CHAPTER VII

SANITARY SEWERS

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ANNE ARUNDEL COUNTY DESIGN MANUAL

CHAPTER VII

SANITARY SEWERS

I. GENERAL

A. Introduction

This Chapter of the Manual outlines the design of house connections, collector sewers, interceptor sewers, grinder pumps, pressure sewer systems, STEP systems, pumping stations, and siphons. Water Reclamation Facilities are generally capital projects for which design criteria will be established by the Department of Public Works.

The Anne Arundel County sewerage system consists of house and building service connections, collector sewers, interceptor sewers, siphons, pumping stations, force mains, and Water Reclamation Facilities.

B. Ownership and Responsibility

Generally, all of the above-named sewerage facilities, which lie within County rights-of-way, are owned and maintained by the County. Beyond the public rights-of-way all sewers are normally owned and maintained privately. In the case of privately owned sewers, a permit is required for connection to the County system. Such facilities are required to be in conformance with all County standards for issuance of a connection permit.

C. Definitions

The following definitions will apply:

Collector sewer: A sanitary sewer constructed within public rights-of-way, which transport sewage to an interceptor sanitary sewer. Collector sewer shall start and end with a structure.

Interceptor sewer: A sanitary sewer designed to collect sewage from several developments or geographic areas and transport the sewage to a Water Reclamation Facility.

House or building connection (SHC): A sanitary sewer, which connects a house or other building to a collector sanitary sewer, grinder pump or STEP system. The portion within the public right-of-way is owned and maintained by the County. The portion beyond the right-of-way is owned and maintained by the property owner.

Long Connection: A long connection is a special house or building connection (SHC) that is 75 feet or less in length within the public right-of-way/easement.

Inverted siphon: A short section of sanitary sewer, which, due to an obstruction such as a stream, is installed below the hydraulic grade line and, therefore, operates under pressure.

Force main: A pressurized sanitary sewer, which conveys sewage from a pumping station to a higher elevation in the sewer from which gravity flow may resume.

STEP System: A septic tank effluent collection system; replaces drain field and ties into collection system.

II. DESIGN CRITERIA

A. General Requirements

For the design professional's guidance, below are listed major elements constituting the Schematic, Development and Construction Documents design phases of a Sanitary Sewer Design Project:

1. Schematic Design Phase

The Schematic Design Phase shall include the verification of the facility plan or any preliminary reports supplied by the County, addressing of alternative solutions to the design problem including present worth cost or life cycle cost comparisons, graphic display of recommended alternatives on design scale drawing, including necessary existing facilities/features to define limit of the project and potential interference/problems.

It will also include the description of design criteria to be utilized; preliminary flow computations, hydraulic analysis and design calculations, identification of right-of-way requirements, and number of property owners involved, listing of permit requirements, and cost estimate based on unit costs for major elements of work.

In addition, the following will be provided:

a. Area to be served (future extension if any);

b. Drainage area and subdrainage areas;

c. Existing utilities - BGE, Comcast, Verizon, County and other Owners;

d. Proposed pipeline routes - the design professional shall locate utilities in accordance with normal utility locations as shown on Standard Reference Drawing Nos. G-8 and G-9 in Appendix B of Chapter I, GENERAL INSTRUCTIONS;

e. Properties to be served.

All information and data developed during the Schematic Design Phase shall be presented to the DPW in the Schematic Design Report.

2. Design Development Stage

Sanitary sewer utility plan is to be based on approved Schematic Design and in such detail as to fully present project and its operation, and permit evaluation of operation and/or construction problems. Design is to be presented in Standard Anne Arundel County Department of Public Works format.

Design shall include, but not necessarily be limited to the following:

a. Pipe size;

b. Plan location;

c. Profile, with all elevations;

d. House floor/basement elevations;

e. Type of service (e.g. basement or first floor);

f. Property data (lot dimensions, all sides of affected properties, account number, owner);

g. Rights-of-way, ready to use by Right-of-way Division;

h. Outline specifications, including indication of material selection and pipe manufacturers' design requirements;

i. Cost estimate, proposed bid format, and Assessment Analysis format.

Reference drawings for concrete and Romar STEP and gravity septic tank installations and reference drawings for grinder pump installations are available from the County DPW. These reference drawings provide the design professional with the minimum notes, details and drawing layouts which the DPW requires on design drawings for septic tank and grinder pump installations.

3. Construction Documents Phase

Based on the approved definitive designs, complete construction documents, ready for advertising, with cost estimate in bid format.

B. Pre-Design Meeting

Prior to commencing any design work on a Capital Project, a pre-design meeting shall be held as provided in Chapter I, General Instructions. For Developer Projects, a pre-sketch meeting may be held at the request of the developer. These meetings will discuss, at a minimum, the following design parameters pertinent to this Chapter, in addition to items, which pertain to any other Chapters, which will govern the design of the project:

- Facility plan or preliminary report supplied by County, if applicable
- Limit of project and future extension, if planned
- Alternative design problems
- Potential problems or limiting factors affecting design
- Design criteria to be used
- Field condition affecting design flow determination in existing or future developments
- Design constraints due to existing utilities
- Site environmental concerns
- Soil condition that may affect infiltration and inflow in sewer pipes and appurtenances, pipe material (corrosion) etc.
- Special topographic conditions affecting design as slopes, streams, floodplain, etc., requiring special design of basement/first floor sewer service, stream crossing, water-tight manholes
- Problems pertaining to pumping station siting
- Special easements requirements
- Special rights-of-way requirements
- Special traffic condition affecting traffic maintenance and control

C. Determination of Design Flows

1. Collector Sewers

a. Design Period: Major components (i.e. pumping stations, force mains, interceptors) of the sewage delivery system shall ordinarily be designed to provide for the projected population at least 15 years from the time the facilities

are placed in operation. Collective sewage systems shall be designed for ultimate buildout of contiguous properties. Whenever cost-effectiveness permits, the construction may be programmed in stages to accommodate the needs.

b. Existing Development: In developed areas, the basis for flowrate projection shall be the actual number of single-family homes, apartment units, various types of businesses, etc., present in the drainage area as determined by field count. An allowance shall be made for undeveloped lots of adjacent land use and for undeveloped areas as described in paragraph 1.c. Unless field investigations indicate a different number, sewage flowrate shall be assumed at 250 gallons per day (gpd) in each dwelling unit. This is the County's Equivalent Dwelling Unit (EDU). If there is strong evidence from field investigations that there is significantly less or more than 250 gpd in each dwelling unit in the drainage area and that this condition will persist throughout the design period, the DPW will consider using a smaller or larger number for design.

c. Future Development: In small-undeveloped areas, the basis for wastewater flow projection shall be the maximum number of residential units per acre according to current zoning regulations. This applies to residential or mixed residential/commercial zones. It shall assume that the wastewater flowrate for each dwelling unit shall be 250 gpd. In the case of small undeveloped portions of commercial or industrial zones, design flowrates shall be based on the land use consistent with current zoning regulations, which would provide the most likely maximum sewage flow.

   In large, undeveloped or partially developed areas, the average daily flowrate shall be derived from Appendix C for residential properties and Appendix D for commercial, industrial and institutional properties based on zoning classification.

   In general, during the development of design flowrates, consideration shall be given to combining design facilities with those required for adjacent proposed developments wherever possible, thus minimizing the number of pumping stations and other appurtenances for a given area.

d. Average Daily Flow: The average daily flowrate for collector sanitary sewers is based on the population and land use inventories and projections described above. The flow from each existing business or institution shall be based on the EDU online calculator when the number of persons using the facility or the gross area of the facility can be determined. The average daily flowrate shall be the sum of the flows projected for the existing or ultimate land use of each lot or parcel in the drainage basin. In the case of largely undeveloped drainage basins, the average daily flow shall be based on Appendices C and D as described in Section II.C.1.c.

Average daily flowrates given in the appendices for industrial facilities are for domestic type discharges only. Flowrates generated by industrial process must be determined on a case-by-case basis.

e. Peak Flow: Peak domestic flowrate is the average daily domestic flow peaked in accordance with the Peak Flow Curves in Appendix F.

Peak commercial or industrial flowrate is the average daily commercial or industrial flow peaked in accordance with a factor determined by evaluation of historical data for the commercial or industrial facilities and the periods in which these flows are projected to be generated. If historic peaking data for these facilities is unavailable, the average daily domestic flowrate, average daily commercial flowrate, and average daily industrial flowrate may be combined and then peaked using the curve (Appendix F).

If it can be established that the peak of the industrial waste flow (and other non-domestic flows) does not occur during peak domestic flow, a percentage (based upon engineer's field observation and judgment) of the peak industrial wastewater flow (and other non-domestic wastewater flow) shall be added.

f. Infiltration and Inflow: In areas where a sanitary sewer is being designed to replace an existing sewer with existing SHC's a minimum infiltration rate of 400 gallons/acre of drainage basin per day shall be used. A higher rate of infiltration may be justified if there is evidence of poor soil conditions, high groundwater table, or deteriorated SHC's.

In areas where the sanitary sewer will serve future development, the infiltration rate should be determined on a case-by-case basis. Factors affecting this determination include the proposed sewer elevation relative to the normal groundwater elevation and the soil types present. The infiltration rate for design of new sanitary sewers shall be 100 gpd/in-dia/mile, unless supporting data indicates the appropriateness of a high infiltration rate.

New clear water connections to sanitary sewers are strictly prohibited, and allowance for storm water inflow shall not be made.

g. Design Hydraulic Flow: The design hydraulic flowrate shall be the sum of the peak flowrates determined as described in Section II.C.1.e., plus the infiltration rate determined as described in Section II.C.1.f., and any industrial process flowrates.

2. Interceptor Sanitary Sewers

Determination of design hydraulic flowrates for interceptor sanitary sewers shall be generally as outlined for collector sewers. The design period, however, should be at least 50 years. Peak flowrates generated by ultimate development allowed by zoning regulations shall be provided for. Interceptors which will carry the flows from a

significant number of older collectors may have infiltration rates far in excess of 400 gallons/acre/day. ASCE Manual on Engineering No. 60 should be consulted for further information on computation of design flows for interceptor sanitary sewers. In all cases, the design hydraulic flowrates shall be approved by the DPW prior to proceeding with interceptor sanitary sewer design.

D. Hydraulic Criteria

1. Collector Sewers

a. Size: The size of the sanitary sewer shall be sufficient to carry the previously discussed design hydraulic flowrate with the hydraulic gradient coincident with or slightly below the crown of the pipe. Sanitary sewer designs allowing surcharging are not permitted. Size shall be determined by the relationship

$$Q = AV$$

where: Q = quantity of sewage in cfs (design flow)
A = required cross sectional area of conduit in sq. ft.
V = velocity in feet per second

b. Velocity: shall be determined by the Manning formula:

$$V = \frac{1.486}{n} r^{2/3} s^{1/2}$$

where: V = velocity in feet per second
n = coefficient of roughness as indicated in table (see Appendix E)
s = slope in feet per foot
r = hydraulic radius-area of liquid divided by wetted perimeter

Minimum velocities of 2.5 feet per second shall be provided. Velocities of 2.0 feet per second or less will be permitted only with written authorization of the DPW. Minimum velocities shall be determined based upon present average daily sewage flowrate. Appendix G "Manning Equation Nomograph" shows required slopes for various velocities with pipes flowing full. Appendix I "Hydraulic Elements of Circular Sections" indicate hydraulic elements of pipes flowing partially full.

Where velocities greater than 15 ft/sec are anticipated, provision shall be made to protect against erosion and displacement by shock. If practical, suitable drop manholes or other methods of dissipating energy and reducing eroding velocity as approved by the DPW shall be provided. When drop manholes are impractical for reduction of velocity, the sewer shall be constructed of ductile iron or other abrasion resistant material as approved by the DPW.

2. Interceptor Sanitary Sewers

   a. Size: Interceptor sanitary sewers shall be sized to convey the design hydraulic flow rate when two-thirds full (i.e., the hydraulic grade line will be at d/D = 0.67) where d = depth of flow, and D = nominal diameter of the interceptor.

   b. Velocity: Velocities in interceptor sanitary sewers shall be as indicated in Section II.D.1.b.

E. System Layout Criteria

1. Collector Sanitary Sewers

   a. Horizontal Layout:

      1) General: Collector sanitary sewers shall be laid on tangents only. All changes of direction and connections to other collector sewers shall be accomplished at manholes. In laying out the sewer the design professional shall take into full account such factors as environmental impact, maintenance of traffic, maintenance of existing utility services, constructability, and system maintenance and shall produce the overall most cost-effective design. All clean outs shall be located in non-paved areas or placed in clean out cover assemblies per the Standard Details.

      2) In New Subdivision: In new subdivisions collector sanitary sewers shall be located seven feet from the centerline of the street right-of-way, generally on the side of the street toward low ground. Collector sanitary sewers shall be located within the pavement area wherever possible, no less than five feet from the face of the existing or proposed curb. Where it is not feasible for manholes to be located within the pavements, they shall be located wholly within the grass plot or wholly within grass plot between the curb and sidewalk.

      3) In Existing Developments With Curbs: In existing developments with curbs, the sanitary sewer location shall generally be the same as in new subdivisions. The location of other existing and proposed utilities shall be fully considered.

      4) In Existing Developments With Pavement and No Curbs: In existing developments without curbs, collector sanitary sewers shall generally be located four feet outside of the edge of pavement, except that the sewer shall not be located under a future curb. The location of other existing and proposed utilities shall be fully considered.

      5) In Parks and Public Rights-of-Way: Where location of the sanitary sewer would require removal of or damage to trees within parks or public rights-of-way, design professional shall obtain approval of the State Department of

Natural Resources, Forest Service for sewer alignment and trees to be removed.

6) Easements: All sewer utility easements shall be 15 feet minimum width. No other utilities will be allowed in the sewer utility easement without the Department of Public Works' written authorization.

b. Profile Layout:

1) Grades: Grades shall be such as to require the least excavation while satisfying minimum and maximum velocity requirements, clearances, and depth requirements discussed hereinafter. All collector sanitary sewers shall be on tangent grades with required breaks in grade accomplished at manholes. The following slopes are the minimum slopes which should be provided, however, slopes greater than these are preferred:

Pipe Diameter (Inches)	Minimum Slope in feet per 100 feet
8	0.44
10	0.28
12	0.24
14	0.17
15	0.16
16	0.14
18	0.12
20	0.11

Pipe Diameter (Inches)	Minimum Slope in feet per 100 feet
21	0.10
24	0.08
30	0.058
36	0.046

Building sanitary sewer service connections shall have a minimum slope of 2.00% unless a flatter slope is authorized by DPW. Terminal sanitary sewer collection lines shall be at a minimum 1% grade regardless of size.

2) Depth: In developed areas, sewer inverts shall be a minimum of 2 ft. + h below cellar elevations, where h = length of house service connection between the sewer and the point of connection to the existing house sewerage system, or stack, multiplied by the required house connection slope. For houses without basement, sewers shall be a minimum of 2 ft. + h below first floor elevations. In all cases, sewer depth shall be sufficient to meet criteria established for house service connection, depth, grade, and clearance.

For unimproved lots, maximum sewer depth shall not exceed 10 feet. Where lots can be expected to be filled to the level of the established grade, depth, as

regulated by adjacent house connections, shall normally not exceed eight feet. Greater depth may be required to clear future storm drains. In all cases, depth shall be sufficient to meet criteria established for building sewer service connection depth, grade, and clearance.

Sanitary sewers at stream crossings shall be constructed with a minimum of three feet of cover between pipe and stream invert. At all stream crossings, the design professional shall consider such items as floatation, stream meandering and scouring, and infiltration and shall include such protective measures in the design as encasement, riprap, special pipe, and/or joints.

3) Upstream from Pumping Station: In order to insure that pumping station features will not result in sewage backing up into basement and first floor plumbing fixtures of nearby residences, the design of all pumping station collection system projects shall:

   a) Determine the rim elevation of the lowest manhole upstream of the pumping station that is not required to have a watertight frame and cover assembly.

   b) For projects having basement service, all basement elevations lower than the manhole frame and cover established in Item a) above shall be identified.

   c) For projects or portions of projects having first floor service only, first floor elevations lower than the manhole frame and cover established in Item a) above shall be identified.

   d) All vacant lots having a ground elevation lower than the manhole frame and cover established in Item 1) above shall be identified.

   e) All dwellings, structures, and lots identified in Items b), c), and d) above shall be noted on the drawing with the following:

   "This lot may be subject to sewage backup in the event of a pumping station malfunction. Backwater valves, if any structure on these lots is connected to the sewage system, shall be required in accordance with the currently adopted Plumbing Code of Anne Arundel County."

4) Gravity Service not to be Provided: Sanitary sewer project plans shall clearly label any improved lots for which gravity service is not to be provided. Any recommendation for not providing gravity service is to be documented, with the reasons therefore, by the design professional, and submitted to the County for approval. For lots where it is determined that gravity service is not available, a note shall be placed on the drawings as follows: "A grinder pump (or ejector, if maintained by the homeowner) is required at the homeowner's

responsibility and expense, for sewer service to this lot." A Public Works Agreement for the grinder pump may be required.

a) Test Borings: Soils investigations (test borings) will be an included part of the scope of all design contracts unless specifically omitted in the scope of work. Test boring results will be shown graphically at their appropriate locations on the profiles whenever possible. Ground water elevations will be shown as well. A written summary of the geotechnical findings, including analysis of expected construction conditions and means of accomplishing construction (dewatering, sheeting, etc.) will be required and be included in the specifications in accordance with Department requirements set forth in Appendix K. (See also, III.B., last paragraph).

c. Clearance at Other Utilities:

1) Interactive Considerations: In general, existing utilities have prior right to maintain their location. The existence and location of such utilities must be considered when designing new sanitary sewers. Clearance shall be measured between outside of pipes. Where specified clearance cannot be obtained, sanitary sewer pipe shall be encased in concrete 10' each side of water mains. For crossings of other utilities the sanitary sewer shall be encased within limits of utility trench. Design professionals shall investigate clearance between sanitary sewer and other utilities both existing and future, and whether or not the existing utilities are protected from corrosion by cathodic protection systems. The clearance to other pipes shall be considered when designing a cathodic protection system (if required) for a new sanitary sewer or if the new sanitary sewer might cause interference with an existing cathodic protection system.

2) Separation of Utilities and Sewer Mains - (Force Main and Gravity Sanitary Sewer):

a) General:

The following design factors must be considered in providing adequate separation:

- Materials and types of joints for water and sanitary sewer pipes;
- Soil conditions;
- Service and branch connection into the water main and sanitary sewer line;
- Compensating variations in horizontal and vertical separations;

- Space for repair and alterations of water and sanitary sewer pipes;
- Location of manholes;
- Future maintenance requirements.

b) Parallel Installation: A horizontal distance of at least 10 feet shall separate water mains and sanitary sewers. In cases where a 10 foot separation is not practical, deviation may be approved on a case-by-case basis by DPW and MDE if supported by data from the design professional. Such deviation may allow closer installation provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sanitary sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sanitary sewer.

c) Crossing of Water Mains: If water mains and sanitary sewers, building drains or storm drains must cross, there shall be a vertical separation of 18 inches between the bottom of the water main and the top of the sanitary sewer, building or storm drain. This vertical separation must be maintained horizontally for a distance of 10 feet. The 10-foot distance is to be measured as a perpendicular distance from the sewer, building or storm drain to the water line.

d) Exceptions: When it is impossible to obtain the proper horizontal or vertical separation as stipulated above, both the water and sewer lines shall be constructed of ductile iron with mechanical joints. Other types of pipe and watertight pressure joints with equal and greater integrity may be used if approved by DPW. Thermoplastic pipe may be used with mechanical. These installations shall be pressure tested to ensure water tightness before backfilling. Where a water main must cross under a sewer, additional protection of the water main shall be provided. DPW shall be consulted to discuss the use of double casing or concrete encasement of the sewer and/or water main.

e) Separation of Utilities and Sanitary Sewer Manholes: No utilities shall pass through any part of a sanitary sewer manhole and no sewer line shall pass through other structures.

f) Clearances with Other Utilities: Sanitary sewer shall have a minimum of 12 inches clearance from storm drains, building drains, gas mains, and other utilities. If 12 inches cannot be maintained at crossings, provide encasement of sewer for the width of the utility trench. The design professional shall consider the possibility of stray current transfer as in (paragraph c.1) above.

g) Appurtenances:

(1) Manholes

(a) Manholes are required under the following conditions:

- Changes in pipe material
- Changes in pipe size
- Changes in grade
- At beginning or end of sewer lines
- At intervals of 400 feet, maximum for sewer lines of less than eighteen inches (18") diameter
- At intervals of 600 feet, maximum, for sewer lines of eighteen inches (18") diameter or larger
- Every change in direction for sewer lines of less than twenty - four inches (24") diameter
- Connections of force mains to gravity sewers
- Junctions of two gravity sewers
- At ends of sewers which will not be extended in the future

(b) Invert difference in manholes shall account for the losses within the structure. A minimum drop of 0.10 feet shall be used, 0.05 feet where the DPW has approved velocities of less than 2 feet per second. Drop manholes shall be used where the invert difference in manholes meet the requirements of the Standard Details

(c) A maximum of four (4) precast concrete grade rings will be used to adjust the frame and cover to grade.

(d) No drop connections will be permitted at manholes where a force main discharges into a gravity sewer.

(e) The design professional shall give consideration to lining the walls and inverts of sanitary sewer manholes per Standard Specification 02565 where the sewerage is anticipated to be particularly aggressive to concrete. Such applications include sewers which will handle industrial effluents, high temperature

discharges, leachate from sanitary landfills and discharge from sewer force mains. Use of manhole liners shall be approved by the DPW.

(f) Where manhole depths exceed twenty (20) feet, the design professional shall incorporate fall protection for the manhole steps in the design. Where fall protection is required, the diameter of the frame and cover opening shall be increased to 30-inches, minimum diameter. Minimum manhole diameter shall be five (5) feet.

(g) Manhole depth is defined as the measured distance between the lowest point in the invert to the rim of the frame and cover.

(h) The design professional shall study flood levels where sewers are installed in the vicinity of streams. All manhole frames shall be set at least 12 inches above existing ground; painted yellow and staked with a yellow marker when the sewer is constructed along a stream or is located in undeveloped areas where location in the forest understory or brush will make future location for maintenance difficult. In no case will sewer lines run through stormwater retention basins or in dam embankments.

Generally keep manholes out of the 100-year floodplain. If unavoidable, provide waterproof manhole frame and cover and corbel assembly.

(i) In areas of high density housing, the design professional shall consider constructing manholes at points where three (3) to five (5) house connections are to be made at a mainline sewer. House connections shall be constructed radially to the center of the manhole whenever possible with nine (9) inches, minimum, separation between pipes. The interior intersection angle between the discharge pipe and any house connection shall not be less than 90°. Each house connection shall be channelized through the manhole in a smooth curve and shall maintain a minimum slope of 2%. All penetrations of the manhole wall shall be sealed with a flexible, mechanical wedge-in-place type gasket, a water-stop type gasket, or a cast-in-place type gasket connector in accordance with the Standard Details and Specifications.

(2) Inverted Siphons: Inverted siphons shall be used only where lowering of the sanitary sewer grade to pass under the obstruction is not economically feasible. Prior to proceeding with the design of the siphon the design professional shall obtain approval from DPW for its use. In any case the siphon shall be as short as possible.

An inverted siphon shall consist of a minimum of two pipes, with a minimum pipe size of 6 inches and minimum velocity of 3 fps at the average daily flowrate. Siphons shall be provided with appurtenances for rodding, and wherever practicable with means of flushing. Wherever average daily flowrate velocities of three feet per second or greater cannot be attained, siphons must be provided with approved blowoffs or facilities for flushing. Blowoffs in lieu of 3 fps will be allowed by special permission from the DPW. Pipes in junction chambers shall be so arranged that low flow is diverted to the small pipe while higher flowrate is into all pipes. Appurtenances for stopping flow in each pipe for maintenance shall be provided.

h) Structural Considerations:

(1) Pipe Bedding and Backfilling: The design professional shall obtain soil borings and soil samples and discuss the analyses of the subgrade and proposed backfill samples with the County.

In all cases, proper bedding and backfilling shall be provided for pipes. Where pipes are to be placed on unconsolidated fill, Ductile Iron Pipe shall be placed on timber pile bents unless special measures satisfactory to the DPW are taken to consolidate the fill and/or provide appropriate engineered pipe bedding.

(2) Grades - Anchors: Sewers designed on slopes of 20 percent or greater shall have anchorages as follows (see Standard Details):

20% - 34%	36 ft. center to center (max.)
35% - 50%	24 ft. center to center (max.)
50% +	16 ft. center to center (max.)

(3) Depth and Loading: Minimum and maximum permissible depths for pipes of the various types and classes shall be in accordance with Manufacturers data. Design calculations for bedding and backfilling, and pipe strength shall be submitted as part of the Engineering report. Ductile iron pipe shall be used where depth is less than 4 feet or greater than 20 feet.

(4) Pipeline Materials: Common materials used in existing and proposed for sanitary sewer construction, together with their Manning's "n" are listed in Appendix E. The choice of materials is subject to the DPW's approval, provided that allowable maximum velocities and structural loading criteria are met. Fittings necessary for wye branches, etc., shall be approved by DPW. Only one type and description of pipe shall be used between two manholes.

The design professional shall consider the effect of the existing soil conditions on the proposed pipe when selecting a pipe material. The design professional shall consider the effect of industrial wastes on sanitary sewer pipe. Several industrial wastes such as sulphuric acid are known to cause deterioration of concrete pipe. Wherever harmful wastes cannot be prohibited from sanitary sewers or diluted prior to entry, the use of other more resistant material or internal lining or other pipe lining protection shall be required for concrete pipe. Pipe lining and alternate corrosion resistant material selection shall be justified in the project design report with the report. Conclusions subject to DPW acceptance.

In addition to the consideration of industrial wastes, the design professional shall also consider other local conditions, such as soil conditions, septicity, exceptionally heavy loadings and abrasion due to high-flow velocities, in selecting pipe materials.

Use Ductile Iron Pipe (D.I.P.) under the following conditions:

- Where sewer depths are less than 4 feet;
- Where sewer depths exceed 20 feet;
- In Right-of-ways;
- Within creek or stream crossings (alternative to D.I.P. is concrete encasement of PVC 10 feet either side of stream bank.);
- Excessive velocities.

(5) Venting: The design professional shall provide for ventilation of gravity sewers, particularly for pressurized sanitary sewers and gravity sanitary sewers with manholes equipped with water-tight manhole frames and covers.

2. Interceptor Sanitary Sewers

a. Horizontal Layout: Interceptor sanitary sewers generally follow streams or the valley of a drainage area. They shall be located so as to best serve the drainage area. Special caution is required to insure the proper location of manholes for future connection of local collecting sewers. Sanitary sewers 27 inches or less in diameter shall be laid with straight horizontal alignment between manholes. Larger diameter interceptor sanitary sewers may employ long radius horizontal pipe curves subject to DPW approval. Where the sanitary sewer is planned in a County road right-of-way or a park, layout shall be as described for collector sanitary sewers in Section II.E.1.a.2) - 5).

b. Profile Layout: Grade requirements shall generally be as described for collector sanitary sewers except long radius vertical pipe curves may be employed. The depth of interceptor sewers is not directly controlled by lot and house elevations. The depth of interceptor sewers shall be sufficient to allow connection of all existing and foreseeable future collector sewers within the drainage basin served. In general, sewer elevation should be three feet lower than the streambed and have six-feet of cover where possible.

Where interceptor sewers cross streams, the same requirements of Section II.E.1.b.2) shall apply, except that concrete encasement shall be required in all cases and will extend 20 feet each way from the top of the stream bank.

c. Clearances with Other Utilities: The requirements for horizontal and vertical clearances between interceptor sanitary sewers and other utilities shall be the same as those for collector sewers. See Section II.E.1.c.

d. Appurtenances: Manhole requirements for interceptor sanitary sewers shall be the same as those for collector sanitary sewers Section II.E.1.c.2).g) with the following modifications. Manholes will normally be required where collector sanitary sewers join the interceptor sanitary sewer. Manholes need not be used at changes of horizontal alignment if a long radius bend is approved by DPW. Brick masonry manholes are not permitted. Precast concrete manholes constructed in these areas shall meet the standard ASTM C478. For diameter of manholes, see Standard Details.

Inverted siphons shall be as provided for in Section II.E.1.c.2).g).(2).

Long radius horizontal or vertical pipe curves shall be permitted for concrete pipe 27 inches and larger. The minimum radius and degree of curvature for four foot and eight foot lengths of pipe with maximum joint opening of ½ inch shall be as recommended by the manufacturer. If concrete pipe with mitered joints is used, deflection shall be limited to five degrees per joint (or less if recommended by manufacturer). For PVC pipe, manufacturer's recommendations shall be followed.

e. Structural Considerations: Standard requirement shall be the same as for collector sewers. See Section II.E.1.c.2).h).

F. Grinder Pumps/Low Pressure Sewer and STEP Systems

1. Purpose

The purpose of this Section is to provide a Policy and Procedural Guide for Alternative Wastewater Systems consisting of Grinder Pump/Low Pressure Sewer and STEP Systems to serve existing or proposed development.

2. Responsibility

   The use of Alternative Wastewater systems as Grinder Pumps/Low Pressure Sewer Systems to serve existing or proposed developments shall be subject to the review and approval DPW.

3. Policy

   a. Determination of Use: Grinder Pumps/Low Pressure Sewer and STEP Systems will not be considered as a method of providing sanitary sewer service that could otherwise be furnished by conventional gravity systems (including pumping stations) at a reasonable cost. Prior to utilization of a grinder pump/low pressure sewer system a comparison will be made to determine if a grinder pump system is appropriate. Economic analysis will be based on a total present worth analysis, including costs to maintain (including homeowner's costs).

   b. Temporary Use: Grinder Pumps/Pressure Sewer and STEP Systems are not to be used on an interim or temporary basis in anticipation of conventional facilities installed in the future.

   c. Ownership and Maintenance: The following grinder pump installations shall be privately owned and maintained by the property owner:

      - Commercial grinder pumps
      - Grinder pumps that are not installed at the property line adjacent to the public right-of-way, this includes "flag" lots.
      - Non-standard grinder pumps

      All other grinder pumps, regardless if installed by the County or by the property owner, will be owned and maintained by the County.

      The property owner will be responsible for electrical costs to operate the pumping units.

   d. Electrician to use 6500 watts, 240 volt for the grinder pump in the load calculation for the whole-house generator. This exceeds the minimum requirement for a 1 hp motor in the NEC but is necessary for the proper operation of the grinder pump on the whole-house generator system. Failure to use this required wattage and voltage in the load calculation will result in a failed electrical inspection.

   e. Required Connections to Grinder Pump/Low Pressure Sewer and STEP System:

      1) All developed (i.e., improved) properties are required to connect to an abutting County wastewater system. If the homeowner does not grant an

easement in time for the pump to be installed by the County's construction contractor, then the owner will be required to install the grinder pump and pressure sewer connection at his/her own expense.

2) All grinder pump installations completed by the property owner shall be secured and inspected through a Public Works Agreement between the owner and the County. Complete Grinder Pump/Low Pressure Sewer and STEP Systems installed by developers shall be by Public Works Agreements between the developer and the County. The installation of the systems will conform to the design Standards promulgated by the Bureau of Engineering. Both connection agreements and Public Works Agreements shall require that the property owner transfer an appropriate easement to the County to allow access to the on-site system components.

f. Design Procedures: Design shall proceed in accordance with the following and with the supplemental Reference Drawings for Concrete and Romar STEP and Gravity Septic Tank Installations, and the Reference Drawings for Grinder Pump Installations, which are available from the DPW.

1) Duplex grinder pumps are no longer to be installed in new development.

2) Capital Projects and/or developments approved for Grinder Pump/Low Pressure Sewer and STEP Systems will be designed and constructed in the same manner as a gravity system. The DPW will review and approve all designs and inspect, approve, and release for service the pressure pipe, grinder pump, electrical equipment, and necessary appurtenances. It will maintain the pressure pipe, grinder pump, electrical equipment from, but not including, the electric meter servicing the grinder pump, and appurtenances in the easements.

3) On all Capital Projects, those that are complete low pressure systems and those which are combination gravity sewer and low pressure systems, the grinder pump unit, associated on-site piping from the core unit to the pressure sanitary sewer and/or gravity sanitary sewer, the 4 inch stubs, the shut off valves at the grinder pump unit, and the electrical installation for all existing inhabited buildings will be provided and installed under the construction of the Capital Project. The property owner will be responsible for electrical usage costs and for connecting improvements on the property to the grinder pump.

4) Under Capital Projects, if existing electrical service to a building does not meet the required power requirements, the County will arrange for BGE to upgrade the wiring to the house service cap and install a new meter and meter box. The County will pay the expense to connect the new power supply from the service cap to the meter, reconnect the house service, and install the electrical equipment from the meter to the grinder pump.

5) Grinder Pumps/Low Pressure Sewer and STEP Systems authorized to serve existing and/or proposed development will be so designed as to accommodate service to all existing or proposed structures as well as all vacant lots abutting the mainline system. Residences and commercial establishments served by wells, residences in excess of 4000 sq. ft. of habitual living space and residences with abnormal waste water plumbing demands (in excess of 250 gallons per day on any day) will be required to double the size of their holding tanks/basins to accommodate this increased waste water flow. County designated land use, topography, proximity of the existing and/or future planned gravity sewers, technological capability of the pumps and pipes, and construction costs are among the factors to be considered by the Department of Public Works as possible constraints that will limit the extent of development or redevelopment that can be accommodated by the proposed system.

6) The County Code requires that first floor service be provided if the property is to be assessed. When design is initiated, a "normal" standard of service for a given community is established, based on engineering and economic analysis. Current usage patterns (i.e., if basements currently contain plumbing facilities) will also be considered in setting the level of service. This will determine if the community will be primarily provided with first floor or basement service. For communities that are primarily designed for gravity service, the following apply:

   a) In a community designed for first floor only by gravity, the majority of homes will be able to connect their first floor to the County's system with a standard 4 inch gravity service. The occasional house that is too low for gravity service will be provided with first floor service by a grinder pump installed by the County. If the owner wants basement service, he has the option of installing and maintaining his own pump at his expense.

   b) In a community designed for basement service by gravity, the majority of homes will be able to connect their basements to the County's system with a standard 4 inch gravity service. For the occasional house that can only obtain first floor service by gravity, the owner has the option of installing a grinder pump, at his expense to obtain basement service. A home that is too low for any gravity service will be provided with service by a grinder pump furnished and installed by the County. Type of service (basement or first floor) will generally be the same as the neighboring properties.

7) If the entire community, or a contiguous part of the community, is being served by a low pressure sanitary system, a stub and service valve will be left at the property line of undeveloped lots. The grinder pump "can" will not be installed on undeveloped lots. At the time of house construction a separate Public Works Agreement will be required for installation of a grinder pump.

8) In communities served either by a gravity system or a low pressure system, the following applies to commercial properties which can only be served by pumping. Commercial properties must utilize grease traps and/or oil and grit separators to prevent excessive wear to the grinder pump's rotating assembly.

   a) If the flowrate is compatible with the County's standard grinder pump installation, the pump will be installed in conformance with residential property policy.

   b) If the flow is greater than that compatible with the standard grinder pump (commercial grinder pump), the property owner is to enter into a connection agreement with the County in order to provide and maintain his own grinder pumping facilities. The property owner will be charged all normal fees and the assessment for commercial properties computed for the project.

9) A visual alarm in plain view of the grinder/effluent pump and an audible alarm on each served building will be a standard feature of this installation.

   On all new developments for which Public Works Agreements are executed where a grinder effluent pump/low pressure sewer and STEP system is to be used, simplex pump systems having a single house connected to a single pump chamber will be required. The installations will also be required to have both an audible and visual alarm system set up for each pump chamber.

10) Location of grinder pumps on site:

   a) The preferred location for the grinder pump is a relatively level site adjacent to the public road right-of-way where a minimum depth grinder pump can be used, provided the site is accessible by normal construction procedures. The design professional is to locate the existing septic system, invert of the sanitary sewer line exiting the dwelling, and locate the grinder pump to facilitate connection of existing sanitary system to the grinder pump while minimizing ultimate construction and operational maintenance costs.

   b) On Capital Projects, after the Department has approved the conceptual grinder pump placement, the design professional is to contact each affected property owner and discuss the location of both grinder pump and the externally mounted control panel.

   c) If the property owner requests a different site, it will be the County's policy to accommodate the request provided that:

      (1) Discharge force main route and pump site are accessible using normal construction methods and equipment.

(2) The property owner waives requirement to restore his/her property beyond site initially selected, except for minimum restoration to meet sediment control criteria.

d) The disconnect and grinder pump control panel are to be mounted on the exterior wall of the dwelling. The Design Professional shall locate the control panel so there are no obstructions within a minimum distance of 36 inches from all sides of the control panel. The homeowner is responsible for maintaining this 36-inch obstruction free area for maintenance and repair. The control panel must be positioned such that there is unobstructed line of sight from the grinder pump unit to the control panel. All wiring from the power company's meter, to the disconnect, to the control panel, to the grinder pump must be external to the structure. Note: Where public grinder pumps are to be connected to whole house generators for emergency backup power, the wiring for the grinder pump will be through the homeowner's electrical panel and not directly to the service meter.

11) Electrical connections to the grinder pump shall be made as quickly as possible following grinder pump "can" installation. Electrical circuit powering the grinder pump shall be left in the "on" or "closed" position to prevent the formation of condensation within the pump core. In no case should the pump core be allowed to remain in the "can" without power for a time period in excess of ninety days - whether stored on site or installed in the ground.

If it is impractical to install and wire the grinder pump within 90 days of delivery, provisions shall be included in the contract documents requiring the contractor to remove the pump cores from the "can" and store them in an enclosed, weatherproof building to include appropriate lay-up and maintenance of cores. For Capital Projects the cost associated with pump core removal, transport, storage, and re-installation shall be incidental to the cost of providing and installing the grinder pump.

12) During design process the design professional shall indicate proposed underground control wiring installation locations. Proposed locations shall be coordinated with future on-site sanitary sewer pipe connections to avoid future conflicts and damage to the wiring.

13) Design of the low pressure force main and STEP system shall be in conformance with other applicable sections of this design manual, the grinder pump manufacturer's recommendations, and design guidelines, as well as other local, state and federal regulations.

Discharge location of the low-pressure force main and STEP system shall be a gravity manhole or gravity sewer house connection (with clean out) for an

individual grinder pump. In no case will a grinder pump or low pressure sewer be permitted to connect to a conventional sewage force main.

14) Residential properties with higher than normal water usage (i.e. due to installations of hot tubs, swimming pools, automatic water filter backflushing units, Jacuzzi's, etc.) shall be required to install, at a minimum, a large capacity tank or shall be required to pay an extra fee as determined by the DPW.

g. Spare Pumping Units: All Public Works Agreements and/or Capital Projects involving grinder pumps shall provide replacement cores (spare grinder pumps) upon completion of the infrastructure in accordance with the following schedule, and shall be based on the total number of units to be installed on the project.

5 to 20 units --- 1 core

21 to 50 units --- 2 cores

51 to 150 units --- 5 cores

151 to 250 units --- 8 cores

The spare replacement cores shall be new and unused. Spare cores shall be delivered to the County in the original manufacturer's package.

Note: Spare cores for projects shall be sent to Mechanical Maintenance in Millersville, MD.

When the total project calls for more than 250 units to be installed, the amount of replacement cores to be supplied shall be determined by the Deputy Director, Bureau of Engineering.

One replacement core shall be delivered to the County's Department of Public Works, Bureau of Utility Operations at the time the first unit is installed, the additional replacement cores shall be delivered at 25%, 50%, 75%, and 100% of total number of units installed and released for service by the County. The number of replacement cores to be delivered at each of the above mentioned times shall be equivalent to the proportion of total units released for service, except all replacement cores are to be delivered prior to conditional acceptance of the entire system.

These spare core units are required to ensure that there will be spare core units available when they are needed. Blind watertight flanges shall be provided on unused grinder pump chambers.

h. Information to be Provided: The following shall be incorporated in all Grinder Pump/Low Pressure Sewer and STEP Systems Designs:

1) Public Works Agreements: A note shall be shown on the cover sheet of the Contract drawings indicating the lots, which will be served by grinder pumps, if any. A separate written Public Works Agreement shall be required on each lot to be served by a grinder pump.

2) Capital Projects: The same notes listed in the preceding Paragraph g.1) should be placed on the cover sheet of the Contract Drawings.

3) At the initiation of a project, the Utilities Revenue Administration Section shall be given a copy of the drawings. A revised list is to be prepared by the inspecting consultant and supplied to the Utilities Revenue Administration Section prior to conditional acceptance testing. The consultant preparing the record drawings shall ensure that all units locations are shown correctly.

4) Utility Operations Bureau shall be responsible for supplying and maintaining the list of grinder and effluent pump units they are responsible for maintaining.

5) The design professional of the project is responsible for providing a hydraulic analysis for the DPW's review and approval. The hydraulic analysis shall include:

   a) The entire pressure collector upstream of the discharge manhole with existing, proposed, and future connections, including infill.

   b) Hydraulic profile and all assumptions made in its development to include number of simultaneous pumps operating; pump operating points along curve; flow used to compute losses through force main; and C-factors for low pressure piping.

   c) Effects of simultaneous pump operation along common manifold force main (low pressure piping).

   d) Cite all appropriate standards and guidelines used to support criteria used and assumptions made (e.g.- County Design Manual, EPA Manual "Alternative Wastewater Collection Systems" (625/1-91/024), applicable manufacturer recommendations (Environment One, etc.).

G. Sewer House Connections

1. Location

The County-owned portion of sanitary sewer house connections shall be built to the property line for all lots within proposed developments. All adjacent improved lots which are not a part of the proposed development, but which may be served by the sanitary sewer line, shall be provided with a capped connection to the property line and shown on the contract drawings. Service connections for these lots shall be

shown where and as directed by the DPW. Where sanitary sewers are at sufficient depth to require drop house connections, the design professionals shall discuss house connection locations with DPW. A similar discussion is required where cast iron pipe sewers are installed. No twin sanitary sewer house connections shall be allowed.

2. Size

   Service connections to large buildings such as apartments or factories shall be designed and sized in accordance with the criteria previously presented for collector sewers. The minimum connection size for smaller buildings shall be six-inch diameter.

3. Materials

   House and building service connections shall comply with ASTM 3034, SDR 35 PVC; ASTM F789, T-1 PVC; AWWA C151 D.I.P or ASTM A-746 Gravity Sewer Pipe. If existing sewer is C.I.P. or D.I.P. and is older than proposed house connection pipe, and proposed house connection is D.I.P., consideration should be given to providing flanged, insulated connection to existing sewer pipe and bonded joints and cathodic protection for the proposed house connection.

4. Appurtenances

   a. House Connections: Drop house connections where sheeting is pulled or stacks where sheeting is left in place shall be used as shown in the Standard Details wherever economical, providing that all requirements for grade, depth, and clearance have been observed.

   b. Cleanouts: Cleanouts shall be provided on all building service connections at the property line on the homeowner's side. Cleanouts shall be as shown in the Standard Details. All Cleanouts must be installed as shown on latest Standard Sanitary Sewer Details. A long sweep 90-degree bend may be substituted in lieu of the wye branch and 1/8th bend. The sweep fitting will, however, have to be approved by the DPW prior to its use. This cleanout is to be used on all systems regardless of the air test requirements. No solvent weld joints will be allowed. The Contractor is to install a 4" x 4" wye and a 4", 1/8 bend at the base of the cleanout. A tee is not acceptable. The open end of the wye can either be plugged or a short piece of pipe and cap installed.

   c. Type "C" Connections: Type "C" connections, when PVC pipe is used, shall be as indicated on applicable Sanitary Standard Details. An approved 90-degree sweep bend can also be utilized in lieu of the consecutive 1/8 bends, if approved by DPW.

5. Grades

   House and building service connections shall be two percent minimum grade, unless otherwise approved by DPW. The maximum grade shall be six percent. Where DPW has approved minimum velocity of 2 ft/sec, for the collecting sewer, house and building service connections minimum grade may be one percent. Minimum cover at property line shall be four feet. Where storm drains have not been designed nor installed, house connections shall have a minimum cover of 6.5 feet within the street right-of-way.

6. Clearance

   a. Crossing Water Main: Clearance shall be measured between outside pipes. Sewer house and building connections crossing water mains (existing or future) shall be a minimum of 12 inches clear below water mains. Sewer house and building connections crossing above water mains shall be encased in concrete 10 feet each side of water main or constructed of AWWA C-151 ductile iron pipe pressure tested in place without leaking (Push-on or mechanical joints).

   b. Parallel to Water House Service: Sanitary sewer house and building service connections shall ordinarily be not less than seven feet horizontally from water house service and a minimum of one foot clear below water house services if extra heavy cast iron soil pipe with rubber gasket joints is used for the sanitary sewer connections. Sanitary sewer service connections may be placed in a common trench with the water service not less than 1'-6" clear horizontally and one foot clear below water service. If DPW approves placing sewer house or building connections above water house service, such sanitary service connection shall be AWWA C-151 ductile iron pipe pressure tested in place without leaking Push-on or mechanical joints only.

   c. Crossing Storm Drains and Other Utilities: Sanitary sewer house and building service connections crossing storm drains and other utilities (existing or future) shall have a minimum clearance of six inches from these utilities.

7. Structural Considerations

   Minimum and maximum permissible depths shall be in accordance with Section II.D.1.c.2).h).3).

   Where poor soil has required the use of ductile iron pipe collector sewers, ductile iron pipe (DIP) pressure pipe house and building service connections shall be used.

   In all cases, proper bedding shall be provided for pipes. Where pipes are to be placed on unconsolidated fill, DIP shall be placed on timber pile bents unless special measures satisfactory to DPW are taken to consolidate the fill.

8. Special Circumstances

In the event extenuating circumstances lead to a request for sewer house connections that are proposed to traverse County rights-of-way or request for long connections, or a request for a long connection in lieu of an extension, a formal written request with details must be submitted to the Deputy Director, Bureau of Utility Operations for approval/disapproval.

Long connections will only be considered for approval when no additional connections are anticipated upstream of the requesting or petitioning lot, and it is anticipated the sewer line will not be extended in the future. Normally the situation will only exist in cul-de-sacs or "dead end" streets where, due to topography, the street cannot be extended, or at street intersections for corner lots where all the abutting lots are presently being served. The decision to provide a long connection or extending the mainline will be handled on an individual basis. The length of connection within the public rights-of-way or public easements shall not be more than 75 feet in order to conform to the County Plumbing Code requirement for cleanout spacing. Connection within private rights-of-way or private easements are subject to the County Plumbing Code. A minimum slope of 2% shall be maintained wherever possible.

When individual sewer house connections are proposed for connection to large diameter sewers (24 inch or greater), they shall be designed for connection to the crown (top) of the pipe.

H. Force Mains

1. Design Criteria

a. Size: Force main size shall be based on its maximum carrying capacity and the minimum construction and pumping costs. The minimum force main size shall be eight (8) inches. Smaller sizes may be used if prior approval from the DPW is obtained. The Hazen-Williams Formula shall be used for determining head losses in force mains. The coefficient of roughness ("C" factors) for force mains shall be as follows:

Material	"C" Factor
Ductile Iron Pipe	120
Plastic Pipe (HDPE, only)	130

b. Velocity: Design velocities in force mains shall be between 3 to 6 feet per second (fps). Although 2 fps velocity may be sufficient to prevent setting of solids, velocities of 2.5 to 3 fps are required to resuspend the solids.

c. Layout: Force mains shall be located within public rights-of-way whenever possible. If it becomes necessary to acquire new rights-of-way for force mains,

the force mains shall be located in the new rights-of-way so future force mains can also be placed within the new rights-of-way.

d. Materials: Special consideration shall be given to the character of industrial wastes, before selecting the types of material for force mains. External loading, abrasive wastes, foundations, minimizing the number of joints, and similar problems should also be investigated. Joints shall be as specified in the latest edition of the Anne Arundel County Standard Specifications.

e. Profile: Force mains shall be located so as to avoid whenever possible high points in the main and the need for air vents. If unavoidable, they shall be equipped with vents regulated by automatic control valves designed specifically for sewage service. Manually controlled blowoff valves with flanges or threaded outlet, depending on valve size, shall be placed at low points in sewage force mains for cleaning or draining force mains. Design methods for disposal of the sewage drained from force mains prior to inspection and cleaning must be submitted to the DPW for approval.

Force mains shall have the following minimum depth of cover:

Mains 10 inches and smaller - 3.5 feet
Mains 12 inches and larger - 4.0 feet

In street rights-of-way cover shall be measured from the top of the force main to the proposed grade or in cases when the proposed grade is above the existing ground surface, the depth of cover shall be measured from the existing ground line.

In rights-of-way across private property, future development in the area shall be given consideration when developing the force main profile and possible future development grades shall be evaluated so the minimum cover depth is met.

f. Clearance: Sanitary force mains paralleling water mains shall have a minimum clearance of 10 feet horizontally and shall be a minimum of 2 feet below water main. Where sewage force mains paralleling water mains must be less than 10 feet apart, the force main shall be 6 feet below the water main. Minimum clearance for sanitary force mains crossing water mains shall be 2 feet below water main.

Sanitary force mains shall have a minimum of 6-inch clearance when parallel to or crossing other utilities.

Clearance shall be measured from the outside diameter of the pipes.

g. Appurtenances:

1) Pipe Deflections: Force mains may be curved by deflecting the alignment at the joints. Deflection at the joints shall not exceed the maximum as set forth by the manufacturer of the pipe used, but in no case shall the joint opening be greater than ½ inch.

2) Air Release and Air/Vacuum Release Valves: Force mains shall ideally be designed to run continuously uphill in profile in the downstream direction, with the high point at the point of discharge. Where this is not feasible due to topography, the design professional shall include automatic air release valves at intermediate high points, as well as air/vacuum valves to allow air into force mains and prevent their collapse when drained, and to expel larger quantities of air when the mains are filled. To minimize installation and maintenance costs, the design professional shall evaluate the feasibility of eliminating intermediate high points by installing the main deeper below grade. Air release and air/vacuum valves shall also be located at all high points along the force main. Air release and air/vacuum valves on sewage force mains shall be specifically manufactured for sewage service, shall be sized according to manufacturer's recommendations, shall include quick-connect flushing hoses, and shall be placed in vaults per Anne Arundel County Standard Details. The following guidelines shall be used to locate air and vacuum release valves:

- Peaks in profiles
- Abrupt increases in downward slopes
- Abrupt decreases in upward slopes
- Long ascents - 1,500 ft. to 3,000 ft. intervals
- Long descents - 1,500 ft. to 3,000 ft. intervals
- Long horizontal - 1,500 ft. to 3,000 ft. intervals
- At pumps - on the discharge pipe as close as possible to the check valve
- At large valves or bypass piping

The air and vacuum release valve vault will be vented above ground as shown on the Standard Details. Odor control measures, such as soil odor filters, may be required by the Department if air release valves are located near populated areas. Air release valve bypasses may be required at the County's option.

3) Blowoff Valves: Where required by the Department, the design professional shall include in his design dewatering connections at force main low points.

Blowoffs shall generally include a valve in a vault and piping to an existing sewer manhole, or to a separate precast manhole with sump or hose connection for pumpout purposes. Consult the Department for special requirements.

h. Structural Considerations:

1) Pipe Loading: Structural designs of sanitary force mains shall be in accordance with the procedures specified in the materials section of II.E.c.2).h).(4) of this Chapter.

2) Anchorages: Force mains shall be anchored at all fittings by harnessing or buttress construction. An analysis of the soils encountered is necessary to determine bearing pressures for buttress design.

i. Water Hammer: When the velocity of a fluid is changed, a phenomenon known as water hammer may result, leading to fractures of pipe and fittings, and other damage. This condition is especially serious on long force mains or where static pumping heads are high.

The design professional shall prepare a complete study of each force main design in conjunction with the related pumping station. A written detailed analysis along with supporting plans and calculations shall be submitted to the DPW for approval prior to completion of the design and the contract drawings. This analysis shall include, but is not necessarily limited to the following:

1) Transient pressures due to water hammer and the effect of these pressures on the entire system.

2) Investigation of the pipeline profile to determine the possibility of water column separation.

3) Reverse rotation characteristics of the pumps.

4) Shut-off characteristics of the proposed pump control valves.

5) A graphic solution of the transient pressures combined with the total system characteristics.

6) Substantiation for the use of surge valves, when necessary, listing recommended size and computed discharge pressures.

When the maximum transient pressure plus the static head is greater than the working pressure strength of the pipe, the design professional shall make an economic evaluation of increasing the design working pressure of the force main and coordinate this evaluation with the pumping station design professional to determine the least expensive method.

j. Sulfides and Sulfide Control: Sulfides are produced when sewage does not have sufficient supply of oxygen. For a given flow and sewage characteristic, the sulfide generator in pipes flowing full is proportional to the pipe diameter. Detention time of as little as ten minutes can cause appreciable sulfide concentration in high BOD sewage.

Where substantial concentrations of sulfide cannot be avoided, exposed walls of a structure required at the junction of force mains and gravity sewers must be constructed or protected with acid resistant materials. This applies to all surfaces exposed to the atmosphere above the sewage containing sulfides.

The design professional shall evaluate proposed sewage force main designs to determine the sulfide control method and materials best suited in each case. These shall be submitted to the DPW for approval.

k. Test: Leakage tests shall be in accordance with the procedures outlined in the latest Standard Specifications, Anne Arundel County.

I. Connections To Existing Sanitary Sewer Facilities

Connection to existing sanitary sewer facilities shall only be made with written permission from the DPW. Request for connection to existing sanitary sewer facilities shall be submitted to the DPW for review and approval and shall include drainage and details of the proposed connection. Manhole-to-pipe connectors and/or saddle assemblies shall provide product description, materials identifications, installation instructions, and detailed measurements (sizes, invert elevations, slopes). The proposed connection shall meet the requirements of section 02564 of the Standard Specifications for Connections to Existing Sanitary Sewer Facilities.

J. Sanitary Sewer Rehabilitation

Sanitary sewer rehabilitation becomes necessary when the capacity of sanitary sewer pipes and/or their appurtenances has been greatly reduced from the original design. Sanitary sewer rehabilitation includes, sewer pipe cleaning, sewer flow control, television inspection, sewer pipejoint testing, sewer pipe joint sealings, sewer manhole sealing, sewer manhole rehabilitation, sewer manhole lining, sliplining, cured-in-place pipe lining, pipe and fitting replacement, and sewer manhole replacement.

1. Sewer Pipe Cleaning

Sewer type cleaning may include sediment, debris, sludge, grease, root intrusion removal in gravity sewer pipelines, force mains, and/or manholes. The purpose of sewer pipe cleaning is to restore the pipeline and/or appurtenances to at least 95% of its original diameter or cross - section. Sewer pipe cleaning shall be made by hydraulically propelled equipment, high-velocity jet equipment or mechanically powered equipment.

2. Sewer Flow Control

   Prior to performing television inspection, joint testing, and/or sealing flow depth in sewer line shall be reduced to the maximum flow depth cited in Section 02565 of the Standard Specifications by plugging, blocking, or by pumping and bypassing. When implementing flow controls, sufficient precaution shall be taken to protect the sewer lines from damage that might result from sewer surcharging and to insure that sewer flow controls do not cause flooding or damage to public or private property.

3. Television Inspection

   The video system shall produce pictures of quality satisfactory to the DPW. The camera shall be able to move in either direction. When manually operated winches are used to pull the television camera through the line, telephone or other suitable means of communication shall be set up at the manholes of the pipe section being examined to insure good communications between members of the crew. Measurement for the locations of the defect shall be made above ground by a distance metering device. Measurements which would require interpolation for the depth of manhole will not be permitted. Accuracy of the distance meter shall be checked prior to the inspection work. Documentation of the television inspection shall be by Television Inspection Logo, photography, and/or videotape recordings.

4. Sewer Pipe Joint Testing and Sealing

   Prior to joint testing, the section of the pipeline to be tested shall be cleared or specified in 1 above and a two part controlled testing in accordance with Section 02565 of the Standard Specifications shall be performed on the equipment to be used. The testing shall be performed on a pipe section basis. The testing shall be either the "Liquid Test Procedure" or the "Air Test Procedure" described in Section 02565. Records of the test shall be kept identifying pipe section tested, method used, location of the each joint tested and the results of the test. Sewer pipe joints visibly leaking will not require pressure testing and will be classified defective and designated for repair. Sewer pipe joint sealing is performed on pipe joints found to be defective. The sealing uses the internal joint sealing method if the sewer pipe section is in sound physical condition. When bell cracks or chips are evident from pipe section offset, sealing may be undertaken where the offset is small enough to allow proper seating of the sealing packer on both sides of the joint to be sealed. Longitudinally cracked or broken pipe will not be sealed.

5. Sliplining

   Sliplining rehabilitation of sewer lines is accomplished by pulling or pushing a continuous flexible smaller diameter liner pipe through the pipeline being rehabilitated. The liner pipe diameter and minimum wall thickness shall conform with requirements of Section 02565 of the Standard Specifications. Prior to sliplining, the pipeline shall be cleaned and inspected in accordance with 1 and 3

above. For thin wall sewer liners, external hydrostatic load due to high water table or flood condition may determine the minimum pipe SDR requirement.

6. Cured-in-Place Pipe Lining

Cured-in-place pipelining shall either be a process which inserts a flexible felt tube impregnated with resin into the pipeline being rehabilitated. The pipe lining may be cured by circulating heated water, air or steam until the liner hardens and cooled down where the water is recooled. Prior to installing this type of pipeline rehabilitation, the pipeline shall be cleaned and inspected in accordance with 1 and 3 above respectively. The materials used in this type of rehabilitation shall meet the requirements of Section 02565 of the Standard Specifications or the manufacture material specification and installation procedure if approved by the DPW. Also required to be submitted is a hydraulic analysis showing the capacity of the rehabilitated pipeline to be equal or be greater than the capacity of the original pipe. The rehabilitated pipe line section shall be tested according to Section 02565 of the Standard Specification and shall meet the test requirement.

K. Sanitary Sewer Abandonment

Sanitary sewer located within public rights-of-way when abandoned shall be left in place and plugged at both ends and at all manholes as shown in the Standard Details. Sanitary sewers abandoned due to new construction shall be plugged 3 feet from the property lines. Sanitary sewers that will be abandoned that cross private property within an easement or right-of-way shall be plugged within the retained public right-of-way 3 feet from the projected property lines.

Sanitary sewer manholes when abandoned shall be filled with either mix No. 1 concrete, sand or selected backfill. When sand or select backfill is used the bottom of the manhole shall be broken and drilled with sufficient holes to permit drainage. The pipes of 15" or smaller diameter shall be plugged with mechanical plugs as shown in Standard Details. For pipes 18" or larger in diameter, provide 9" brick masonry or mix No. 3 concrete bulkhead.

Sanitary sewer house connections shall be abandoned by the plugging the house connection within the right-of-way 3 feet from the property line.

L. Traffic Control

All sewer utility construction projects which will impact existing traffic shall have an approved traffic control plan. The design professional shall consult the DPW in preparing the plan to ensure compliance with requirements. The traffic control plan should be included as part of the Contract Documents.

M. Repaving of Roads

Repaving of roads for trench repair shall be in accordance with Anne Arundel County Standard Details

III. CONTRACT DRAWINGS AND DOCUMENTS

A. Reports

Engineering reports shall be prepared and submitted as stipulated in the Design Criteria Section. The report shall include a map (1" = 200') of the entire drainage area and a tabulation of flow quantities (see Appendix J - Flow Tabulation).

B. Design Computations

The design professional shall submit design data and calculations as stipulated in the Design Criteria Section. The following shall be included:

- A table shall be submitted showing the average, peak, and design flows and the figures used to determine these flows. (See Design Worksheet in Appendix J).
- Hydraulic/system curve calculations for sizing pumping equipment.
- Structural computations for all pipes, or manufacturers' permissible depth/bedding requirements tables shall be submitted.
- Design computations for all special structures shall be submitted. Computation for sizing of emergency generators.
- Formal/written design calculations shall be provided to the Department of Public Works at major review submissions.
- Computations of coordinates shall be submitted when coordinates are required on the contract drawings.

Where information pertinent to design, such as borings, and laboratory tests on soil samples, has been collected; this information shall be submitted to the Department of Public Works.

The locations of borings shall be shown on the plan sheets, and the boring logs shall be included in the contract special provisions along with a written analysis of the findings and anticipated construction requirements in accordance with Appendix M.

C. Specifications

Contract specifications shall be prepared in accordance with the Department of Public Works requirements utilizing the Anne Arundel County Standard Specifications for Constructions to the maximum extent possible.

D. Contract Drawings

Format, size, drafting standards, etc., for contract drawings shall be in accordance with the Department of Public Works requirements documented in Chapter I of this manual.

Sanitary sewer contract drawings may also include water mains, if part of the contract. Strip plans showing plan and profile shall be used whenever possible. The plan shall be at the top of the drawing. The drawing numbers of drawings of other utilities being prepared at the same time shall be listed on sewer drawings. Manhole numbers, job orders, and contract numbers shall be obtained from the DPW.

All applicable items shown on the drawing checklist shall be clearly shown on the contract drawings. One copy of the checklist shall be submitted along with the final contract drawings. Generally sewers and manholes within streets and adjacent developed areas shall be located in plan by dimensions from property markers or other well-defined physical features. However, in areas where physical features are not available and for all interceptor sewers, coordinates of manholes and bearings of sewers based on the Anne Arundel County Coordinate System shall be shown. Survey baseline coordinates, bearings, and distances shall be indicated so that sanitary sewer and appurtenances construct stakeout can be developed.

Contract drawings shall include the front line property surveys of the property bordering water or sewer extensions and shall indicate the names of the present owners of such property with the recording reference number of the deed, tax account number, lot numbers, house numbers, subdivision names and block numbers, as well as existing rights-of-way for each property shall be provided, accompanied by a written description of each new right-of-way. The profile shall be shown under the plan. Contract drawings will show plans and profiles of transmission and collection lines on the same sheet.

The scale of sewer plans shall be 1" = 40' or larger. The scale of all profiles for ordinary sewers shall be 1" = 40' horizontal and 1" = 4' vertical. The scale of profiles for interceptors shall be 1" = 40' horizontal and 1" = 4' vertical with plan and profile on the same sheet.

Sewer profiles on straight streets shall be shown to correct scale. On curved streets horizontal distances between structures shall be plotted using length of street centerline between radial projections to structures. The true length between structures shall be noted on the plan.

The established grade of proposed or existing streets (noted as top of curb or centerline) shall be shown. Where sewer is located in present or proposed pavement or shoulders,

the existing centerline grade of road shall be shown. Where sewer is outside pavement or shoulders for a length greater than 50 feet, existing ground over sewer shall be shown and labeled.

Where sewer is to be constructed on fill, a profile of the undisturbed earth (at sewer location) shall also be shown.

Drop house connections shall be shown as indicated on the Standard Details. The elevation shown shall indicate the invert of the house connection where it connects to the drop house connection.

Other existing and proposed utilities shall be accurately and clearly shown in plan and profile according to the standard symbols in Chapter I, General Instructions.

A drainage area map shall be shown on the first sheet of the contract drawings indicating the entire drainage area to be served both presently and ultimately by the proposed sewers, scale 1" = 200'. If the drainage area map does not show at least two well-known streets or routes, a vicinity map shall be added (1" = 2,000') showing the location of the work. Benchmarks and horizontal control points based on Anne Arundel County datum shall be shown as listed in the checklist.

Structures or details not included in the Standard Details shall be clearly detailed on the contract drawings, preferably where the detail is located in plan. See Chapter I, General Instructions for scale.

E. Cost Estimates

The design professional shall submit an estimate of probable project costs for each contract, including contingent items when requested by DPW. The cost estimate shall be prepared as described in Chapter I, General Instructions.

IV. APPENDIX

A. References

B. Sewer Check List

C. Basis for Residential Wastewater Flow Projections for Undeveloped and Partially Developed Areas

D. Commercial, Industrial and Institutional Wastewater Flow Projections by Zoning

E. Sewer Materials and Manning's Coefficients

F. Peak Flow Curve

G. Manning's Equation Nomograph

H. Hazen-Williams Nomograph

I. Hydraulic Elements Graph

J. Flow Tabulation Form

K. Geotechnical Requirements for Utility Design and Construction Inspection

APPENDIX A

REFERENCES

The following is a list of some of the references available for use in sanitary sewer design. Some of these have been used in the development of these guidelines.

American Society of Civil Engineers, Manual 60 - Gravity Sanitary Sewer Design and Construction, New York, 2007.

Anne Arundel County "Standard Details for Construction," 2001.

Anne Arundel County "Standard Specifications for Construction," 2011.

Metcalf & Eddy, Inc., Wastewater Engineering Collection and Pumping of Wastewater, McGraw-Hill Book Company, New York, 1981.

Water Pollution Control Federation, WPCF Manual of Practice No. 9 and Construction of Sanitary and Storm Sewers, Washington, D.C., 1970.

Water Pollution Control Federation, WPCF Manual of Practice No. FD-5 Gravity Sanitary Sewer Design, Washington, D.C., 1982.

APPENDIX B

UTILITIES DESIGN

SEWER CHECKLIST

The following checklist is provided to assist the design professional in developing complete plans to expedite review by the Department. All final water and/or sewer plans for County capital projects submitted for review are to include a copy of the checklists(s) signed by a registered design professional in responsible charge with the firm. Submittals not including the checklist will be returned without review, comments, or approval.

Compliance with the checklist, however, in no way is meant to relieve the design professional of responsibility for project design.

LOCATION: _____

DATE: _____

CHECKED BY: _____

I. Cover Sheet

1. Name of Capital Project or Subdivision.
2. Anne Arundel County Project and Account Numbers.
3. Grant Number.

II. Vicinity Map, Location Plan, Index of Drawings Sheet and General

1. Vicinity Map - located in upper right hand corner.
2. Vicinity Map - oriented with north to the top.
3. Vicinity Map - scale shown.
4. Vicinity Map - State and County roads shown
5. Location Plan - scale 1-inch to 200 feet
6. Location Plan - north arrow.
7. Location Plan - existing and proposed sewers.
8. Location Plan - existing and proposed manholes.
9. Location Plan - flood plain limits shown.
10. Location Plan - coverage of individual plan sheet.
11. Location Plan - street names - Capital Project areas - proposed subdivision.
12. Index of Drawings - all drawings included.

13. General Notes - appropriate general notes added.
14. General Notes - phone number and agency titles checked.
15. General Notes - pipe material and material class checked.

III. Plan Sheets

1. Recorded plat reference.
2. Street names and alignment.
3. Lot dimensions, lot numbers, and street address numbers.
4. Owners and tax account numbers in all areas up to 60 feet beyond end of main.
5. Road surface: symbol and label.
6. State road labeled on plan, where such roads are shown.
7. Dimensions between street lines and curb lines.
8. Arc Radii of curvatures along property lines if proposed main is crimped.
9. "Full Trench Compaction" - special bedding requirements indicated where required.
10. Existing utilities using proper symbols.
11. Show drawing numbers of all existing sewer plans.
12. Existing water, sewer and drains checked against Record Drawings.
13. Distance of existing dead ends from street centerline, property line or macadam edge.
14. Check with BGE, and all utility owners for existing utilities in all traveled roads.
15. Engineer to contact BGE, Verizon, Comcast, and Cable Television for necessary relocations of existing utilities.
16. Proposed utilities, sewer accentuated by bold, heavy line weight.
17. Drawing numbers of all proposed adjoining sewer plans.
18. Other proposed utilities checked against construction plans of same.
19. Proposed sewer services to be at least 10 feet minimum distance from existing or proposed water connections.
20. Right-of-way reference.
21. North Arrow - Scale - Coordinate Ticks (3).
22. Call out method of connection to existing sewer, i.e., "Kor-n-Seal" process, existing stub, proposed manhole over existing sewer.
23. Scales shown in proper location.
24. Mark limits of proposed or existing paving under this contract.
25. House connections - shown for all lots, improved and unimproved.
26. Minimum house connection size - 4 inch.
27. Minimum sewer main size - 8 inch.
28. Collection sewer - extended to limit of property.
29. Collection sewer - manhole at the end of all collection sewer lines. No terminal clean-outs are permitted.
30. Collection sewer - dimensioned for location (minimum 10 feet horizontal from water main).

31. Collection sewer - size between manholes shown.
32. Distance of proposed sewer from macadam edge to centerline or property line.
33. Proposed and/or existing curb gutter - show symbol.
34. Benchmark - B. M. No. (if any) description and elevation.
35. Restrictions, if any, as to number of connections in this particular service area.
36. House connections to be at low end or middle of lot frontage.
37. Right-of-way provided where sewer is not located within road R/W.
38. Minimum right-of-way 15 feet.
39. Right-of-way to be indicated on plan and clearly labeled as to existing or future.
40. Property - basement elevations or existing ground at building line and labeled.
41. Property - owner's name shown where sewer is in R/W.
42. Roads and streets - names of road or street and intersecting streets, labeled.
43. Utilities - existing - crossing and parallel lines shown and labeled.
44. Utilities - existing - sewer manholes numbered and invert elevations shown and record drawing checked.
45. Utilities - proposed - crossing and parallel lines shown and record drawing checked. Proposed sewer encased in concrete where appropriate.
46. House connections - drop connections shown (with top elevation at stack).
47. Collection sewer - size, type, kind and grade of pipe (grades to be multiples of .04%).
48. Collecting sewer - checked for minimum grades and maximum manhole spacing.
49. Collecting sewer - manholes numbered and stationed.
50. Collecting sewer - manhole inverts labeled (upstream and downstream).
51. Collecting sewer - arithmetic for establishing invert elevations and grades checked.
52. Collecting sewer - profile labeled "street name" or R/W.
53. Collecting sewer - pipe checked for allowable maximum and minimum cover.
54. Collecting sewer - drop manholes shown and type labeled - drop distance checked to determine Type A or Type B.
55. Collecting sewer - clearance between cellar elevation and sewer invert checked.
56. Collecting sewer - in case of pumping station failure, limit of surcharge and location of over-flow point identified, (planned over-flows are not permitted).
57. Collecting sewer - pipe material identified.
58. Collecting sewer - watertight manholes provided in non-traveled rights-of-way, and clearly identified.
59. Collection sewer - restraining structures provided for steep slopes.
60. House connections - connected to manholes where possible.
61. House connections - connection does not interfere with electric transformer.
62. Grinder pumps - check against County Standards.
63. Soil boring/water table data shown.
64. Pumping Station - checked against County Standards.
65. Sediment and Erosion Control Plan provided.

66. Engineer's seal and signature.

IV. Specifications

1. Special provisions - All County capital projects and subdivision projects involving pumping station or other mechanical equipment.
2. Project Name, County Contract Number, EPA Grant Number and engineer's seal shown on cover sheet.
3. Index - All appropriate sections have been included.
4. Proposal form - submitted in duplicate.
5. Proposal form - quantities for contingent items based on engineer's estimate.
6. County sign - all County projects.
7. EPA and state signs - all Federal grant projects.
8. Federal insert - all Federal grant projects - modified to County requirements.
9. Wage rates - all Federal grant projects.
10. Special provisions - Minimize repetition of Standard Specifications and Standard Details.
11. Special provisions - summary of shop drawings, certifications, catalog cuts and other submittals required.
12. Special provisions - materials testing by independent agent through County inspection contract.
13. Inspection trailer, utilities and telephone service provided.
14. Testing and turnover procedures - separate section where appropriate.
15. Training requirements - separate section where appropriate.
16. Maintenance of Traffic Plan - all projects involving existing County roads.
17. List of changes to County Standard Specifications.
18. Engineered Dewatering Plan - well points or trench dewatering.

APPENDIX C

BASIS FOR RESIDENTIAL WASTEWATER FLOW PROJECTIONS FOR UNDEVELOPED OR PARTIALLY DEVELOPED AREAS BY ZONING

	PROJECTED POPULATION PER ACRE	PROJECTED DWELLING UNITS PER ACRE	PROJECTED AVERAGE FLOW GPD/ACRE	I/I PER ACRE @ 100 GPD/ACRE
LOW DENSITY				
RA	0.54	0.1	---	---
RLD	0.54	0.2	---	---
R1	2.59	1.0	250	100
R2	4.71	2.5	625	100
MEDIUM DENSITY				
R5	8.96	3.5	875	100
R10	18.81	10	2500	100
HIGH DENSITY				
R15	25.88	15	3750	100
TC	21.66	12.00	3000	100
APARTMENT				
R22	30.68	22	4400	100

- 250 GPD PER EQUIVALENT DWELLING UNIT (EDU) HAS BEEN ADOPTED BY THE COUNTY FOR WASTEWATER FOR ALL SEWER SERVICE AREAS. AN APARTMENT UNIT IS ESTIMATED AT 200 GPD PER UNIT.

Reference: Master Plan for Water Supply and Sewage Systems 2007-2012, pg. A-4.

APPENDIX D

COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTEWATER FLOW PROJECTIONS FOR UNDEVELOPED OR PARTIALLY DEVELOPED AREAS BY ZONING

ZONE	AVG. DAY GPD/AC.	INFLOW/INFILTRATION @ 100 GPD/ACRE
C1	1300	100
C2	500	100
C3	1300	100
C4	1300	100
W1	500	100
W2	500	100
W3	1000	100
OS	(No public sewer)	
SB	500	100
MA1	1300	100
MA2	1300	100
MA3	1300	100
MB	1300	100
MC	1300	100
MXD-R	3000	100
MXD-C	3000	100
MXD-E	3000	100
MXD-T	3000	100

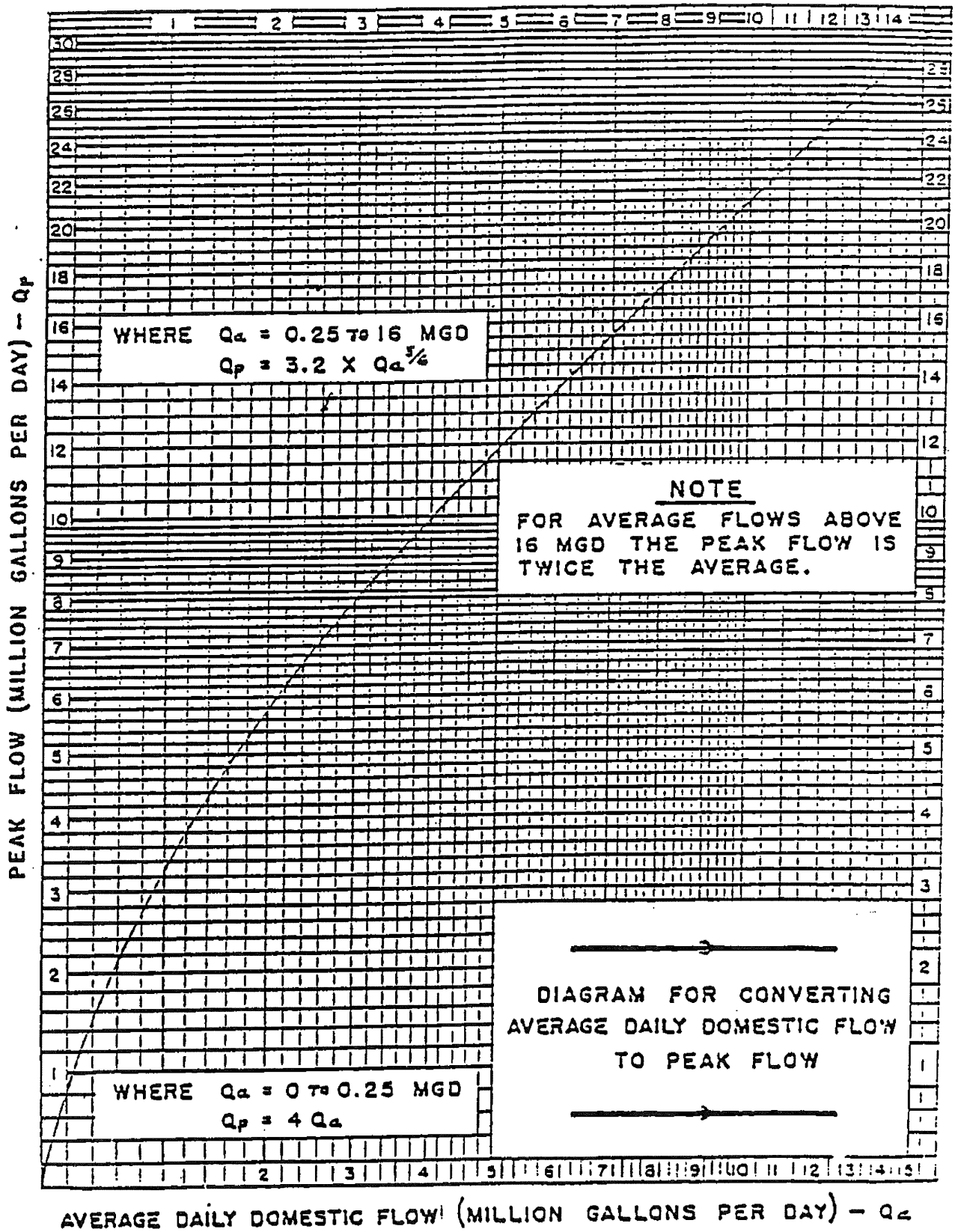
APPENDIX E

SEWER MATERIALS

AND MANNING'S COEFFICIENTS

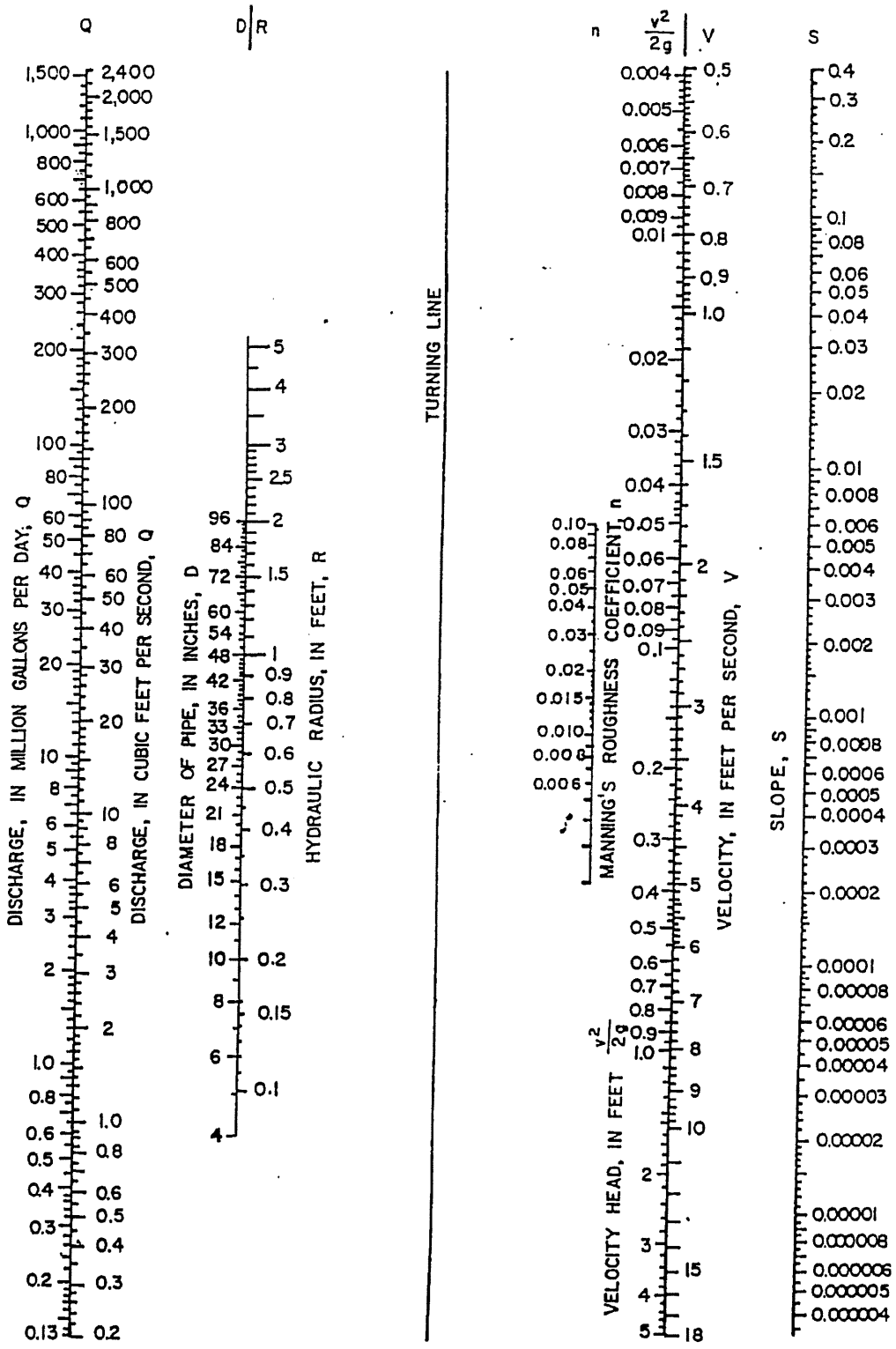
MANNING'S	PIPE	TYPE AND DESCRIPTION OF PIPE
0.009	HDPE	High Density Polyethylene Pipe
0.011	ACSP	Asbestos Cement Sewer Pipe
0.011	PVC	Polyvinyl Chloride
0.012	DIP	Ductile Iron Pipe
0.012	CSPX	Extra Strength Concrete Sewer Pipe 8 Ft. lengths or longer
0.012	RCSP	Reinforced Concrete Sewer Pipe 8 Ft. lengths or longer
0.012	RCCP	Reinforced Concrete Culvert Pipe 8 ft. lengths or longer
0.012	RCCPX	Extra Strength Reinforced Concrete Culvert Pipe 8 ft. lengths or longer
0.012	PCCP	Prestressed Concrete Cylinder Pipe
0.013	CSPX	4 ft. or shorter lengths
0.013	RCSP RCCP RCCPX	
0.013	VCPX	Extra Strength Vitrified Clay Pipe
0.013	UCPX	Extra Strength Unglazed Clay Pipe
0.013	CISPX	Extra Heavy Cast Iron Soil Pipe (House Connections Only)
0.013	VCP	Standard Strength Vitrified Clay Pipe
0.015		Brick Sewers
0.015		Concrete Pipe with Vitrified Liner Plates

APPENDIX F
PEAK FLOW CURVE
(from State of Maryland "Design Guidelines for Sewerage Facilities")



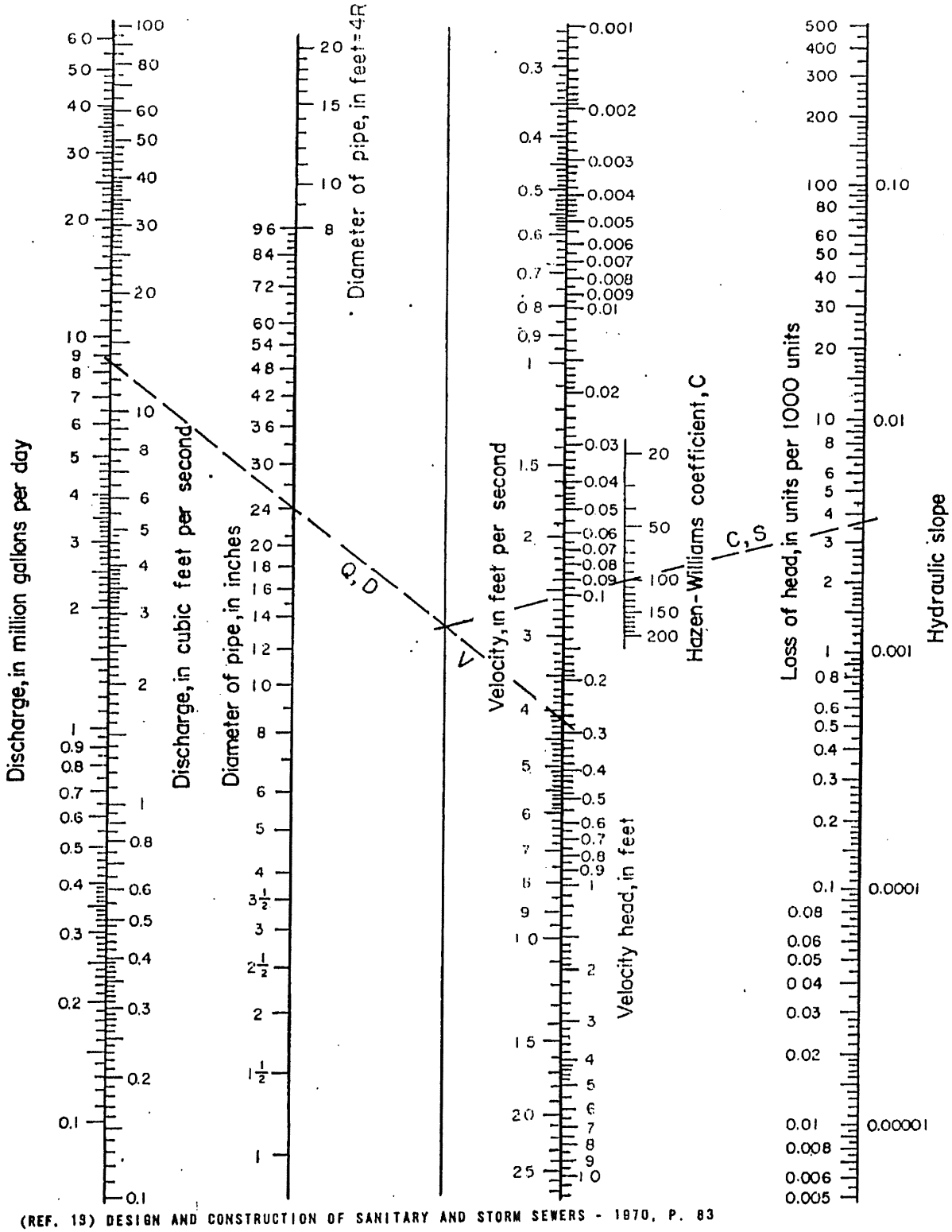
APPENDIX G

MANNING'S EQUATION NOMOGRAPH



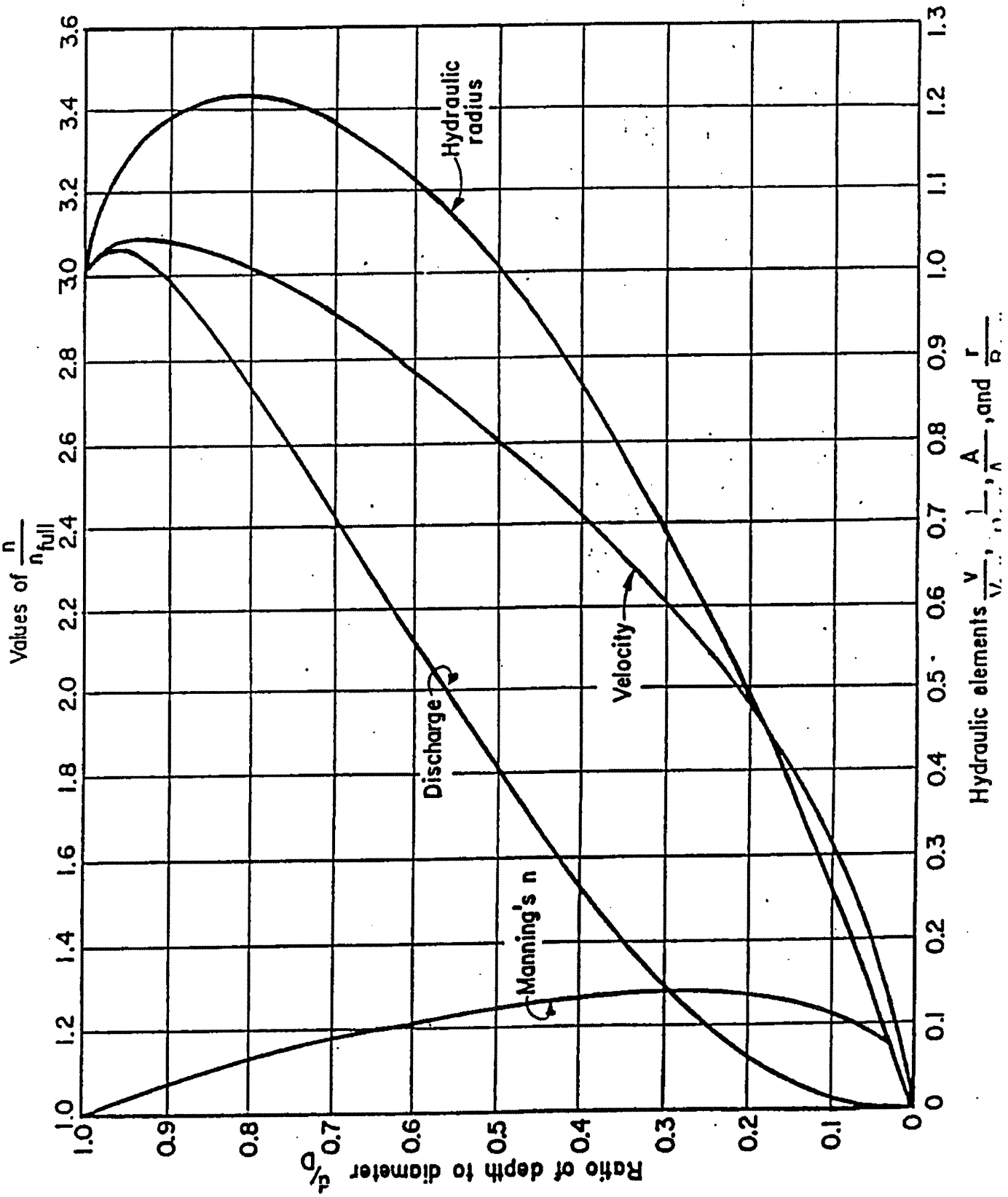
APPENDIX H

HAZEN-WILLIAMS NOMOGRAPH



(REF. 19) DESIGN AND CONSTRUCTION OF SANITARY AND STORM SEWERS - 1970, P. 83

APPENDIX I
HYDRAULIC ELEMENTS GRAPH



Published: 9/00 Revised: 5/13

JOB NAME: _____ DISTRICT _____

PREPARED BY: _____ DATE: _____

CHECKED BY: _____ DATE: _____

SHEET ____ OF ____

ANNE ARUNDEL COUNTY
DEPARTMENT OF PUBLIC WORKS
SEWER DESIGN

AREA SYMBOL		AREA ACRES			POPULATION DENSITY		POPULATION		AVG. DOMESTIC FLOW M.G.D.		AVG. COMMERCIAL FLOW M.G.D.		AVG. INDUSTRIAL FLOW M.G.D.		PEAK DOM./COMM. FLOW M.G.D.		PEAK INDUSTRIAL FLOW M.G.D.		INFILTRATION M.G.D.	DESIGN FLOW M.G.D.		APPROX. GRADE %	TENTATIVE SIZE - INCHES	VELOCITY F.P.S.	
FROM	TO	DOM.	COMM.	IND.	PRES.	ULT.	PRES.	ULT.	PRES.	ULT.	PRES.	ULT.	PRES.	ULT.	PRES.	ULT.	PRES.	ULT.		PRES.	ULT.			PRES AVG.	ULT. PEAK
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

ANNE ARUNDEL COUNTY DEPARTMENT OF PUBLIC WORKS	APPROVED _____ _____ DATE:	STANDARD SANITARY SEWER DESIGN / FLOW TABULATION FORM

Published: 01/.01 Revised: 5/13

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GEO-TECHNICAL REQUIREMENTS FOR UTILITY DESIGN AND CONSTRUCTION INSPECTION

PURPOSE

The following is intended to provide guidance to the engineer and contractor in their pursuit of the project and not to specifically dictate their activities.

DESIGN PHASE

Geotechnical services provided during water or wastewater utilities design shall include the selection of boring and test pit locations, and the selection of sample types and intervals, the selection of field and laboratory test procedures, and the preparation of a geotechnical report. At a minimum, the report shall include the following:

1. Project overview.
2. Types of measures that will be needed to check stabilization of excavations and provide values of design parameters (lateral earth pressure distribution, allowable slopes).
3. Need for dewatering systems that may be needed and provide description of groundwater conditions over project limits of work.
4. Foundation preparation measures to be used.
5. Allowable bearing pressures, anticipated total and differential settlement, pipe bedding requirements, etc., to support design loads.
6. Backfill material characteristics required.
7. Estimated volumes of borrow.
8. The level of compaction needed to satisfy design criteria and methods of achieving this compaction through appropriate combinations of compaction equipment, water contents, and lift thicknesses.
9. Pavement design considerations.
10. Pavement reconstruction considerations - address need for road reconstruction around excavations.
11. The basis that will be used for field evaluation of material suitability, adequacy of compaction, acceptability of shoring, etc.
12. The potential sources and magnitudes of uncertainty in geotechnical conditions.
13. Guideline construction specification with respect to geotechnical requirements.

Implementation of geotechnical report recommendations and design requirements is critical to satisfactory completion of the project. The following guidelines are to be followed by the project inspector.

1. The design phase geotechnical engineer should be involved during construction. (Depending on the size of the project, this involvement could range from telephone consultation to on-site inspections. However, geotechnical expertise should be available during construction.)

2. A qualified testing laboratory should be engaged.

3. The geotechnical report prepared during design should be provided to the inspector prior to construction. Both the inspector's office and field personnel should be familiar with all aspects of the report, including, but not necessarily limited to the following:

   a. Existing conditions.
   b. Feasibility of using materials from trench for backfill.
   c. Appropriate compaction methods for excavated materials.
   d. Procedures for selecting and approving borrow sites.
   e. Appropriate compaction methods for borrow materials.
   f. Recommendations for when select materials should be used.
   g. Appropriate methods for compaction of select materials.
   h. Appropriate methods for monitoring 'c', 'e', and 'g' above:
      (1) Sampling.
      (2) Laboratory testing.
      (3) Field testing.

The inspection personnel must have a sound working understanding of the geotechnical report in order to effectively implement its recommendations. Therefore, this responsibility should be clearly defined in the scope of services for inspection.

4. In consultation with the design geotechnical consultant, the resident inspector should develop a written plan for implementation of the recommendations of the geotechnical report. This plan should include the following:

   a. Identification of the person responsible for insuring adherence to geotechnical report recommendations in the field. Because immediate field decisions are usually required at some time during construction, this person should be well grounded in the subject of backfill materials, methods and compaction, and at least knowledgeable enough to recognize field conditions that do not conform with the geotechnical report and to seek necessary assistance.

   b. Establishment of general criteria for use by the field representative in meeting the requirements of the geotechnical report:

(1) Frequency of standard Proctor determinations.
(2) Frequency of soil density determinations.
(3) Criteria for using visual characteristics and soil consistency for spot determinations of backfill material suitability without consulting geotechnical experts.
(4) Criteria for using visual characteristics and soil consistency for spot determinations of compaction suitability without soil density determinations.

c. Establishment of procedures for detailed record-keeping using a daily inspection report form. This form would require that each of the following be addressed:

(1) Conditions encountered.
(2) Help sought from supervisors, geotechnical engineer, etc.
(3) Location of field tests.
(4) Weather conditions.
(5) Notations on visual and manual observations.
(6) Exceptions to geotechnical report recommendations (field decisions).