

SECTION 2 - DESIGN STANDARDS FOR GRAVITY SANITARY SEWERS

2.1. General Requirements

Sanitary sewers are to be provided solely for the removal of sanitary waste. Under no circumstances shall any roof drains, foundation drains, 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 forbidden connections.

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.
- B. All sanitary sewers shall be located in:
 - (1) Legally established road rights-of-way.
 - (2) Legally established permanent easements for such purpose, either existing or as proposed by the designer in accord with 1.3. "Easement Requirements" of these Standards.
- 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 justified 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. Sewers should intersect in manholes at angles not greater than 90 degrees. In the event that this is impractical the designer must satisfy the Department that adequate losses have been provided in the hydraulic analysis.
- F. Sewer mains and manholes shall be a minimum of 10 feet horizontally from any part of a building or structure.
- G. Sewers shall not be located within 50 feet of an existing well.

2.2.02 System Design

- A. The overall design shall be in accordance with the provisions of the approved

Engineering Report in accordance with 1.1.02 "Engineering Report" of these Standards.

- (1) Design carrying capacities of lateral, trunk and interceptor sewers shall be based upon the total drainage area served by the line or lines in question. The design flow shall be based on acreage density, using the County's Land Use Plan, Planned Water or Sewer Service Area Maps, and/or approved zoning, whichever allows higher densities.
- (2) Equivalent flows from specific institutional entities (motels, schools, hospitals, etc.), shall be based upon that of the Commonwealth of Virginia "Sewerage Regulations".
- (3) In the absence of information on densities or equivalent flow, the designer shall supply sufficient information, substantiated by sound engineering judgement to verify the design. This information shall be subject to approval by the Department.

2.2.03 Capacity Design

- A. Laterals shall be designed to carry ultimate tributary population with a 50 year projection as an upper limit. Design flow shall be determined by using the peaking formula as follows: [For 0-20 mgd, $Q_p = 3.5 Q_a^{0.807}$ and for 20-50 mgd, $Q_p = 2Q_a$].
- B. Trunks and interceptors shall be designed on the same basis as laterals except in cases where capacities of the system or parts thereof can be readily increased by future parallel relief lines, allowing for shorter capacity design life of initial or subsequent lines. The Engineer shall supply justification in the Engineering Report to justify lines designed under this exception subject to Department approval.
- C. Computations of all lines shall be shown on form similar to the sewer design form in Section 6 – Standard Forms and Notes, Form F-1, including anticipated future relief lines that may be required.
 - (1) Computations shall be accompanied by a Drainage Area Map, conforming basically to requirements of Index Map, 1.2.02 C. Map(s) shall show entire drainage area involved, location(s) of line(s) in system and points of entry of flows, including any flows being received from other areas. Drainage Area Map shall be keyed to computation sheet (hydraulic analysis, Form F-1). Computations and maps shall be submitted to the Department for approval.

2.2.04 Hydraulic Design - Sewers

- A. Minimum grades shall not be less than those required to produce a velocity of approximately two and one quarter (2.25) feet per second when the sewer size selected is flowing full or half full. Under no circumstances shall pipe sizes 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:

Sewer Size (Inches)	Minimum Slope in Feet/100 Feet
8	0.40
10	0.32
12	0.24
14	0.20
15	0.16
16	0.16
18	0.12
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 upon the following values of "N" as used in the Kutter or Manning formula for velocity of flow.

(1) Sizes 8 inch through 21 inch: N equals 0.013

(2) Sizes 24 inch and above: N equals 0.012

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. Generally the sizes of pipe shall be continually increasing with increase of tributary areas. However, when steep grades are available and length is such that a significant cost savings will result without jeopardizing the system, the size of pipe may be reduced a maximum of two (2) normal diameters, but not below twelve (12) inches. Proper hydraulic allowances must be made for resulting head losses.

H. Miscellaneous head losses at manholes and curves shall be computed as follows. (Junctions of three (3) pipes will require special consideration.)

(1) Manholes where radius of turn is less than 2 pipe diameters:

$$H = .50 (\text{angle} / 90^\circ)^5 (V^2/2g)$$

- (2) Manholes where radius of turn is greater than 2 pipe diameters:

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

Where: angle is horizontal deflection angle
 $\frac{V^2}{2g}$ is velocity head of effluent pipe

- (3) Loss for straight run manhole shall be 0.05 feet. In no case shall loss less than 0.05 feet be allowed.

- I. Where pipe diameters increase at manholes, in direction of flow, the influent and effluent crowns shall match elevations.
- J. Special consideration shall be given to cases where pipe diameters decrease in direction of flow.
- K. Where velocities greater than 15 feet per second are expected, special provisions shall be made to protect against internal erosion by high velocity. The pipe shall conform to appropriate ASTM or AWWA specifications, which provide protection against internal erosion.

2.2.05 Structural Design

- 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.
- E. The thickness of precast concrete manhole walls shall be increased when total depth of manhole exceeds thirty (30) feet. The minimum manhole diameter shall be increased to 60" when the total depth exceeds 18 feet.
- F. Gravity systems receiving pumped flows shall be protected against sulfide attack for a distance of 1200 feet downstream from point of pumped flow entry.
- (1) 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 for all streams, or estuary crossings, or any crossing in fill material.
- H. Anchor sewers on slopes of 20 percent or greater with concrete anchors or equal. The following minimum requirements shall be used:
 - (1) Not over 36 feet center to center on grades 20 percent and up to 35 percent;
 - (2) Not over 24 feet center to center on grades 35 percent and up to 50 percent;
 - (3) Not over 16 feet center to center on grades 50 percent and over.
- I. Steel casing pipe shall be sized in accordance with Paragraph 3.2.01S.
- J. When velocity of the sewage will exceed 15 feet per second, special protection will be afforded to the pipe to prevent internal erosion. Erosion protection measures must be in accordance with ASTM, AWWA, ANSI, or other appropriate standards.

2.2.06 Sewer Appurtenances

- A. Standard and drop manholes, service connections and other appurtenances shall be constructed in accordance with Standard Drawings.
- B. Manholes shall be installed at the end of each line, at all grades, size or alignment changes, and at all sewer line intersections.
- C. 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 Department Standards.
- 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 and less shall not exceed 350 feet.
- E. Greater spacing than above may be permitted in sewers larger than 30 inches of up to 600 feet.
- F. Sewer lines shall be protected from a 100 year flood by either raising manhole tops above flood plain 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.

- G. Vandal proof manhole frames and covers shall be used on all manholes not in paved streets unless watertight covers are required.
- H. All new food preparation facilities, such as restaurants and bakeries, shall be required to construct an outside grease trap for the retention of grease, fats, and oils generated by that business. The design of the grease trap shall be approved by the County. The grease trap shall be operated and maintained properly by the discharger.
- I. Oil/Water Separators shall be evaluated on a case-by-case situation and shall meet the requirements of the most recent version of the International Plumbing Code.
- J. 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.
- K. Where possible in unpaved areas, manhole castings shall be placed to final grade.
- L. Sewer laterals shall be a minimum of 6-inches. Connections shall be made at an angle of 90° to the main.
- M. Sanitary sewer laterals shall be laid above storm sewers unless it can be demonstrated that no practical alternative exists. Where laterals must cross under storm sewers they shall be constructed of Special Class 52 restrained joint DI pipe and shall have minimum clearance under the storm sewer of no less than 1'.
- N. All sewer laterals shall have a clean out box installed to final grade at the property line. See detail 471 and 472

2.2.07 Depth of Sewers

- A. Generally, all sewers shall be of sufficient depth to provide service to lowest sewer elevation of structure in question, allowing proper service connection grade. However, a greater depth may be required due to future extension or possible future lowering of existing road grade or utilities. Minimum depth of cover over sewers shall be 5.5 feet in rights-of-way and 3.5 feet in easements exceptions may be made for crossing under cul-de-sacs, ditchlines or other draws in subdivisions, or other areas where less depth will not adversely affect structural integrity or possible future extensions of the sewer line. Sewers crossing under ditches or other sharply defined draws should be designed to maintain 3.0' of cover. In no case shall any portion of a sewer line have less than 2.0' of cover when crossing under a ditch and the line shall be constructed of CI52 DI pipe. In no case shall any sewer in right of way or easements be less than 3.5' of cover except as otherwise provided in this paragraph.
- B. Where a roadside ditch is used instead of curb and gutter, the engineer shall profile

each sewer service connection from the sewer main in the street to the property line being served and must show the service connection material, grade and cover at the ditch line.

- C. Exceptions to the above requirements will be considered only if impractical to provide required depths, in which case, special approval must be secured, in writing, from the County. In the special case of less than minimal cover, ductile iron pipe of adequate thickness shall be provided.
- D. Sewers over 18 feet deep shall be of Class 52 ductile iron.
- E. Sewers over 24 feet deep shall be polylined ductile iron with a minimum film thickness of 4.0 mil minimum.
- F. Sewers over 30 feet deep shall be evaluated on a case-by-case basis. Generally, sewers shall not exceed 30 feet in depth.
- G. Sanitary sewer lines crossing under storm sewers shall have a minimum clearance of 36” when the sanitary sewer is constructed of PVC. Lesser clearances are permitted if the sanitary sewer is constructed of CL 52 restrained DI but in no case shall be closer than 18” unless it can be demonstrated that there is no feasible alternative and additional measures to protect the sanitary sewer acceptable to the Department are installed.
- H. Sanitary sewer lines crossing over storm sewer shall have a minimum clearance of 18” when the sanitary sewer is constructed of PVC. Lesser clearances are permitted if the sanitary sewer is constructed of CL 52 restrained DI but in no case shall be closer than 12” unless it can be demonstrated that there is no feasible alternative and additional measures to protect the sanitary sewer acceptable to the Department are installed.

2.3. Drawings

2.3.01 In addition to requirements in Section 1.2. "Drawing Organization and Format" of these Standards, drawings shall also have:

- A. Stationing, pipe size, material, bearings, direction of flow, deflection angles, grade and distance between center lines of manholes.
- B. All manholes numbered, with drop manholes identified and top, influent and effluent elevations clearly shown.
- C. The plans shall indicate the following information to provide for service to elevation of the connection as follows:

- (1) Lowest sewer structure elevation.
 - (2) Low ground corner of structure with first floor service only.
 - (3) Ground level at building line on unoccupied parcel.
 - (4) The elevation and location of any existing structure to be sewerred shall be clearly shown.
- D. If in conjunction with water project, water mains shall be shown and profiles shall indicate points where crossings occur, clearly indicating vertical clearance between utilities.
- E. Consultants shall show the location of erosion control devices on the plans. These devices shall be in conformance with the Virginia County Erosion and Sedimentation Control Handbook. Consultants shall include approved erosion control details from the County.
- F. Any other pertinent details.
- (1) Consultants designing facilities for developers shall show the appropriate Sewer and Water Notes on the drawings (see Section 6 – Standard Forms and Notes, F-3).

END OF SECTION