at the uppermost building connection. Such construction shall be in accordance with County Standards.
- B. Sewer lines located in flood plains shall be protected from flooding by either raising the manhole tops above the 100 year flood elevation or by the use of watertight frames and covers. Where watertight frames and covers are used, unventilated length of sewer cannot exceed 1000 feet. Manhole covers shall be no more than 30 inches above ground level.
- C. Restaurants, bakeries and other facilities involved in preparation of food have the potential to discharge oil and grease to the sanitary sewer system. It is the discharger's responsibility to install and properly maintain such pretreatment system necessary to ensure that concentrations of oil and grease discharged to the sanitary sewer system do not exceed 300 parts per million (ppm) as required by Section 23-109 of the County Code.
- D. Oil/Water separators, where required, shall be shown on the plans. Separators shall comply with requirements of the Plumbing Code. A schematic of the oil/water separator shall be shown on the plans.
- E. A monitoring manhole shall be required on all new construction or renovations or modifications to existing facilities, where the discharge originating in the new, renovated, or modified facility is, or will have the potential to be, non-domestic in nature. All waste from the facility shall flow through the monitoring manhole.
 - (1.) For multi-use buildings such as shopping centers, the sewer should be an adequate distance from the building to allow installation of a monitoring manhole and grease traps on each sewer lateral when the tenant spaces are

- upgraded.
- (2.) For facilities with individual water meters, a sewer lateral and monitoring manhole is required for each meter. Enough space to accommodate installation of the monitoring manhole should be provided.
 - (3.) If the multi-use facility or building has a master water meter, a common monitoring plan is required for the entire facility. A monitoring manhole shall be provided.
- F. Where possible in easements not subject to regular mowing or landscape maintenance, manhole castings shall be approximately 12 inches above final grade.
- G. These standards apply to sewer laterals from the sewer main extending to the property line or to the edge of the permanent sewer easement. Sewer laterals for non-residential connections shall be a minimum of 6 inches. Sewer laterals for residential connections shall be a minimum of 4 inches. Connections shall be made at an angle of 90° to the main. Connections shall be installed at a minimum grade of ¼ inch per 1 foot. Connections shall be installed on the property to be served such that a horizontal distance of at least 10 feet is provided between the lateral and the common property line with any adjoining parcel unless otherwise shown on the plans.
- H. At the upstream manhole in a cul-de-sac, the maximum number of sewer connections allowed into the manhole is three (3).
- I. When the project requires new sewers to connect to existing sewers, field verify the invert elevations of the existing sewers using the appropriate vertical datum prior to designing the new sewers.

2.2.08 Depth of Sewers

- A. Generally, all sewers shall be at sufficient depth to provide service to the lowest sewer elevation of structure in question, allowing proper service connection grade. Minimum depth of cover over sewers shall be 5.5 feet in rights-of-way and 3.5 feet in easements; however, a greater depth may be required due to future extension or possible future lowering of existing road grade or utilities.
- B. The Engineer shall certify that sewer mains are designed such that all proposed sites will be served by gravity for sewer service connections installed at a slope of ¼ inch per 1 foot except where shown otherwise on the plans. The sewer mains are designed such that the depth of service connections shall be in accordance with Paragraph 13.3.7.D when installed at ¼ inch per foot.
- C. Exceptions to the above requirements will be considered only if it is impractical to provide required depths, in which case, special approval must be secured, in

writing, from the Department. In the special case of less than minimal cover, ductile iron pipe of adequate thickness shall be provided.

- D. Sewer pipe at depths greater than 18 feet deep shall be ductile iron. The depth shall be determined by measuring from the ground surface to the pipe invert.
- E. Sewer pipe at depths greater than 24 feet deep shall have a polyethylene or epoxy lining specifically designed to resist hydrogen sulfide corrosion. Manufacturer's data shall be submitted prior to plan approval.
- F. Sanitary sewers crossing under storm sewers shall maintain a minimum separation of 12 inches. Where this separation is not possible, ductile iron pipe shall be used. Concrete supports may be required for the storm sewer.
- G. If an aerial crossing is required, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the 50 year flood. Ductile iron pipe with mechanical joints shall be used. Detailed design shall be submitted to include location of piers, structural design of piers, and foundation requirements. Maximum distance between piers shall be based on pipe manufacturer's recommendations.

2.2.09 Separation of Water Lines and Sanitary and/or Combined Sewers

- A. Comply with Virginia Department of Health Waterworks Regulations for separation of water mains and sewer lines.
- B. Parallel Installation.
 - (1.) Normal Conditions - Water mains shall be laid at least 10 feet horizontally from a sanitary sewer or sewer manhole. The distance shall be measured edge-to-edge.
 - (2.) Unusual Conditions - When local conditions prevent a horizontal separation of 10 feet, the water main may be laid closer to a sewer or sewer manhole provided that:
 - a. The bottom (invert) of the water main shall be at least 18 inches above the top (crown) of the sewer.
 - b. Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe, pressure-tested in place without leakage prior to backfilling.
 - c. The sewer manhole shall be of watertight construction and tested in place.

C. Crossing.

- (1.) Normal Conditions - Water lines crossing sewers shall be laid to provide a separation of at least 18 inches between the bottom of the water line and the top of the sewer whenever possible.
- (2.) Unusual Conditions – When local conditions prevent a vertical separation as described in Paragraph C (1) of this section, the following construction shall be used:
 - a. Sewers passing over or under water mains shall be constructed of the materials described in Paragraph B.(2).b above; and
 - b. Water lines passing under sewers shall, in addition, be protected by providing:
 1. A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line.
 2. Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the water line; and
 3. That the length of the water line be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer.

D. No water pipes shall pass through or come in contact with any part of a sewer manhole.

2.2.10 Sewer in Relation to Streams, Estuaries, Lakes, or Reservoirs

A. Location of Sewer in Relation to Streams, Estuaries, Lakes, or Reservoirs.

- (1.) The tops of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, one foot of suitable cover shall be provided where the stream is located in rock, and three feet of suitable cover shall be provided in other material. Less cover will be considered if the proposed sewer crossing is encased in concrete and will not interfere with future improvements to the stream channel. Reasons for requesting less cover shall be given in the application. In paved channels, the top of the sewer lines should be placed below the bottom of channel pavement. Sewers shall remain fully operational during 25-year flood/wave action. Sewers and their appurtenances located along streams shall be protected against the normal range of high and low water conditions, including the 100-year flood/wave action. Sewers located along streams shall be located outside the stream bed wherever possible and sufficiently removed therefrom to provide for future possible channel widening. Reasons for requesting sewer lines to be located within stream beds shall be given in the application.

B. Sewer Crossings of Streams, Estuaries, Lakes, or Reservoirs.

- (1.) Sewers entering or crossing streams shall be constructed of watertight pipe. The pipe and joints shall be tested in place; shall exhibit zero infiltration; and shall be designed, constructed, and protected against anticipated hydraulic and physical, longitudinal, vertical and horizontal loads and erosion and impact. Sewers laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no other practical alternative exists. Such sewers on piers shall be constructed in accordance with the requirements for sewers entering or crossing under streams. Construction methods and materials of construction shall be such that sewers will remain watertight and free from change in alignment or grade.

2.2.11 Protection of Water Supplies

A. Water Supply Interconnections.

- (1.) There shall be no physical connection between a drinking water supply and a sewer, sewage pumping station, or appurtenances thereto.

B. Relation to Water Works Structures.

- (1.) No general statement can be made to cover all conditions; however, for public wells or other public water supply sources and structures, sewers shall meet the requirements of the Virginia Department of Health Waterworks Regulations with respect to minimum distances from water supply wells or other water supply sources and structures. For all other potable water supply wells or potable water supply sources and structures, sewers should meet the requirements of the Virginia Department of Health Waterworks Regulations with respect to minimum distances from water supply sources and structures. No sewer line shall pass within 50 feet of a potable water supply well or other potable water supply source or structure unless special construction and/or pipe materials are used to obtain adequate protection. The designer is referred to current editions of the Virginia Department of Health Waterworks Regulations, SCAT Regulations, and Sewage Handling and Disposal Regulations [Waterworks Regulations and the requirements contained in "Rules and Regulations of the Board of Health, Commonwealth of Virginia, Governing the Disposal of Sewage"] as basic design references. The proposed sewer design shall identify and adequately address the protection of all potable water supply structures within 100 feet of the proposed project.