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To: Holders of Howard County Design Manuals

Subject: Revisions to Volume II Water and Sewer

Dear Sir or Madam:

Howard County periodically updates its Design Manuals. The last update to Volume II Water and Sewer was May 2003. In order to maintain current design standards the Department of Public Works periodically issues policy statements addressing revisions in design and construction standards, approved construction materials and standard details.

The following policy statement modifying Volume II, Section 3.5, Water House Connections, is a result of County Council Bill 5-210 adopting the 2009 International Residential Code which requires fire suppression systems in new single family residential construction. All water and sewer plans signed after July 1, 2010 are required to comply with the revised requirements. The revisions will be incorporated into Volume II in the next amendment to the Design Manual. Until that time, these revisions are in affect for all construction within Howard County.

Very truly yours,

Ronald G. Lepson, Chief
Bureau of Engineering

Enclosure

THE DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING
HOWARD COUNTY, MARYLAND

HOWARD COUNTY DESIGN MANUAL
VOLUME II
WATER AND SEWER

Howard County Council
Resolution No. 56, May 2003

VOLUME II

HOWARD COUNTY DESIGN MANUAL

WATER AND SEWER

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CHAPTER 1

INTRODUCTION AND GENERAL INFORMATION

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INTRODUCTION AND GENERAL INFORMATION

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CHAPTER 1 INTRODUCTION AND GENERAL INFORMATION

1.1 Introduction

A. History

The construction of public water and wastewater facilities to serve the citizenry is virtually as old as human existence. The supply of potable water to the public in communal living circumstances is of utmost concern to municipalities. Because of the long history of efforts to design and construct safe and reliable drinking water supplies and distribution systems, the technology for providing this service has advanced to a high level. Similarly, the science of collecting and treating wastewater has been and is being refined to accommodate concentrated populations in small areas and to handle processed wastes generated by the industrial/manufacturing activities of modern society.

For some time and particularly since the adoption of Public Law 66 in 1958, a national policy evolved for the provision of safe, reliable and adequate supplies of potable water to the citizens of this country. Likewise, a national policy of pollution abatement evolved under Public Laws 92-500 and 95-217 in recognition and concern of the consequences of despoiling and endangering the dwindling supply of clean potable water. From this national policy certain planning, engineering and construction performance standards evolved, which must be complied with under law or regulation.

B. Authorization

The Water and Sewer Design Manual is Volume II of four volumes of the Howard County Design Manual authorized and required to be promulgated under the Howard County Subdivision and Land Development Regulations as formulated in Council Bill Number 41, enacted November 24, 1975. The other volumes so authorized are:

- Volume I, Storm Drainage Design Manual
- Volume III, Roads and Bridges Design Manual
- Volume IV, Standard Specifications and Details for Construction

The Design Manual is to provide, "... the master technical standards required by Howard County for design, construction and inspection ..." of the various public facilities associated with land development activities. Although the Design Manual is mandated through the land development regulations, it is nonetheless applicable to all other public works projects undertaken by the County.

C. Purpose of the Manual

The Water and Sewer Design Manual is intended to provide a summary of information, procedures, criteria and practices, which are applicable to the undertaking of public water and sewer projects within Howard County. The procedural aspects presented represent

current County practices, which to some degree may be considered fluid as these standards are in continuous evolution, subject to both administrative and legislative action at federal, state and local governmental levels. The design criteria and engineering practices set forth in this manual shall be considered firm requirements for the development of water and wastewater projects for Howard County.

The engineering requirements included in this manual are intended to assist land developers and engineers with designing and building public water and wastewater facilities within Howard County. Developer Projects and Capital Projects, sponsored by private Developers and the County administration, respectively, shall conform to the procedures, requirements and criteria set forth in this manual.

The manual is not intended to restrict the Designer's opportunity to create innovative, practical and economical designs for water and sewer system improvements. Rather, it is intended to assist the Designer in completing the projects efficiently and economically within the framework of design parameters established herein.

D. Waivers

If the Designer for any reason finds it necessary or desirable to use procedures, standards or criteria other than those included in this manual, the Designer must apply to the County for a waiver of the design requirements. A request for a waiver is to be addressed to the Chief of the Bureau of Engineering and shall, at a minimum, contain a narrative indicating the design objective and the justification for the request. Approval or denial of the waiver request will be by return letter signed by the Chief of the Bureau of Engineering.

E. Jurisdiction

1. County

The Howard County Department of Public Works (DPW) has the complete responsibility for the design, construction, operation and maintenance of public water and sewer systems within its political boundaries. The design and construction of public water and sewer systems within Howard County shall conform to the Howard County Design Manuals, Volume II, Water and Sewer, and Volume IV, Standard Specifications and Details for Construction.

The design and construction of private water and sewer systems shall conform to the Howard County Plumbing and Gasfitting Code, the Howard County Design Manual, Volume II, Water and Sewer, and the Howard County Design Manual, Volume IV, Standard Specifications and Details for Construction. In the event there is a conflict, the more stringent criteria shall govern. Single lot residential development is excluded from the provisions of this paragraph.

2. State and Federal

All construction contract documents for the extension or alteration of water and sewer systems within the State of Maryland are subject to the guidelines contained in the latest edition of the Maryland Department of the Environment's (formerly the Department of Health and Mental Hygiene) Design Guidelines for Sewerage Facilities. Other State and Federal agencies exercising control over water and sewer projects with respect to locating and siting of facilities include the U.S. Army Corps of Engineers, Maryland Department of Natural Resources, Soil Conservation Service (through the Howard Soil Conservation District) and Federal and State Highway Administrations. Control is exercised when the project will impact the environment or will occupy their facilities or areas of jurisdiction.

1.2 Abbreviations

Whenever in this chapter or other chapters, the following abbreviations are used, they will represent:

AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
ACP	Asbestos Cement Pipe
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ARD	Age Restricted Development
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATS	Automatic Transfer Switch
AWWA	American Water Works Association
BGE	Baltimore Gas and Electric Company
BOCA	Building Officials Conference of America
CAD	Computer-aided Drafting
CIP	Cast Iron Pipe
CIPP	Cured-in-place Pipe Lining
COMAR	Code of Maryland Regulations
DHC	Drop House Connection
DILP	Department of Inspections, Licenses and Permits
DIP	Ductile Iron Pipe
DIPRA	Ductile Iron Pipe Research Association
DPZ	Department of Planning and Zoning
DPW	Department of Public Works
ENR	Engineering News Record
FCP	Forest Conservation Plan
FEMA	Federal Emergency Management Agency
FGCC	Federal Geodetic Control Committee

FIRM	Flood Insurance Rate Map
FSD	Forest Stand Delineation
GIS	Geographic Information System
GPAD	Gallons Per Acre Per Day
GPCD	Gallons Per Capita Per Day
GPS	Global Positioning System
GPM	Gallons Per Minute
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HGL	Hydraulic Grade Line
HSCD	Howard Soil Conservation District
HS-20, H-20	Truck Loading Designations
LPSHC	Low Pressure Sewer House Connection
LPSS	Low Pressure Sewer System
LPWRP	Little Patuxent Water Reclamation Plant
LRFD	Load and Resistance Factor Design
MCC	Motor Control Center
MDE	Maryland Department of the Environment
MDSPGP-1	Maryland State Programmatic General Permit
MGD	Million Gallons per Day
MTBM	Micro-tunnel Boring Machine
NACE	National Association of Corrosion Engineers
NAD	North American Datum
NAVD	North American Vertical Datum
NEC	National Electric Code
NGS	North Geodetic Survey
NOI	Notice of Intent
NSF	National Sanitation Foundation
NFPA	National Fire Protection Association
NPSHR	Net Positive Suction Head Required
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
PCCP	Pre-stressed Concrete Cylinder Pipe
PCF	Pounds Per Cubic Foot
PLC	Programmable Logic Controller
PRV	Pressure Reducing Valve
PSC	Planned Senior Community
PSI	Pounds Per Square Inch
PVC	Polyvinyl Chloride
RCP	Reinforced Concrete Pipe
RF	Radio Frequency
RPM	Revolutions Per Minute
RQD	Rock Quality Designation
RSGV	Resilient Seated Gate Valve
RTK	Real Time Kinematic
RTU	Remote Telemetry Unit

SCADA	Supervisory Control and Data Acquisition
SDR	Standard Dimension Ratio
SHC	Sewer House Connection
SPT	Standard Penetration Test
VCP	Vitrified Clay Pipe
VFD	Variable Frequency Drive
WHC	Water House Connection

1.3 **Definitions**

Designer: A professional engineer, registered in the State of Maryland, who is responsible for the design of the project.

Health Department: Howard County Health Department

Master Plan: The latest approved version of the “Howard County Master Plan for Water and Sewerage.”

Standard Specifications, or Standard Details: Howard County Volume IV Design Manual, Standard Specifications and Details For Construction.

1.4 **Projects Defined**

Water and sewer projects for Howard County are divided into two basic categories: Developer Projects and Capital Projects.

A. Developer Projects

A Developer Project arises whenever a land developer engages in the subdivision of land or the development of a parcel of land, either of which fall under the requirements of the Subdivision and Land Development Regulations. If the lots or parcels to be developed are within the Metropolitan District and the zero to five-year service area as defined in the Master Plan, each lot or parcel created through the subdivision and land development process shall front and be directly connected to the public water and sewer systems. When this is the case, the Developer will be required to completely underwrite the cost of construction of these facilities and will cause the preparation of an engineering report, the development of construction plans and specifications, the easement documents and the stakeout and inspection of the construction work. A Developer Project is represented by a signed contract called a Developer Agreement between the Developer and the County. The Developer Agreement identifies the area to be served and financing requirements. The Developer Agreement also stipulates the terms and conditions of rebates to be made to the Developer upon successful completion of the development. The rebated portion of construction costs is recoverable by the rate structure of charges universally applied to property owners serviced by the system constructed under the Developer Agreement.

B. Capital Projects

A Capital Project may arise by any of several administrative means. The common identifying feature distinguishing a Capital Project from a Developer Project is that funds for implementation of the Capital Project are allocated through the regular budgetary processes within Howard County. Capital Projects may involve the installation of major elements of the water or sewer system such as water supply, transmission or storage facilities and sewer outfalls, interceptors or treatment facilities.

1.5 Systems Description**A. General**

Public water and sewer service is restricted by the Howard County Code to those properties located within the Howard County Metropolitan District. The Metropolitan District limits are established by the DPW administrative or Council action reflecting the desires of individuals or groups of property owners. The Metropolitan District is a special district wherein ad valorem charges are assessed so as to provide funds for the advancement of water and sewer facilities. The Metropolitan District area has gradually advanced to the west from its beginning in the Elkridge area and initial expansion in the North Laurel-Savage area. Accurate and current maps showing Metropolitan District limits are available from the DPW and the Land Records Office.

There is not an adequate supply of raw water available in Howard County and treated water is purchased from both Baltimore City and the Washington Suburban Sanitary Commission.

B. Water System

The County water system consists of a network of distribution mains, storage facilities and pumping stations. All of these facilities are designed to provide a hydraulically balanced system to accommodate fluctuations in consumer demands and to provide adequate flow rates for combating fires in combination with other system requirements. Fire hydrants are always included with the construction of distribution mains. Water supplied to consumers is metered at the point of use. The County has developed a central monitoring system using telemetry to continuously monitor the operational condition of the system and to permit quick response under emergency conditions. Howard County assumes full responsibility for the operation and maintenance of its water system.

The DPW maintains a series of maps showing the location and size of both existing and planned elements of its water system. Because of the topographic relief of the County, the water system is divided into pressure gradient zones in order to provide an acceptable range of operating pressures to individual consumer systems. These gradient divisions are also shown on various maps maintained by the DPW. Pressure gradient elevations have been determined for both the existing network and planned extensions and are identified by the maximum pressure gradients available in terms of elevations above mean sea level

and their limits have been defined on the basis of ground elevations. These service gradients are **300, 350, 400, 550, 630 and 730**. Other pressure zones may be created, upon approval of the DPW.

C. Wastewater System

The public wastewater system serving Howard County is similar in extent and complexity to the water system. The system for collection and transport of wastewater has generally followed the patterns of growth of the potable water system, with a time lag due to the increased economic burden inherent in this type of system. There is a system of interceptor sewers installed or planned in all of the major natural drainage basins within the eastern portion of the County and extensions are being made and will be made as the need arises and as funding is authorized.

Sewer pipelines involving the collection and movement of wastewater from its point of origin to its point of treatment and disposal are categorized by two descriptive terms relating to the function performed. The two categories are collector and interceptor.

Collector Sewers

A collector sewer, usually 8 inches in diameter and installed in a street, is the portion of the system which is installed adjacent to an individual property or groups of properties to provide a direct connection or service to abutting properties. A collector sewer is a public main designed to serve one or more customers.

Interceptor Sewers

Interceptor sewers are major pipelines following long drainage courses, accepting flows from collectors and conveying them to the point of disposal. Collector sewers are directly connected to the interceptors. Interceptors seldom accept individual service connections. An interceptor by definition is a sewer that transports wastewater from a collection system to a wastewater treatment facility, or to another interceptor and not to another collection system.

Pumping Stations and Force Mains

Pumping stations and force mains, when employed in approved permanent locations, facilitate servicing areas not normally serviceable by gravity sewers, and also serve as collection points for multiple drainage areas to transport wastewater to major interceptors. The existing and planned locations of all permanent wastewater pumping stations are noted on the Master Plan.

Treatment Facilities

At the present time, there are two locations where wastewater is disposed of from the interceptor systems. The Patapsco River System follows the Patapsco River and continues into Baltimore County and Baltimore City, where it is treated at the City's Patapsco Wastewater Treatment Plant. The Little Patuxent River System follows the Little Patuxent River to the eastern County line, where it is treated at the County owned and maintained Little Patuxent Water Reclamation Plant (LPWRP) located in the Savage area. The LPWRP also accommodates flows from the Patuxent River, Guilford Run, Hammond Branch and Dorsey Run drainage basins.

As with the water system, the DPW maintains a series of maps showing both the size and extent of existing and planned wastewater facilities.

As a general policy, the Howard County wastewater system is intended to collect, transport and dispose of wastewater associated with human habitation of residential or employment units. The wastewater system is reserved for these types of wastes only. Under no circumstances are storm water flows permitted to be introduced into the wastewater system. Industrial wastes resulting from manufacturing or processing operations are not always accepted into the system and must be handled by the originator in accordance with the Howard County Code and all other applicable laws and regulations.

D. Water and Sewer Charges

The Howard County Council establishes charges for water and sewer services. Current rate schedules can be obtained at County offices. Charges are made for services under the following categories:

1. Connections
2. Water Meter Setting
3. In-Aid-of Construction
4. Quarterly Water & Sewer User Charges
5. Ad Valorem Charges
6. Front Foot Benefit Assessment Charges
7. Surcharges
8. Special Charges

1.6 Project Development

As previously indicated, water and sewer projects fall into two categories: Developer Projects and Capital Projects. How these projects arise and the requirements associated with each are briefly outlined below.

A. Developer Projects

When a Developer is to provide public water and sewer services to a proposed development, the Developer must submit to the Department of Planning and Zoning (DPZ), a request in writing for consideration. It is the Developer's responsibility to insure that the development to be served with public water and sewer facilities is entirely incorporated within the Metropolitan District. The DPW will evaluate the request to determine if adequate system capacity is available and that the proposal is in conformance with the Master Plan. If any of these requirements cannot be met, the Developer shall be so advised and will be directed to an alternate course of action.

If system capacity is in question, the Developer may be required to employ an engineer to determine the system capacity and the improvements required to provide system capacity. The Developer shall be financially responsible for the design and construction of all necessary improvements to the public water and sewer system required as a result of his development.

If the project meets the basic requirements, the DPZ will indicate to the Developer the financial requirements that the Developer must satisfy in order to continue with the project. If the project is eligible for water and sewer services, the Developer may advance the project by developing an engineering report, if required by the DPW, addressing the considerations set forth in the following chapters of this manual. The report will be used as the basis for a Developer's Agreement, which includes the financial arrangements for both engineering design and construction costs.

Generally, the downstream interceptor sewers 12-inches and larger in diameter and major water facilities as shown on the Master Plan outside of the development area shall be the responsibility of the County. The Developer shall be responsible for the adequacy of the proposed public water and sewer systems within their development. The Developer shall also ensure that there is no adverse impact on the existing public water and sewer system as a result of their development. The capacity of downstream collector sewers shall be reviewed by the Developer to ensure adequate capacity to accept the additional wastewater flows from the development. Adequate internal and external looping of the public water system for pressure and redundancy requirements shall be provided.

Upon the receipt and approval of the engineering report and the preliminary water and sewer plan, the engineering design of construction plans is authorized. For Developer Projects, the alignment of the water and sewer mains shall be located so that all lots/parcels to be served shall front public water and sewer mains. These plans are advanced to the preliminary plan level of completion at which time they are submitted for review to the DPZ, together with a construction cost estimate. The plans are then brought to completion and resubmitted to the DPZ for final review and approval. After approval by the DPZ, and in coordination with other approvals under the subdivision regulations and Section 16.121 of the Howard County Code, the project will advance to the construction phase. The final action under the Developer Agreement is the financial

settlement between the County and the Developer in accordance with the terms of the Developer Agreement.

All improvements to collector sewers, interceptor sewers, wastewater pumping stations, force mains, and treatment facilities required to convey and treat wastewater from the development must be in service prior to any units from that development connecting to the public sewer system. The water system within the development must be capable of supporting the maximum day demand rate plus a two-hour fire flow while maintaining the minimum required pressures.

B. Capital Projects

Capital Projects may begin in several ways. Residents may petition the County to undertake projects or to advance projects previously contemplated. Petitions for water or sewer service are received by the DPW, reviewed by the DPW staff and endorsed with its recommendations, then forwarded to the Director of the DPW. The DPW may originate projects to alleviate existing or projected problems in the overall operation of the systems. The Howard County Health Department may propose water and sewer projects, which come to its attention through its responsibility in maintaining the public health and welfare. The County Council may request of the County Executive to create a Capital Project. Regardless of who or what the originating cause is for a Capital Project, the County Executive is charged with the responsibility of annually preparing a budget of Capital Projects for adoption by the County Council.

As required by County Charter, public hearings are held prior to action by the County Council. This is done for the purpose of reviewing the proposed budget items, publicly displaying all proposals for Capital Projects and receiving relevant citizen comments.

The DPW staff accomplishes most of the preliminary work associated with the identification of Capital Projects. However, after the adoption and funding of Capital Projects are approved, it is normal practice for the County to engage the services of consulting engineers (Designers) to provide the detailed engineering for water and sewer projects. Selection of a Designer is made in accordance with County regulations and policies.

Contracts with Designers on water and sewer projects will stipulate the scope of work, schedule to be followed and arrangements and other details normally associated with contractual procedures. Changes in the Designer's scope of work will be through a change order to the engineering agreement. Unless otherwise accepted by contract, the Designer for Capital Projects will advance a project in the same general manner as described for Developer Projects. All submissions of reports, plans and specifications shall be made directly to the DPW.

The Designer will begin the project by preparing a concise report of the project describing the purpose and extent of the work, providing a preliminary cost estimate and other items of an engineering nature as specified in Chapter 2, "Engineering Reports." Review and approval routines as described in this manual will be followed. When engaged in a Capital Project, either water or sewer, the Designer's point of contact is with the DPW. The DPW will designate a Project Manager from its staff who will assume responsibility for monitoring the project, coordinating details and reviewing reports, plans, specifications and other data to ensure that the engineering work satisfies the project requirements.

1.7 Engineering Reports

The requirement for an engineering report is applicable to Developer and Capital Projects alike whenever water or sewer system extensions or improvements are being considered for construction. The report shall be prepared by a professional engineer, experienced in water and sewer systems, who is licensed to perform such services in the State of Maryland. Refer to Chapter 2 for engineering report requirements

1.8 Preparation of Construction Plans

A. General

Contract documents for construction projects in Howard County are commonly comprised of construction plans and the construction specifications. Taken together, these documents form the basis for the construction contract between the owner and contractor. Contract documents are prepared by the Designer, who is responsible for a complete description of all work to be performed, in accordance with the Standard Specifications. The Designer remains responsible for adequately designing, detailing, and specifying through the Special Provisions and the Technical Specifications, all contract-specific materials and methods of construction not described in the Standard Specifications.

B. Purpose

1. The primary purpose of construction plans is to show the size, horizontal and vertical location and type of materials and structures to be installed as part of a water or sewer system. The construction plans must be developed in sufficient detail to depict the improvements and their spatial relationship with both existing conditions and planned future improvements.
2. This section sets forth requirements for information to be placed on construction plans. When completed according to County standards and properly implemented in construction, the original plans for water and sewer facilities form a permanent record of the completed work and the materials employed on the project. When modified with as-built notations, the plans provide a comprehensive and accurate statement as to where the facilities are located, the materials used and their relationship to other important improvements.

3. In order for the Bureau of Utilities to provide necessary maintenance activities, including emergency repairs, etc., it is necessary that the plans are clearly drawn, can be accurately scaled and show all information necessary to be included as a permanent record. In addition, water and sewer plans are utilized in many other record-keeping activities by the County that requires standardized accurate information. One of the most common uses of record drawings, other than for repair information, is for remodeling portions of the system. In these cases, the record drawings may be used for the re-evaluation of design capacities in the light of changed conditions after the original project was completed.
4. Construction plans shall clearly designate the facilities or portions of the facilities that are proposed to be privately maintained by the Developer or other agencies. The plans shall provide all information, if known, as to who is to be contacted in the event of an emergency, complete with name, address and telephone number(s) of individual(s), firm(s), partnership(s), etc., who are responsible for maintenance of the private system. All applicable DPZ site development numbers shall be shown on the plan.

C. Drafting and Graphic Standards

1. Sheet Size, Borders and Materials

All water and sewer construction projects shall be prepared on 2' x 3' Mylar drafting film (minimum thickness 0.004 inches, matted both sides). Borders shall be ½-inch on all sides with the exception of the left side, which shall be 1¾ inches, with standard title block. All drafting and lettering shall be performed directly on the original plans and no reproductions, rub-on or adhesive materials shall be used.

2. Computer-aided Drafting (CAD)

All requirements of this section, "Drafting and Graphic Standards," shall be met. Plotters used for CAD shall be equipped with technical ballpoint pens, standard drafting pens or an electronic printer device. Electronic deliverables to the County (i.e. CAD disks, CDs, etc.) shall be in software formatting compatible with existing County systems. The format to be used will be decided at the pre-design meeting. Hand drafting may be used on any project if the Designer so desires.

3. Scale

Water and sewer plans shall be drawn on a scale of 1" = 50'. Water and sewer profiles are typically drawn to accompany the plan layout and shall be shown below the applicable plan layout on each sheet. For Developer Projects, the complete layout of the piping system may be shown in the plan view drawing. Profiles shall then be shown on a separate sheet and cross-referenced to the appropriate plan. Profiles shall be drawn to a horizontal scale of 1" = 50' and a vertical scale of 1" = 5'.

The scale to be used for details on any set of drawings shall be $\frac{1}{4}$ ", $\frac{1}{2}$ ", 1", $\frac{3}{8}$ ", $\frac{3}{4}$ " or $1\frac{1}{2}$ " = 1'- 0".

4. Use of Standard Symbols and Abbreviations

The "Standard Symbols and Abbreviations" shown in the Standard Specifications shall be used wherever possible. Non-standard symbols and abbreviations deemed necessary shall be clearly defined in a legend on the title sheet or for a project involving multiple disciplines, such as mechanical, electrical, structural and architectural, on the first sheet of each discipline in which they are used. If symbols fail to convey the required information clearly, they shall not be used.

5. Lettering

Vertical lettering shall be used throughout. Lettering shall be uniform, neat in appearance, free of stylization and large enough to be read when reduced for County use. Lettering for titles, sub-titles and notes placed on the drawings shall be the size approved by the DPW and as shown in the "General Drafting Standards" in the Standard Specifications. All notes, descriptions, etc. shall be minimum of No. 4 (4/32-inch) in size and shall be either all upper case or all lower case. Proper names only shall be capitalized. Construction notes shall not be placed in shaded areas. Crowding of notes into a small space shall be avoided. Leaders shall be used to identify the object to which each note refers. All lettering in the same contract shall be of the same style.

6. Vicinity Map and Initial Drawing

- a. The first sheet of all projects shall include a 1" = 600' scale vicinity map with three unique sets of grid coordinates, sufficient road names and other features to allow easy recognition of the site. When a set of contract plans contain only one or two sheets, the vicinity map shall be placed at the upper right portion of the first plan sheet in a space measuring 8½-inches vertically by 11-inches horizontally. If the vicinity map cannot fit in the 8½ x 11-inch space or whenever there are 3 or more sheets to the contract, then the first sheet shall be designed as a title sheet with the vicinity map centered on the plan. When the 600' scale location map exceeds the size of the sheet, the map shall be drawn at a scale of 1" = 1,000'.
- b. The vicinity map shall, in addition to the above, show the location, size and contract number of adjacent existing water and sewer facilities, proposed facilities, fire hydrants, valves and manhole numbers for sewers. Provide under the vicinity map an informational block containing the following: number of lots and parcels serviced, number of water house connections, number of sewer house connections, use of buildings/structures, drainage area, treatment plant service area, water code and sewer code. The County will supply the water and sewer codes to the Designer

- c. In addition to the vicinity map, the initial plan shall show the contract title, contract number and capital project number. The initial plan shall also include a tabulation of materials with columns for bid quantity, as-built quantity and material/supplier. If the project is divided into two or more contracts, each associated contract shall be identified on the vicinity map. Likewise, the plan coverage of each sheet of the construction plans shall be shown on the vicinity map with its corresponding sheet number for ready reference. For projects with more than three plans (total), a complete sheet index shall also be provided on the title sheet indicating the data shown on each sheet.
- d. When space permits, the first plan of a set shall also show the General Notes pertaining to the contract. If the notes cannot be placed on the initial sheet, a note shall be included on the initial sheet indicating on which sheet the General Notes appear.

7. Information Required on Each Construction Plan

a. General

The purpose of the contract plans is to portray graphically to the review agencies, project engineer and contractor the nature and extent of the proposed work and the conditions under which the work is to be performed. All information that can best be shown by plans and their accompanying dimensions and notes should be shown on the contract plans or appropriate reference to the County's Standard Details made where applicable. Lengthy written descriptions or requirements regarding the work are best included in the specifications, and therefore, shall not be repeated on the plans.

b. Title Block

Each sheet shall have a title block along the lower border of the sheet. The title block shall show the project name, sheet title, contract number, scale, 600-scale reference map number and block numbers, date, sheet number and signature blocks for the DPW and/or the DPZ. Sheets shall be numbered sequentially 1 through X, where X is the total number of sheets in the contract.

c. Seal and Signature

The professional engineer's seal, original signature and registration number belonging to the Designer responsible for the design, registered in the State of Maryland, shall be shown on the title block of the first sheet and each finished sheet of the set of plans. The date on which seal and signature were affixed to the plans shall be shown in the same location on all the sheets.

The Designer's seal, signature, registration number and date of signature shall also be shown on the first page of the project specifications.

d. Revision Box

Each sheet shall have a revision box in the title block. The revision box shall be as shown on the "Standard Reference Plan" in the Appendix A. The revision box shall document all revisions after the Designer's seal and signature has been affixed to the plan.

e. Benchmarks and Traverse points

A tabulation of benchmark descriptions and elevations shall be shown on the sheet that the benchmark occurs. A minimum of two benchmarks shall be shown on each plan sheet. For Capital Projects, traverse point recovery diagrams with dimensions shall be shown for each traverse point on the sheet where the traverse point occurs. Traverse referencing shall be made to permanently fixed objects that will not be disturbed during construction of the proposed project or other projects. Wherever possible, permanently fixed objects used to locate traverse points shall appear on the plan. Traverse points shall be clearly identified and coordinates of each point shall be either shown at the traverse point in a neat manner, or in tabulation form, on each plan sheet for which the traverse points occur. Bearings and distances between traverse points shall be shown. The traverse shall be assigned continuous stationing, with stations shown every 100 feet and at traverse points, and equalities shown at each intersecting point for spur lines and loops. See Chapter 5, "Control Surveys" for more information on the display of benchmark and traverse control on the drawings.

f. North Arrow and Grid Ticks

Each plan sheet and location map shall have a north arrow. Plan sheets shall be oriented so that the north arrow points toward the top or toward the right side of the sheet, or toward the upper right quadrant of the sheet.

Each plan sheet shall show a minimum of three coordinated grid ticks based on the Maryland State Plane Coordinate System and all bearings shall be related to grid north. See Section 5.2.A, "Control Surveys" of this manual for more information on the required horizontal and vertical control for the project design and plans. Two of these grid ticks shall be on the same N-S or E-W line, forming a right angle arrangement. The coordinated grid ticks shall be at multiples of 250 feet. Recovery cards for Howard County horizontal control stations are available from the DPW.

g. Contract Limits

The limits of the contract shall be clearly shown on all plans.

h. Match Lines and Cross-references

All plans in the same contract shall be cross-referenced by ascending numbers. Match lines with a minimum length of 4 inches shall be used wherever the plan is to be continued on the same or another sheet. Data shall be cut off at the match line; duplication of data on matching sheets is not permitted.

8. Sediment and Erosion Control Sheets

a. Approval and Certificate Blocks

Sediment and erosion control sheets shall contain Developer's and Engineer's certifications. The Designer shall contact the Howard Soil Conservation District for current certification blocks.

- b. All water and sewer construction projects that require sediment control shall have detail sheets with required notes dedicated exclusively to sediment control. Existing and proposed contour lines shall be shown on the erosion and sediment control plans in accordance with the requirements of the Howard Soil Conservation District. Contours shall be displayed as required on separate erosion and sediment control plans. If approved by the DPW, the contours may be shown on the water and/or sewer plans screened to a 50% level. All sediment and erosion control plans and specifications are reviewed and approved by the Howard Soil Conservation District.

9. Checklists

The Designer shall fully complete the "Preliminary Plan" and "Final Construction Plans" checklist(s) for each sewer and water project, as applicable. The Designer shall verify that all information detailed on the checklist is shown on the plans. A copy of the checklists may be provided to the Designer together with his notice to proceed, or the Designer may request a copy from the County, as applicable. The appropriate checklist shall be completed and attached to each set of plans submitted for review. This shall apply to all Capital Projects as well as Developer Projects.

D. Computer Applications

Computer programs in the public domain and proprietary computer programs may be used by the Designer with the approval of the appropriate County department. Submittal of the programs to be used shall be made at the pre-design meeting. The currently approved

computer programs may be identified by contacting the County. To secure approval for the use of additional computer programs, program documentation, especially computational methodology, must be submitted to the County for review prior to the use of the program in design. A standard benchmark run of the program, including program input and output and the corresponding longhand calculations must also be submitted. At the County's option, the County may supply standard data to be run in the program.

E. Standards for Depicting Existing Conditions

All construction plans shall be drawn to scale and must clearly and completely depict all existing topography and man-made features. In order to develop the required information to scale, the Designer is required to conduct field surveys to accurately establish horizontal and vertical control points along the route of the project based on the system of coordinates adopted by the County. This coordinate system is, in fact, based on the Maryland State system and is represented with sufficient accuracy in most cases by monuments and benchmarks interposed by the DPW through its aerial and ground mapping program.

Maps based on aerial photogrammetry may not be used for the preparation of construction plans unless sufficient fieldwork is done to make any necessary adjustments to obtain satisfactory accuracy in both the horizontal and vertical planes.

In surveying, plotting and drafting of existing features onto the construction plans, the inclusion or elimination of information must be carefully evaluated in the interest of efficiency of work, clarification of plans and sufficiency of representative information. A complete listing of required survey and as-built information to be included on the base plans is given in Section 5.2.B, "Topographic Surveys" of this manual. On projects requiring more detailed information, it is the responsibility of the Designer to recognize the extent and detail of information necessary to show a complete picture of the project area. However, in no case shall the Designer show less than the requirements listed in Chapter 5.

On projects requiring additions and/or modifications to existing electrical/mechanical equipment or controls, the Designer shall be responsible for reviewing all existing operation and site conditions; and fully coordinating the project with the DPW to ascertain whether any modifications have been made subsequent to initial construction.

Instructions for conducting and coordinating field surveys together with the requirements for accuracy, note keeping, placing of monuments and benchmarks and other details are set forth in the Department Procedures 501.7, Specifications for Surveying Procedures and Documents.

As previously indicated, existing natural and man-made topographical features as developed through field survey activities are drawn onto the construction plans using standard notes, symbols and established drafting techniques to present a clear representation of the area.

1.9 Preparation of Construction Specifications

A. General

1. Howard County's standard specifications are set forth in Volume IV of the Design Manual, "Standard Specifications and Details for Construction." Non-standard specifications, special provisions, proposal form, contract and bond forms and other designated items, when required by the County, shall be developed by the Designer specifically for each project and shall be published in booklet form. A draft of the project specifications shall be submitted with each plan submittal for review by the County. These requirements apply to both Developer Projects and Capital Projects.
2. Upon completion of the construction plans for water and sewer projects, the Designer is required to provide the necessary non-standard specifications to accompany the plans. At this stage of the project, the Designer should be able to finalize most of the non-standard portions of the specification with the possible exception of items relating to permits or easement commitments. When all details of the specifications are completed, the Designer shall submit three completed copies of the non-standard portions of the specifications for Developer Projects and the stipulated number of copies of the complete and bound specifications for Capital Projects. The final specification shall have the Designer's Professional Engineer's seal, signature and date of signature on the title page.

B. Standard Format

The Standard Specifications (Volume IV) format is to be used in the preparation of the non-standard portions of the specifications.

C. Special Provisions/Technical Specifications

This section is vitally important to the contract as it contains additions and/or modifications to the Standard Specifications, as applicable to each particular contract. The Designer is to contact the DPW for advice on those items normally placed in the Special Provisions and/or Technical Specifications. However, it is incumbent on the Designer to include in this section all conditions to the contract and the work required not otherwise covered, such as special construction methods, materials, measurement and payment, etc., so as to provide a complete contract document.

D. Proposals

1. The proposal form may be designed for a single lump sum payment, a series of unit priced items or a combination of the two. For pipeline work, Howard County employs a combination type of proposal where some items of work are bid and paid without regard to measurement. Other items are bid and paid on the basis of a unit of actual measurement multiplied by the corresponding unit price bid by the Contractor

or fixed by the contract. The basis of measurement and payment is described in the Standard Specifications and/or in the project specifications.

2. Proposals are often divided into parts to facilitate cost accounting procedures required to allocate costs by projects, administer charges and account for cost participation by various parties involved in the financing.
3. The proposal form for pipeline projects shall contain a statement by the Contractor indicating the type of pipe the Contractor intends to use on the project. The period of time in calendar days (to be determined by the Designer) permitted for the Contractor to complete the work is stated on the form. The amount of liquidated damages to be charged per day, in the event the work is not completed within the prescribed time period, shall also be given.
4. For pipeline and other types of projects, there are a number of contingent items of work or materials to be employed, which may develop during the course of construction that cannot always be anticipated or that can be anticipated without being qualified. To facilitate the employment of additional materials and the authorization of incidental items of work, all contracts contain a list of fixed price contingent items, which are not bid items, which have an assigned unit price and quantity as applicable. These fixed price items are utilized to enable the Contractor to be paid an equitable sum of money when the particular item of work or the furnishing of materials is authorized and directed during the course of construction. Modifications of this list or modification of the fixed prices shall not be made by the Designer except with the full concurrence of the DPW.

E. Treatment Plants and Water Storage Facilities

Since water and wastewater treatment plants and water storage facilities involve unique and non-recurring design features, they are considered beyond the scope of this manual. These types of projects are typically Capital Projects and would involve specific design criteria and other special requirements, as determined by the DPW for each project.

1.10 Record Drawings

A. General

After the water and sewer plans have been signed by the County, the original water and sewer plans and all prints thereof become the property of Howard County. During construction, the Contractor and the County's inspector, acting together, will maintain a set of as-built or redlined prints of the water and sewer plans. Following construction, the original water and sewer plans shall be revised to reflect the as-built conditions.

By submitting the original water and sewer plans for signature, the Designer agrees to allow the County or its representative to modify the water and sewer plans to reflect the as-built conditions of the water and sewer utilities. At the County's option, the County may

require the Designer to complete the modifications to the plans to reflect the as-built conditions. The County will hold harmless the Designer for as-built information if added to the drawings by others.

Incorrect information shall be deleted and replaced with the as-built information. The revision block shall be completed, initialed and dated by the individual making the modifications. Each plan in the set shall bear the words AS-BUILT in bold letters above the title block on the lower right-hand corner of the plan along with the date that the as-built modifications were completed. All as-built information and lettering shall be of the same style and quality as the original water and sewer plans.

B. Electronic Files

If the plans are prepared in electronic format, in addition to the modifications to the original water and sewer plans, the County may require that the electronic files be modified to reflect the as-built conditions and delivered to the County.

C. Replacement Drawings

Plans bearing original signatures and dates of approval are important for the DPW's historical records. However, there may be rare instances where extensive modifications to a plan may render the plan illegible. In order to insure that the plans are clear and legible for operation and maintenance purposes, the DPW may require that a completely new plan with modifications be developed for the as-built plan. The plan shall be noted as "AS-BUILT Replacement Sheet" above the title block on the lower right-hand corner of the plan and dated. Each new plan sheet shall be circulated for all required signatures.

CHAPTER 2

ENGINEERING REPORTS

**CHAPTER 2
ENGINEERING REPORTS**

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CHAPTER 2 ENGINEERING REPORTS

2.1 Applicability

The requirement for an engineering report is applicable to Developer Projects and Capital Projects alike whenever water or sewer system extensions or improvements are being considered for construction. In addition, an engineering report may be required under certain circumstances not involving system extensions or improvements. When required by the Department of Public Works (DPW), a detailed analysis and investigation shall be performed to determine the performance of the existing system or to evaluate the impact that proposed additions or special uses will have on the system.

The report shall be prepared by a Professional Engineer (hereinafter referred to as the “Designer”), experienced in water and sewer systems who is licensed to perform such services in the State of Maryland. The report shall be signed and sealed by a principal member of the firm by whom the report is prepared.

2.2 Purpose

The engineering report is intended to be a concise presentation of all relevant project facts together with a proposal for satisfying the needs of the project. The report shall be addressed to the Director of the Department of Public Works and delivered to the designated Project Manager. The report shall be presented in an organized manner so that the Director, his staff, County officials and other interested agencies may quickly identify and comprehend all aspects of the project including, but not limited to, the purpose, scope, cost and scheduling of the project. The Designer is expected to present a discussion of background information, design criteria, alternate solutions, cost comparisons and recommendations, which are fully consistent with applicable County, State and Federal regulations and practices.

The report shall characterize the project, which was previously described in broad and general terms, to one of finite definition, scope and content. The report is preparatory to undertaking the development of detailed design and construction plans. Upon completion and acceptance of the engineering report, the Designer shall convey a proposal for engineering scope of services based on an analysis of all relevant facts and engineering principles. The report may also serve other purposes simultaneously so as to:

- (1) Provide a historical record of the engineering principles and criteria under which the project was designed and constructed.
- (2) Form the basis for acceptance, rejection or modification of the scope of the project.

- (3) Provide a basis for legislative or administrative action on scheduling or funding.
- (4) Provide necessary details to guide preparation of construction documents.
- (5) Provide a basis for correlating the project with other DPW programs.
- (6) Provide an analysis and a program for the operation and maintenance of any part of a facility or system.

2.3 Report Content

A. General

Reports shall be presented in a neat and legible manner. They shall be submitted on 8½-inch x 11-inch bond paper from any standard word processor, suitable for reproduction. Brief reports may be published in letter form, properly identified and with attachments referenced in the text. Lengthy or complex reports shall be suitably bound on the left edge and shall include a cover with appropriate identification of the Designer, project name, owner and date. Unless otherwise stipulated, the Designer shall provide four (4) copies of reports on Developer Projects, and ten (10) copies of reports on Capital Projects. Reports shall be delivered to the County Project Manager in the early stages of the project.

In considering the preparation of the report on water and sewer facilities, the Designer shall perform the following tasks:

- Become familiar with existing conditions
- Consider the impact that the proposed improvements will have on the system
- Offer proposals to satisfy project needs after they have been carefully evaluated for performance and cost

The Designer shall present a concise discussion of all relevant factors that led to the report conclusions and recommendations.

It is understood that all required subject matter for reports cannot usually be determined in advance of the research and development, as is necessary to identify all potential project issues. However, through experience and practice it is recognized that there are certain categories of information which, when properly addressed, will ensure all factors are considered prior to establishing appropriate conclusions. The text of the report will usually include a discussion of some or all of the following topics as applicable:

1. Location, origin, purpose and scope of project
2. Existing project conditions
3. County population projections and projected needs
4. Design analysis including all design criteria employed
5. Design computations
6. Function, layout and siting requirements of proposed facilities
7. All alternatives to primary proposal
8. Cost estimates and comparison of alternatives including rights-of-way requirements and costs
9. Required permits and approvals of other agencies
10. Conclusions and recommendations
11. Schedule for implementation
12. Project illustrations

The addition or elimination of subject matter for the report is well within the authority of the DPW, whenever the nature of the project dictates.

B. Design Analysis

1. General

In developing design requirements for elements of a water or sewer system, the Designer shall refer to the Howard County Master Plan for Water and Sewerage to ascertain both the extent of existing or planned facilities in the service area and their relationship to the project under consideration. One or more maps shall be prepared showing the project location and the relationship of major elements of the system as shown on the Master Plan. See Section 2.3H, "Report Content: Illustrations" for a list and description of available standardized County maps that may be of use for developing project maps. The project map(s) shall be developed based on the following criteria:

- a. Displayed at a scale of 1" = 600' or 1" = 200'
- b. Include a reasonable area surrounding the project
- c. Show significant topographical features such as roads, railroad lines, water courses, power transmission routes, political boundaries, water pressure zone limits, drainage divides and zoning

- d. Show the location, size and extent of the existing system(s) being addressed in the report
- e. Show locations of all proposed system additions
- f. All design notations used as a basis for computing system loads, such as drainage area or service area limits by zoning, future extensions of pipe systems or networks, other Capital Projects and any public improvements contemplated by other governmental agencies shall be superimposed on the report map

For water and sewer facilities identified in the Master Plan, Howard County may elect to provide the Designer with specific design requirements determined as a result of previous engineering analysis. In such cases, the Designer will incorporate these requirements into the design report and will reference the letter or other documentation by which the requirements are conveyed to the Designer from the Project Manager. For example, Howard County may specify system flow rates to be used in sizing pump stations and sewer lines or water transmission main sizes based on a previous hydraulic analysis.

2. Zoning Analysis

Where design requirements are not supplied by Howard County, the Designer shall establish water and sewer system design flows by performing a zoning analysis. All residential zoning analysis shall utilize the zoning density and household size factors established in Tables 2.3A, "Density Relationship vs. Land Use" and 2.3B, "Density Calculations", respectively. These relationships are based on past patterns of development in Howard County and shall be used for all residential density calculations unless otherwise specified by the County. As indicated in Table 2.3A, all institutional, commercial and industrial land uses are to be determined on an individual basis.

TABLE 2.3A DENSITY RELATIONSHIPS vs. LAND USE

Zoning Districts	Typical Yield Dwelling Units Per Acre		New Town Zoning District	Typical Yield Dwelling Units Per Acre
	Normal	ARD*		
Protected	0	0	Single Family, Low Density	2.0
Rural Conservation (RC)	0.23 (Base Density)		Single Family, Medium Density (New Town)	4.0
	0.5 (Max. Density)	1		
Rural Residential (RR)	Same as RC	1	Townhouses	10
R-20	1.7	5	Apartments	15
R-12	2.9	6	Retail Centers	Determined Individually
R-SC	4	8	Employment Centers	Determined Individually
R-SA-8	8	12	Industrial Plant Loads	Determined Individually
R-MH	8		PSC **	8
R-A-15	15	25		

*Age Restricted Development

**Planned Senior Community

When age restricted developments are planned for development in other than PSC zoning, the ARD typical yields as shown in Table 2.3A shall be used in the zoning analysis.

TABLE 2.3B: DENSITY CALCULATIONS

Residential Classification	Density (Persons per Dwelling Unit)
Single Family Units	3.15
Townhouse Units	2.60
Apartment Units	1.90
Mobile Homes	2.40
Planned Senior Community	1.20

3. Design Criteria and System Layout

All systems shall be designed based on the guidelines and criteria established by this manual. The following chapters provide relevant design information regarding system layout and construction plan requirements for each respective system component:

- Chapter 3: Water Design Guidelines
- Chapter 4: Sewer Design Guidelines
- Chapter 5: Common Design Guidelines
- Chapter 6: Wastewater Pumping Station Guidelines
- Chapter 7: Water Pumping Station Guidelines
- Chapter 8: Alternate Sewer Systems

For facilities that require pumping, a detailed analysis shall be performed on the following topics:

- Pump size and power requirements balanced by economical pipe sizes
- Existing and future pumping capacity requirements
- Upgrading capacities
- Surge control
- Secondary emergency power requirements
- Alarms

4. Wastewater Pretreatment Requirements

In cases where the engineering report provides for the design of sewer facilities for a specific non-domestic user of the sewer system, the report must address wastewater pretreatment requirements, as required by the DPW. Pretreatment requirements are established during site development plan review or during building permit review. Pretreatment facilities are required if the quality of the wastewater to be discharged would otherwise violate provisions of Howard County Code Section 18.122A. Pretreatment facilities must conform to applicable State and Local design requirements.

C. Design Computations

Design computations, if required by the County, shall be developed for all features of the proposed system and shall be in sufficient detail to enable the DPW to make an expeditious review of the methods and criteria employed and the corresponding results obtained. In particular, see Chapter 3, “Water Main Design” for water demand and hydraulic calculations and Chapter 4, “Sewer Main Design” for wastewater flow calculations. Design computations shall be submitted with the report.

For the development of water and sewer system requirements, Howard County has standardized the manner in which these demands are organized and presented in reports. The forms for the tabulation of system demands are included in Appendix B & C for both the water and sewer systems.

D. Design Life of Facilities

For facilities identified in the Master Plan, design of system components will ordinarily be performed on the basis of the affected area being fully populated in accordance with population density determined from zoning. The Designer shall examine operating conditions using existing population and other intermediate population levels to ensure the satisfactory operation of the system throughout the design life of the system.

The full development potential is determined based on a complete zoning analysis of the service area as described previously in Section 2.3.B, "Design Analysis". In determining whether or not a facility should be initially constructed to meet 20-year or full development demands, the following issues shall be addressed in the engineering analysis of the proposed project:

1. Present worth analysis comparing the cost of phased implementation (construction of parallel mains, incremental pump station expansion, etc.) with the cost of a facility initially providing capacity for full development. For the purpose of economic analysis, full development is to be projected for a 40-year period.
2. System hydraulics considering such factors as differences in pump or pipe sizes required for 20-year and full development flows, head losses, retention time, etc.
3. System limitations considering the advisability of having parallel facilities to provide for limited flow capacity during maintenance or repair periods.
4. Construction limitations considering the difficulties involved with constructing parallel facilities after initial construction is complete.
5. System design life considering the useful life of the facility.

E. Alignment Issues

Water and sewer lines are generally extended within public rights-of-way wherever feasible. This is because most properties to be served by these utilities have frontage on public roads, facilitating direct connections to the public water and sewer system by consumers. Fire hydrants are also located alongside roadways to permit direct access by emergency equipment. As

proposed systems increase in complexity, other factors such as topography, economy of sizing, construction costs, power requirements for pumping, maintenance considerations and conflicts with other utilities must be considered during design. The Designer shall evaluate alternative designs that provide a design with overall lowest cost and least impact on natural and man-made features. The Designer shall also consult Chapter 5.3, "Rights-of-Ways, Easements and Construction Strips" for utility easement requirements. The Designer's report shall include life cycle cost comparisons for all alternatives considered.

F. Construction Cost Estimates

The cost of all facilities addressed in the report shall be tabulated in a clear and concise manner and shall be derived from recognized sources. For Developer Projects, estimates shall be based on unit prices provided by the County. For Capital Projects, estimates shall be based on current bid prices for comparable work in the locale of the project with consideration of soil conditions, water table, etc., and shall reflect quotations from suppliers of equipment and materials whenever appropriate. Cost estimates for the report need not be itemized to the extent usually found in bid proposals, and shall be qualified as to what is included in unit prices so that reviewing agencies are aware of the cost factors used in the estimate. In estimating costs for alternate proposals, care shall be taken that costs are truly equivalent and can be directly compared. The current Engineering News Record (ENR) Construction Cost Index shall be provided with the cost estimates.

Whenever alternative solutions involve different types of facilities such as a gravity system versus a pumped system, cost comparisons are more truly representative when analyzed to include capital, operation and maintenance costs on a life cycle basis, using reasonable interest rates. Current construction costs shall be adjusted and projected to the planned construction year as indicated in the project schedule with consideration of the effects of current inflation rates. The factors used in these projections shall be clearly stated.

G. Project Schedule

A project schedule shall be prepared by the Designer and included in the report. For Developer Projects, the schedule may be statements in the text of the letter report describing the Developer's estimate as to when the various phases of the development will be ready to accommodate the water and sewer construction program and the target date for completing the development and for occupancy. For Capital Projects, the Designer shall prepare a schedule in bar graph form displaying the best estimate of when the major elements of the project will be initiated and completed. As appropriate to a given project, the schedule shall include the following time considerations:

1. Preliminary Design Period
2. 50% for pipeline design and 60% for pumping station designs
3. Review by County
4. Geotechnical and Corrosion Control Reports
5. Rights-of-Way, Easement and/or Property Documentation
6. Final Design (95% Complete)
7. Final County Review & Approval
8. Obtaining Permits
9. Advertising and Bidding
10. Award of Construction Contract
11. Material Availability
12. Construction Period
13. Other Special Items Affecting Schedules

The project schedule shall indicate the critical path, including required completion date and target dates for each phase, which must be met in order to achieve the schedule. In addition, any procedure, which can advance the completion date, such as pre-purchase of materials and equipment and a division of the project into two or more construction contracts, shall be identified.

H. Illustrations

An engineering report is considerably enhanced by the inclusion of maps, graphs, diagrams and charts to illustrate and amplify issues presented in the text. As previously discussed, Howard County maintains several series of maps that are standardized as to map scale, size and information recorded. These standardized maps, which are available to the public for purchase at a nominal charge, are indicated in Table 2.3C, "Available Maps and Documents."

As indicated in Table 2.3C, some information is available both in paper and electronic format. In addition, the County maintains a Geographical Information System (GIS) which contains GIS layers such as roads, floodplain boundaries, water/sewer infrastructure, storm drains, orthophotography, etc. that may be beneficial for illustrative use in engineering reports. County owned GIS information is available from the County.

Report maps are easily developed from one or more of the aforementioned maps. To facilitate the coordination of projects, the County requires that all reports include a map at a scale of 1"= 600' or 1" = 200', showing the immediate project areas as well as the surrounding area.

Maps for other specialized requirements such as drainage limits, floodplains, property limits, zoning, population densities, etc. may be drawn to a scale

appropriate to the size best suited to display the required information. Maps in a vertical plane (profiles) are not ordinarily required for reports, unless required to demonstrate economical design features and ability to adequately service existing and future areas. Graphs and charts are to be utilized whenever possible to enhance the text and to demonstrate time, cost, growth and flow comparisons or other compound relationships, which would have great visual impact when, represented pictorially.

**TABLE: 2.3 C
AVAILABLE MAPS AND DOCUMENTS**

Type	Coverage	Scale	Showing
Property Tax Maps (1)	County Wide	1" = 600'	All properties & owners
Water System Maps(2)	Planned Service Area	1" = 600'	Size & location of system
Sewer System Maps(2)	Planned Service Area	1" = 600'	Size & location of system
Land Use Maps(2)	County Wide	1" = 600'	Land Use
Zoning Maps(2)	County Wide	1" = 600'	Zoning
Aerial Photogrammetric (2)	County Wide	1" = 200'	Topo: natural & cultural, contours
Water/Sewer Construction Plans	System limits	1" = 50'	As-built facility construction
Water & Sewerage Master Plan Maps	Planned Service Area	1" = 2500'	Existing & planned major water & sewer facilities

Notes:

- (1) Prepared and distributed by State of Maryland's Department of Planning
- (2) Available in Paper and Electronically

Schematic drawings showing arrangements of site development, piping, appurtenances, special structures and the like, will help to convey what the Designer is considering and will tend to expedite the review and approval process as well as providing a firm basis for proceeding with the construction plans.

CHAPTER 3

WATER MAIN DESIGN

**CHAPTER 3
WATER MAIN DESIGN**

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CHAPTER 3 WATER MAIN DESIGN

3.1 General

A. Responsibility of the Designer

This chapter addresses the selection and use of design criteria and practices applicable to the design of water system projects in Howard County. The subject matter discussed includes the layout of piping systems, selection and employment of pipeline materials and the use of appurtenances. While the requirements described for the various aspects of design will include and cover the majority of conditions encountered, there is no intention to relieve the Designer of responsibility to recognize when conditions are not favorable for the application of standards. The Designer must be continually alert to conditions that cannot be satisfied by the application of these standard criteria.

B. Limitation of Topics Presented in Design Manual

It is not possible to include in this manual all features of design and drafting, which are necessary to accomplish the development of construction documents for all projects. The topics addressed are limited to those that will help the Designer perform most engineering tasks in an efficient manner and comply with County practice. Although it is the Designer's responsibility to exercise professional judgment in the acceptance or use of the standards or features of design included herein, the Designer shall recognize that they are given to assist in the development of the project in the manner preferred by Howard County. Deviations from the design standards must be brought to the attention of the DPW. Waivers of the design manual must be justified to the DPW, in writing, from an engineering evaluation, which includes consideration of life cycle costs and maintenance requirements. Approval or denial of the waiver requests will be by return letter signed by the Chief of the Bureau of Engineering.

C. Abbreviations

For standard abbreviations, see Section 1.2, "Abbreviations" of this design manual.

D. Definitions

Average Day Demand: The volume of water used in the year divided by 365 days, expressed in gallons or million gallons.

Average Day Rate: The water used during the Average Day Demand expressed in gallons per day (gpd) or million gallons per day (mgd) or divided by 1,440 minutes and expressed in gallons per minute (gpm).

Design Flow: The minimum flowrate required to satisfy the following demand and pressure conditions during a 24-hour period, expressed in gpm or MGD:

Maximum Day Demand:	40 psi minimum at curb
Peak Hour Demand:	30 psi minimum at curb
Maximum Day + Fire Flow Rate:	20 psi minimum at curb

Distribution Mains: Water mains connecting the transmission mains to the water house connections. The distribution mains provide area wide fire protection. Generally, the distribution mains will be in a grid or branched configuration.

Maximum Day Demand: The largest volume of water used in one day during the year, expressed in gallons or million gallons.

Maximum Day Rate: The volume of water used during the Maximum Day Demand expressed in gallons per day (gpd) or million gallons per day (mgd) or divided by 1,440 minutes and expressed in gallons per minute (gpm).

Peak Hour Demand: The largest volume of water used in one hour during the year expressed in gallons or million gallons. The Peak Hour Demand usually occurs during Maximum Day Demand.

Peak Hour Rate: The Peak Hour Demand volume divided by 60 minutes, expressed in gpm; or multiplied by 24 hours, expressed as mgd.

Transmission Mains: Large diameter water mains that convey water from the supply source to the storage facilities and the distribution mains.

Water House Connection: Service lines within public roads or rights-of-way connecting the distribution mains to individual homes, buildings or facilities for both consumptive use and on site fire protection.

3.2 Design Criteria

A. General

The sizing of major components of the County water supply system such as transmission mains, major distribution mains, storage facilities and booster pumping facilities are generally the responsibility of the DPW.

The Master Plan generally shows the major existing and planned supply system components. The Designer shall be familiar with and design in accordance with the Master Plan.

Generally, the Designer will be selecting distribution mains of 12-inch diameter and smaller and often will be required to provide the minimum size mains meeting the design criteria as presented in Section 3.3A, "Hydraulic Computations".

The water design criteria presented herein shall apply to Developer Projects as well as County funded Capital Projects. For Developer Projects, the Designer shall be familiar with “Sewage Disposal and Water Supply” regulations of the latest edition of the Howard County Subdivision and Land Development Regulations.

B. Pre-Design Meeting

Prior to commencing any work, the Designer is encouraged to schedule a pre-design meeting with the DPW, or other appropriate agency, to discuss any topics that are particularly important in the development of the Engineering Report and subsequent design of the project. Pertinent topics may include any of the following:

1. Sizing of major water supply components
2. Development of population projections and water demand
3. Applicable plumbing codes
4. Route selection and location of the pipe in the public right-of-way
5. Interaction with, and crossings of, other known utilities, particularly if those utilities employ cathodic protection systems
6. Methods of crossing roads, railroads, and streams
7. Pipe materials and appurtenances
8. Pipe access
9. Future extensions
10. Identification of any storage facilities in the network to be affected by the project
11. Requirement for new or upgrading of existing telemetry systems

For Developer Projects which require minor extensions of the public water and sewer systems, the pre-design meeting may take the form of a preliminary water and sewer plan showing the general layout of the utilities in relation to the proposed development. The plan shall be accompanied by a letter report, which shall include general information about the project, design criteria used, alternatives investigated and the cost estimates for all alternatives. The plan shall be submitted after the sketch plan for the development has been approved by the DPZ.

Developer Projects involving more than 200 residential units will be required to submit a comprehensive utility plan along with the engineering report unless waived by the Chief of the Bureau of Engineering. Following the comprehensive sketch plan approval; the Designer shall submit to the County a comprehensive utility plan showing the location and size of the water and sewer utilities within the development. The comprehensive utility plan shall be signed and sealed by a professional engineer registered in the State of Maryland.

If the construction of the utilities within a development is to be phased, the Designer shall provide a phasing plan showing the phasing and timing of the construction of the utilities. The phasing plan shall be signed and sealed by a professional engineer registered in the State of Maryland.

During each phase of the development, the public water and sewer systems must be able to support the design flow requirements noted in the Design Manual. The Designer shall provide calculations (computer simulations) for each phase of the development. The water system must be capable of supporting the maximum day demand rate plus a two-hour fire flow while maintaining the minimum required pressure for each phase of the development.

Seven copies of the comprehensive utility plan, phasing plan and engineering report shall be provided to the DPZ. The comprehensive utility plan and phasing plan shall have standard DPZ water and sewer title blocks with approval signature lines. Following approval, the comprehensive utility plan and phasing plan cannot be revised without the authorization of the County. Revisions to the comprehensive utility plan and phasing plan will require a reevaluation by the Designer of the design flows and the ability of the proposed water and sewer systems to meet Design Manual requirements. Changes to the comprehensive utility plan and phasing plan shall be noted in the revision blocks.

C. Demand Calculations

1. General

All population densities required for determining water demands are to be established as described in Chapter 2, "Design Analysis". The average day demand for a service area is the sum of the average day demands for the residential, institutional, commercial and industrial components within the service area. Similarly, the maximum day demand for a service area is the sum of the maximum day demands for the residential, institutional, commercial and industrial components within the service area.

2. Residential

For residential flows, average day demands shall be determined by multiplying the applicable population densities by the average day per capita demand indicated in Table 3.2A, "Average Day Water Demands". Maximum day and peak hour demands shall be determined by multiplying the applicable average day demand by the required peaking factor indicated in Table 3.2B, "Maximum Day and Peak Hour Peaking Factors".

TABLE 3.2A: AVERAGE DAY WATER DEMANDS

	Water Demand for Design Flows		
<i>Land Use</i>	<i>Average Day</i>	<i>Thru Meter (1)</i>	<i>Unaccountable (2)</i>
Residential	94 gpcd	80 gpcd	14 gpcd (3)
Institutional	412 gpad	350 gpad	62 gpad (4)
Commercial and Industrial	1,175 gpad	1,000 gpad	175 gpad

Notes:

- (1) Through meter flows are approximately 85% of average day demand
- (2) Unaccountable flows are approximately 15% of average day demand
- (3) gpcd: gallons per capita per day
- (4) gpad: gallons per acre per day

TABLE 3.2B: MAXIMUM DAY AND PEAK HOUR PEAKING FACTORS

	Peaking Factors	
<i>Design Flow Ratio</i>	<i>Communities</i>	<i>Major Systems</i>
Maximum Day Demand to Average Day Demand	2	1.7
Peak Hour Demand to Average Day Demand	4.5	2

3. Institutional, Commercial and Industrial Demands

For institutional, commercial and industrial flows, the estimation of average daily water consumption demands vary greatly dependent on the type of facility. With the exception of industries using process water, the fire demand generally is the major component of the design demand used to size distribution main extensions and service connections to buildings having sprinkler systems. For derivation of building design flows, the Designer shall refer to the County Plumbing Code if the number of fixture units is known or may be estimated. Likewise, the Designer shall determine the design flows based on building capacity, type of use, number of persons using the facility, projected processes, etc. Whichever estimate of design flows is greater shall be used for design purposes. When more specific information is unavailable, Table 3.2A shall be used to determine the average day demand.

Maximum day and peak hour demands shall be determined by multiplying the applicable average day demand by the required peaking factor indicated in Table 3.2B.

4. Fire Flow Rates: The required fire flow rates shall be calculated using Table 3.2C.

TABLE 3.2C: FIRE HYDRANT FLOW RATES FOR DESIGN

<i>Land Use</i>	<i>Design Fire Flow Rates (gpm)</i>
Residential (one and two family)	750
Residential (multi family), Commercial, Industrial, Educational, and Institutional	1,500*

*The special use of a property may require a higher flow rate that is to be accommodated by on site storage. Higher fire flow rates (and storage requirements) may be specified by the Owner, Fire Administrator's Office, or the Department of Inspections, Licenses and Permits.

The water system storage facilities shall be considered at their minimum elevation when determining fire flow residual pressures.

3.3 Water Main Design

A. Hydraulic Computations

1. General

As discussed in Chapter 2, "Engineering Reports," the DPW reserves the right to determine sizing of major water transmission mains, storage facilities and pumping stations based on the Master Plan.

For extensions or improvements to the public water system serving more than 200 residential units, or for critical areas of the public water system, the County may require the Designer to provide a computer-based hydraulic model of the effects of the proposed improvements on the public water system. To assist the Designer in the capacity analysis, the County will make available to the Designer a computer program to model the major water system components. The Designer shall consult the DPW for baseline information regarding pressures, pressure zone boundaries, system capacities and other operational considerations. The modeling shall be based on the constraints outlined in the Master Plan. Computer model simulations of the proposed water system improvements shall be submitted to the DPW for review and approval.

If required, 24 and 48-hour extended period computer simulations shall be performed using average day demand, maximum day demand, and peak hour demand, for both current and full development conditions.

The hourly demand ratios used in the 24 and 48-hour extended period simulations for average day demand and maximum day demand shall be based on actual Howard County average day demand and maximum day demand records, or as

directed by Howard County. Hourly demand ratios shall be calculated by dividing each hour's water demand by that day's average hourly water demand. The highest hourly ratio experienced during the maximum day demand is the peak hour demand ratio for that water pressure zone. The hourly demand ratios may differ between water pressure zones. During the extended period simulations, all water pressure zones shall be connected to allow modeling of pumping station suction pressures and storage tank refill rates. Fire flows shall be modeled as a single event assuming a maximum day demand ratio of 1.0 and a 2-hour fire event at 1,500 gpm with all water storage facilities assumed empty. If proposed designs require modifications to the Master Plan, the Designer shall pursue such changes in accordance with the County Code and applicable regulations.

The Hazen-Williams formula shall be used in the determination of friction loss for all piping. See Table 3.3A, "Hazen-Williams 'C' Factors" for appropriate C-values. The Hydraulics Institute Standards shall be used for head-loss attributed to pipe fittings and other miscellaneous appurtenances. Where the Hydraulic Institute Standards do not apply, the head-loss for these items shall be in accordance with the manufacturers certified test data for the item. The Designer shall submit design data and calculations for all water projects, whether they are the work of others (properly referenced) or the Designer's own work. The design data and computations shall include average and peak demands, fire demand and future requirements. Design computations for all special structures shall be submitted.

2. Design Flows and Residual Pressures

The Designer shall follow the guidelines in this manual for the derivation of design flows. The calculation of the design flow rate will usually require the computation of the average day rate for the facility, application of a peaking factor to derive the maximum day rate and then addition of the fire flow requirement. System losses are accounted for in the peaking factors.

Water house connections (WHCs), distribution mains and transmission mains shall be sized in accordance with the Master Plan and the Howard County Plumbing Code. The following three pressure requirements must be met within the distribution system and are to be used in the design of public water mains whether they will be constructed by a Developer or Capital Project.

- Maximum Day Demand: 40 psi minimum at the curb
- Peak Hour Demand: 30 psi minimum at the curb
- Maximum Day Rate + Fire Flow Rate: 20 psi minimum residual maintained at the curb

In some locations, the main size will be determined by the flow rate required to refill a storage facility, which may be more critical than the above requirements. The DPW will identify this design condition, if applicable.

First floor elevations of served facilities shall not exceed the applicable County pressure gradient elevation minus 90 feet (i.e., maximum first floor elevation in Howard County's 550 water zone = 550' - 90' = 460' above sea level). If this situation is unavoidable, the served facilities will be provided with a connection to an adjacent higher-pressure zone or provided with a water booster pumping system to achieve the pressure requirements.

In areas where static pressures are projected to exceed 60 psi, the Designer shall be responsible for fully identifying these areas on the plans and note that pressure reducing valves will be required for service connections (present or future).

3. Flow Velocities

Although the flow velocities and direction may vary considerably in distribution mains, there are upper and lower velocity limits that indicate to the Designer that design deficiencies may exist. The following are useful guidelines:

- a. Velocities greater than 6 fps at the maximum day rate of flow may produce large friction losses and high potential for valve and joint damage due to water hammer. Velocities greater than 6 fps at the maximum day rate shall be avoided.
- b. The design of pipelines based solely on velocity considerations may not provide optimum operating conditions for the distribution system.

4. Hazen-Williams "C" and Minor Losses

The total head loss at the point of discharge for design flows shall be the sum of both friction and minor losses. The elevation difference between the source and discharge point shall be algebraically added to the total head loss.

Head losses for new pipes shall be computed using the Hazen-Williams formula and the following coefficients:

TABLE 3.3 A HAZEN-WILLIAMS “C” FACTORS

Type	Pipe Diameter	Hazen-Williams “C”
Service Connections		
Copper	1" – 2"	130
DIP (Cement Lined)	4"	120
Distribution Mains		
DIP (Cement Lined)	4"-8"	120
DIP (Cement Lined)	10"-12"	130
Transmission Mains		
All Material (Cement Lined)	16"-20"	130
All Material (Cement Lined)	24" – and larger	135

B. Pipeline Alignment

1. General

The Designer has the responsibility to identify where factors of good planning and design are in conflict with these guidelines and requirements of other agencies. The proposed alignment must be the best overall design. Failure to identify conflicts during the preliminary design may result in delays and possibly costly changes.

Consideration must be given to space requirements for future utilities, particularly sanitary sewers and storm drains. In the absence of sewer or storm drain design, the Designer shall recommend the space requirements of the sewer or drainage facilities and provide the necessary clearances. This requirement is particularly important at roadway intersections.

The Designer shall identify and locate all existing and underground facilities before selecting the location of the pipeline. When plans of existing facilities are insufficient to accurately locate existing underground obstructions, the designer shall request the DPW for permission to perform test pit excavations to uncover the subject facility so that the horizontal and vertical positions of existing utilities can be accurately determined. If approved, the Designer will be responsible for providing all traffic control and public safety measures necessary to locate the utilities and restore the surface. The Designer shall coordinate the test pit operations and provide a field survey crew to physically locate the subject facility. A utility permit will be required from the Howard County Bureau of Utilities for all test pit excavations.

The Designer shall also adhere to the requirements in Chapter 5, “Geotechnical Design Criteria,” when selecting the horizontal alignment.

2. Horizontal Alignment - Location

The horizontal alignment shall take into account the following general alignment guidelines. Pipelines larger than 12 inches in diameter may have other limitations and requirements that alter these general alignment guidelines.

- a. Extensions of distribution mains will normally be in a grid pattern with interconnecting nodes at street intersections.
- b. In the layout of distribution mains, non-looped situations shall be avoided. All mains both internal to the project and external shall be continued to the nearest point of connection as directed by the DPW. Where temporary non-looped connections are appropriate, the main shall be terminated so as to facilitate connection or extension in the future with minimal inconvenience to the existing system. In situations where non-looped mains cannot be reasonably avoided, the following criteria shall prevail:
 - 1) The water distribution system for residential areas where fire protection is to be provided shall meet the following criteria. The maximum length of non-looped 6-inch mains shall be 600 ft. The maximum length of non-looped 8-inch mains shall be 2,500 ft. or the length required to provide service to not more than 50 units, whichever is shorter. A non-looped condition exceeding these criteria may be allowed on a temporary basis. However, if the DPW determines that the non-looped condition will exist for an unacceptable length of time (for example, a line extension that is dependent on future development which has not been initiated), the network must be extended to provide for immediate looping of the system. All easements shall be provided where required by the DPW for the looping of the public water system.
 - 2) The water distribution mains for institutional, commercial and industrial areas where fire protection is to be provided shall meet the following criteria. The minimum size shall be 8-inch, except for fire hydrant leads of less than 200 ft. and service connections. The maximum lengths of non-looped 8-inch mains shall be 800 ft. and the maximum length of non-looped 12-inch mains shall be 2,000 ft. All easements shall be provided where required by the DPW for the looping of the public water system.
- c. In Developer Projects where all new facilities are to be constructed, and in existing developments with curbs, water mains are usually placed 7 feet from the centerline of the street and on the side nearest the higher ground. Mains shall be located within the pavement area, wherever possible, and no less than 5 feet from face of curb or proposed curb. Water main location usually

defers to the location selected or reserved for the sewer main, which will normally be on the opposite side of the street centerline and 7 feet therefrom. Occasionally, when the number of lots or houses makes it cost effective, the sewer main will be designed on the high side of the street. On curved streets, care must be taken to observe minimum horizontal and vertical clearances between water and sewer mains. See Chapter 5, "Crossings and Clearances" for appropriate crossing and clearance design guidelines.

- d. In Developer Projects, the design of the public water, sewer and storm drain utilities within proposed developments shall be prepared concurrently to ensure compatibility of the utilities. If public water and sewer mains cannot be located within the paved roadway section, the Designer shall request a waiver of the design standards and provide reasons why the standards not be met.
- e. Distribution mains may be designed on a curved alignment to reduce the number of bends. Along curves, the maximum joint deflection angle for 12-inch and under diameter pipe is 4 degrees. The maximum joint deflection angle for 14-inch and over diameter pipe is 2-1/2 degrees. These values, recommended by AWWA C-600 for design, are approximately 80 percent of the maximum manufacturers recommended deflections.
- f. In existing developments where roads are paved, and without curbs, the water main is generally placed outside the edge of paving and inside the right-of-way line in a location having the least conflict with existing utilities. This alignment shall be on the high side of the street, or on the side opposite the one reserved for the sewer main. When existing underground utilities are in place such as gas, telephone, or electric, water mains are normally placed on the same side so as to preserve space for sewers clear of these obstructions.
- g. The alignment within existing areas (streets or roads), shall avoid high traffic volume roads, if other options are available. The alignment shall be designed to allow the construction of the pipeline without the need to have road closings. When a water main is required to cross a Howard County road, the Designer, after considering the type and condition of the road, traffic volumes, disruption to traffic, possible conflicts with existing utilities, and specific conditions on the project site, shall recommend whether to open cut, tunnel, or jack and bore the utility across the roadway, on a case by case basis. The Chief of the Bureau of Engineering shall make the final decision as to the method to be used and the approved method shall be noted on the plans by the Designer.
- h. In existing areas (streets or roads) the alignment shall also try to avoid the removal of trees or landscaped areas. In parks and public rights-of-way where location of the water main would require removal of trees, the Designer shall obtain the approval of the appropriate agency or agencies for

tree removal. When the pipeline must be located outside the road right-of-way, the alignment shall be located to minimize disruption to environmental features. In addition to trees, the alignment shall attempt to avoid steep slopes, wetlands and other sensitive areas. The alignment shall follow the property lines as much as possible.

- i. When existing roadways are involved, the horizontal alignment of the road must be evaluated for acceptable geometry and the water main designed with respect to these possible roadway improvements to avoid costly relocations. The Designer shall evaluate the plan geometry of the road with respect to movement of traffic and available right-of-way width for the accommodation of the pipeline. If easements must be acquired for the main, a recommendation shall be provided to the DPW as to whether additional rights-of-way shall be acquired for future roadway modifications.
- j. Water main easements are routinely acquired during the subdivision process for the future extensions of the water system to serve adjacent properties. Where the future extension of the water main would undermine a foundation of a structure, a water main shall be constructed as part of the subdivision.

In residential subdivisions where an easement is required between two adjacent lots for the extension of the water system, a water main shall be provided within the easement between the adjacent lots. The water main shall extend the full length of the easement between the lots.

In cases where only a utility easement is required to be extended to the limits of the property being developed in order to provide future service to an adjacent property, that easement shall be cleared and otherwise prepared for the future extension of the main.

- k. In Developer Projects, utilities owned by other public and private entities such as gas, electric, telephone, cable TV and others, shall be located within the shoulder of the road or behind the curb line. If necessary, a 5-foot wide easement contiguous to the road right-of-way line shall be provided for the placement of these utilities. Within private roads, public water mains shall be located within the paved roadway sections, whenever possible.

3. Vertical Alignment - Location

The vertical alignment shall take into account the following general alignment guidelines:

- a. The minimum ground cover required over a water main is 3.5 feet and is measured from the outside top of pipe to the actual ground surface in existing developments. In new subdivisions, when grading and paving is to be accomplished as part of the project, the cover is measured from the top of the pipe to finished grade.

- b. When existing roadways are involved, the vertical alignment of the road must be evaluated for acceptable geometry and the main designed with respect to possible roadway improvements to avoid costly relocations. Acceptable geometry shall be determined by current roadway design standards. Where existing conditions are sub-standard, the Designer shall superimpose an improved grade on the profile and shall use this grade in the vertical positioning of the main where applicable. When a centerline road grade is thus established by the Designer, the main shall be designed to maintain the necessary cover below existing ground where fills are indicated and below the proposed grade where cuts are indicated. Plan and profile realignment must be considered in a coordinated manner.

When the Designer establishes or uses a proposed centerline grade by others in connection with a water main design layout, the Designer shall identify the origin of this grade on the profile.

4. Sizing

Distribution mains shall be sized to provide the required design flow rate and residual pressures as detailed in Section 3.3.A, "Hydraulic Computation," of this chapter.

5. Cover

Minimum ground cover over water mains shall be 3' - 6", except at crossings over other utilities where a minimum cover of 3' - 0" shall be maintained. The maximum ground cover permitted over distribution mains is 8' - 0."

In areas outside of existing or planned streets, cover shall be measured from existing grade. The Designer shall thoroughly investigate, and make suitable allowances for likely changes to existing topography. Such changes include future erosion of streambeds or grading of lots.

C. Water Mains : Plan

1. Water main plans shall be drawn to a scale of 1" = 50'
2. All proposed pipe shall be shown and symbolized as shown in the Standard Details. More specifically, the pipe is to be identified by two parallel lines, with alternating segments evenly shaded, showing valves, vaults and fittings. Pipe lines 24-inches in diameter and smaller shall be shown symbolically as two-feet wide as a minimum, based on a scale of 1" = 50'. Pipe lines over 24-inches in diameter shall be shown to scale.
3. All pipe sizes shall be clearly identified. The pipeline and appurtenances shall be carefully dimensioned in the plan view of the plans, so that the horizontal alignment is clearly identified and fixed. Dimensioning of the proposed facility,

including fittings and appurtenances, shall be as noted in Section 5.2, "Control, Topographic and Construction Surveys." Fittings shall be shown by symbols and identified by appropriate notation. Appurtenances shall be called by symbols and notes and dimensioned both in respect to pipeline stationing and in respect to required positions in relationship to surface features.

4. WHCs shall be shown in the plan view as a pipe from the main to the property line. See Section 3.5, "Water House Connections" of this Chapter for additional guidelines on the design of WHC.
5. The horizontal (and vertical) alignment changes of water mains must be made to follow changes in street alignment or to pass safely over, under or around obstructions. These changes in alignment may be made by the insertions of bends, joint deflections or beveled end pipe. The degree of deflections at joints, the length of pipe sections and the radius of the centerline curve of the pipe must be noted on the plans.
6. A restoration schedule shall be provided on the plans. The table shall cover the entire limits of the project and include restoration of all disturbed surfaces including roadways, grassed areas, driveways and open space. Where more than one material is required for restoration of the surface at a location (i.e. bituminous pavement to the right of the pipeline and sod to the left of the pipeline), the limits shall be noted and the material replaced in kind.

D. Water Mains: Profile

1. Profiles for water main are drawn to accompany the plan and shall be shown below the applicable plan layout on each sheet. For Developer Projects, the complete layout of the piping system may be shown in the plan view drawings. Profiles shall then be shown on a separate sheet and cross-referenced to the appropriate plan.
2. Profiles shall be drawn to a horizontal scale of 1"=50' and a vertical scale of 1"=5'.
3. Pipe diameters and manhole diameters, if applicable, shall be shown to scale. Pipe wall thickness shall be noted and shown for all concrete pipes and shaded.
4. Stations and invert elevations shall be provided on the water line profile at 50-foot intervals, at fittings and at all vertical and horizontal deflections.
5. Profiles within Proposed Roads:

In developing the profile information for water pipelines in proposed roads, the proposed centerline grade and stations of the roadway are to be used as the reference line for both the horizontal and vertical plane. Stations along the street centerline are established in plan and these stations and corresponding elevations

are transferred in true scale to the profile. Water main stations are projected in plan onto the centerline of the road and plotted in respect to this projection on the profile. Following this procedure means that the plan stations of the water main cannot be accurately scaled on the profile when there is any deviation from a tangent alignment in plan. Invert elevations are set to maintain not less than 3 ½ feet of pipe cover below the approved proposed centerline road grade or below the proposed grade over the centerline of the pipe, whichever is lower. On a combined water and sewer project, each utility shall be projected onto the centerline road grade.

6. Profiles Within or Outside Existing Roads:

In developing the profile information within or outside existing roads, the centerline length of the water main in plan shall be used for the profile stationing, which will provide true length profiles. For existing roads that do not conform to Volume III of the Design Manual, a centerline road grade conforming to the design standards is to be shown on the profile and identified as “possible future centerline road grade.” On a combined water and sewer project, the sewer shall be projected onto the water pipeline centerline.

7. For minimum vertical clearances see Chapter 5, “Crossings and Clearances.” When lesser clearances are desirable for cost or other reasons, special details must be developed to ensure no undesirable interaction between the two utilities.
8. Changes in vertical alignment of water mains shall be achieved by fittings, joint deflections or beveled joints. When changes in alignment are made in the horizontal and vertical plane simultaneously (see Chapter 5, “Rotation of Fittings” for design), the degree of change in both planes shall be indicated. The total joint deflection shall not exceed 80% of the manufacturer’s maximum recommended deflection measured from the axis of the pipe (see Section 3.3.B.2.e above).
9. For pipelines smaller than 24-inches in diameter, the pipeline profile may be shown with curves. Centerline pipeline stations and invert elevations shall be provided at fifty (50) foot intervals.
10. For pipelines 24 inches in diameter and larger, the pipeline shall be shown as a series of straight lines with deflections. The deflections shall be based on twenty (20) foot intervals with stations and invert elevations given at each deflection. When the pipeline is designed with no deflections, the stations and invert elevations shall be provided at fifty (50) foot intervals.
11. Invert elevations shall be provided for every high and low point on the pipeline profile.
12. Utilities that cross water mains shall be plotted to horizontal and vertical scale and identified so as to advise the Contractor of their specific locations. Stations and invert elevations shall be provided at every pipeline crossing for each pipe shown.

If the elevation of the existing pipeline to be crossed is unknown and it is likely to have a significant impact on the water main vertical alignment, the Designer shall arrange to have a test pit excavated to determine the exact horizontal and vertical location of the existing utility or utilities.

13. The type of fitting, the stationing of the fitting and the fitting invert elevation shall be shown on the profile.
14. Vertical deflections required to facilitate crossing of irregularities in terrain, such as rivers, streams, ditches, swales, etc. and to maintain clearance at other underground obstructions, shall be detailed at a larger scale showing existing and/or proposed grade, horizontal station, and invert elevations at each vertical fitting and joint deflection point.
15. The date of survey work used to establish ground lines shall be noted on the profile. Proposed, interim, future and possible future ground lines shall be shown where applicable as well as the source from which the information was acquired. The following information as minimum requirements shall be shown on the profile.
 - a. Property lines and property owner's name with lot, parcel number, liber/folio and street address
 - b. Road names
 - c. Areas requiring fill and compaction prior to pipe installation
 - d. Utilities, existing and proposed
 - e. Storm drains, existing and proposed
 - f. Existing ground elevation line
 - g. Proposed ground elevation line
 - h. Obstructions
 - i. Relocations of conflicting utilities
 - j. Establishment of streets grades

E. Pipeline Materials

1. Pipeline materials and installation practices employed by Howard County DPW are based on providing the maximum service capability with the least costs of installation and maintenance. Pipelines have a prolonged service life when properly designed and installed. There are many factors which must be considered in the selection and employment of design principles to reduce or eliminate failure and resulting costly repairs.
2. In the interest of fair and open competition, the Designer shall make recommendations and prepare plans to permit the widest range of employment of different materials and appurtenances consistent with the principles of economy and performance. The Designer is responsible for recommending specific materials and appurtenances required to correct potentially detrimental effects due to adverse site conditions that would render some products unacceptable.

3. Allowable water pipe materials for routine projects are Ductile Iron Pipe (DIP), Prestressed Concrete Cylinder Pipe (PCCP), Steel Pipe and Copper Pipe meeting the requirements of the Standard Specifications. Generally, for pipelines smaller than 36", only DIP and copper tubing are used in the public water system. PCCP and Steel Pipe, in addition to DIP, will be considered for transmission mains. The following tabulation shows the types of pipe that may be employed within the range of sizes or uses noted:

TABLE 3.3 B PIPE MATERIALS

<u>Pipe Material (Abbreviation)</u> <u>(Specification – Latest Edition)</u>	<u>Size - Inch - Diameter</u>
Distribution & Transmission Mains	
Pre-stressed Concrete Cylinder Pipe (PCCP) (AWWA C-301)	36" and larger
Steel Pipe (AWWA C-200)	36" and larger
Ductile Iron Pipe & Fittings (DIP) (AWWA C-151, C-153)	4" and larger
Cast Iron Pipe - Fittings Only (CIP) (AWWA C-110, C-111)	4" and larger
Service Lines – House Connections	
Copper Pipe (Federal Specification WW-T-799 –Type K)	1" through 2"
Ductile Iron Pipe & Fittings (DIP) AWWA C-151, C-153)	4" through 12"
Cast Iron Pipe - Fittings Only (CIP) (AWWA -110, C-111)	4" through 12"

Ductile iron pipe is required to have a double standard thickness cement lining.

Pipe materials other than those listed in the above table may be selected when specialized functions are to be satisfied. The use of alternate pipe materials must be approved by the DPW. When alternate pipe materials are to be used, the appropriate specifications shall be adhered to in the design.

4. The Designer shall indicate the pipe class designation in the General Notes on the plans and in the Special Provisions. Changes in the pipe class shall be shown with the limits defined on the pipeline profile. Selection of pipe class and wall thickness shall be as follows:

a. Copper Tubing, Type K

The copper tubing in the Standard Specifications is suitable for normal Howard County system pressures and earth cover.

b. DIP

The Standard Specifications use the “special” wall thickness classes of DIP (e.g. class 50, 51, etc.), given in AWWA C150. A special thickness class of 52 shall be used unless the Designer determines that an alternate special thickness class is required due to a special application (see below). The alternate must be calculated in accordance with the method given in AWWA Standard C150/ANSI A.21.50. The thickness of the selected class shall be equal to or greater than class 52, as the calculations require. In no case shall the pipe thickness be less than class 52. Pipe thickness, in combination with the pipe bedding, must be sufficient to resist excess deflection and bending stress, compensate for negative manufacturing tolerances and withstand internal operating and surge pressures.

Calculations shall be performed conservatively, based on using a Type 1 Laying Condition as defined in AWWA C-150. Where field conditions are expected to be moderate, the unit weight of soil shall be 120 pounds per cubic foot (pcf) and the truck load shall be a single AASHTO H-20 truck on unpaved road or flexible pavement with a 1.5 impact factor. A trench/bedding detail, as shown in the Standard Specifications, shall be placed on the plans.

c. DIP Wall Thickness for Special Applications

The wall thickness of DIP for the following special applications is not covered by the Standard Specifications. Additional consideration/calculations are required as indicated above:

- 1) Shallow cover, less than three and one half (3 1/2) feet.
- 2) Vehicular or equipment loading greater than AASHTO H-20 or HS-20 load configuration.
- 3) Operating pressures greater than those normally encountered in the Howard County water distribution system.
- 4) Excessive surge pressures. Pressures given in Table 3.3.C, “Maximum Permissible Surge Pressures,” shall be considered excessive and should be avoided if possible:

**TABLE 3.3 C
MAXIMUM PERMISSIBLE SURGE PRESSURES**

Pipeline Diameter in Inches	Surge Pressure in lb/in ²	Pipeline Diameter in Inches	Surge Pressure in lb/in ²
4 to 10	120	20	90
12 to 14	110	24	85
16 to 18	100	30 and above	80

The Designer shall exercise judgement in determining whether a detailed surge analysis is necessary. Conditions warranting a surge analysis may include the following:

- a) Impact of a power failure, pump start up or quick closure of discharge valves at water pumping station or in-line booster station.
 - b) Impact of water column separation
 - c) Rapid closure of in-line valves
 - d) Rapid closure of fire hydrants
 - e) Inadvertent, rapid closure of altitude valves at storage tanks
- d. PCCP

The design of PCCP to withstand the required external loads and internal pressure combinations shall be performed in conformance with the methods described in AWWA C-304. Where field conditions are expected to be moderate, the unit weight of soil shall be 120 pcf and HS20 truck loading shall be used unless other loading is specified.

- e. Steel Pipe

The design of Steel Pipe to withstand the required external loads and internal pressure combinations shall be performed in conformance with the methods described in AWWA M11.

5. Hydrostatic Pressure and Leak Tests

- a. Hydrostatic pressure testing of completed pipelines shall be performed as stipulated in the Standard Specifications. Test pressures to be induced at the low point of the test section shall be based on the static gradient within the pressure zone the pipe is to be installed plus the maximum surge pressure given in Table 3.3. C above for the specific pipe diameter.
- b. Hydrostatic leak tests shall also be performed as stipulated in the standard specifications. Test pressures to be induced at the high point of the test section shall be based on the static gradient within the pressure zone the pipe is to be installed in, but never less than 100 psi.

- c. The hydrostatic test pressures for pressure and leak tests shall be stipulated in the Special Provisions of the Contract Specifications.

F. Types of Joints

1. General

Pipe joints shall be in accordance with the Standard Specifications.

2. Ductile Iron Pipe (DIP)

- a. Pipe joints shall be push-on bell, unless otherwise noted on the plans or the Standard Details.

- 1) Allowable pipe joints for buried DIP shall be mechanical joint bell, plain end (for mechanical joint or push-on), push-on bell, or push-on bell with proprietary restrained joints as approved by the DPW.

- 2) Buried flange joints are generally not allowed because of the rigidity of the joint; however, the use of buried insulated flanged joints is permissible for corrosion control on a case-by-case basis. This type of joint requires a minimum special thickness class 53 DIP and the flanges are threaded and screwed on the pipe by the manufacturer. When the design requires insulating joints, a short piece of flanged pipe (flanged x plain end) shall be used. For design of insulating joints, see the Standard Details and Section 5.13, "Corrosion Control Surveys and Design."

- b. Joints for fittings shall be in accordance with the Standard Specifications and AWWA C110. Allowable joint ends on fittings shall be mechanical joint bell, plain end (for mechanical joint or push-on), push-on bell or push-on bell with proprietary restrained joints as approved by the DPW.

- c. When laying out a pipeline alignment, the Designer shall design the pipeline using push-on joint pipe, with mechanical joint fittings.

- d. When the design requires special restrained joints, Megalug or U. S. Pipe FieldLok Gasket type joint restraints shall be used. See Chapter 5, "Thrust Restraint Design for Buried Piping." The Designer shall submit the design of any other types of joints used for restraining the pipeline for review by the Howard County DPW. The use of restrained joints other than those listed above will require the approval of the DPW.

3. Steel Pipe and Prestressed Concrete Cylinder Pipe (PCCP)

Pipe joints shall be designed on a case-by-case basis and approved by the DPW.

G. Fittings

1. General

- a. The employment of properly designed concrete thrust blocks (buttresses and anchors) at fittings is of great importance. Details of these buttresses and anchors are shown in the Standard Details and are to be employed in all cases compatible with the design conditions. Where field conditions will not permit the use of buttresses and anchors, restrained joints using tie rods or harnessing may be employed. See Chapter 5, “Thrust Restraint Design For Buried Piping” for additional design requirements.

2. Bends

- a. The water main alignment shall minimize the use of bends. The Designer shall try to align the pipeline by deflecting the pipe joints. Deflecting the joints on bends is not permitted, unless design calculations for restraining the bend for the additional joint deflections are submitted in accordance with Chapter 5, “Thrust Restraint Design for Buried Piping.”

- b. Allowable bends are as follows: 1/4th or 90 degrees, 1/8th or 45 degrees, 1/16th or 22.5 degrees and 1/32th or 11.25 degrees.

1/4th or 90 degree bends in the horizontal plane shall be used only upon approval. 1/4th or 90 degree bends are not permitted in the vertical plane.

- c. Bends designed to be rotated in both the horizontal and vertical plane require special pipe restraint. The Designer must submit design calculations to the DPW for review and approval. See Chapter 5, “Rotation of Fittings” for design guidelines.

3. Tees

- a. The connecting branch pipe must be perpendicular ninety degrees (90°) to the mainline pipe.

- b. The Designer shall use a tapping sleeve and valve (TS&V) when connecting to an existing main having more than ten (10) domestic services that would be placed out of service during the installation of a tee (see Section 3.3.H, “Connections” of this chapter).

- c. No joint deflections are permitted at the branch connection of the tee.

- d. Tees that are designed to be rotated greater than five degrees (5°) in the vertical plane may require special pipe restraint.

4. Cross

- a. A cross is required for two perpendicular extensions, in close proximity, from the main pipeline. Tees shall not be used in lieu of crosses, unless the connections are spaced far enough apart. If the design requires connections on both sides of the pipeline and a cross cannot be used, the spacing between the tees shall be a minimum of ten (10) feet apart.
- b. A valve shall be installed on each branch, strapped to the cross. The branch connections of the cross must be extended a minimum of one full length of pipe on both sides of the cross, with the required standard thrust blocking on the ends. If a branch connection of a cross cannot be extended, the Designer shall utilize two tees, properly spaced, with valves strapped to the tees and the required standard thrust blocking.
- c. If the alignment from the cross requires using a reducer on one side of the cross, the Designer shall provide special pipe restraints for any unbalanced forces due to the reducer.

5. Welded-on Boss Outlets

- a. If the mainline pipe is DIP and 24-inches in diameter or larger, welded-on boss outlets, 8 inches and smaller, may be used in lieu of tees. The minimum size of welded-on boss outlets shall be 4-inches in diameter and the minimum class of DIP shall be special thickness class 52. Welded-on bosses shall also be considered for blow-off connections, 8-inches and smaller, and air valves 8 inches and smaller.
- b. If a welded-on boss is designed in lieu of a tee, it shall be restrained or blocked in the same manner as a tee.
- c. A note shall be provided on the plan and profile indicating the location of the welded-on boss outlet and type of outlet connection.
- d. The welded-on bosses shall be located on a mainline flanged pipe with the centerline of the outlet a minimum of $\frac{1}{2}$ the boss diameter plus 14-inches from the inside edge of the flange. For bosses on other than flanged pipe, the centerline of the outlet must be a minimum of five (5) feet from the bell face of the mainline pipe.
- e. The joint connections for welded-on bosses shall be flanged, as per AWWA C-110 or ASME/ANSI B16.1 Class 125, when installed in a vault or mechanical joint when buried.

6. Reducers

- a. Reducers are required for reducing the pipeline size. The Designer shall avoid using reducers on short runs of pipe, if the cost of downsizing the pipeline, which includes the reducer, pipe restraints for reducer, house connection taps with saddles, etc., exceeds the cost of the larger diameter pipeline.
- b. Reducers may require special pipe restraint for unbalanced forces.
- c. When reducing the pipe size on 16-inches and larger in diameter pipelines, the profile must be examined to determine if the reducer will create a high point at the large end of the reducer. This must be corrected with the use of an eccentric reducer.

7. Solid Sleeves and Mechanical Couplings

- a. Generally, mechanical joint solid sleeves shall be used for burial conditions and mechanical couplings with tie rods shall be used in vaults and structures.

H. Connections

1. General

Where connections to existing mains are to be made, the County will determine during the preliminary review whether the main shall remain in service necessitating the use of a TS&V or whether a specific shut down period can be accommodated for making the connections.

2. Tapping Sleeve and Valve

In general, a TS&V will be used for a connection 8-inches and larger in diameter, if the existing line serves more than 10 dwellings. The as-built plans and contract files shall be checked to ascertain the existing pipe class or thickness to design the appropriate compatible tapping sleeve and gasket. If the class or thickness of the existing pipeline cannot be identified, the Designer shall test pit the pipeline to determine the pipe outside diameter. The main being tapped may be the same size as the proposed main. The location of the tapping sleeve on DIP or CIP shall be designed so that the centerline of the connecting pipeline is a minimum of five (5) feet from the face of any existing bell joints. TS&V's shall be restrained or blocked in the same manner as a tee.

3. The County's practice is to prohibit the manipulation of valves by any party other than representatives of DPW's Bureau of Utilities. This practice shall be stated in all plans and specifications.

I. Relocation of Water Pipelines

1. General

When designing the relocation of a water main, the Designer shall consider such matters as environmental impact, maintenance of pedestrian and vehicular traffic, maintenance of existing and proposed utility services, constructability and system maintenance. In addition to the following, the design shall follow the requirements for water pipelines as stated elsewhere in this manual.

2. Alignment - Horizontal and Vertical

- a. When selecting an alignment, the existing pipeline must be maintained and stay in service until the relocated pipeline is ready for final connection to the existing main. The final connection must be designed to allow a quick shutdown and transfer of services, so that water service is not disrupted for an extended period.
- b. The relocated pipeline shall have a minimum ten (10) feet, centerline to centerline, horizontal clearance from the existing main, if the existing main is to remain in service during construction of the new main.
- c. The relocated pipeline shall have a minimum one (1) foot vertical clearance between the existing pipeline that will be abandoned by the relocation.
- d. The relocated alignment shall not disturb the existing blocking/restraints on the existing pipeline that is in service. Pipe restraints shall be designed for the relocated pipeline. If the shutdown time is limited, the design will require a quick-type blocking for restraining the relocated pipeline.
- e. The design of the relocated pipeline must provide for continuous service from the existing pipeline, until the relocated pipeline is placed in service. At that time, the existing pipeline shall be shutdown and all tie-ins and transfer of WHCs between the existing pipeline and the relocated pipeline shall be made.
- f. The Designer must contact the DPW for limitations on shutdowns of the existing pipeline. Conceptual approval from the DPW must be obtained if the Designer determines the existing pipeline must be replaced in the same location/alignment, which may require an extended shutdown period or provisions for temporary service.
- g. Abandonment of the existing pipeline, structures and /or appurtenances shall be shown on the plans, indicating the limits of abandonment and description of the facility to be abandoned and the method of abandonment. See Chapter 5, "Pipeline Abandonment."

- h. When large portions of the service area will be affected by the relocation or when service will be interrupted for extended periods, the DPW may require the use of linstops to reduce or eliminate the disruption time.

3.4 Appurtenances

A. General

There are numerous appurtenances incorporated in pipelines to ensure satisfactory and trouble-free performance and to provide a measure of control when emergency conditions prevail.

B. Valves

1. The placement of valves in a water distribution system at strategic locations is foremost in the control of the system. It is the responsibility of the Designer to ensure that the valves are located so that minimal disruption of water service will occur during maintenance, emergency conditions and future extension work.
2. Valves shall be provided at the intersection of water mains. A valve shall be placed on the outlet side of any cross or any tee. In a grid network, normally the number of valves will be the same as the number of pipes at the intersection. Where there are one or more dead ends, a valve on each pipe at an intersection shall be provided.
3. For high traffic volume intersections, to avoid disturbance to traffic flow and for ease of operation, valves shall be located outside the intersection on the projection of the street right-of-way line. The exception to this is where a branch main is considerably smaller, 4-inches or more than the major main, in which case the branch valve is placed as close as possible to the larger main and strapped. When a branch pipeline is not extended or stops at the road right-of-way line, the valve shall be located at the connection to the mainline pipeline. Valves on mains located in places other than street intersections are to be placed near fire hydrants for ease of location by field personnel.
4. When reducers are used, provide a valve on the smaller pipeline within twenty (20) feet of the reducer.
5. Valves shall be provided on mains between intersections and on dead end mains as noted below:

<u>Main Size</u>	<u>Maximum Valve Spacing</u>
6"	800 feet
8" to 12" (Multi-Family Residential Use)	500 feet
8" to 12" (Residential Land Use)	1000 feet
8" to 12" (Other Land Use)	1200 feet
14" to 16" (with WHCs)	1200 feet
14" to 16" (no WHCs)	2000 feet
Over 16"	3000 feet

On dead end mains for which no extension will be made in the future (cul-de-sacs), valves will be provided after the last fire hydrant (except when the fire hydrant is within 200 feet of the end of the water main).

6. When the existing County system requires a number of domestic services to be shut down during the installation of a connection, an additional valve shall be installed next to the connection on the mainline pipeline to reduce the number of domestic services placed out of water during any future shutdown.
7. Water zone division valves shall be provided when directed by Howard County. The following information shall be provided on the drawings:
 - a. Label the valve as a division valve and indicate size.
 - b. Show the pressure zone lines and indicate the zone pressure on each side of the valve.
 - c. Indicate if the valve shall be normally closed or open.
8. Water mains 4-inch to 24-inch in diameter shall have valves of the same size as the main. All valves larger than 24-inches in diameter shall have bevel gears and enclosed gear case.
9. All valves 4-inch to 24-inches in diameter shall be resilient seated gate valves (Baltimore Standard, Open Right) and comply with the Standard Specifications. Operators for direct buried valves 4 inch to 24-inches in diameter shall be housed in standard valve boxes. Valves larger than 30-inches in diameter shall be direct buried butterfly valves. Butterfly valves greater than 48-inches in diameter shall be specified by the Designer. Refer to the Standard Details for roadway valve box dimensions. See Section C below for valve vaults.
10. Valve stem extensions are required in accordance with the Standard Details when the top of the valve's operating nut exceeds three and one half (3 ½) feet of cover. The Designer shall provide the following note on the drawings: "See Standard Details for Valve Key Extensions."
11. The pipeline vertical alignment at the valve shall be designed as nearly parallel with the road grade as possible so that the valve may be installed upright and

perpendicular to the road grade. The adjusted vertical alignment at the valve shall be shown on the profile. When a valve is to be located on a pipeline that is not level, the Designer shall check the pipe slope and depth of the valve to verify that the buried valves will be operable.

C. Valve Vaults

1. All piping within the vault shall have flanged joints.
2. During the preliminary design, the Designer shall submit the vault layout for approval by the DPW.
3. A mechanical coupling or mechanical joint solid sleeve shall be included in the vault piping, for the removal of the valve, pipe and fittings within the vault. A mechanical coupling requires special pipe restraints. A mechanical joint solid sleeve requires the joints to be restrained, using Megalugs or retainer glands. The Designer shall determine the appropriate form of restraint based on the pressure rating requirements for each type of restraining joint.
4. The inside dimension of the vaults shall be determined by the dimensions of the piping assembly (valves, pipes and fittings) that is required in the vault.
5. The vaults for valves larger than 24-inches shall be designed as poured in place concrete vaults, giving the option to the contractor to provide pre-cast vaults.
6. On the profile, the Designer must determine the invert of the pipeline using the design depth shown on the details for the valve vaults.
7. The valve shall be restrained in the closed position.

D. Fire Hydrants

1. The fire hydrant is another common appurtenance for which the DPW has adopted standard details for installation. These requirements are shown in the Standard Details and include size of hydrant, valve and lead, location of hydrant with respect to the edge of the curb or road, valve location, bury length and joint restraint.
2. Normally, hydrants placed within developed sites are part of the public system; however, in certain instances, hydrants become part of the internal fire protection system and require specific arrangements and/or agreements with the DPW.
3. All hydrant barrels shall be a minimum of five and one quarter (5 1/4) inches in diameter and the connection (lead) from the main to the hydrant and the valve shall be six (6) inches in diameter.

4. Hydrants shall be located three (3) feet behind the back of the curb or two (2) feet behind the sidewalk on curbed streets. Hydrants shall be located within twelve (12) feet of the limit of stabilized shoulder or pavement of open section roads. Where the location behind the sidewalk or on an open section road places the hydrant less than five (5) feet from the road right-of-way/property line, the Designer shall obtain a utility easement from the property owner conforming to the Standard Details.
5. Hydrant valves shall be located next to the tee on all fire hydrant leads.
6. The bury length required for each fire and blow-off hydrant shall be noted on the plans. The bury length shall be determined by the vertical distance from the applicable existing or proposed grade at the hydrant to the invert of the branch of the tee in the main line. The accuracy of this length is to be given to the nearest half (0.50) of a foot. The main line tee elevation shall be designed to provide for a level run from the main to the hydrant and maintain adequate cover over the hydrant lead. For this reason the minimum bury length is four (4) feet. The maximum bury length is eight (8) feet and additional length will require the DPW's approval. The invert elevation and station of the hydrant tee on the main line shall be noted on the profile. The bury line elevation and bury length of the hydrant shall be noted in the plan view. For installation on existing grades, bury lengths shall be determined from field surveys.
7. Profiles will be required in the following cases:
 - a. When the fire hydrant lead crosses other utilities, except when it is clear from the profile of the water main that the hydrant lead has sufficient clearance.
 - b. When the grade/ground line at the hydrant location and over the hydrant lead is not the same as the mainline pipe.
 - c. When bends are required for the fire hydrant lead. Fire hydrant leads shall not have bends, offsets, etc. between the fire hydrant tee and the fire hydrant if at all possible.
8. Where bends are required for fire hydrant leads, the Designer shall use smooth transition, restrained, s-bends specifically designed for hydrant use.
9. Hydrants shall be restrained at every joint with mechanical joint restraints from the tee through to the hydrant or by a combination of mechanical joint restraints, ¾-inch threaded steel bars and concrete buttresses. See Standard Details for available options.
10. Hydrants shall be located along roadways with a spacing of 500 feet in one and two family dwelling unit areas and a hydrant spacing of 350 feet in all other areas. Hydrant spacing is measured along the water main. Hydrants may be required to be located at closer intervals if the existing or proposed buildings are located at a distance greater than normal from the roadway.

11. A fire hydrant shall be located at the neck of all cul-de-sacs or tee turn-arounds where the water main terminates within the roadway. When planning fire hydrant placement, the Designer shall first position a fire hydrant at the neck of each cul-de-sac having a terminating water line; and then, measure the required distance for the next fire hydrant placement. As always, fire hydrants will be located at intersections whenever possible. In many cases, it will be necessary to place a fire hydrant at both the neck of the cul-de-sac and at a nearby intersection, even if the distance between the two fire hydrants is closer than the required spacing.
12. Fire hydrants must be carefully placed to prevent interference with pedestrian and vehicular movement and to be accessible to Fire Department vehicles. Hydrants are usually located at the point of curvature of curbs at intersections and at common property lines, clear of driveway entrances.
13. Fire hydrants shall be protected by bollards in areas such as parking lots, where they are exposed to damage by vehicular traffic.

E. Blow-off Connections

1. Flush type hydrants, for use as a blow-off for maintenance activities, flushing and periodic removal of accumulated sediments shall be installed at the lowest elevation point of a water main system. They shall also be placed at the end of all dead end mains with a negative slope that do not have a fire hydrant within 75 feet of the end of the main. If a fire hydrant is located within 75 feet of a negatively sloping dead end main, a 1½-inch drain may be utilized at the dead end in lieu of a blow-off hydrant.
2. Fire hydrants may be utilized for permanent blow-offs when the location requirements for both types of hydrants are accommodated.
3. If possible, the blow-off shall be located as close as possible to an existing/proposed sanitary sewer manhole to allow for the disposal of the chlorinated water into the manhole. Under no conditions can the blow-off discharge piping be connected directly to a storm drain pipe or sanitary sewer pipe and/or any type of storm drain or sanitary sewer structure (inlet, manhole, etc.).

F. Air Valves

1. General
 - a. Air release valves and air vacuum valves are two basic types of air valves that are utilized to prevent or reduce the occurrence of air pockets and vacuum conditions, respectively, within pipelines. The two types of valves can be joined together to form a combination air valve that performs the functions of both. Air release valves contain a small discharge orifice (1/2 inch or less) that allows the escape of accumulated air under normal pipeline

operating conditions. Air vacuum valves contain a large discharge orifice (1/2 inch or larger) that allows the escape of large quantities of air during line filling and permits air to enter during line draining, with relatively small pressure differentials across the valves.

- b. Under normal operating pressures within the distribution system encountered in Howard County (25 to 60 psi), very little air is expected to accumulate. Fire hydrants set at summits can be manually operated to release or admit air under filling or emptying conditions. Furthermore, since collapse of water lines from negative pressures resulting from draining or a main break is normally not a factor with the type of pipe ordinarily employed, air vacuum valves may not be required under ordinary conditions in the distribution system.
2. Sizing of Air Release valves shall be as follows:
 - a. Design charts provided by the air release valve manufacturer shall be used to determine the orifice size required for an estimated rate of air release under a certain range of operating pressures. Various combinations of operating pressures and air release rates shall be considered to determine the optimum size of the air release valve. The Designer shall provide computations to justify the selection of the valve and orifice size. In making these calculations it is reasonable to assume that a pressurized water main contains 2% free air. See Standard Details for installation details.
 - b. The types and sizes shall be checked against the manufacturer's specification to ensure consistency between valve type, size, model number and the applicable operating pressure range.
 3. Sizing of Air Vacuum Valves shall be as follows:
 - a. Air vacuum valves shall be sized based on manufacturer's valve performance curves. The largest valve size shall be determined by considering normal operating conditions and a reasonable approximation of catastrophic conditions.
 - b. Air vacuum valve sizing shall consider slow venting of air during line filling. The Howard County Bureau of Utilities may be consulted with regard to line filling rates. In the absence of more detailed information, a line filling rate of one (1) foot per second is a satisfactory guideline.
 - c. Air vacuum valve sizing shall consider admission of air under operating conditions that generate negative pressures. These conditions may occur under normal use. For example, during the draining of the pipeline, the blow-off connection will be opened to drain the pipeline. The air vacuum valve shall be sized to admit air at the maximum, instantaneous rate of water discharging through the blow-off connection. During closure of a mainline

valve, negative pressure may develop in the pipeline, downstream of the mainline valve.

- d. There are also possibilities of the occurrence of negative pressure under catastrophic conditions, such as water column separation due to hydraulic transients or line breakage at a system low point. Under such conditions, it is necessary to estimate the rate at which an internal vacuum may occur. Reasonable assumptions shall be made as it is impractical to size vacuum valves using an excessively high rate of vacuum occurrence. Some manufacturers recommend using 60% of the negative pressure caused by a line break as the maximum catastrophic condition.
4. Location of the Air Release Valve, Air Vacuum Valve or Combination Air Release and Vacuum Valve shall be as follows:

The use of air release valves, air vacuum valves or combination air release and vacuum valves shall be minimized due to the susceptibility of the valves to operation and maintenance problems. The Designer shall exercise judgement in selecting the number and location of the air release valves, air vacuum valves or combination air release and vacuum valves. The following shall be considered in selecting appropriate locations for these valves:

- a. For transmission mains 16-inches in diameter and larger:
 - 1) Air release and air vacuum valves shall be considered at all high points.
 - 2) For pipelines with a decrease in upward slope, small orifice air release valves shall be considered on the downstream, less steep side of the slope change.
 - 3) For pipelines with an increase in downward slope, air release valves shall be considered on the downstream, steeper side of the slope change.
 - 4) For pipelines with long ascending profiles, an air vacuum valve shall be considered at ½ mile intervals along the upward sloping profile. For pipelines with long descending profiles or for pipelines with horizontal profiles, air vacuum valves and air release valves shall be considered at the same intervals along the pipeline.
 - 5) At mainline valves on transmission mains, air vacuum valves may be used to relieve negative pressures that may develop on the downstream side of the mainline valves when they are closed.
 - 6) For pipelines where a predominant flow direction cannot be defined, air release valves and air vacuum valves shall be considered at or near the high points, slope changes and along long pipeline profiles.
- b. For distribution mains less than 16-inches in diameter:

Excess air in distribution mains are often dissipated through service connections and fire hydrants. Due to the maintenance required on air release valves, air vacuum valves and combination air release and vacuum

valves, the use of such valves on distribution mains should be avoided if possible. This is an engineering judgement and it is the responsibility of the Designer to adequately protect the system. However, in areas along distribution mains where few service connections exist, the Designer shall use the same criteria for the placement of air release valves, air vacuum valves or combination air release and vacuum valves on distribution mains as on transmission mains.

5. Connecting the air release valve, air vacuum valves or combination air release and vacuum valve to the main pipeline shall be as follows:
 - a. For a valve with a 2-inch inlet or smaller, use a tapped corporation stop.
 - b. For a valve with a 3-inch inlet or larger or water mains 24-inches and larger in diameter, use a welded-on flanged boss outlet.
 - c. The air release valve or combination air release and vacuum valve shall be centered on a twenty (20) foot length of pipe, with both ends of the pipe section having the same elevation.
6. For air valve manhole and valve construction details see the Standard Details. The following shall be shown on the plans for air valves: size of valve and orifice size. The following shall be shown on the plans for combination air release and air vacuum valves:
 - a. Size of both valves
 - b. Orifice size of the air release valve
 - c. Model numbers
 - d. Piping layout
 - e. Pressure rating of the gate valve which shall be provided between the air vacuum valve and the air release valve.

The water main and manhole shall be designed at sufficient depth to accommodate access and maintenance of the air release, air vacuum or combination air release and air vacuum valve.

G. Entry Ports

1. When greater than 2000 feet of 30-inch or larger diameter pipe is proposed, the DPW will determine the necessity of entry ports. The DPW will advise the Designer of the requirements for pipe access at the pre-design meeting. During the preliminary design phase, the Designer shall determine the appropriate location and size for all required entry ports.
2. Entry ports shall be located on the pipeline at every high point with a maximum spacing of two thousand (2000) feet. If placed at a low point in the pipeline, an entry port may be combined with a blow-off.

3. The minimum and nominal size of the entry port opening shall be 24 inches in diameter. The fitting for the entry port shall be a flanged tee. A blind flange shall be designed to plug the branch outlet of the tee with the following requirements:
 - a. The material for the blind flange shall be steel, meeting the requirements of AWWA C207 and the Designer shall specify the class of flange per AWWA C207.
 - b. The Designer shall provide a design and detail for lifting handles on the blind flange. A total of four (4) handles shall be placed on the blind flange at ninety (90) degrees apart.
 - c. The vault shall have a hook or eyebolt on the underside of the top slab designed for removing the blind flange.
 - d. A $\frac{3}{4}$ -inch corporation stop shall be provided on top of the blind flange to verify that the pipeline has been isolated and dewatered, prior to removing the flange.
4. The entry port shall be located in a poured-in-place concrete vault or a precast vault. A platform shall be provided in the vault along the pipeline for access into the tee. The joints on the tee shall not be encased in concrete.

H. Specialty Valves

1. Altitude Valves
 - a. Altitude valves are designed for installation at water storage facilities (elevated tanks, standpipes or reservoirs) to control the water level at a specified level and prevent overflow.
 - b. The DPW shall determine the need for and the type of altitude valve required for a facility. The Designer shall design a vault to house the valve and appurtenances. The vault shall contain a watertight, H20 load sustaining, equipment access hatch designed directly over the center of the altitude valve, large enough to permit the removal of the valve. A watertight, H20 load sustaining, personnel access hatch shall also be provided, with a minimum 30" by 30" opening.
 - c. Gate valves shall be provided on each side of the altitude valve for maintenance or removal of the altitude valve. A bypass shall also be provided around the altitude valve with a gate valve, which will normally be closed in service.

2. Pressure Reducing Valves (PRV)

- a. A pressure reducing valve shall be designed whenever a water pipeline of high working pressure needs to be reduced to a lower working pressure. The DPW utilizes individual PRVs and system PRVs. Individual PRVs are designed to reduce the incoming pressure on a single WHC for a single property. System PRVs are publicly owned and operated and are designed to reduce the pressure within the public water system. The Designer shall determine if the project requires installation of individual PRVs or the installation of a system PRV and vault.

- b. Individual PRVs

The Howard County Plumbing and Gasfitting Code requires the installation of an individual PRV and an approved relief device after the meter when the static pressure is over sixty (60) psi. The Designer shall identify on the plans, all lots where the static pressure will exceed sixty (60) psi. The location of the PRV shall be in the service line after its entrance to the building.

- c. System PRVs

If a system PRV is required, the Designer shall determine the appropriate location for the PRV and submit the hydraulic analysis and proposed PRV location to the DPW for approval. After approval, the Designer shall determine the required sizes, type and pressure setting for the PRV.

For system PRVs, two PRVs are installed, one to handle peak fire flows and the other to handle low flows. Usually the smaller PRV is adjusted for a discharge pressure setting of five (5) psi above the setting of the larger PRV so that the smaller PRV will handle the low flow requirements. The large PRV opens only when demands exceed the capacity of the smaller PRV and the pressure drops to the pressure setting of the large PRV.

A vault shall be designed to house the system PRV and appurtenances. An equipment access opening of sufficient size shall be designed directly over the center of the PRV. Where two PRVs are required, the hatch shall be placed over the larger of the two PRVs. A personnel access hatch shall be provided with a 30-inch by 30-inch opening. The hatches shall be designed as watertight hatches and capable of sustaining an H20 load.

Gate valves shall be provided on each side of the PRV, for maintenance or removal of the PRV. Typically, the PRV is located on a branch line off of the primary water main between two tee connections. The branch from the first tee extends through the PRV vault and back to the second tee connection at the primary main. A divisional (gate) valve, normally closed, is installed

between the two tee connections on the primary main, which act as a bypass line to the PRV and vault.

Three (3) inch and larger PRVs shall have flanged ends and the pressure rating shall be designed similar to gate valves, class 125 ANSI valves. PRVs, smaller than 3-inches, shall have threaded ends (National Pipe Threads). The setting information for the PRVs shall be noted on the plans.

In most cases, when PRVs are required, the installation of a pressure relief valve will also be required.

3. Pressure Relief Valves

- a. Pressure relief valves are designed to protect the water pipeline against excessive pressure, and shall be used in conditions where the water pipeline has a pressure reducing valve connection from a higher pressure zone. The DPW will notify the Designer if the project requires the installation of a pressure relief valve and vault.
- b. A vault shall be designed to house the valve and appurtenances with hatches for equipment and personnel. The vault shall be similar to that required for the pressure reducing valve.
- c. An isolation gate valve shall be installed on the pressure side of the pressure relief valve at the branch connection to the mainline water pipe. The discharge of the pressure relief valve shall be designed to discharge to the atmosphere. The discharge piping shall not connect directly into a storm drain inlet, manhole or structure. The discharge end of the pipe shall have a flap valve to eliminate any potential cross-connection condition. Provide an end wall for the discharge piping in the location of the flap valve.
- d. The pressure setting information for the pressure relief valves shall be noted on the plans.

I. Tunnels and Casing Sleeves

1. Water mains are placed in tunnels or casing sleeves under railroads and highways or in other locations where open cut excavation is not allowed or is excessive in cost.
2. Steel liner plates shall be hot dipped galvanized and coated with bitumastic material according to the Standard Specifications. Steel casing sleeves shall be lined with bitumastic material, on the inside only, according to the Standard Specifications.
3. The ends of casing sleeves shall be bulkheaded to prevent entry of foreign objects. The water main included within the casing or tunnel shall be anchored and

designed for all internal and external forces, which can be transmitted without consideration of the casing pipe. The water main within the casing shall have restrained joints. The casing pipe will not be filled with concrete or grout, but the annular space between the main and casing pipe will remain open and accessible for repair and replacement of the main. Joints in the main shall be placed immediately outside the bulkhead to allow flexibility and to relieve shear stresses on the pipe.

4. Grouting plugs shall be provided in tunnel liners and steel casing sleeves 36 inches in diameter and larger, to facilitate pressure grouting of the annular space outside of the tunnel.
5. See Chapter 5, "Alternate Installation Techniques" for additional design criteria for tunneling or jack and bore installations.

3.5 Water House Connections

A. General

Water house connections (WHCs) provide the connections from the distribution main to the consumer's system at a convenient point along the property line. Small WHCs (2-inch and smaller) extend from the main to the property line using flexible pipe, terminating with a meter vault at the property line or public right-of-way line. All services are metered. Beginning on July 1, 2010, for all new services 2-inches and smaller in diameter, meters will be placed in outside meter vaults at the property line or right-of-way line per Volume IV Standard Details, with radio transmitters attached to the meters. Inside meter settings for small WHCs may be used with the approval of the DPW on a case by case basis.

All Large WHCs (4-inches and larger) shall be for inside meter settings per Volume IV Standard Details. Outside meter settings for large WHCs may only be used with the approval of the DPW.

The County does not permit the use of 3-inch pipe, therefore any 3-inch water connection (designated as such due to the need for a 3-inch water meter) shall use 4-inch diameter pipe per Volume IV Standard Details and shall be considered a Large WHC.

The County's construction work for water house connections, installed by the County or under County Contract, as well as the County's liability for the WHCs stops at the property line or public right-of-way line. Where outside meter settings are installed, the County's responsibility stops at the meter vault with the meter and appurtenances the responsibility of the County. Where inside meter settings are installed, the county's responsibility stops at the property line valve.

B. Location

1. WHCs shall be shown in the plan view as a pipe off of the mainline pipe to the front property line of the dwelling or building and shall be within the roadway right-of-way. Occasionally, water mains may be constructed within public

easements abutting or extending through a property. WHCs may be provided to properties abutting the public easement in which the water main is constructed. In this case, the public WHC extends from the water main to the edge of the public easement.

2. The location for a single WHC is generally at the center of the lot frontage unless the existing well location permits a more accurate setting, and must be a minimum of 10 feet from the location selected for the sewer house connection. See Chapter 5, "Crossings and Clearances" for additional options for clearances between water and sewer house connections. If possible, the WHCs shall be no closer than ten (10) feet to the edge of the property lines.
3. The property owner is usually given the option of locating a single service. The property owner's preferred location is considered accepted unless there are special design features or cost factors precluding his selection, such as where the design requires a twin WHC.
4. Twin WHCs shall be located at the property line between the two properties being served by the connection. When providing twin WHCs, particularly for individual dwellings/buildings, consideration shall be given to the location of telephone, cable and electric appurtenances, which are typically located at the property line between lots.
5. All WHCs shall be designed a minimum 5' - 0" clear horizontally from permanent structures and other utility appurtenances such as storm drain inlets, street lighting poles, transformers, etc. and adjacent parallel piping, with the exception of SHCs.

C. Size of Single and Twin Unit WHCs

1. The minimum size of a single residential WHC is 1½ -inch diameter with a 1-inch meter, per Volume IV Standard Details.
2. Two dwellings may be served by a 1½-inch diameter WHC from the main to a twin meter vault at the common property line. Each dwelling shall have a 1-inch meter and a 1½-inch diameter WHC, per Volume IV Standard Detail W 3.32.

D. Multi-family, Commercial and Industrial Facilities

1. The size of the WHC is based on the usage requirements of each building as determined by the Designer. The Howard County Plumbing and Gasfitting Code shall be used for estimating demands.
2. If a multi-family building such as an apartment or condominium is provided with a sprinkler system, the WHC shall be sized to support the sprinkler system. The Designer shall submit computations to justify the sizing of the WHC.
3. WHCs or service connections for on-site water systems (4-inch and larger) must be located based on the design of the on-site system. The design of the connection will be typical of a small diameter water pipeline and shall be based on the design requirements for water pipelines.

4. Where large meters (1½-inch to 12-inches in size) are required, the Designer will be required to submit the flow calculations to substantiate the meter sizing to the DPW.
5. WHCs or service connections to accommodate fire flows require special design for each installation. Approved backflow preventers with metered bypass or compound meters are required when fire flows are included in the WHC. Compound meters are employed when design flow rates to a building, or groups of buildings, are high enough to require their installation to obtain accurate meter readings under all flow rates.

E. Limits of Public Water House Connections (in Public Rights-of-Way)

1. WHCs 2-inch and smaller
 - a. The WHC for outside meter settings shall terminate within the roadway right-of-way at the location shown in the Standard Details with an outside meter vault containing all internal piping and a two-foot stub. The meter vault must not be located within a curb or gutter section, and it must be located in a public right-of-way or public easement. The Designer shall avoid locating the meter vault within a sidewalk, driveway or any other paved surfaces.
 - b. The WHC for inside meter settings shall terminate at the property line with a curb stop and a two-foot stub (see Standard Details). The curb stop must not be located within a curb or gutter section, and it must be located in a public right-of-way or public easement. The Designer shall avoid locating the curb stop within a sidewalk, driveway or any other paved surfaces.
 - c. On rural roads, when the right-of-way limit ends at the edge of the paving or at the curb or gutter lines, the Designer will be required to provide the County with a right-of-way or easement for the WHC.
 - d. On private roads, water easements shall be sufficiently wide to accommodate outside meter vaults or curb stops outside the paved area and within the public easement.
2. WHCs 4-inch and larger
 - a. The WHC for outside meter settings shall terminate within the road right-of-way or public easement at the location shown in the Standard Details with a pre-cast or cast-in-place concrete vault with all internal piping (see Standard Details for piping layout and vault dimensions).
 - b. The WHC for inside meter settings shall terminate within the roadway right-of-way or public easement at the location shown and in the manner illustrated in Standard Details.

F. Location of Meters

1. WHCs 2-inch and smaller
 - a. WHCs 2-inches and smaller shall be designed in accordance with the Volume IV Standard Details to accommodate outside meter settings, unless otherwise specified by the DPW during the preliminary design phase. The Designer must obtain approval from the DPW for any or all inside meter settings that are not specified by the DPW.
 - b. The Designer shall avoid locating the outside meter setting within driveways or other paved surfaces whenever possible. The preferred location of the outside meter setting is in a grass area within the road right-of-way and outside of traffic bearing areas. See Standard Details for preferred locations.
 - c. Provide a minimum 5' - 0" horizontal clearance between meter setting and all permanent structures such as storm drain inlets, street light poles, other utility appurtenances and pipelines.
2. WHCs 4-inch and larger
 - a. During the preliminary design phase, the Designer shall coordinate the location of the meter with the Howard County Bureau of Utilities Meter Section (Inside or outside the dwelling/building). Also, see the requirements for large water meters in the Howard County Plumbing and Gasfitting Code.
 - b. For outside meters, larger than 2-inch, a note shall be added to the plans stating that the meter shall be supplied by the DPW upon payment of fees and installed by the Developer's contractor. (See Standard Details for vault piping, meter and valve assembly configurations and dimensions.)

G. Allowable Pipe Material for WHCs

1. For WHCs 2-inch and smaller, the pipe material shall be copper per Standard Specifications.
2. For WHCs 4-inch and larger, the pipe material shall be DIP per Standard Specifications.
3. The County does not permit 3-inch WHCs.

H. Cover

The normal minimum cover over WHCs shall be 3'-6" except at crossings over other utilities, where a minimum cover of 3'-0" shall be maintained. The maximum ground cover permitted over WHCs is 6'-0."

CHAPTER 4

SEWER MAIN DESIGN

**CHAPTER 4
SEWER MAIN DESIGN**

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CHAPTER 4 SEWER MAIN DESIGN

4.1 General

A. **Responsibility of the Designer**

This chapter addresses the selection and use of design criteria and practices applicable to the design of sewer system projects in Howard County. The subject matter discussed includes the layout of piping systems, the selection and employment of pipeline materials and the use of appurtenances. While the requirements described for the various aspects of design will include and cover the majority of conditions encountered, there is no intention to relieve the Designer of responsibility to recognize when conditions are not favorable for the application of standards. In the preparation of the contract documents, the Designer shall take into account such matters as environmental impact, maintenance of pedestrian and vehicular traffic, maintenance of existing and proposed utility services, constructability, system maintenance and shall produce the overall most cost-effective design. The Designer must be continually alert to conditions that cannot be satisfied by the application of these standard criteria.

B. **Limitation of Topics Presented in Design Manual**

It is not possible to include in this manual all features of design and drafting, which are necessary to accomplish the development of construction documents for all projects. The topics addressed are limited to those that will help the Designer perform most tasks in an efficient manner and comply with County practice. Although it is the Designer's responsibility to exercise professional judgment in the acceptance or use of the standards or features of design included herein, the Designer shall recognize that they are given to assist in the development of the project in the manner preferred by Howard County. Deviations from the design standards must be brought to the attention of the DPW. Waivers from the design manual must be justified to the DPW, in writing, from an engineering evaluation standpoint that includes consideration of life cycle costs and ease of maintenance. Approval or denial of the waiver requests will be by return letter signed by the Chief of the Bureau of Engineering.

C. **Abbreviations**

For standard abbreviations, see Section 1.2 "Abbreviations" of this design manual.

D. **Definitions**

Average Day Flow Rate: The volume of wastewater generated in a year divided by 365, expressed in gpd or mgd.

Building Sewer: A sanitary sewer, which conveys wastewater from a private residential, commercial or industrial structure to the public sewer. The building sewer extends from the structure being served to the public right-of-way or easement line.

Collector Sewer: A sanitary sewer constructed to transport wastewater to an interceptor sanitary sewer. A collector sewer is a public sewer main designed to serve one or more customers. All collector sewers shall start and end with a structure.

Design Flow Rate: The design flow rate shall be the sum of the peaked average day flow rate for the service area plus an infiltration and inflow allowance as described in Section 4.2 “Design Criteria” of this chapter.

Drop House Connection (DHC): A sewer house connection (SHC) that extends vertically from the collector sewer and then horizontally to the building sewer at the property line.

Force Main: A pressurized sanitary sewer that conveys wastewater from a pumping station to a higher elevation in the sewer system from which gravity flow may resume.

Interceptor Sewer: A sanitary sewer used to transport wastewater from collector sewers within a drainage basin to another interceptor sewer or a treatment plant.

Sewer House Connection (SHC): A sanitary sewer which conveys wastewater from a building sewer to a collector sewer. The SHC extends from the collector sewer to the public right-of-way or easement line.

4.2 Design Criteria

A. General

The sizing of major components of the County sewer collection and conveyance system such as major pumping stations, force mains and interceptor sewers are generally the responsibility of the DPW.

The Master Plan shows the major existing and planned wastewater collection and conveyance system components. The Designer shall be familiar with and design in accordance with the approved Master Plan.

The sewer design criteria presented herein shall apply to both Developer and Capital Projects. For Developer Projects, the Designer shall be familiar with “Sewage Disposal and Water Supply” regulations of the latest edition of the Howard County Subdivision and Land Development Regulations.

B. Pre-Design Meeting

Prior to commencing any work, the Designer is encouraged to schedule a pre-design meeting with the DPW or other appropriate agency to discuss any topics, which are particularly important in the development of the Engineering Report and subsequent design of the project. Pertinent topics may include any of the following:

1. Preliminary or prior reports prepared by the County, if applicable

2. Development of population projections and wastewater flows
3. Sizing of major system components
4. Applicable plumbing codes
5. Limit of project and future extension, if planned
6. Route selection and location of pipe in public right-of-way
7. Pipe materials and appurtenances
8. Design criteria to be used
9. Both design constraints due to and anticipated interaction with existing utilities
10. Soil conditions that may affect infiltration and inflow in pipes and appurtenances
11. Bedding requirements
12. Special topographic conditions affecting design such as slopes, streams, floodplain and stream crossings
13. Special permitting issues created by the presence of wetlands, rare and endangered species, historical and/or archaeological artifacts
14. Easement requirements
15. Conditions affecting traffic maintenance and control

For Developer Projects which require minor extensions of the public water and sewer systems, the pre-design meeting may take the form of a preliminary water and sewer plan showing the general layout of the utilities in relation to the proposed development. The plan shall be accompanied by a letter report, which shall include general information about the project, design criteria used, alternatives investigated and the cost estimates for all alternatives. The plan shall be submitted after the sketch plan for the development has been approved by the DPZ.

Developer Projects involving more than 200 residential units will be required to submit a comprehensive utility plan along with the engineering report unless waived by the Chief of the Bureau of Engineering. Following the comprehensive sketch plan approval, the Designer shall submit to the County a comprehensive utility plan showing the location and size of the water and sewer utilities within the development. The comprehensive utility plan shall be signed and sealed by a professional engineer registered in the State of Maryland.

If the construction of the utilities within a development is to be phased, the Designer shall provide a phasing plan showing the phasing and timing of the construction of the utilities. The phasing plan shall be signed and sealed by a professional engineer registered in the State of Maryland.

During each phase of the development, the public water and sewer systems must be able to support the design flow requirements noted in the Design Manual. The Designer shall provide calculations for each phase of the development. For sewer systems, all downstream facilities must be sized to support the flows from each phase of the development. All improvements to collector sewers, interceptor sewers, wastewater pumping stations, force mains, and treatment facilities required to convey and treat wastewater from that phase must be in service prior to any units from that phase connecting to the public sewer system.

Seven copies of the comprehensive utility plan, phasing plan and engineering report shall be provided to the DPZ. The comprehensive utility plan and phasing plan shall have standard DPZ water and sewer title blocks with approval signature lines. Following approval, the comprehensive utility plan and phasing plan cannot be revised without the authorization of the County. Revisions to the comprehensive utility plan and phasing plan will require a reevaluation by the Designer of the design flows and the ability of the proposed water and sewer systems to meet Design Manual requirements. Changes to the comprehensive utility plan and phasing plan shall be noted in the revision blocks.

C. Wastewater Flow Calculations

1. General

Population densities required for wastewater flow calculations shall be established as described in Chapter 2, "Design Analysis". All components of the sewer system shall be sized to handle the design flow rate for the contributing area. The design flow rate shall be the sum of the peaked residential, peaked institutional, peaked industrial and peaked commercial flow rates for the service area plus the corresponding infiltration and inflow components within the service area.

2. Residential Flow Rates

Residential average day flow rates shall be determined by multiplying the applicable population densities by the average day flow indicated in Table 4.2A, "Average Day Flows for Wastewater Systems". The ratio of peak residential wastewater flow to average day residential wastewater flow is given by the empirical curve published by the Maryland State Department of Health and Mental Hygiene, now the Maryland Department of the Environment (MDE). A copy of the curve is included in Appendix D, "Diagram for Converting Average Daily Domestic Flow to Peak Flow".

All design computations for residential flow rates shall include the indicated allowance for inflow and infiltration. However, the Designer is cautioned not to include infiltration rates when determining peak residential flow rates since infiltration flows are considered to be constant flow rates. The design flow rate for residential areas is the peak residential flow rate plus the residential infiltration/inflow flow rate noted in Table 4.2A, "Average Day Flows for Wastewater Systems".

3. Commercial, Industrial and Institutional Flow Rates

Commercial, industrial and institutional average day flow rates shall be determined based on the information given in Appendix E, "Commercial/Industrial/Institutional Wastewater Flow Projections" when the number of persons using the facility or the gross area of the facility can be determined. If this information cannot be determined, the average daily flow shall

be determined by multiplying the applicable acreage by the average day flow indicated in Table 4.2A, “Average Day Flows for Wastewater Systems”.

All industrial, commercial and institutional design flow rates shall be calculated independently of residential design flow rates. Peaking factors for such facilities shall be determined by an analysis of historical data for such facilities. If such information is unavailable, the industrial, commercial and institutional wastewater design flow rates shall be determined by applying a peaking factor of 2 to the average day flow rate.

Table 4.2A: Average Day Flows for Wastewater Systems

Type of Use	Average Day Flow
Residential Usage	72 gallons per capita per day
Infiltration / Inflow – Residential Area	40 gallons per capita per day
Institutional Usage (1)	350 gallons per acre per day (2)
Industrial / Commercial Area (1)	1,000 gallons per acre per day (2)

Notes: (1) Also see Technical Bulletins: M-DHMH-EHA-S-001, “Design Guidelines for Sewerage Facilities”, Environmental Health Administration, Department of Health and Mental Hygiene, State of Maryland.

(2) Average day flow includes infiltration

4.3 Gravity Sewer Main Design

A. Hydraulic Calculations

1. General

As discussed in Chapter 2, “Engineering Reports,” the DPW reserves the right to determine sizing of major wastewater conveyance lines and pumping facilities, based on the Master Plan. If proposed designs require modifications to the Master Plan, the Designer shall pursue such changes in accordance with the County Code and applicable regulations.

For extensions or improvements to the public sewer system serving more than 200 residential units, or for critical areas of the public sewer system, the County may require the Designer to provide hydraulic calculations on the proposed sewer system improvements and the effects of the proposed improvements on the existing downstream sewer system. The Designer shall consult the DPW for information regarding available flow measurements, drainage area boundaries and other operational considerations. The hydraulic calculations on the proposed sewer system improvements and the effects on the downstream sewers shall be submitted to the DPW for review and approval.

The Manning Equation shall be used to determine the hydraulic capacity for all gravity systems. (See Table 4.3A, “Manning ‘n’ Coefficients”). The Designer shall submit design data and calculations for all sewer projects, whether they are

the work of others (properly referenced) or the Designer's own work. The design data and computations shall include average and peak flow rates, infiltration/inflow rates and design flow rates. Design computations for all special structures shall be submitted.

2. Pipeline Size

The size of the sanitary sewer shall be sufficient to carry the design flow rate with the hydraulic gradient coincident with or below the crown of the pipe. See Section 4.2.C, "Wastewater Flow Calculation" for design flow rate calculations. The design flow rate of the sewer shall not exceed the pipe capacity at full flow. Sanitary sewer designs allowing surcharging are not permitted. All sewer sizes shall be determined by the following Equation of Continuity relationship:

$$Q = AV$$

where:

Q = quantity of wastewater in cfs (design flow)

A = required cross sectional area of conduit in sq. ft.

V = velocity in feet per second

All sewer sizes shall continually increase progressing downstream. If there is an increase in the slope of the downstream sewer and the Designer determines that a smaller diameter sewer can accommodate the design flow rate, the Designer may reduce the downstream pipe diameter by one size. All such pipe reductions require the approval of the DPW.

3. Flow Velocity

Pipeline velocities shall be determined by the Manning formula:

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

where:

V = velocity in feet per second

n = coefficient of roughness

(see Table 4.3A "Manning "n" Coefficients")

s = slope of the hydraulic gradient in feet per foot

r = hydraulic radius = cross sectional area of liquid divided by wetted perimeter of the pipeline

Table 4.3A: Manning “n” Coefficients

Pipe Type (abbreviation)*	“n” Coefficient
Polyvinyl Chloride (PVC)	0.010
Ductile Iron Pipe (DIP) (Cement Lined)	0.013
Reinforced Concrete Pipe (RCP)	0.013

Notes: *See Section 4.3 E, “Pipeline Materials” for applicable design standards, specifications, and size limitations for individual pipe materials.

The minimum slopes for sewers of various sizes are shown in Table 4.3B, “Minimum Allowable Sewer Slopes”.

Laying pipes on slopes that provide minimum velocities shall be avoided whenever possible. Minimum velocities of 2.5 feet per second at design flow shall be provided whenever possible. Velocities of less than 2.5 feet per second will be permitted only with written authorization of the DPW. When pipelines are flowing less than half full, the fluid velocity shall be examined on the basis of partial flow relationships and the pipeline shall be sloped to maintain minimum velocities under the design flow conditions. A nomograph showing partial flow conditions for circular pipelines is provided in Appendix H.

Slopes producing design velocities greater than 10 feet per second shall be avoided whenever possible. Pipeline slopes exceeding 20% are permitted only with the approval of the DPW. See Section 5.10, “Concrete Encasements, Arches, Cradles and Anchors” within this design manual for special anchor requirements for steep slope pipelines. If practical, suitable drop manholes or other methods of dissipating energy and reducing eroding velocities shall be provided as approved by the DPW.

B. Pipeline Alignment

1. General

The layout of a gravity sewer system of collectors and interceptors is a function of the topography. The Master Plan shows the existing and planned major wastewater facilities, along with the location and service areas of pump stations. The design of sewer subsystems relying on pumping stations not indicated on the Master Plan cannot be constructed without successfully undertaking a change to the Master Plan. Collector and interceptor systems shall be prepared to service all areas up to the drainage area limits and no further unless specifically authorized. The plan and vertical arrangement of the sewer system shall provide for future connections within the drainage area limits. The design shall accommodate future

service requirements, while minimizing both expense and modifications to the existing system.

The Designer has the responsibility to identify where good planning and design are in conflict with these guidelines and the requirements of other agencies. The proposed alignment must be the best overall design. Failure to identify conflicts during the preliminary design may result in delays and possible costly changes.

Consideration must be given to space requirements for future utilities, particularly water and storm drains. In the absence of water and storm drain design, the Designer shall recommend the space requirements for future water or drainage facilities and provide the necessary clearances. This requirement is particularly important at roadway intersections.

When plans of existing facilities are insufficient to accurately locate existing underground obstructions, the Designer shall request permission from the DPW to perform test pit excavations to uncover the subject facilities so that the horizontal and vertical positions of existing utilities can be accurately determined. If such permission is granted, the Designer shall be responsible for providing all traffic control and public safety measures necessary to locate the utilities and restore the surface. The Designer shall coordinate the test pit operations and provide a field survey crew to physically locate the subject facility. A utility permit will be required from the Howard County Bureau of Utilities for all test pit excavations.

2. Horizontal Alignment-Location

The horizontal alignment shall take into account the following general alignment guidelines:

- a. Due to the greater depth of the sewer in relation to most other utilities, the location for the sewer main shall be given first priority.
- b. Sanitary sewers less than 36-inches in diameter shall be designed with a straight horizontal alignment between manholes. Curved horizontal sewer alignments may be designed for sewers 36-inches in diameter and larger and are only allowed in must-fit situations. A curved alignment will require approval from the DPW. The Designer shall provide the DPW with data and computations on curved sewer alignments for review, including the manufacturer's recommendations for the design of the pipe joint.
- c. For Developer Projects, the design of the public water, sewer and storm drain utilities within proposed developments shall be prepared concurrently to ensure compatibility of the utilities. If public water and sewer mains cannot be located within the paved roadway section, the Designer shall request a waiver of these design standards from the DPW, providing reasons why the standards cannot be met.

- d. In new developments where sewers are constructed in advance of the road pavements, the sewer shall be placed on the lower side of the street, 7 feet from the street centerline. On curved streets, this location must be compromised, since straight horizontal alignments are required between manholes, except as noted above. Where curbs will exist, the sewer shall be placed no less than 5 feet from the face of the curb. The sewer may be placed on the high side of the street if the number of house connections makes it cost effective.
- e. Where sewers in residential developments are constructed between or across lot lines, the centerline of the pipe shall be constructed on the lot line between lots, or along the rear property line. Under no circumstances shall sewers or required easements cut across building envelopes. In cases where sewer mains are between or behind lots where access from public roads is limited, access easements from the nearest public roadway shall be provided between lots. All such easements shall allow adequate access to the sewer by maintenance personnel and equipment. See Section 5.3, "Rights-of-Way, Easements and Construction Strips" within this design manual for additional information regarding easement and access requirements.
- f. Sewer main easements are routinely acquired during the subdivision process for the future extensions of the sewer system to serve adjacent properties. Where the future extension of the sewer main would undermine a foundation of a structure, all such sewer mains shall be constructed as part of the subdivision.
- g. In residential developments where easements are required between two adjacent lots for the extension of the sewer system, a sewer main shall be provided within the easement between the adjacent lots. The sewer main shall extend the full length of the easement between the lots.
- h. In cases where a utility easement is required to be extended to the limits of the property being developed to provide future service to an adjacent property, that easement shall be cleared of trees and otherwise prepared for the future extension of the main.
- i. In existing developments, the preferred location of the sewer is between the edge of pavement and the road right-of-way. When this space is limited or is occupied by other utilities, the Designer shall take into account cost variables such as pavement replacement, additional easement acquisitions, relocation of existing utilities and interference with vehicular and pedestrian traffic in determining the most cost effective horizontal alignment.
- j. When sewer mains are designed within existing rights-of-way, the sewer shall be designed a minimum 5 feet from the right-of-way line. When a sewer needs to be placed within existing rights-of-way at a distance closer than 5 feet from the right-of-way line, a minimum 5-foot wide easement shall be

required directly adjacent to the existing right-of-way line. If the sewer needs to be placed directly adjacent to, but outside of the existing rights-of-way, an easement size shall be required to provide a minimum 5-foot clearance from the sewer to the new outer easement line. For easements not contiguous to a County owned rights-of-way, see Section 5.3, “Rights-of-Way, Easements and Construction Strips” within this manual for required easement widths.

- k. Sewer mains shall be designed to minimize disruption to environmental features. See Section 5.15, “Pipeline Design in Wetlands, Stream Crossings and Tree Protection” within this design manual for additional information regarding the installation of utilities within environmentally sensitive areas. The Designer shall take into account all existing environmental factors and avoid disturbance of sensitive areas, whenever possible.
- l. The sewer alignment within existing areas (streets or roads) shall avoid high traffic volume roads if other options are available. The alignment shall be designed to allow the construction of the pipeline without the need to have road closings. When a sewer main or lateral connection is required to cross a Howard County road, the Designer shall recommend whether to open cut, tunnel or bore and jack the utility across the roadway after considering the type and condition of the road, traffic volumes, disruption to traffic, possible conflicts with existing utilities, and specific conditions on the project site. See Section 5.14, “Alternate Installation Techniques” within this design manual for information regarding alternate installation techniques to open cut methods. The Chief of the Bureau of Engineering shall make the final decision as to the method to be used and the approved method shall be noted on the plans by the Designer.
- m. In existing areas (streets or roads), the alignment shall attempt to avoid the removal of trees or landscaped areas. In parks and public rights-of-way where the location of the sewer main would require the removal of trees, the Designer shall obtain the approval of the appropriate agency or agencies for tree removal. When the pipeline must be located outside of the road right-of-way, the alignment shall minimize disruption to environmental features. In addition to trees, the alignment shall try to avoid steep slopes, wetlands and other sensitive areas. The alignment shall follow the property lines as much as possible.
- n. When existing roadways are involved, the horizontal alignment of the road must be evaluated for acceptable geometry and the sewer main designed in respect to these possible roadway improvements to avoid costly future relocations. The Designer shall evaluate the plan geometry of the road with respect to movement of traffic and available right-of-way width for the accommodation of the pipeline. If easements must be acquired for the main, a recommendation shall be provided to the DPW as to whether additional rights-of-way should be acquired for future roadway modifications.

- o. Where existing sewer mains are too shallow or do not contain adequate capacity for new incoming sewers, the existing sewers shall be redesigned as required and all existing connections shall be reconnected to the new sewer. Paralleling of gravity collector sewers shall not be allowed. See Section 5.6, “Pipeline Abandonment” of this design manual for sewer abandonment requirements.
- p. Within private roads, public sewer mains shall be located within the paved roadway sections wherever possible.
- q. For Developer Projects, utilities owned by other public and private entities, such as gas, electric, telephone, cable T.V. and others, shall be located within the shoulder of the road or behind the curb line. If necessary, a 5-foot wide easement contiguous to the road right-of-way line shall be provided for the placement of these utilities.
- r. Sewers and appurtenances shall not be placed in existing or proposed future storm water management pond locations.

3. Vertical Alignment

a. Grades

The vertical position of gravity sewers is determined by the rate of slope between the unit to be served and the collector sewer, the rate of slope of the ground along the course of the pipeline and by the existence of obstructions that cannot be economically relocated. All sewer grades shall be established as to require the least excavation while satisfying minimum and maximum velocity requirements, design flow conditions, clearances, and depth requirements. All sanitary sewers shall be designed on a continuous grade between manholes. Table 4.3B, “Minimum Allowable Sewer Slopes”, indicates the minimum slopes permitted.

Table 4.3B: Minimum Allowable Sewer Slopes

Pipe Diameter (Inches)	Minimum Slope in feet per 100 feet
8” Terminal Main	0.72
8”	0.50
10”	0.28
12”	0.22
14” and greater	Slope to provide min. 2.5 ft/s velocity at the design flow rate

The minimum size for all collector and interceptor sewers shall be 8-inches in diameter. The minimum slopes noted above are required to maintain a velocity greater than 2.5 ft/s based upon a Mannings “n” coefficient of 0.010 when the pipes are flowing full or half full.

Sewer house connections (SHCs) shall have the minimum slopes as discussed in Section 4.5 “Sewer House Connections” in this design manual.

For gravity systems, pipeline layout is directly affected by minimum acceptable fluid velocities as determined by the design flow, pipe size, slope and applicable Manning roughness “n” coefficients. See Section 4.3.A, “Hydraulic Calculations” in this design manual for applicable Manning “n” coefficients and system velocity requirements.

Where different diameter pipes meet at manholes, the crown of all upstream pipes shall be set at the same elevation as the crown of the downstream pipe unless hydraulic gradient computations require a higher setting.

b. Sewer Depths: General

The collector sewer shall be designed at a sufficient depth to provide gravity sewer service to the basement or lowest floor level of all buildings unless otherwise directed by the DPW. The minimum cover over any sewer or SHC within the road right-of-way or public easements shall be four feet. Where storm drains have not been designed or installed, each SHC shall have a minimum cover of 6.5 feet within the street right-of-way. The required service depth at the collector sewer shall be determined by the following criteria:

1) Improved Lots

Unless test pitted, the building sewer coming from existing houses shall be assumed to have an invert elevation 2.5 feet below the lowest floor elevation at the exterior wall. The invert elevation of the SHC at the collector sewer shall be calculated as follows:

$$E = CE - 2.5' - (L G)$$

where:

E = elevation of SHC at collector sewer (ft.)

CE = cellar elevation or lowest finished floor elevation (ft.)

L = required length from existing structure to the sewer main (ft.)

G = required building sewer and SHC grade (ft/ft)
(see Section 4.5.D)

When the septic tank is located in the rear of the existing structure, “L” shall be measured from the center rear of the building around the structure to the collector sewer in the street.

2) Unimproved lots (Residential)

On vacant lots, in addition to providing an invert elevation of the SHC at the property line, the cellar elevation or the minimum service elevation shall also be shown on the plans to the nearest 100th of a foot (denoted thus: CE = 423.67 or FF= 432.02), which shall represent the lowest floor elevation that may be serviced by gravity. In determining this elevation, it shall be assumed that any future structure will be constructed so that gravity sewer service shall be available to the most distant part of the lot or property within the building restriction line.

3) Unimproved lots (Commercial/Industrial)

For commercial and industrial sites, the Designer shall determine a reasonable sewer service elevation, taking into account the probable size of the building and the extent of gravity service required. Unless specific information is available regarding future development plans, it must be assumed that a large structure such as a warehouse may occupy the lot with the building located at the most distant part of the lot within the building restriction line. The sewer service elevation determined shall be shown on the plans as “minimum service elevation”.

The Designer shall also take into consideration requirements to provide separate SHCs to the collector sewer for attached or semi-detached commercial/industrial units as specified in Appendix I, “Policy on Public/Private Water and Sewer System”.

4) New Developments

In new developments, when subdivision plans include lot grading and structure elevations, the sewer shall be designed to serve the lowest floor level of each structure. When site plans have not been prepared, the sewer shall be designed in the same manner as for unimproved residential lots, with the minimum cellar elevations shown on the plans to the nearest 100th of a foot (denoted thus : CE = 423.67 or FF= 432.02). For townhouse developments, the minimum cellar elevations may be shown in tabular form.

c. Sewer Depths at Stream Crossings

Where a sewer parallels a water course, the Designer shall ensure that the proposed sewer depth will be adequate to facilitate future crossings of the stream while maintaining a minimum 3 feet of cover over any future stream crossings. The centerline of the adjacent stream bottom shall be indicated on the sewer main profile if the sewer is located within 25 feet of the stream. See Section 5.15, “Pipeline Design in Wetlands, Stream Crossings and Tree

Protection” within this design manual for additional considerations for stream crossings.

Where sewer pipes cross streams, the crossing angle shall be as near to 90 degrees as possible, and the crossing pipe shall be set at an elevation to provide a minimum of 3 feet of cover over the pipe. Ductile iron pipe, Class 52, shall be employed for the stream crossing and shall extend from manhole to manhole. Details of riprap protection of stream banks are shown in the Standard Details.

4. Sewer Surcharge Protection

In order to ensure that pumping station malfunctions will not result in wastewater backing up into nearby residences, the Designer of collection systems connected to a pumping station shall:

- a. Determine the rim elevation of the lowest manhole upstream from the pumping station that is not required to have a watertight frame and cover assembly.
- b. Identify all basement elevations lower than the manhole frame and cover established in Item a. above.
- c. Identify first floor elevations lower than the manhole frame and cover established in Item a. above.
- d. Identify vacant lots having a ground elevation lower than the manhole frame and cover established in Item a. above.
- e. A note shall be provided on the plans for all dwellings, structures, and lots identified in Items b, c and d stating the following:

“This lot may be subject to wastewater backup in the event of a pumping station malfunction. A back water valve is required on the private building sewer serving this lot.”

C. Sewer Mains: Plan

1. Sewer plans shall be drawn to a scale of 1" = 50'.
2. All proposed pipelines shall be shown and symbolized as noted in the Standard Details. More specifically, the pipe is to be identified by two evenly shaded parallel lines. Pipelines 24- inches in diameter and smaller shall be shown symbolically as two feet wide as a minimum, based on a scale of 1" = 50'. Pipelines over 24-inches in diameter shall be shown to scale.

3. The plan location of the pipeline and appurtenances shall be carefully dimensioned so that its route is clearly identified. Dimensioning of the proposed pipeline, including appurtenances, shall be as noted in Section 5.2, "Control, Topographic and Construction Surveys." Appurtenances shall be called by symbols and notes and dimensioned both in respect to pipeline arrangement and in respect to required positions in relation to surface features.
4. Manholes shall not be shaded. Manholes shall be numbered in consecutive order with the numbers placed within a standard circle. The slope of the frame and cover shall conform to the proposed finished grade. The type of manhole shall conform to the Standard Details.
5. All pipe sizes shall be clearly identified together with flow directional arrows.
6. A restoration schedule shall be provided on the plans. The table shall cover the entire limits of the project and include restoration of all disturbed surfaces including roadways, grassed areas, driveways and open space. Where more than one material is required for restoration of the surface at a location (i.e. bituminous pavement to the right of the pipeline and sod to the left of the pipeline), the limits shall be noted and the material replaced in kind.
7. Sewer House Connections (SHCs)

The following provides a description of the required design information for SHCs that must be provided on the sewer plans. See Section 4.5, "Sewer House Connections" later in this chapter for additional information regarding depth location requirements:

- a. All new SHCs shall be indicated in plan by a single heavy line with a wye (or tee if noted) at the collector sewer. All SHCs shall be extended to the property line and denoted by size (4-inch, 6-inch or 8-inch) and type (SHC or DHC). All proposed invert elevations shall be indicated at the property line. SHC inverts for townhouses and apartments may be shown in tabular form with the locations of the inverts well defined.
- b. All buildings that cannot be served or are limited to first floor service shall be clearly noted on the plans. All such service limitations must be approved by the Chief of the Bureau of Engineering.
- c. Service connections to properties in low areas that may experience flooding in the event of wastewater backups and or surcharging of main line sewers shall be identified as such. The plans shall note that preventive measures, as required by the National Standard Building Code, provided by the property owner when the connection is made to the system by the plumber. See Section 4.3.B.4, "Sewer Surge Protection" for analysis requirements.

- d. On vacant lots, minimum service elevations must be calculated as described in Section 4.3, "Vertical Alignment". This minimum service elevation must be provided on the plans in addition to the invert elevation of the SHC at the property line.
- e. All percent grades for the SHC shall be indicated on the plans if the design grade for a SHC is either less than or greater than 2%.

D. Sewer Mains: Profile

1. Profiles shall be drawn for all public sewer mains at a scale of 1" = 50' horizontal and 1" = 5' vertical.
2. Profiles shall be shown below the sewer plan view wherever possible. For Developer Projects, the complete layout of the piping system may be shown in the plan view drawings. Profiles shall then be shown on a separate sheet and cross-referenced to the appropriate plan sheet.
3. Manholes in profile shall be numbered to correspond to the manhole numbering on the plan. The numbers shall be within a standard circle together with the manhole top elevation.
4. Profiles Within Proposed Roads

The methods for developing sewer profiles are identical with those described for water mains with the resultant opportunity to utilize a single profile arrangement for combined water and sewer projects. As in the case of the water mains, sewer lines and manholes to be located within proposed roadways shall be projected onto the centerline of stationing of the roadway even though the true stationing is developed between manholes. This procedure means that the scaled length of the sewer lines in the profiles will not equal the true length as shown in the plan view. On a combined water and sewer project, each utility shall be projected onto the centerline road grade.

5. Profiles Within or Outside Existing Roads

In developing the profile information within or outside existing roads, the centerline length of the sewer main in plan shall be used for the profile stationing, which will provide true length profiles. For existing roads that do not conform to Volume III of the Design Manual, a centerline road grade conforming to the design standards is to be shown on the profile and identified as "possible future centerline road grade." On a combined water and sewer project, the sewer shall be projected onto the water pipeline centerline.

6. For minimum vertical clearances see Section 5.4, "Crossings and Clearances." When lesser clearances are desirable for cost or other reasons, special details must be developed to ensure no undesirable interaction between the two utilities.
7. Utilities that cross sewer mains shall be plotted to horizontal and vertical scale and identified so as to advise the contractor of their specific locations. Stations and invert elevations shall be provided at every pipeline crossing for each pipe shown. If the elevation of the existing pipeline to be crossed is unknown and it is likely to have a significant impact on the sewer main vertical alignment, the Designer shall arrange to have a test pit excavated to determine the exact horizontal and vertical location of the existing utility or utilities.
8. For each SHC, a light vertical line shall be drawn from the collector sewer to the elevation of the SHC at the property line. All SHCs shall be shown as intersecting pipes in the profile. The applicable finished floor or cellar elevation of the dwelling to be served shall be shown at the appropriate elevation relative to the house connection, and to the correct vertical scale.
9. The date of the survey work used to establish ground lines shall be noted on the profile. Proposed, interim, future and possible future ground lines shall be shown where applicable as well as the source from which the information was acquired. The following information as minimum requirements shall be shown on the profile:
 - a. Property lines and property owner's name with lot number, parcel number and street address
 - b. Cellar or first floor elevation of proposed or existing building to be served (denoted thus: CE = 423.67 or F.F=432.02), to nearest 100th of a foot. For Developer Projects, or where lack of space permits, the information may be provided in tabular form on the profile sheet.
 - c. Road names
 - d. Areas requiring fill and compaction prior to pipe installation
 - e. Utilities, existing and proposed
 - f. Sewer hydraulic information indicated in Table 4.3.C, "Sewer Hydraulic Information"
 - g. Storm drains, existing and proposed
 - h. Existing ground elevation line
 - i. Proposed ground elevation line
 - j. Bottom of stream or swale, that parallels proposed sewer
 - k. 100 year flood level with elevations
 - l. Obstructions
 - m. Relocations of conflicting utilities
 - n. Establishment of streets grades
 - o. SHCs projected at property line elevations

Table 4.3C: Sewer Hydraulic Information

Information	Symbol	Units
Pipeline Diameter	NA	Inches
Pipeline Slope	NA	%
Pipeline Capacity *	Q_{cap}	MGD
Design “n” value *	n	NA
Velocity at Capacity *	V_{cap}	FPS
Design Flow *	Q_{des}	MGD
Velocity at Design Flow *	V_{des}	FPS

* For interceptors or collector sewers serving more than 200 homes or collector sewers receiving pumped flows

10. The sewer hydraulic information indicated in Table 4.3.C, above, shall be provided in the profile for each segment of sewer between manholes. When this design procedure is followed, it will be apparent where slight adjustments in invert slopes will provide a pipeline capacity closer to the total system capacity. In this way, restrictions due to a single, flat grade set within the larger system of manholes and pipe lengths may be avoided.
11. It is brought to the Designer’s attention that excessive pipe slopes that may induce stripping of hydrogen sulfide will not be permitted (See Section 4.7, “Hydrogen Sulfide Analysis.”) The DPW may require sulfide analysis calculations.

E. Pipeline Materials

1. General

Pipeline design practices and materials used in sewer systems for Howard County are employed to ensure maximum service capability with the least costs of installation and maintenance. Factors that determine the equivalency of pipe materials include the following:

- a. Structural strength under field conditions.
- b. Hydraulic capacity as determined by the roughness coefficient as used in the Manning formula for pipeline velocities.
- c. Characteristics of existing site conditions, which may have detrimental effects on pipe materials.
- d. Characteristics of wastewater, which may have detrimental effects on pipe materials.

The Designer must be aware of the particular properties of each type of pipe so as to include or exclude the possibility of its employment under the greatest range of applications, leaving the construction contractor as many options as possible for the selection of the type of pipe to be installed. Any special design features and/or special materials required due to the specific nature of the project shall be

submitted for approval to the DPW. The Designer shall thoroughly stipulate in the Technical Specifications and show on the plans which types of pipe materials are acceptable for the various applications on each project.

The following Table 4.3D, “Sewer Pipe Materials” indicates the pipe materials that are acceptable to Howard County for interceptor and collector sewer construction. These materials are acceptable when supplied in conformance with the material and installation requirements of the Standard Specifications and this design manual.

Table 4.3D: Sewer Pipe Materials*

Pipe Type (abbreviation)	Specification	Range of Diameters	Design Standard
Polyvinyl Chloride (PVC)	SDR 35 meeting ASTM D3034	8" – 27"	AWWA M23
Ductile Iron (DIP)	AWWA C151	8" & larger	AWWA C150
Reinforced Concrete Pipe (RCP)	ASTM C76	21" & larger	American Concrete Pipe Association’s Concrete Pipe Handbook and Concrete Design Manual

Notes: See Section 4.5G, “Sewer House Connections, Materials” for acceptable SHC pipe materials

2. Special Circumstances

- a. In addition to the types of pipe shown above, other pipe materials may be considered on a case-by-case basis when recommended by the Designer and approved by the DPW. For special projects or conditions, the Designer and the DPW may select pipe manufactured to industry standards other than those listed in the Standard Specifications.
- b. The DPW will require the use of DIP under the following circumstances:
 - 1) When sewer depths exceed 16 feet.
 - 2) For all open cut stream crossings. (See Section 5.15, “Pipeline Design in Wetlands, Stream Crossings and Tree Protection” for additional considerations for stream crossings.)
 - 3) Sewers within casing pipes or tunnels shall be restrained DIP.
 - 4) When flow velocities exceed 10 feet per second.
 - 5) When pipeline slopes exceed 20% (See Section 5.10, “Concrete Encasements, Arches, Cradles and Anchors” for additional steep slope requirements).

- c. In areas where significant hydrogen sulfide concentrations are expected to exist, such as downstream from a pumping station or pressure sewer discharge, hydrogen sulfide resistant materials such as PVC shall be used if available in the required diameter. If PVC is not an option in the required diameter, the Designer shall investigate other solutions such as polyethylene-lined or fiberglass-lined DIP, T-Lock RCP or other special protective linings. See Section 4.7, "Hydrogen Sulfide Analysis" for additional details regarding Hydrogen Sulfide analysis requirements.
- d. Application of corrosion resistant materials indicated in paragraph c) above shall be required in other areas anticipated to be particularly aggressive to concrete, such as sewers which will handle industrial effluents, high temperature discharges and leachate from sanitary landfills.

F. Pipe Thickness Design

1. General

The acceptable installation depths discussed below for the various pipelines are based on the standard bedding, backfill, trench width and all other criteria indicated in the Standard Specifications. Even within these given parameters, the Designer shall be responsible for all pipe designs. For special applications that differ from those detailed in the Standard Specifications and the design criteria of this manual, a special analysis must be performed to determine the appropriate pipe thickness and/ or increased bedding conditions and submitted to the DPW for approval. If such analysis is required, the pipe strength requirements for in-place trench conditions shall be determined by the design standards indicated in Table 4.3D, "Sewer Pipe Materials," for each pipe material. The following design criteria shall be utilized for pipe thickness design:

- a. The maximum and minimum pipe depths along the pipeline alignment;
- b. A unit weight of soil of 120 lb/ft³ unless site specific soil information is available indicating otherwise;
- c. A trench bedding condition one "type" or "class" lower than actually specified for installation.

2. Polyvinyl Chloride (PVC) Pipe

The design of PVC pipe requires the use of flexible pipe design equations. The Modified Spangler formula shall be used for all required calculations. The maximum allowable pipe deflection shall be limited to 3%, using a deflection lag factor of 1.5. The PVC pipe specified in the Standard Specifications is suitable for standard buried applications from four (4) feet to sixteen (16) feet of earth cover when installed using the specified bedding, backfill and compaction requirements detailed in the Standard Specifications. For situations requiring greater than sixteen (16) feet depth or for shallow installations less than four (4) feet, DIP shall be used.

3. Ductile Iron Pipe (DIP)

DIP for sanitary sewers and force mains shall be special thickness class 52, except that special thickness class 50 may be substituted in those areas where PVC gravity sewer pipe is acceptable. For loading situations such as depths greater than twenty (20) feet, less than four (4) feet, or where other extreme loadings are anticipated, thickness design shall be based on the design methods outlined in AWWA C150.

4. Reinforced Concrete Pipe (RCP)

The design of RCP requires the use of rigid pipeline design formulas. The three-edge bearing strength analysis shall be utilized for all RCP Analysis. A design safety factor of 1.25 shall be utilized for all RCP design calculations.

4.4 Gravity Sewer Appurtenances

A. Manholes

1. General

- a. Within the sewer pipeline system, the most significant appurtenance is the manhole. Manholes are employed for several functional requirements and to ensure their ability to perform these functions, their design features have been standardized. The design requirements for all manhole structures are provided in the Standard Details. All manholes shall be designed as precast concrete structures. Cast in place concrete or brick manholes are acceptable alternates. Inverts of manholes are generally constructed of brick carefully configured to provide smooth channels for both through-flow and directional changes. Pre-cast manhole channels are an acceptable alternative to brick channels.
- b. Inverts are formed to receive future flows when the direction and grade of future connections are identified in the design process. When a future extension from the manhole is to be provided, a formed invert channel and a 5-foot long stubbed connection shall be provided from the manhole.
- c. Manholes represent a significant potential source for infiltration and therefore, waterproofing is a standard feature. Brick manholes are parged on the exterior by mortar and bitumastic material as shown and specified in the Standard Specifications. The exterior of all precast manhole sections are coated with coal tar epoxy and all joints are gasketed as required by the Standard Specifications. Standard heavy traffic manhole frames and covers are used on all manholes.

- d. Manholes shall be kept away from inconvenient or inappropriate locations such as curbs, gutters, ditches, vehicular parking area, athletic and playing fields, near buildings and the like.
- e. The top of manholes placed in cross-country areas shall be set at a height equal to or above grade as recommended by the Designer based on actual site conditions. All such manholes shall be set a maximum 18-inches above existing grade elevations.
- f. When the manhole is within a 100-year floodplain, a raised watertight frame and cover shall be provided.
- g. When the pipe size entering and exiting manholes are the same, a minimum drop between invert in and invert out shall be 0.10 foot. The maximum drop between invert in and invert out shall be one (1) foot. For pipelines of different sizes, the pipeline crowns shall be matched. For manholes where vertical drops are required, see Section 4.4.B, "Drop Manholes."

2. Manhole Spacing

Manholes shall be installed under the following circumstances:

- a. Change in horizontal direction or vertical grade
- b. Change in pipe size
- c. Change in pipe material
- d. Pipeline junctions
- e. At spacings not to exceed 400 feet for sewers less than 24-inches in diameter and 600 feet for sewers 24-inches in diameter and greater
- f. At the terminal end of all sewers
- g. At locations along the sewer where future extensions are planned
- h. At any additional place required by the DPW for maintenance, sampling, venting or flow measurement purposes
- i. At transitions from private to public sewer mains

3. Manhole Size

The minimum manhole size for all gravity sewer pipelines shall be 4 feet in diameter. For pipeline sizes of 27-36 inches in diameter, a minimum 5 feet in diameter manhole shall be utilized. For pipelines greater than 36-inches in diameter, the Designer shall submit design drawings and details of the manholes to the DPW for approval prior to placement of the details on the plans.

4. Manhole Channels

Typical manhole channels are illustrated in the Standard Details. If channeling for standard manholes is required that differs in geometry from those configurations shown in the Standard Details, the Designer shall detail the channel on the plans,

showing curve data, invert and bench elevations, bench slopes, etc. This effort shall also be provided for all manholes over 5 feet in diameter, bend structures and junction chambers. Manhole channels shall not have a centerline radius of less than 2.5 times the pipe diameter.

5. Manhole Linings

The Designer must take into consideration the use of special invert and manhole lining materials when significant hydrogen sulfide (H₂S) concentrations are anticipated. In addition, the use of drop manholes is discouraged when Hydrogen Sulfide is present or likely in the wastewater. See Section 4.7, "Hydrogen Sulfide Analysis" of this Chapter for hydrogen sulfide design analysis and manhole lining material requirements. The use of manhole liners shall be approved by the DPW.

6. Deep Manholes

The manhole depth is defined from the lowest invert to the top of the frame and cover. An intermediate landing is to be provided for all manholes greater than 18 feet in depth and at 10-foot intervals when the manhole depth exceeds 25 feet. Intermediate landing construction details are included in the Standard Details.

In addition, if the manhole depth exceeds 20 feet, the Designer shall take into consideration the following design requirements:

- a. Check the manhole for flotation.
- b. Verify that the groundwater pressure on the precast concrete manhole section joints will not exceed the requirements of ASTM C 443 and the Standard Specifications.
- c. Verify that the groundwater pressure on the pipe to manhole connections will not exceed the requirements of ASTM C 923 and the Standard Specifications.
- d. Identify any modifications necessary to the standard manhole details as a result of the manhole depth and groundwater pressure.

B. Drop Manholes

Design details as well as maximum and minimum allowable drops are indicated for drop manholes in the Standard Details for various sewer sizes. When the drop required is less than the minimum indicated on the standard details (2'-2" to 2'-6", depending on pipe size), no drop manhole is required. In lieu of a drop manhole, the slopes of the connecting pipelines and manhole channel shall be adjusted to limit the difference between the invert in and invert out of the manhole to less than one foot.

All drop manholes shall typically utilize outside drop connections. Inside drop connections to existing manholes shall only be considered when there is imminent damage to existing utilities or structures in construction of an outside drop connection. All use of inside drop connections will require the approval of the DPW. There shall be no more than one (1) inside drop connection allowed in any single manhole.

C. Inverted Siphons

1. General

Inverted siphons are considered for use when it is necessary to maintain a suitable protective ground cover over a pipeline or to reduce extensive trench depths when an obstruction to the preferred grade requires a lowering of the sewer for a significant distance. Inverted siphons should be avoided wherever possible. Inverted siphons will only be permitted with the approval of the DPW. The Designer shall provide all required specialized details to the DPW for approval.

a. Design

When a siphon is determined to be an acceptable design alternative, at least two pipes shall be provided with a minimum pipe size of 6-inches. One redundant pipe shall be provided for bypass capacity, for emergencies or when the other pipeline is taken out of service. Each pipe shall be capable of carrying the full design flow rate. In pipe sizes 6-inch to 24-inch in diameter, restrained DIP shall be used.

Siphons shall be designed preferably for a minimum velocity of 4 fps at the design flow rate with an absolute minimum velocity of 3 fps. The capacity of the inverted siphon shall not be less than the capacity of the sewer system upstream of the siphon. Sufficient hydraulic head shall be available to pass the design flow without submergence of the upstream sewer. All hydraulic calculations shall utilize the Manning's equation.

Inlet and outlet structures shall be designed with valve arrangements to facilitate flushing of each siphon line and to minimize maintenance. All inverted siphons shall be designed with inlet and outlet vaults. Vaults shall contain sluice gates on the inlet and outlet of each barrel and shall have clear access from above for maintenance. Sluice gates shall have operators on top of the vaults.

b. Alignment

The horizontal and vertical alignments of an inverted siphon shall be maintained as straight as possible. Abrupt alignment changes shall be avoided. For inverted siphons crossing under a stream, see Section 5.15, "Pipeline Design in Wetlands, Stream Crossings and Tree Protection" within this design manual for general stream crossing requirements.

D. Connections Into Existing Systems

1. General

All connections into the existing public sewer system are subject to the approval of the DPW. The Designer shall provide on the plans all applicable notes and details for any required connections to an existing system. All connection designs must address all issues regarding maintaining flow in the existing system at all times. See the Standard Details for typical connection details.

2. Connections Into an Existing Manhole

If the existing manhole within the sewer system has an existing stub connection, the Designer shall match the existing pipe material or remove the connection if the existing pipe material is not one of the approved pipe materials. If the existing manhole does not have an existing opening or a knockout for a future connection, the manhole shall be cored, the invert channel formed and a field gasket connector installed to secure the new sewer to the existing manhole.

When there is not sufficient clearance between the existing pipe openings in the manhole and the new pipe opening, the Designer may provide a design for the sewer to enter the existing manhole offset from the manhole centerline. The Designer shall provide all required details, dimensions etc. to the DPW for approval.

3. Connections Into an Existing Sewer

If a new manhole must be designed over an existing sewer, the Designer shall refer to the Standard Details. The following items shall be considered when designing a connection into an existing sewer:

- a. When the existing sewer is above the new pipeline, the Designer must submit details of the connecting manhole to the DPW for approval for the connection between the new manhole and the existing sewer.
- b. Manhole drop connections may be designed for connections into an existing sewer when the drop connection is for the new pipeline.

4.5 Sewer House Connections (SHCs)

A. General

SHCs are to be provided to connect individual buildings to the collector sewer main. All SHC configurations are connected to the main line by a combination of fittings including wyes, tees and bends as indicated in the Standard Details. SHCs shall be

indicated in plan and profile as described in Sections 4.3C, “Sewer Mains: Plan” and 4.3D, “Sewer Main: Profile.”

B. Location

1. The County-owned portion of sanitary sewer house connections shall be built to the property line. It is the practice of Howard County to provide a SHC at the time of initial sewer construction to all properties having frontage on the collector sewer. All such properties shall be provided with a capped cleanout at the property line as shown in the Standard Details.
2. All SHCs for improved lots shall be located so as to readily serve the cellar or lowest floor of the existing dwellings or buildings in a cost effective manner. All SHCs for unimproved lots shall be located at the low point of the lot. Where the location or depth of the sewer main is established by a critical sewer house connection, this connection shall be located by the Designer in the most advantageous position to minimize costs to the County while providing cellar service to the lot. In non-critical areas, the actual location of the SHC shall be determined by the property owner in the field prior to construction as long as it is compatible with the system as designed. However, it shall be the responsibility of the Designer to propose a feasible location for the SHC based on the location of existing wells, septic tank facilities, topography and other features.
3. In developments where an easement is required between two adjacent lots for the extension of a SHC, the SHC shall be constructed within the easement between the adjacent lots as part of the development. The SHC shall extend the full length of the easement between the lots.

C. Size

The size of all SHCs shall be 4-inch, 6-inch or 8-inch depending on the land use type and the discharge flow requirements established by the Designer.

D. Grades

SHCs shall be designed for a 2% minimum grade. Where this rate of slope results in an excessively deep collector sewer, a reduction in the SHC slope to 1% may be considered if approved by the DPW. The maximum allowable grade for a SHC shall be 5%. All SHCs designed on a grade of less than or greater than 2% (1% min., 5% max.) shall be noted on the plans.

E. Depth

All SHCs shall be installed at the required depths to provide gravity service to the cellar of each lot served. See Section 4.3.B.3.b, “Sewer Depth: General” for establishing required service elevations at the collector mains.

F. Type

All SHCs shall be of the single service type. A twin SHC shall not be used unless approved by the Chief of the Bureau of Engineering. A Drop House Connection (DHC) shall be provided when the invert of the SHC at the collector sewer is greater than 2 feet higher than the invert of the collector sewer when the house connection is extended from the house at a 2% grade to the sewer main.

Where conditions permit, the Designer may use a 45° DHC if approved by the DPW. In specifying a 45° DHC, the Designer shall ensure that the use of a 45° DHC will not preclude or interfere with the placement of future utilities.

G. Materials

The following Table 4.5, “SHC Materials” shows pipe materials that are acceptable to Howard County for SHCs when supplied meeting the material and installation requirements of the Standard Specifications.

Table 4.5: SHC Materials

Pipe Type (abbreviation)	Specification
Polyvinyl Chloride (PVC)	SDR 35 meeting ASTM D3034
Ductile Iron (DIP)	AWWA C151
Cast Iron Soil Pipe	ASTM A-74

For all new sewer construction, SHCs shall be of the same material as the sewer except for RCP. For existing sewers, SHCs shall be either PVC or DIP subject to the approval of the DPW.

H. Appurtenances

Cleanouts shall be provided on all SHCs at the property line on the homeowner’s side. Cleanouts shall be as shown in the Standard Details.

I. Manhole Connections

SHCs can be installed as a drop house connection using an outside drop at the manhole. See Section 4.4.B, “Drop Manholes” of this Chapter for information regarding drop manhole connections.

Multiple SHCs installations into a single manhole are subject to the approval of the DPW. The following information shall be considered when making multiple connections:

1. A maximum of three (3) SHC installations will be permitted into any one manhole.
2. SHCs shall not enter the manhole at an angle less than 90 degrees to the downstream flow direction.
3. Radial installation should be made whenever possible.
4. The centerline of the SHCs shall pass through the centerline of the manhole.
5. When radial installation is not possible, a maximum of two (2) parallel SHCs may be installed at any one manhole.
6. See the Standard Details for information regarding multiple radial and parallel SHCs installations.

J. Structural Considerations

Minimum and maximum permissible SHC depths shall be in accordance with the guidelines of this Chapter when installed in accordance with the standard bedding, backfill, trench width and all other criteria indicated in the Standard Specifications. In all cases, proper bedding shall be provided for SHCs.

4.6 Force Main Design

A. Hydraulic Calculations

1. General

The design of a wastewater force main must be coordinated with the design of the wastewater pumping station. The proposed alignment and profile of the force main shall be developed. The profile shall depict the changes in force main elevations. The Designer shall strive to achieve a vertical profile that rises continuously from the pumping station toward the transition manhole. The system curve for the force main, showing the total energy losses associated with the range of possible pumping rates, shall be developed. Using the system curve, the Hydraulic Grade Line (HGL) profiles can be developed. For the design of small diameter force mains for low pressure sewer systems, see Section 8.2, "Public Low Pressure Sewer Systems" within this design manual.

The Hazen-Williams (Appendix F) equation shall be used for estimating friction losses in force mains. Minor losses at transitions and bends shall also be added in the determination of the total energy losses. The HW coefficient of roughness ("C" factors) for force mains shall be as follows:

<u>Material</u>	<u>"C" Factor</u>
Ductile Iron Pipe (Cement Lined)	120
HDPE	130
PVC	130

The use of HDPE pipe is only allowable for directional drill applications if approved by the DPW, see Section 5.14, "Alternate Installation Techniques." The

use of PVC is only allowed for corrosion control protection and if approved by the DPW.

The Hazen-Williams factors indicated are representative of long-term design values for the system. The Designer shall check all pump station and force main selections for the anticipated lower headlosses (higher C value) that are typical of newer pipelines to ensure the satisfactory operation throughout the design life of the system.

- a. HGL profiles shall be developed for the various flow scenarios planned for the pumping station. All HGL profiles shall be provided on the plans separately from the standard force main design profiles. Such profiles shall be condensed at a scale of 1"=200' horizontal; 1"=20' vertical and shall indicate hydraulic gradients, flows, force main velocities, design friction coefficients, existing ground, proposed pipe invert elevations and all other pertinent data.
- b. The static head shall be based on the difference in vertical elevations between the lowest "normal pump stop" level in the wet well and the point the force main discharges to the gravity sewer.

2. Size

Force main size shall be based on the required pipe's maximum carrying capacity to convey the design flow rate at permissible velocities, while minimizing life cycle costs including construction, maintenance and pumping costs. The minimum force main size shall be four (4) inches in diameter.

3. Velocity

Design velocities in force mains shall be between 2.5 to 6 feet per second (fps). A minimum velocity of 3 fps-3.5 fps shall be required to re-suspend any solids within force mains that have multiple high and low points. The maximum velocity shall be based on the ultimate design pumping rate.

B. Force Main: Plan

Force mains shall be located within public road rights-of-way whenever possible. The design location of the force main shall be as described for a water main in Section 3.3.C, "Water Mains: Plan" with the following exceptions:

1. When installed parallel to a water main, the force main shall be designed per the horizontal and vertical clearances indicated between water and sewer mains in Section 5.4, "Crossings and Clearances."
2. When installed parallel to an existing sewer pipeline, provide 10 ft. minimum horizontal clearance.

C. Force Main: Profile

The profile layout for a force main shall be as described for a water main in Section 3.3.D, “Water Mains: Profile” with the following exceptions:

1. Ideally, the force main shall be designed without intermediate high points and with the top of the force main being below the hydraulic grade line at the minimum pumping rate so that air release valves will not be needed. If the elimination of high points is not feasible or if the design requires long, relatively flat vertical alignments, the design may require air release and air and vacuum valves.
2. Blowoffs along the force main are required where the force main contains a depressed section between two high points.
3. Continuous uphill pumping is preferred for a force main, where the force main discharge point to the gravity sewer is at a higher elevation than the rest of the system, so as to keep the force main full.
4. Force mains with intermediate high points above the gravity sewer discharge point can create partial vacuum conditions in the force main under circumstances such as, draining conditions that occur due to intermittent pumping or when the HGL profile drops below the pipeline profile. The Designer shall provide appropriate air release and air vacuum valves to protect the force main against damage under these conditions.
5. Downhill pumping is prohibited.
6. All force mains shall have a minimum 4-foot depth of cover. 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 easements 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 to ensure that the minimum depth of cover is met.
7. The top of the force main and its appurtenances shall generally be designed to be lower than the HGL.

D. Pipeline Materials

Allowable force main materials for routine projects are indicated in the Standard Specifications. Generally, for pipelines 54-inch and smaller, only cement lined special thickness class 52 DIP is used. HDPE will only be considered for directional drill installations in certain circumstances such as unavoidable conflicts with existing

utilities, crossing sensitive areas and corrosive soils. The use of HDPE shall require the approval of the DPW.

Special consideration shall be given to the character of industrial wastes before selecting the types of material and/or coatings for force mains. External loading, corrosive soils, abrasive wastes, foundations, minimizing the number of joints, and similar problems shall also be investigated. Joints shall be as specified in the Standard Specifications.

E. Types of Joints/Fittings

Allowable pipe joints and fittings shall be as described in Chapter 3, "Water Main Design." Force mains shall be anchored at all fittings by restrained joints or buttress construction. The operating pressure and the surge pressure shall be considered in designing thrust restraint. See Section 5.9, "Thrust Restraint Design for Buried Piping" for analysis requirements.

F. Clearances

See Section 5.4, "Crossings and Clearances" of this manual for force main clearance requirements

G. Appurtenances

1. Air Release and Air and Vacuum Valves

Force mains shall ideally be designed to rise continuously in profile from the pumping station to the point of discharge. To minimize installation and maintenance costs, the Designer shall evaluate the feasibility of eliminating intermediate high points by installing the main deeper below grade. Where this is not practical, the Designer shall include automatic combination air and vacuum valves at the intermediate high points to expel accumulated air under pressure, to allow air into force mains to prevent vacuum conditions and expel larger quantities of air when the mains are filled. Valves on wastewater force mains shall be specifically manufactured for wastewater service, be sized according to manufacturer's recommendations, include quick-connect flushing hoses, and shall be placed in precast manholes per the Standard Details. The following guidelines shall be used to locate combination air and vacuum valves:

- a. Peaks in pipeline profiles
- b. Abrupt increases in downward slopes
- c. Abrupt decreases in upward slopes
- d. Long ascents - 1,500 ft. to 3,000 ft. intervals
- e. Long descents - 1,500 ft. to 3,000 ft. intervals
- f. Long horizontal - 1,500 ft. to 3,000 ft. intervals

2. Blowoffs

Blowoffs along the force main are required where the force main contains a depressed section between two high points. Blowoffs shall generally include a valve in a vault and piping to an existing sewer manhole, or a separate precast manhole with a sump or hose connection that a pump can be used to drain the force main to a gravity sewer manhole, tank truck, etc.

3. Flushing Connections

If required by the DPW, the Designer shall provide a flushing connection on the force main. The flushing connection shall be designed to allow the DPW to clean the force main in a manner appropriate to their equipment. Therefore, the spacing of flushing connections and the size shall be determined by the DPW.

4. Transition Manholes

The connection between the force main and gravity sewer shall be designed with a transition manhole. The termination of the force main in the transition manhole shall be designed so that the force main will be flowing full at all times. See the Standard Details for transition manhole details.

- a. The invert of the gravity sewer shall be designed one (1) inch above the crown or top of the force main.
- b. When the force main is 12-inches in diameter and larger, the Designer shall provide a means to protect maintenance personnel from falling into the pipeline at its connection to the manhole.
- c. The interior of the transition manhole and at least one hundred feet of force main leading up to the transition manhole shall be coated per the Standard Specifications to resist hydrogen sulfide corrosion.
- d. The interior of the gravity sewer pipeline after the force main discharges into a gravity system shall be coated to resist Hydrogen Sulfide corrosion if it is other than PVC pipe. See Section 4.7, "Hydrogen Sulfide Analysis" for additional downstream coating requirements.
- e. All transition manholes shall have a watertight frame and cover.
- f. There shall be no branch laterals or SHCs at a transition manhole.

H. 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 Designer shall prepare a complete study of each force main design in conjunction with the related pumping station. A written detailed analysis along with supporting calculations shall be submitted to the DPW for approval during the engineering report phase of the project. This analysis shall include, and 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 computer analysis 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 Designer shall perform an economic evaluation of alternatives to increase the design working pressure of the force main, including fittings, valves and all necessary restraints and buttress requirements. The Designer of the force main shall coordinate this evaluation with the pumping station Designer to determine the least expensive method for controlling water hammer pressure.

4.7 Hydrogen Sulfide Analysis

A. Analysis

Sulfides are produced when wastewater does not have a sufficient supply of oxygen. This is especially true downstream from a pump station or pressure sewer/force main discharge. These situations may result in the release of H₂S that may corrode concrete manholes, concrete pipe, concrete lined pipe or ferrous pipe materials.

The Designer shall evaluate the design of all proposed wastewater and grinder pump force mains to determine the sulfide control method and materials best suited in each case. The following Pomeroy equation shall be utilized for the calculation of sulfide generation in closed force main piping systems:

$$S_2 = S_1 + (M t) (EBOD) [(4/D) + 1.57]$$

where:

S_2 = Effluent sulfide concentration from force main (mg/l)

S_1 = Influent sulfide concentration from wetwell (mg/l)

M = Empirical coefficient for sulfide production = 0.0003 m/d

t = time (days)

$EBOD = (BOD_5) [1.07^{(T-20)}]$

T = wastewater temperature ($^{\circ}C$)

D = force main diameter (meters)

B. Design Considerations

If sulfide concentrations for a system are predicted at concentrations greater than 1.0 mg/l, the Designer shall include provisions to either neutralize the hydrogen sulfide at the pumping station or protect the piping and structures downstream of where the force main discharges into the gravity system. The following general design considerations are for systems where 1.0 mg/l is anticipated to be exceeded.

1. The use of drop manholes is discouraged when it is found or predicted that Hydrogen Sulfide (H_2S) is already present or likely in the wastewater.
2. Where substantial concentrations of sulfide cannot be avoided, the structure at the junction of the force main and gravity sewer must be constructed or protected with acid resistant materials. All interior surfaces and inverts of sanitary sewer manholes within 400 feet downstream of either a force main or grinder pump discharge shall be coated with a hydrogen sulfide resistant material such as H_2S resistant epoxy paints, polyvinyl chloride (PVC), polypropylene (PP) and high-density polyethylene (HDPE). In addition, hydrogen sulfide protection shall be provided downstream of a force main or grinder pump discharge where significant turbulence may be caused due to a drop manhole, severe pipeline slopes or any other sources of turbulence within a sewer system. Protection must be provided to all surfaces exposed to the sulfides. All applications of specialized coatings and liners are subject to the review and approval of the DPW. See the Standard Specifications for all coating and lining material requirements.
3. For references purposes, the Designer may use the latest publication from the U.S. Environmental Protection Agency for design guidelines in evaluating the sulfide generation.

CHAPTER 5

COMMON DESIGN GUIDELINES

**CHAPTER 5
COMMON DESIGN GUIDELINES**

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CHAPTER 5 COMMON DESIGN GUIDELINES

5.1 Common Design Guidelines

A. Scope

This chapter contains minimum design criteria which are common to the design of both water and sewer pipelines. This chapter is intended to be used in conjunction with Chapter 3, “Water Main Design,” and Chapter 4, “Sewer Main Design,” to provide a complete range of topics relevant to water and sewer design. It remains the Designer’s responsibility to review the criteria presented in all the appropriate chapters and verify the applicability of all material presented as it pertains to the specific project under design.

B. Abbreviations

For Standard abbreviations, see Section 1.2, “Abbreviation” of this manual.

C. Definitions

These definitions apply throughout this chapter. Other definitions applicable to specific sections of this chapter are given within those sections.

Construction Strip: A temporary easement granted by the property owner for the use of land during the period of original construction. The construction strip reverts back to the Grantor after construction and the cleanup of the area is completed.

Easement: For purposes of this manual, an easement is an acquired legal right to the use of land owned by others for a specified purpose.

Health Department: Howard County Health Department.

Low Pressure Sewer System (LPSS): A sewer system consisting of 1-4 homes connected to individual grinder pumps that pump into a common low pressure force main which discharges into a gravity system.

Right-of-Way: For the purposes of this manual, a right-of-way is the land area where County or State owned roads, streets or highways are placed. A list of County owned and maintained roadways are contained in the Howard County Master Road Book Index.

5.2 Control, Topographic and Construction Surveys

A. Control Surveys

1. All survey controls for the design and construction of water and sewer installations shall be established based upon the Howard County DPW Procedures 501.7, “Specifications for Surveying Procedures and Documents,” latest edition.

2. Horizontal control shall be established by conventional closed traverse or Global Positioning System (GPS) surveys. All horizontal control shall be tied to the Maryland State Plane Coordinate System, utilizing the monumentation of the National Geodetic Survey (NGS) or the Howard County Geodetic Survey Stations. The State Plane Coordinate System Datum shall be specified, (i.e. NAD. 83 or NAD. 83/91).

Conventional traverses shall have a minimum closure ratio of 1:15000. GPS control points shall be established in accordance with the specifications and requirements of the Federal Geodetic Control Committee (FGCC) for using GPS relative positioning techniques as amended. All control points shall be referenced in detail on the plans to permanently fixed objects that will not be disturbed during construction of the proposed project or other projects. Traverse points shall be clearly identified, and coordinates of each point shall be either shown at the traverse point in a neat manner, or in tabulation form on each plan sheet for which the traverse points occur. Bearings and distances between traverse points shall be shown. The traverse shall be assigned continuous stationing, with stations shown every 100 feet and at traverse points, and equalities shown at each intersecting point for spur lines and loops.

3. Vertical control for all projects shall be referenced to the North American Vertical Datum of 1988 (NAVD 88) as projected by Howard County Geodetic Survey Stations. If NAVD 88 control is not available in a one (1) mile radius the project area, the Designer may contact the DPW for vertical control. The Designer shall clearly indicate on all plans the datum used. Project benchmarks shall be of a permanent nature and shall be spaced at a maximum distance of 1000 linear feet. All project benchmarks shall be established by traverse as part of a closed vertical control loop. Benchmarks shall be clearly shown and referenced in detail on the plans. A minimum of two (2) benchmarks shall be shown on each plan sheet. As the vertical datum has changed over the years, the Designer is cautioned against using elevations from as-built plans without field verification.
4. Survey baselines shall be extended for the full length of the project and a minimum of 200 linear feet beyond anticipated limits of work. Station equalities shall be shown for all common intersecting control points. Bearings and distances between control points shall be shown. Coordinates of all control points shall be either shown at the control point in a neat manner or in tabulation form on each plan sheet for which the control points occur.

B. Topographic Surveys

1. Limits of Area Covered

The limits of the area to be shown on the plans may vary to some degree on various types of projects, and in general for Capital Projects, the area covered is usually a continuous strip of a minimum of 100 feet on each side of the proposed facility, 200 feet beyond the anticipated limits of work and 400 feet beyond the end of proposed

pavement for future roadways (for Developer Projects, limits of work shall be as required on a case by case basis).

2. Items to Include in Topographic Surveys

- a. All buildings and other structures within and immediately adjacent to the project limits, together with all improvements, including wells, springs, septic tanks, drain fields, dry wells, etc.
- b. Property and right-of-way lines (proposed and existing) including right-of-way widths and identifying road names.
- c. Property information:
 - 1) Owner Name(s)
 - 2) Front foot distances of each property along the facility
 - 3) Deed and recording references, including parcel number, lot number, subdivision name and record plat reference(s)
 - 4) Property pipes, monuments or markers
 - 5) Street address
- d. Roadway pavements, curb lines, driveway entrances, walkways, fences, walls, etc., including types of materials, widths, heights, and all other descriptive data.
- e. Horizontal and vertical location of all water mains, valves, hydrants, meters, manholes, clean-outs, storm drain inlets and culverts.
- f. Horizontal and vertical location of all existing and proposed overhead, surface and subsurface gas, electric, telephone and cable utilities as determined by field surveys, or other proposed plans, and fully coordinated with existing record drawings and applicable utility companies.
- g. Trees:
 - 1) Trees 12-inches in diameter and larger within proposed rights-of-way shall be individually located and identified by type. All trees, regardless of size, shall be located and identified by size and type that exist on the landscaped area of the property, including hedges, shrubs, flower beds, etc.
 - 2) For trees whose foliage overhangs the right-of-way or construction strip, the extent and diameter of the foliage (fall line) shall also be indicated.
 - 3) Tree stands or woods line shall be located and general characteristics of the wooded area given including approximate average size of the trees, density and general type of trees represented.
 - 4) Brush and dense undercover areas shall be so noted as applicable.
- h. Water courses, such as streams, swales and ditch areas, shall be shown and located including width, depth and water depth data, if applicable. Watercourses shall be contoured from field data together with the 100-year flood plain and elevations shown on the plans. Contours shall be shown on both sides of the

watercourse and extended at least 100 feet beyond the parallel alignment of the proposed facility. The Designer shall determine the flood plain data with criteria based on existing zoning and full future development of the drainage area.

- i. Embankments and other irregularities of terrain including roadside drainage ditches shall be shown and spot elevations of top and bottom of the bank given every 50 feet.
 - j. Vehicular access routes for off road or undeveloped areas shall be identified for use during construction.
 - k. Identify and reference contract numbers and Capital Project numbers of all existing and proposed facilities within and adjacent to the project limits.
 - l. On projects requiring permanent structures, the extent of the area shown outside of the anticipated property or right-of-way shall be determined by the Designer on a case by case basis, but shall not be less than 100 feet.
 - m. In new developments where the terrain is being transformed, most of the information shall be obtained directly from approved plans prepared to satisfy proposed improvements including curbs, storm drains, street right-of-ways and lots as taken from the record plat and construction plans and shall show all existing features that are to remain undisturbed.
3. Method of Locating Topography
 - a. The method of locating topography shall be by field surveys utilizing the radial survey method, the GPS Real Time Kinematic (RTK) method or the right angle plus offset method. Survey field notes may be kept in the classical method (handwritten notes) or by the electronic data collection method as per the Howard County DPW Departmental Procedures 501.7, Specifications for Surveying Procedures and Documents.
 - b. Topography may be provided by aerial photogrammetry for engineering studies and drainage area maps. All vertical survey requirements for preliminary and final design shall be acquired by actual field surveys, unless otherwise approved by the DPW.
 - c. The Howard County Survey Division will furnish field books for classical methods.
 4. Existing and Proposed Contour Lines

If required, existing and proposed contour lines shall be shown on the plans. Sufficient information shall be obtained in order to allow the contours to be shown at 2-foot intervals or less. In areas of steep slopes (greater than 20%), contours may be shown at 5-foot intervals with the approval of the DPW.

5. Cross-sections

Where required, cross-sections shall be taken at fifty (50) foot stations and at intersecting roads, driveways, entrances, rivers, streams, and railroads. Cross-sections shall be at right angles or radial to the proposed alignment and extend a minimum of 100 feet beyond each side of the proposed facility and a minimum of 200 feet beyond anticipated project limits. The minimum distances shown herein shall be extended accordingly in order to provide sufficient information to established profile grade lines beyond the actual project limits or to locate other topography or topographic relief, relative to the design or construction of the proposed improvements. Cross sections shall be plotted on standard cross-section sheets of a quality that will provide acceptable prints.

6. Property Corners

Property corners within the construction area shall be referenced such that they may be reset after construction.

7. Howard County Survey Control Stations

Howard County Survey Control Stations that will be affected by the proposed construction shall be noted on the plans as being protected or to be relocated accordingly. Where there is a need to protect or relocate Control Stations, the DPW shall be notified by the Designer in writing prior to the approval of the plans.

C. Construction Surveys

1. General

The Designer shall provide the necessary stakeout controls on the plans for setting the alignment, both horizontally and vertically, to construct the pipeline.

2. Water Mains

Dimensioning shall be shown by providing a table listing key points defining the alignment, including points of curvature and tangency, fittings and appurtenances with their respective stations along the pipeline and coordinate values.

Alternative:

Dimensioning of the proposed facility, including fittings and appurtenances may be made by providing right angle distance and stationing of traverse or centerline road station (proposed roads only).

3. Sewer Mains

Dimensioning shall be shown for gravity sewers by providing a table listing the manholes with their respective numbers and coordinate values. Dimensioning shall be shown for sewer force mains and appurtenances in the same manner as for water mains.

Alternative:

Gravity sewers, force mains and appurtenances may be drawn with dimensions fixing the locations from established traverse control points.

4. Pumping Stations

A stakeout table listing all components of the proposed facility along with their corresponding survey coordinate locations shall be provided on the plans.

Alternative:

The locations of proposed facilities may be projected from a base line established from the traverse shown on the plans.

5. Additional alignment stakeout information for pressure pipelines with horizontal curves:

- a. Pipelines smaller than 24-inch diameter:
Provide the radius of the curve, pipeline station and location of the tangent points of the curve (PC and PT).
- b. For pipelines 24-inches and larger in diameter:
Provide the delta, radius, tangent, length or arc of curve, pipeline stationing and location of the tangent points (PC and PT).

5.3 Rights-of-Way, Easements and Construction Strips

A. General

1. Water / sewer mains are typically laid in public rights-of-way (roadways) wherever possible. There are occasions where it may be economical and even necessary to deviate from this practice. For example, interceptor sewers can present a myriad of problems primarily due to the fact that natural drainage courses deviate from roadways, and because property lines seldom follow drainage courses.
2. An individual easement is required for fire hydrants when an existing road right-of-way is too narrow to accommodate the installation of a fire hydrant as shown in the Standard Details.

3. Private water and sewer mains or house connections are not to be constructed within a public right-of-way or easement. Where necessary, private mains or house connections may cross public easements/rights-of-way at 90 degrees.
4. When a public main extends into private property or into space where an easement has previously been granted for some other use, it is necessary to obtain either a right-of-way or permanent utility easement from the property owner and in some cases, the agency holding the previous easement before proceeding with the construction of the new main.
5. In the case of a public main extending into private property, the proposed alignment should minimize the effect of the proposed construction on the natural and man-made features of the property and avoid the occupation of space to be used for future improvements. In the latter case, a preferred location is along property lines wherever possible.
6. The use of private easements are only permitted with the approval of the DPW. A private easement across an individual lot to allow an adjoining property to connect to the public water and/or sewer main will only be permitted in order to serve an existing property under the following conditions:
 - a. The property to be served does not abut an existing public right-of-way or easement in which a water main or sewer is laid.
 - b. The property cannot be serviced by the extension of the public water or sewer system through an existing right-of-way.

Private easements extending through more than one property will not be permitted.

The creation of private easements to serve lots created through the subdivision process is generally not permitted. The exception to this is when new subdivision lots share a common driveway. In order to allow adequate separation between the private water and sewer house connections, a shared private easement overlaying the use in common driveway may be permitted with the approval of the DPW.

The minimum width of a private easement containing a single utility is 10 feet. The minimum width of a private easement containing two utilities is 20 feet. The public water and/or sewer house connection will stop at the public right-of-way or easement line. The ownership and maintenance responsibility of the water and/or sewer house connection within the private easement is the property owner's.

B. Easement Widths

1. The minimum easement width for a single water or sewer main less than 15-inches in diameter is 20 feet. In addition, a 10-foot wide temporary construction strip is required on each side of the easement for use by the contractor during the period of initial construction. An acceptable alternate to this arrangement, when one or more

easement negotiations can be eliminated or existing structures must be avoided, is to acquire a 20-foot wide construction strip on one side only. The construction strips expire after the construction is complete and revert back to the property owners. When a 12-inch or smaller diameter water main is to utilize the same easement with a 12-inch or smaller diameter sewer, the minimum width of the permanent easement is increased to 30 feet and the utility lines are placed along the third points of the easement. Easement widths for pairs of larger diameter pipelines shall be determined by the DPW on a case-by-case basis.

2. When water or sewer mains are 15-inches in diameter or larger refer to the following two tables:

TABLE 5.3 A
Easement and Construction Strip Minimum Width Requirements for Water Pipelines

Pipe Diameter	Width of Easement	Total Width of Construction Strips
16" to 24"	25 feet	20 feet
30" and larger	30 feet	20 feet

TABLE 5.3 B
Easement and Construction Strip Minimum Width Requirements for Sewer Pipelines

Pipe Diameter	Width of Easement	Total Width of Construction Strips
6" to 12" with installation depths greater than 16 feet	30 feet	20 feet
15" to 24"	30 feet	20 feet
30" and larger	45 feet	To be determined by DPW

3. The above tables are minimum requirements. It is the responsibility of the Designer to ensure that both the easement and construction strips are adequate to construct and maintain the utility main. The topography of the utility alignment, anticipated soil conditions and required excavation depths shall be taken into consideration when determining required easement and construction strip sizes. All easement widths shall provide the DPW with adequate space for future repairs and maintenance of the utility. The Designer shall consider such factors as the size of equipment, and material required for the excavation and repair of the utility. Consideration shall be

given to the possibility of future pipeline installations within the same easement, such as relief sewers.

C. Access

Adequate access shall be provided to the utility easement for both construction and maintenance purposes. In determining adequate access, the Designer shall evaluate the Contractor's and County's ability to deliver the required materials and equipment to every location along the pipeline alignment without traversing through private properties. The maximum distance between access points shall be 1,500 feet unless otherwise directed by the DPW. In selecting points of access, the Designer shall avoid environmentally sensitive areas, such as wetlands, slopes over 20% and heavily wooded areas. If the Contractor requires access through private property during construction, the Designer shall be required to obtain, in writing, all rights of entry for temporary access. The Designer is also responsible for preparing all permanent easement documents required by the DPW.

D. Preparation of Plats and Descriptions

The Designer shall prepare plats and descriptions for the DPW for all required easement acquisitions. The DPW Procedure 501.4, "Standard for Preparation of Land Acquisition Documents" sets forth the standard practice and requirements for the preparation of these plats and descriptions. All plats shall be drawn at the same scale as the construction plans (1" = 50'). With prior DPW approval, plats may be drawn to the scale of 1" = 100'.

5.4 Crossings and Clearances

A. General

All clearance dimensions referenced in this section are measured from the outside edge of the utilities. Where specified clearance cannot be obtained between water/sewer mains and other utilities, the water/sewer main shall be constructed in accordance with Section 5.4.E., "Waivers", of this Chapter.

B. Clearances

The following clearance criteria shall be used for water main and gravity (sanitary) sewer installations:

1. Gravity sewers shall have a minimum 10-foot horizontal clearance from any existing or proposed water main. The top of the sewer shall be installed below the bottom of the water main. In cases where maintaining a 10-foot separation is not possible, the DPW may allow deviation on a case-by-case basis. Such deviation may allow installation of the water main closer to the sewer, provided that the water main is installed with a minimum vertical clearance of 6 feet above the sewer main.

2. Whenever sewers are laid within 50 feet of a private well, sewer joints shall be utilized that are capable of withstanding a 25 psi internal hydrostatic pressure. These joints shall be used from manhole to manhole.
3. Water mains shall maintain a minimum 1-foot vertical clearance above any sewer main at any crossing. The sewer pipeline must remain below the water main at all locations within 10 feet of the water main. At all water and sewer crossings, a full length of water pipe shall be centered over the sewer pipe so the pipe joint on each end of the water pipe is located as far as possible from the sewer pipe.
4. The minimum vertical clearance of a water main above any oil line shall be 1.5 feet or as required by the oil pipeline company. The minimum vertical clearance between any water/sewer line and other utility shall be 1-foot. The minimum horizontal clearance between any water/sewer line and other utility shall be 5 feet.
5. The minimum horizontal clearance between any permanent structure and the edge of the utility easement shall be ten (10) feet.
6. A pond buffer shall be provided for stormwater management facilities in accordance with the Howard County Design Manual, Volume I, Storm Drainage. The minimum horizontal clearance between the toe of embankment or edge of 100-year water level of a stormwater management facility and the centerline of the water or sewer pipe shall be 25 feet.

C. House Connections

Sewer house connections (SHCs) shall ordinarily be installed in a separate trench with a minimum 10-foot horizontal clearance from any water house connection (WHC). The top of the SHC connection shall be below the bottom of the WHC. If a combined or common trench is utilized the following criteria shall apply:

1. If ductile iron is used for the WHC, the WHC must be installed with a minimum 1.5-foot horizontal clearance and 6-foot vertical clearance above the SHC.
2. If copper is used for the WHC, the WHC must be installed with a minimum 1.5-foot horizontal clearance and 1-foot vertical clearance above the SHC.
3. The minimum distance between SHCs is 10.0 feet.
4. The minimum distant between WHCs is 7.5 feet.

D. Force Mains and Low Pressure Sewer House Connections (LPSHCs)

Sanitary force mains and LPSHCs (grinder pump/step system) shall be installed a minimum of 10 feet horizontally and 1 foot vertically below any water main or WHC. LPSHCs and WHCs shall not be installed in a common trench.

E. Waivers

The Chief of the Bureau of Engineering must approve any deviations from any of the previously listed clearance criteria. Where clearance criteria between water and sewer mains cannot be maintained, both the DPW and the Maryland Department of the Environment must approve any waiver request. The Designer is responsible for obtaining all required approvals for waivers.

Where specified clearances between water and sewer installations indicated in Section 5.4.B.1, C or D of this chapter are not possible, the sewer house connection materials installed shall be waterworks grade 150 psi pressure rated pipe or equivalent and shall be pressure tested to ensure water tightness.

Where the specified vertical clearances indicated in Section 5.4.B.3 of this chapter are not possible, one of the following methods must be specified:

1. Either the water main or sewer main may be encased in a watertight carrier pipe that extends 10 feet on both sides of the crossing, measured perpendicular to the water main.
2. The sewer materials installed shall be waterworks grade 150 psi pressure rated pipe or equivalent and shall be pressure tested to ensure water tightness.

The concrete encasement of water or sewer mains will not be allowed.

5.5 Pipeline Buoyancy**A. General**

All pipelines installed in saturated conditions, such as areas of high groundwater, stream crossings and floodplain areas shall be designed to prevent pipeline flotation. A pipeline will float due to buoyancy, if the buoyant force acting upward on the pipe is greater than the dead load forces acting downward on the pipe (weight of pipe, weight of dry soil, and weight of saturated soil). All calculations shall assume the pipeline is empty, as during periods of non-use or cleaning.

B. Methodology For Buoyancy Computations

The following methodology should be utilized for all buoyancy computations:

1. The per linear foot weight of pipe (W_p) shall be obtained from a representative manufacturer of the pipeline material specified. If not specified, the thinnest wall pipe available for the calculation shall be used.
2. The force due to the weight of the saturated soil on the pipeline shall be calculated as follows:

$$W_{ss} = w_{ss} (H_{ss}) D$$

where:

W_{ss} = Weight of Saturated Soil (lb/L.F.)

w_{ss} = Weight of Saturated Soil (lb/ft³)

H_{ss} = Height of Saturated Soil above Pipeline (ft)

D = Outside Pipeline Diameter (ft)

Note: A saturated unit weight of 60 lb/ft³ shall be used for w_{ss} unless soil information is available indicating otherwise.

- The force due to the weight of the unsaturated soil above the water table on the pipeline shall be calculated as follows:

$$W_{DS} = w_{DS} (H_T - H_{ss}) D$$

where:

W_{DS} = Weight of Dry Soil (lb/L.F.)

w_{DS} = Average Unit Weight of Dry Soil (lb/ft³)

H_T = Total Height of Soil from Ground Surface to Pipe Crown (ft)

H_{ss} = Height of Saturated Soil above Pipeline (ft)

D = Outside Pipeline Diameter (ft)

- The buoyant force on the pipe shall be calculated as follows:

$$W_w = \pi D^2 / 4 \times 62.4$$

where:

W_w = Weight of Displaced Water = buoyant force upward (lbs/L.F.)

D = Outside Pipeline Diameter (ft)

- A safety factor against pipeline flotation can be calculated as follows:

$$(W_p + W_{ss} + W_{DS}) / W_w = S.F.$$

If the above calculated safety factor is less than 1.5, alternative pipeline materials or concrete anchors designed to increase the downward force on the pipeline must be utilized.

5.6 Pipeline Abandonment

A. General

All limits and methods of pipeline and appurtenance abandonment shall be delineated on the plans. The Designer shall coordinate with the DPW regarding all salvaging, abandoning or removing of existing pipelines and appurtenances.

B. Sewers

All sewers 15-inches and smaller shall be abandoned by inserting a mechanical plug a minimum of 12-inches into the abandoned pipeline. All space around the pipeline behind the plug shall be filled/surrounded by non-shrink grout or 2,500 psi concrete.

For sewers larger than 15-inches, a masonry plug shall be installed in lieu of a mechanical plug and the pipeline abandoned, as previously described.

C. Manhole/Vault Structures

All sanitary sewer manholes or pipeline vaults shall be abandoned in accordance with the following:

1. All structure frames, covers and sections shall be removed to a minimum 1-foot below finished grade. All frames and covers shall be salvaged and reused when approved by the DPW. It shall be noted on the plans when surplus frames and covers shall be salvaged and delivered to the DPW.
2. For sanitary sewer manholes, mechanical plugs on all incoming and outgoing sewers and laterals shall be installed. If sewers are larger than 15-inches, a masonry plug in lieu of a mechanical plug shall be installed.
3. All structures within the road right-of-way shall be completely filled with concrete or flowable fill. All structures outside of the road right-of-way shall be filled with stone.

D. Water Mains

1. Water mains to be abandoned shall be capped. Concrete blocking shall be placed to retain the cap on all water mains that will remain in service.
2. The limits of abandonment for all pipe, fittings and appurtenances shall be indicated on the plans. The Contractor shall be directed on the plans to remove and salvage all abandoned pipe, fittings, valves, valve boxes and fire hydrants, if their reuse appears practical. Otherwise, the Contractor shall be directed to remove and dispose of the items offsite. The Contractor shall be directed on the plans to properly cut and plug the existing main and provide adequate buttressing or restraints where needed.
3. Building service connections shall be abandoned by closing the corporation stop, disconnecting the building service therefrom, removing the corporation stop and plugging the line. All meters shall be removed, meter pits backfilled and meters salvaged if their condition permits reuse. If water meters are located inside the residence or building, the ball valve box shall be removed at the property line.

4. For abandonment of water mains 20-inch and larger diameter, a brick bulkhead nine inches thick or an approved plug shall be required at each location where the pipe is cut or valve is removed.
5. For abandonment of water mains smaller than 20-inch diameter, bulkheads using brick masonry, 2,500 psi concrete, plugs or caps shall be required at the end of abandoned sections.

5.7 Evaluating Loading Conditions on Existing Pipelines

A. General

The adequacy of an existing pipeline to support additional loads needs to be evaluated if increased loading conditions due to change in grade or other loading conditions are anticipated. The Designer shall submit all calculations indicating all design assumptions and methodologies. All evaluations shall address the adequacy of the pipeline material thickness to handle the anticipated increased loads without exceeding recommended loads or deflections for a given pipe material and thickness. All design criteria for pipe material/thickness, existing pipeline depth, pipe-bedding conditions etc. shall be based upon as-built plans for the existing utility. All pipelines shall be designed for the applicable working or surge pressures. If design information pertaining to pipe thickness class or bedding conditions is not available, the most conservative (i.e. weakest class or worst bedding conditions) allowed by the DPW at the time of installation shall be assumed. Pipelines shall be designed with a factor of safety of 1.25 for DIP and 1.5 for all other pipe materials. If the depth of the pipeline cannot be determined from the plans, test pits shall be performed.

B. Method

All pipe loading analysis shall be performed based upon the industry standard for the pipe material/thickness actually installed. Table 5.7A, "Pipeline Design Standards" provides an outline for available design standards for various pipeline materials. This list is not inclusive of all pipeline materials that could be encountered. If pipelines of other material types are encountered, the Designer shall be responsible for submitting supporting documents for all required analysis.

If the evaluation of loading conditions indicates that the capacity of the pipeline to support additional loading will be exceeded, the following methods shall be investigated to determine the most appropriate method to reduce the loading on the pipe to acceptable levels:

1. Revise the loading conditions above the pipeline so that the supporting strength of the pipeline is not exceeded.
2. Upgrade the pipeline bedding conditions for the existing pipeline to decrease the loads on the pipeline to within acceptable limits.
3. Installation of a concrete arch or cradle can be used in limited situations. See Section 5.10, “Concrete Encasements, Arches, Cradles and Anchors” for limitations on concrete arches and cradles
4. Relocate the existing pipeline to an area where loads will be decreased below the limitations of the pipeline.
5. Replace the existing pipeline with a pipe material capable of carrying the required loading conditions.

TABLE 5.7 A
Pipeline Design Standards

Pipe Type (abbreviation)	Design Standard
Ductile Iron Pipe (DIP)	AWWA C150
Reinforced Concrete Pipe (RCP)	American Concrete Pipe Association’s Concrete Pipe Handbook and Concrete Design Manual
Cast Iron Pipe (CIP)	AWWA H1
Polyvinyl Chloride Pipe (PVC)	AWWA M23
Asbestos Cement Pipe (ACP)	AWWA C401
Pre-stressed Concrete Cylinder Pipe (PCCP)	AWWA C304
Vitrified Clay Pipe	National Clay Pipe Institute Pipe Engineering Manual

5.8 Rotation of Fittings

A. Rotation of Bends

1. Bends can be rotated to produce a simultaneous deflection in both the horizontal and vertical directions. All deflection angles for bends to be rotated in both the vertical and horizontal directions shall be labeled as the horizontal and/or vertical deflection angle.
2. For allowable bends see Chapter 3, “Water Main Design.”

3. When the rotation of the bend has a deflection greater than 10° , the Designer must give special considerations to restrain the horizontal and vertical components of the thrust force caused by the rotation of the bend.
4. The following formula is for the design of horizontal bends rotated in the vertical plane. The Designer can use these formulas, with some modifications, to design vertical bends rotated in the horizontal plane.

$$\cos B = (\cos HD \cos V \cos V') + (\sin V \sin V') \text{ or}$$

$$HD = \cos^{-1} [(\cos B - (\sin V \sin V')) \div (\cos V \cos V')]$$

where:

B = Total manufacturer's deflection angle of the bend
(45° , $22\text{-}1/2^\circ$, or $11\text{-}1/4^\circ$)

V = Vertical angle of the approaching line (incoming) of the bend with horizontal plane

V' = Vertical angle of the departing line (outgoing) of the bend with the horizontal plane.

HD = horizontal deflection of the combined bend

VD = vertical deflection of the combined bend

VD = V + V' (See Note A)

Note A: V and V' are positive or negative if the pipe is sloping upward or downward, respectively, in the direction of laying. For V or V' positive, sinV or sinV' and cosV or V' are positive. For V or V' negative, sinV or sinV' is negative and cosV or V' are positive.

This formula is graphically depicted in Appendix J, "Vertical/Horizontal Pipeline Deflection Chart."

B. Rotation of Tees

1. When the branch of a tee has a valve, the maximum allowable rotation of the branch shall not exceed 3° .
2. When the rotation of the branch connection is 10° or more, the Designer must design special thrust blocking design for the vertical components of the thrust forces caused by the rotation of the tee.

C. Rotation of Other Fittings

Rotation of any fittings other than bends or tees is not permitted.

5.9 Thrust Restraint Design for Buried Piping

A. General

Thrust restraint is required for all pressurized water and sewer mains where plugs, tees, bends or reducers occur. Buttresses and anchors shall be used whenever possible to provide thrust restraint. Buttresses are shown in the Standard Details and are to be employed in all cases compatible with the design conditions. The Designer shall verify that standard buttress details apply to the particular project. If required by the DPW, the Designer shall prepare and submit calculations based on internal hydraulic, surge pressures and soil bearing capacities as determined by field measurements.

B. Alternate Buttress / Restrained Joint Design

1. Special or Modified Thrust Blocks

Special or modified thrust block details are to be employed for conditions not covered by the Standard Details. All buttresses shall be designed based on actual soil conditions, groundwater depths and design pressures. (See Section 5.12, "Geotechnical Design Criteria" for thrust block soil boring criteria).

Horizontal bends, reducers, tees, tapping sleeves and valves (TS&V), plugs and caps shall be designed using one of the appropriate earth pressure theories available. "Design Method for Vertical Anchor Slabs in Sand," by N. Krebs Oversen and Helle Stormann is recommended. (See pages 1481 to 1500, Performance of Earth and Earth-Supported Structures, Volume 1 Part 2, ASCE, 1972). A design concept based on bearing capacity shall not be used. For blocks in cohesive soils, the soil resistance shall be evaluated in terms of short and long-term shear strengths. The lowest resistance between the two shall be used for the design. The calculated net soil resistance for the block to be used shall be at least 1.5 times the design thrust force. Design criteria for pipe anchors for vertical bends shall neglect the weight of the earth over the pipe. The weight of the pipe and water in the pipe shall also be considered negligible for pipe 16-inches in diameter and smaller.

2. Restrained Joints

The use of concrete thrust blocks shall always be considered first. However, where field conditions are such that there is not enough clearance between the proposed pipeline and nearby existing or proposed utilities or structures, or where there are poor soil conditions, restrained joints shall be used in place of buttressing. When the design requires special restrained joints, Megalug or U.S. Pipe FieldLok Gasket type joint restraints shall be used. All other proprietary restrained joint mechanisms are subject to the approval of the DPW.

All design of restrained joint systems shall be in accordance with the Ductile Iron Pipe Research Association (DIPRA) Thrust Restraint Design for Ductile Iron Pipe

(1997). All restrained joint designs shall have a factor of safety of 1.5. All design parameters for restrained joint designs shall be based on actual field conditions including soil types, groundwater conditions, design depths, and pipeline pressures.

5.10 Concrete Encasements, Arches, Cradles, and Anchors

A. Concrete Encasements

The concrete encasement of sewer or water mains will not be considered as an option for any installations.

B. Concrete Arches/Cradles

1. Existing Pipelines

The use of concrete arches is only allowed in situations where increased loads on an existing gravity sewer requires the upgrading of the pipeline bedding factor to increase the pipeline load carrying capacity.

The use of concrete cradles is allowable in situations where increasing the bedding conditions for an existing water line or force main is required. See Section 5.7, "Evaluation Loading Conditions on Existing Pipelines."

The use of either a concrete arch or cradle is allowed only with the approval of the DPW and if other rehabilitation methods are not practical. All design computations and details must be submitted to the DPW for review and approval prior to using a concrete arch or cradle.

2. Proposed Pipelines

Concrete cradles or arches shall not be utilized for any proposed pipelines.

C. Concrete Anchors For Steep Slopes

Concrete anchors are required for all pipelines constructed on a grade equal to or greater than 20%. All anchors shall be installed in accordance with the Standard Details. All anchored pipelines shall be restrained joint DIP. Pipelines that are not ductile iron or are greater than 12-inches in diameter are not covered by the Standard Details and require special design. The Designer shall submit all required analysis to the DPW for such cases. The spacing requirements for anchors shall be in accordance with Table 5.10A.

TABLE 5.10 A
Required Concrete Anchoring Based on Installed Pipeline Slope

Pipe Grade	Concrete Anchor Spacing
Less than 20%	Anchors not required
20%-35%	Alternate lengths of pipe (40' max)
36%-50%	24' maximum
Greater than 50%	16' maximum

5.11 Design of Pipeline Structures

A. General

The following guidelines are for the design of structures for water and sewer pipelines including structural concrete and miscellaneous metals design. These include cast in place or precast concrete structures, such as valve vaults, manholes, junction chambers, air release/vacuum valve vaults, metering vaults, entry port vaults, etc. Whenever conditions permit, the Designer shall use the Standard Details for these structures. Structures larger than those shown in the Standard Details or structures required for unusual conditions are considered special design. These shall be designed and detailed by the Designer using the guidelines herein. All special designs require the submission of structural calculations for approval by the DPW and shall be performed by a Professional Structural Engineer registered in the State of Maryland.

B. Physical Characteristics

1. Size

- a. A minimum of 6 feet of headroom shall be provided inside the structure. When the structure does not require maintenance of equipment or operation of flow control devices, the minimum headroom may be reduced to 5 feet. A minimum of 18-inches shall be provided vertically between the vault floor and the bottom of the pipe as maintenance access. The Designer shall use these design criteria in establishing the depth of the pipeline entering and exiting the structure. The pipeline with valves, meters, entry ports, etc. shall be supported by masonry columns from the floor.
- b. A minimum of 3 feet shall be provided horizontally between parallel pipes within the vault or between the outside of pipe and wall for maintenance personnel to work.
- c. The Designer shall consider the limitations of size and weight of the structure for shipping precast structures to the site.

2. Structure Appurtenances
 - a. Vaults with over 64 square feet of floor area shall have sloping floors with sump pits. The DPW will determine the requirement for a sump pump or gravity drain.
 - b. The DPW will determine the requirement for lighting and heat.
 - c. The DPW will determine the requirement for painting schedules of all pipelines and equipment, and coatings for the interior and exterior of the structure.
3. Setting of Frames and Covers or Hatches
 - a. For structures requiring frequent maintenance of equipment or operation of flow control devices, the Designer shall endeavor to place the vault outside of the roadway surface and within the right-of-way.
 - b. Frames and covers or hatches shall be set to finish grade if placed within the roadway or off the roadway in developed areas subject to vehicular traffic. Design loads for frames and covers or hatches shall include traffic loads. Hatches shall not be permitted in roadways or areas adjacent to roadways subject to high traffic volume.
 - c. When vaults are located off the roadway and are protected from traffic by standard concrete curbs, guardrails, steel/concrete bollards or other permanent barriers, the vault rim shall be designed to nine (9) inches above the existing ground elevation or as directed by the DPW. A design load of 300lb/sq. ft. with a maximum deflection of $L/150$ is required in these circumstances.
 - d. When in undeveloped areas, the manhole or vault rim shall be designed to one and a half (1 1/2) feet above the existing ground elevation or as directed by the DPW. Traffic loads do not need to be included for design in these situations.

C. Design Loads

1. Dead loads: Dead weights of materials.
2. Hydrostatic: 62.4 lb/cu. ft.
3. Live loads: 300 lb/sq. ft. on equipment floors.
150 lb/sq. ft. other areas.
4. Traffic loads: AASHTO H20 wheel loads with an impact factor of 1.5.
5. Surcharge load: Assume 2 feet of earth cover, unless other information is available.
6. Lifting loads: Precast structures shall be designed for lifting loads.

D. Design Criteria

Pipeline structures shall be designed according to the following codes and standards:

1. BOCA Building Code
2. ASTM C 890 Standard Practice For Minimum Structural Design Loading for Monolithic or Sectional Concrete Water and Wastewater Structures.
3. ACI 318 Building Code Requirements for Reinforced Concrete Structures
4. ACI 350 Environmental Engineering Concrete Structures
5. AISC Code - Specification for the Design, Fabrication and Erection of Structural Steel Buildings
6. AASHTO Code
7. Aluminum Association, Aluminum Design Manual

E. Concrete Structures

1. Design methods: Per ACI 318 with special limitations in accordance with ACI 350.
2. Precast structures

- a. Design

Precast structures shall be designed by the precast manufacturer and certified by a Professional Engineer registered in the State of Maryland. The structural computations shall be submitted for review along with the shop drawings.

- b. Lifting inserts

Lifting inserts for precast structures/members shall be designed for four (4) times the maximum load transmitted to the inserts.

3. Buoyancy design

The design for below ground structures shall consider the effects of buoyancy. The groundwater elevation shall be considered at the top of the structure. The structure shall be sized with a flotation safety factor of 1.1 minimum with no earth overburden or lateral component.

4. Concrete strength

The concrete strengths ($f'c$) indicated below shall be used for the design and noted on the plans as follows:

- a. Cast in place structures:

$f'c = 4000 @ 28$ days

- b. Precast structures:

$f'c = 5000$ psi @ 28 days

5. Steel reinforcement: ASTM A615 Grade 60
6. Structure components: All underground concrete structures shall be designed for the minimum loads indicated in ASTM C 890.
7. All concrete structures shall meet the requirements of Federal, State and Local agencies.

F. Miscellaneous Metals

1. Steel structures
 - a. The Working Stress Design Method by the AISC manual or Load and Resistance Factor Design (LRFD) may be used in the design of steel structures.
 - 1) Frame Structures
Steel frames shall be wide flange, angle or channel members and designed for the load tributary area.
 - 2) Pipe thrust restraint system
Tie rods shall be designed for the full thrust tensile force. Lugs or thrust rings shall be designed for the full thrust force and shear. Bending moment and deflection must also be evaluated. Stress on the pipe due to welded-on thrust rings or lugs shall be checked through structural calculations.
2. Aluminum Structures
 - a. Gratings
Gratings shall be designed or selected for 150 lb/sq. ft. loading, unless given other specific loading conditions or a higher load is expected. The span direction of the grating bearing members shall be shown on the plans. The Designer shall follow the manufacturer's recommendations and limit the deflection to 1/4" or span length $L/360$ whichever is smaller at the design load. Removable sections with anchoring devices shall be provided.
 - b. Frames
Aluminum frames are to be wide flange, angle or channel members and designed for the load tributary area. Allowable stress of aluminum members shall be in accordance with the Aluminum Association Specifications. Connections shall be designed and detailed on the plans using stainless steel bolts. Anchor bolts or expansion bolts embedded in concrete shall be designed for shear and tension forces.
 - c. Hatches
Hatches that are located in open areas adjacent to low traffic volume roadways shall be designed for an H20 loading. If hatches are located in confined areas

protected from H20 loading, as explained in Section 5.11.B.3, “Setting of Frames and Covers or Hatches” above, and the hatch is at least 9-inches above ground, a minimum 300 lb/sq. ft design load shall be required. The maximum deflection shall be limited to $L/150$. If the structure opening is located in either an existing or future roadway or in an open area adjacent to a high traffic volume roadway, a heavy duty (H20 loading) frame and cover shall be used in lieu of a hatch.

d. Ladders

Ladders shall be designed for a 300 lb. concentrated load at the middle of the ladder rung. Rungs shall be constructed of a solid bar with serrated surface. Stringers shall be a minimum of 3/8" thick. Bracket supports for the stringers shall be provided at four (4) foot spacings.

5.12 Geotechnical Design Criteria (For Capital Projects Only)

A. General

The following are guidelines for geotechnical services that the Designer is required to provide for the design of water or wastewater projects. At the discretion of the DPW, additional information may be required. The Geotechnical services provided during the design shall include the selection of boring locations, sample types and intervals, and field and laboratory procedures as outlined below. All information obtained and design recommendations shall be provided in a Geotechnical report for a specific project as outlined below.

B. Preliminary Geotechnical Analysis

1. A review of the proposed utility alignment shall be performed to identify possible obstructions, roadway, stream, wetland, waterway and utility crossings.
2. Geological, soil survey, floodplain and wetland maps shall be reviewed.
3. Boring / tunneling / structural subsurface investigations shall be reviewed from previous area projects.
4. Tunneling options shall be considered and reviewed based on feasibility, obstructions, roadway, stream, wetland, waterway, utility crossings, and soil and rock geology.
5. Tunneling options shall include but not be limited to:
 - a. Liner Plate Tunnelling
 - b. Boring and Jack
 - c. Directional Drilling
 - d. Microtunnelling

C. Soil Borings

1. Layout

The minimum layout requirements for soil borings are as follows:

- a. Water or Sewer Pipeline
Borings shall be drilled at a maximum spacing of 200 feet. If rock is encountered, additional borings may be taken on the alignment equidistant between the original borings to identify the horizontal and vertical limits of the rock.
- b. Thrust Blocks
One boring shall be taken at each thrust block location.
- c. Manhole Structures
One boring shall be taken at each manhole structure location.
- d. Roadway Crossings/ Waterway, Stream and Wetland Crossings
 - 1) Boring spacing shall not exceed 100 feet.
 - 2) For crossings less than 100 feet in length, a minimum of two (2) borings are required, one on either side of the crossing.
 - 3) For crossings greater than 100 feet in length, a minimum of three (3) borings are required, one on either side of the crossing and one at the intermediate point.
- e. Structures (pumping stations, tanks, treatment facilities)
A minimum of two (2) borings shall be taken at each structure location or as recommended by the Designer and approved by the DPW.

2. Boring Depth

All borings shall be taken to a minimum depth as indicated below or until rock refusal is encountered.

- a. Water or Sewer Pipeline
Three (3) feet below pipe invert.
- b. Thrust Blocks and Manhole Structures
Five (5) feet below pipe invert.
- c. Roadway, Waterway, Stream and Wetland Crossings
Minimum ten (10) feet below crossing pipe invert.
- d. Structures - as recommended by the Designer.

3. Equipment

The following methodologies are allowed for obtaining subsurface information:

- a. Mechanical (Drilling rigs, tripod rigs)
- b. Hand (Hand augers)
- c. Combination mechanical and hand.
- d. In addition to soil borings, dynamic cone tests, or non-intrusive techniques such as ground penetrating radar may be used. If irregularities are identified based on these tests, then soil borings shall be performed at the identified locations.

4. Sampling Methods

The following methods shall be utilized unless otherwise stated by the DPW for obtaining required samples:

- a. Auger Probes: A minimum of one jar sample (minimum pint size with sealable lid) and one bulk bag sample (minimum 50 pounds of soil) for each soil type encountered.
- b. Standard Penetration Tests (SPT), (ASTM D1586): One sample shall be taken every two and a half (2.5) feet within the upper 10 feet of each boring and one at each five (5) foot interval thereafter. Additionally, a sample shall be taken at any noticeable change in material and at the bottom of each boring. A representative jar sample shall be collected at each interval. Soil borings for roadway, stream, wetland and waterway crossings SPT are to be performed and samples are to be taken continuously from the ground surface to the bottom of each boring.
- c. If auger refusal is encountered in a drilled hole before the depth specified, the drilling shall not be terminated. It shall be advanced continuously using a double tube barrel, with a diamond drill bit, capable of retrieving rock samples at least 1-5/8 inch in diameter (ASTM D2113). The percent of core recovery and Rock Quality Designation (RQD) shall be determined.
- d. Electronic apparatus sampler for field measurement of groundwater / soil temperature / PH / and Resistivity.

5. Boring Logs

Boring Logs shall be typed and contain the following minimum information:

- a. Project Name

- b. Boring Hole Numbers
- c. Ground Elevation
- d. Boring Hole Location
- e. Blow Counts from Standard Penetration Tests for each six- (6) inch increment of each split spoon penetration
- f. Elevation and depth from surface to each soil or rock (if encountered) stratum
- g. Elevation and depth of the bottom of the boring
- h. Visual description of each soil encountered, including:
 - 1) Color
 - 2) Consistency / relative density
 - 3) Moisture condition
 - 4) Soil description, including ASTM D2488 and ASTM D 2487 designations
 - 5) Extent and character of weathering, type, color and hardness of rock
 - 6) Groundwater elevations
 - a) First encountered
 - b) At completion
 - c) At 24 hours
- i. Note any special observations, such as auger refusal, bag samples taken and other pertinent remark.

D. Laboratory Testing

The following laboratory tests shall be performed on each representative soil type encountered during the sampling.

- 1. Cohesive Materials:
 - a. Atterberg Limits (ASTM D4318)
 - b. Natural Moisture (ASTM D2216)
 - c. Unconfined Compression Tests (ASTM D2166) shall be made on undisturbed clay and cemented soil samples.
- 2. Cohesionless Material:
Gradation (ASTM D422)
- 3. Rock: Unconfined Compression Tests (ASTM D2938) shall be performed on selected rock samples.

4. Moisture - Density Relationships (ASTM D1557 or ASTM D698)
5. Corrosion Test: See section 5.13, "Corrosion Control Surveys and Design."

E. Geotechnical Report

The geotechnical report shall, at a minimum, include the following items that are pertinent to the project:

1. Project overview
2. Site map and drawing location of the utility and boring locations
3. Geology of the area of the borings
4. Discussion of subsurface conditions from boring data including groundwater observations
5. Discussion of laboratory analysis
6. Discussion of soil corrosivity (CIP,DIP, iron, steel, or PCCP)
7. Discussion and recommendation on excavation stability
8. Design parameters such as active and passive earth pressures, seismic coefficient, allowable bearing capacity and other geotechnical related design criteria
9. Discussion and recommendation for dewatering, if required
10. Recommendation on foundation preparation measures to be used
11. Recommendation for pipe and manhole bedding requirements to support design loads
12. Recommendation on backfill materials
13. Estimated volumes of borrow
14. Recommendation of 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 thickness
15. Recommendation of construction procedures for "open cut" and trenchless construction at roadway crossings
16. Recommendation of construction procedures for "open cut" and trenchless construction at waterway, stream and wetland crossings

17. Recommendation of pavement design
18. Recommendation of pavement reconstruction considerations, addressing the need for road reconstruction around excavations, if applicable
19. Recommendation and listing of criteria to be used for field evaluation of material suitability, adequacy of compaction, acceptability of shoring, etc.
20. Description of the type of rock and ripability of the rock encountered, if rock is encountered before the specified depth of the boring is reached.

F. Submittals

The following shall be submitted to the DPW:

- Geotechnical Report (s)
- Laboratory Testing Data Results
- Boring Logs
- Groundwater Observations Readings

5.13 Corrosion Control Surveys and Design

A. General

All pipelines 16-inch diameter and larger are subject to the corrosion control provisions of this manual. In addition, corrosion control design will be required in areas where the County has had a history of pipeline corrosion failures or where soils and conditions are conducive to corrosion failures. The DPW may require a corrosion control survey in any area of suspected corrosion activity.

The following are guidelines for corrosion control services that the Designer is required to provide for the design of a water or wastewater utility design project. The corrosion control services shall be provided for ductile iron, prestressed concrete, steel and the metallic fittings/components of non-metallic pipelines. The corrosion control services are intended to minimize and/or eliminate external corrosion for the new piping. All corrosion control services shall be performed by a Corrosion Specialist who is certified by the National Association of Corrosion Engineers (NACE) and is under the direct supervision of a Maryland Registered Professional Engineer.

B. Preliminary Corrosion Analysis

1. Review of the proposed utility alignment shall be performed to identify possible obstructions, roadways, streams, wetlands, railroads, utility crossings, sources of stray current or other high risk features relevant to external corrosion.
2. Review of proposed utility alignment shall be performed for parallel or crossing of natural gas and petroleum pipelines.

3. Review of proposed utility alignment shall be performed for parallel high voltage power lines.
4. Review of proposed boring locations shall be performed to verify that the borings are adequate for the corrosion control analysis. Additional borings shall be obtained if required for the corrosion control evaluation. Samples utilized for corrosion evaluation shall be taken from the proposed pipe depth.
5. The owners of existing utilities shall be contacted to determine if the piping systems are protected with impressed current cathodic protection systems. If so, the location and output of all existing impressed current rectifiers and groundbeds shall be documented.

C. Field Survey

1. In-situ soil resistivity measurements shall be obtained at a maximum 500-foot spacing along the alignment. Shorter spacing between resistivity measurements may be used if required for the corrosion control analysis. Soil layer resistivity shall be measured to the bottom of the proposed pipe depth. Layer resistivity values shall be calculated for each test location utilizing Barnes Layer Analysis. Testing shall be conducted using the Wenner Four-Pin Method in accordance with ASTM G57.
2. In-situ soil pH measurements shall be obtained at a maximum 500-foot spacing along the alignment. Soil pH shall be measured at a minimum depth of 1-foot. Testing shall be conducted in accordance with ASTM G51 for soil samples and ASTM D1293 for water samples.
3. In-situ soil, Redox (reduction-oxidation) Potential Testing shall be performed in the field in accordance with ASTM 1498.
4. In-situ stray DC current measurements shall be conducted in the vicinity of natural gas and petroleum pipelines as well as at other locations determined to be necessary to evaluate stray current activity along the proposed alignment. Testing shall include measurement of cell-to-cell earth gradients in select areas and structure-to-earth DC potential measurements on existing utilities where available.
5. In-situ induced AC voltage measurements shall be conducted in the vicinity of high voltage overhead electric lines as well as at other locations determined to be necessary to evaluate induced AC voltage impacts along the proposed alignment. Testing shall include measurement of the strength of electric fields in select areas and structure-to-earth AC potential measurements on existing utilities where available.

D. Laboratory Evaluations

1. Soil Samples

Soil samples from the anticipated pipe depth shall be obtained by the boring contractor at a maximum spacing of 1,000 feet along the final alignment. Shorter spacing between soil borings may be used if required for the corrosion control analysis. The proposed boring locations shall be reviewed by the Corrosion Specialist before any samples are obtained. Each soil sample shall be between a pint and a quart in size and shall be sealed within an airtight container.

2. Laboratory testing of each soil sample shall include the following:

- a. Chloride concentration (ppm): ASTM D4327
- b. Sulfate concentration (ppm): ASTM D4327
- c. Presence of sulfides: ASTM D4658

E. Evaluation of Data

The evaluation of the soil corrosivity and stray current risks will include consideration of the following minimum design requirements:

1. Steel piping shall be cathodically protected. Cathodically protected steel piping shall be provided with an external, bonded, dielectric coating.
2. Ductile iron water transmission mains shall be cathodically protected. Cathodically protected ductile iron piping shall be provided with an external, bonded, dielectric coating.
3. Ductile iron water distribution piping may or may not be cathodically protected depending on the corrosivity of the site soils, the presence of stray current and the critical nature of the distribution piping. Polyethylene encasement shall not be utilized as a corrosion control measure.
4. Prestressed concrete piping shall be provided with a corrosion monitoring system as a minimum.
5. Prestressed concrete piping shall be externally coated with a bonded, dielectric coating if installed in corrosive soils. Cathodic protection using zinc anodes may be required for extremely corrosive soils or in stray current areas.
6. Metallic fittings of non-metallic pipelines shall be provided with positive corrosion control (this may include cathodic protection in corrosive soils).

7. In all cases, proper bedding shall be provided for the piping. Piping shall not be placed on undisturbed earth.
8. In all cases, new piping shall be electrically isolated from existing piping.
9. In all cases, piping made of different metals shall be electrically isolated from each other.
10. Stray DC current mitigation systems shall be provided in areas where existing piping is protected with impressed current cathodic protection systems.
11. Induced AC voltage mitigation shall be provided in areas where the pipeline crosses or runs immediately parallel to high voltage, overhead electric lines.
12. Galvanic anodes shall be used when cathodic protection is necessary for corrosion control. Impressed current cathodic protection shall not be utilized.
13. Casings shall be electrically isolated from the pipeline.
14. Generally casing pipes shall not be filled with grout. In special instances where casings must be grouted, casings shall only be filled with a portland cement grout with a minimum pH of 10. Fly ash flowable fills shall not be used to fill casings. Casings that are filled with cement grout shall be provided with a corrosion rate monitoring system that is installed within the casing between the pipeline and the casing.

F. Corrosion Control Report

The final corrosion control report shall be submitted in hard copy and in digital format (Microsoft Word, Times New Roman, 12-point font and capable of being imported into the Howard County Database). The report shall, as a minimum, include the following items that are pertinent to the project:

1. Title Page
2. Table of Contents:
 - To include titles and subtitles
3. Overview
4. Executive Summary of results with conclusions
 - Field results, resistivities, pH, redox, stray DC current, induced AC voltage
 - Laboratory results, chlorides, sulfates, sulfides
5. Recommendations
 - Methods recommended to prevent or mitigate corrosion
6. Scope of work
7. ASTM Standards
 - Standard methods used for corrosion control evaluation
8. Procedures
 - Procedures used for field and laboratory evaluations

9. Results
 - Field Data – In Situ
 - Laboratory Data
10. Appendices
 - GIS locations
 - Relevant Photographs
 - Estimated Construction Costs.

G. Corrosion Control Submittals

The corrosion control design procedure consists of the Corrosion Control Report discussed previously and a corrosion control design. All corrosion control submittals shall be signed and sealed by a Professional Engineer registered in the State of Maryland. The following shall be submitted to the DPW for corrosion control designs:

1. Corrosion Control Report
2. Corrosion control layout drawing
3. Corrosion control details
4. Corrosion control specifications
5. Corrosion control cost estimate

5.14 Alternate Installation Technologies

A. General

In some cases, traditional open cut methods for installation of utility pipelines are not suitable because they are excessively expensive or disruptive. Trenchless technologies were developed specifically to handle these difficulties and should be considered by the Designer for utility crossings in the following cases:

1. Environmentally sensitive areas such as wetlands, streams or hazardous waste sites
2. Railroads
3. Primary or secondary roadways where traffic cannot be disrupted
4. Areas already crowded with existing utilities or adjacent to buildings where open trenching could undermine existing utilities or foundations

Trenchless technologies for new pipe installation and rehabilitation of existing pipelines include:

1. Tunneling
2. Boring and Jacking
3. Directional drilling
4. Microtunneling
5. Pipeline rehabilitation

The information provided within this manual does not address specific design procedures as they pertain to any alternate installation technologies. It does provide a reference of

installation technologies that DPW recognizes as viable options for specific applications. It also highlights particular design issues that the Designer should consider.

All uses of trenchless technologies require the approval of the DPW. The Designer shall be responsible for determining the applicability and cost effectiveness for any project specific application. In addition, the Designer shall be responsible for ensuring all designs are based on sound engineering principles, with all pipeline materials installed within applicable design limitations. Geotechnical investigations shall be performed in accordance with Section 5.12, "Geotechnical Design Criteria" of this manual. It should be noted that most of these alternate technologies require more thorough preliminary geotechnical analysis to determine which, if any, alternate technology is appropriate.

The Designer is responsible for coordination with all affected agencies, such as railroads, State Highway Administration, other utility companies and other Federal, State and Local agencies. The Designer shall also be responsible for securing all required environmental, archeological, waterway, highway or railway permits. All alternate installation technology techniques and materials require the approval of the DPW prior to design and installation. The Designer shall support the selection of any alternate installation with a report addressing all necessary design criteria.

B. Tunneling/Boring and Jacking

1. General

The Designer shall obtain the latest edition of specifications and/or policies of the agency or company who has jurisdiction or ownership over the facility being crossed to determine the correct materials, dimensions, appurtenances and procedures to be used in the design. All tunnels shall be designed with the following objectives in mind:

- a. Stability of tunnel openings
- b. Protection of adjacent or overlying structures
- c. Ability of the tunnel to perform over the intended life

Tunneling methods shall include either bore and jack installation or excavations with liner plate supports.

2. Design Standards

- a. All tunnel/carrier materials and installation methods require the approval of the owner of the area to be crossed and the DPW.
- b. The crossing is to be located as near perpendicular to the railroad or roadway alignment as practical and, hence, a minimum tunnel casing length is to be used.

The minimum casing length of a tunnel crossing a railroad is to be the width of the railroad right-of-way.

- c. The minimum soil cover above the tunnel shall be four and one half (4 1/2) feet, one and one half (1.5) times the outside diameter of the tunnel or the depth requested by the jurisdictional authority, whichever is greater.
- d. For bore and jack applications, the casing pipe shall be steel pipe. See the Standard Specifications for casing pipe requirements. Bore and jack installations are limited to a maximum of a 60-inch diameter casing pipe and a maximum tunnel length of 200 feet.
- e. Liner plate excavation shall only be used for tunnels of 48-inches or larger diameter. See the Standard Specifications for liner plate, gravel packing, grout and concrete requirements.
- f. For tunnels of both types, a minimum of one-foot vertical clearance shall be maintained between the tunnel and other utility lines. A minimum of fifteen (15) feet horizontal clearance shall be maintained with surrounding surface structures or subsurface structures.
- g. The ends of the tunnel are not to be located in steep slopes, streams or drainage ditches.
- h. Casing diameters shall be sufficient in size to correctly install the water or sewer main. All water and sewer mains installed within casing sleeves shall be DIP and have restrained joints throughout the length of the sleeve. Casing pipe insulators shall be provided to support the pipeline throughout the sleeve. The use of flow ash or grout within the annular space of the pipeline will not be allowed. See the Standard Specifications for casing pipe and carrier pipe installation details.
- i. Entrance and exit pits are required for bore and jack installations. In locating a bore and jack crossing, the Designer must allow adequate room for the entrance pit to provide sufficient working room for all tunneling/jacking equipment as well as for the insertion of the jacking pipe into the jacking equipment. The length and width required will vary depending on the length, size and joint type of the installed carrier pipe. The exit and receiving pits must be large enough to receive the shield or machine.

C. Directional Drilling

1. General

Horizontal directional drilling (HDD) is a method for installing subsurface piping and conduit. By using a surface mounted rig, first a guided hole is drilled along a bore path consisting of a shallow arc and then a string of pipe is pulled back through

the hole. Pullback is facilitated by a back-reamer, which enlarges the hole to approximately one and a half times the pipe's diameter. Drilling fluids are normally injected into the borehole to stabilize the hole and lubricate the pipe and drill-string. Tracking equipment is used to guide and direct the drilling.

HDD provides the ability to install subsurface piping and conduit over a longer distance than other trenchless methods. HDD can bypass obstacles at greater depths than other trenchless technologies without deep insertion or retrieving pits. However, HDD is not as effective as other trenchless technologies in subsurface sewer installations where minimum grades must be maintained or for alignments with horizontal bends. Directional drilling shall not be used for gravity sewer installations.

2. Design Standards

All directional drills shall be designed and installed in accordance with the following standards:

- a. ASTM F-1962-99 or latest revision "Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings"
- b. ASCE Manuals and Reports on Engineering Practice No. 89 Pipeline Crossings
- c. All applicable manufacturer's recommendations

3. Design Considerations

The following are design considerations for directional drilling:

- a. The Designer shall ensure that there is adequate room available on the drill entry side for any required bentonite slurry pits and for the drilling rig and any associated equipment. Adequate room must also be available on the drill exit side for any required pipe welding or fusing equipment as well as for the pipeline to be laid out continuously prior to pull back. Drill entry and exit locations will be determined by the minimum bending radius of the pipeline, the depth of pipeline and available land. Adequate room shall also be maintained at all times for public safety.
- b. All necessary safety considerations regarding the operation of drilling equipment in the location of existing utilities or environmentally sensitive areas must be followed. Bentonite slurries used for drilling operations must be certified by the National Sanitation Foundation (NSF).
- c. Typical pipeline materials for directional drilling include welded steel or fused High Density Polyethylene (HDPE). See the Standard Specifications for material requirements. The design of pipeline thickness shall be based upon the installation loads and stresses that will be experienced during installation as well

as the in-use loads such as operating pressure, soil loads, static water loads, surface loads etc. The minimum pipe wall thickness shall be standard dimension ratio (SDR) 11 for HDPE, and 60 for steel pipe. The Designer shall ensure that the maximum pull length for a given pipe material, thickness and installation condition is not exceeded. Pipeline thickness shall be increased if engineering calculations indicate that a lower SDR is required due to anticipated service or installation loads.

- d. Directional drill bore paths and pipelines shall be designed in accordance with the guidelines stipulated in ASTM F-1962. For HDPE installations, the minimum radius of curvature used for design is typically limited by the allowable bending radii of the drill rod. For steel pipe installations, the bending radius is limited by the pipeline. The minimum radius for either case can be calculated as follows:

$$R_{\min} = 1200 D_{\text{rod}} \quad (\text{HDPE})$$

$$R_{\min} = 1200 D_{\text{pipe}} \quad (\text{Steel})$$

where:

R_{\min} = Minimum Bore path Radius (in.)

D_{rod} = Diameter of Drilling Rod (in)

D_{pipe} = Diameter of pipe (in)

- e. Additional directional drilling design considerations include the following (ASCE Pipeline Crossings):
- Minimize the number of pipeline bends, making the crossing as straight as possible. Attempt to have vertical bends only with the entire alignment in one vertical plane.
 - Avoid crossings that are close to steel structures such as bridges, pipelines, steel barges, etc.
 - Maintain adequate separation from other pipelines.
 - Minimize crossing lengths.
 - Design entry angles from 8° to 20° (preferably 12° to 15°) and exit angles from 5° to 12° (preferably less than 10°).
 - The entry and exit locations shall be as close to the same elevation as possible. If elevation differentials occur, the rig should be set up on the lower side to assist with the return of drilling fluids.

D. Microtunneling

1. General

Microtunneling is an unmanned entry method that uses a remotely operated micro-tunnel boring machine (MTBM) to install pipes underground with minimal surface disruption. Microtunneling continuously installs pipe behind a remotely controlled, articulated MTBM. The pipe to be installed is connected to and follows

the MTBM. The length of a tunnel is dependent upon the jacking force, pipe material and pipe size.

Microtunneling has the added advantage over other trenchless installation methods of being able to install pipes in close proximity to other utilities or structures and requiring minimal area for jacking and receiving shafts. Microtunneling provides a safe construction environment, with no workers below grade. At little additional expense, microtunneling can install the pipeline at a greater depth to avoid utility conflicts or to bore through a more suitable layer of soil.

2. Design Standards

- a. The jacking force required for pipeline installation is a function of many variables including the soil conditions, depth of the pipeline, annular space between the pipe and the soil, lubrication of the pipe, water table location, overburden loads, installation time, pipe material, out-of-roundness, pipe diameter and pipe strength. All microtunneling operations shall be designed and installed in accordance with ASCE Standard Construction Guidelines for Microtunneling (1998).
- b. Typical pipeline materials for microtunneling include ductile iron, reinforced concrete, vitrified clay or welded steel. See the Standard Specifications for material requirements.

3. Design Considerations

- a. The design of pipeline thickness shall be based upon both the installation loads and stresses that will be experienced during installation as well as the in-use loads such as operating pressure, soil loads, static water loads, surface loads etc.
- b. The pipeline material, thickness and coating shall be adequate to resist internal and external corrosion over the lifetime of the pipe.
- c. Joints shall be designed that are capable of transferring the required jacking loads while allowing adequate angular rotation flexibility to permit routine steering as well as being able to tolerate long-term operating conditions.
- d. The Designer shall consider the following in the attempt to maximize the benefit/cost ratio of microtunnel design:
 - 1) Drives shall be straight with constant slope.
 - 2) In general, shafts are typically located at manhole locations and at locations where changes in vertical and/or horizontal alignments are required. It may be advantageous to use the same jacking pit to advance the pipeline upstream and downstream. The optimum alignment is the one that requires the smallest number of shafts (pits) without exceeding the practical drive length of the microtunnel system and pipe being used.

- 3) The Designer shall identify potential obstructions in the preliminary analysis and plan methods of resolution. Cutters on smaller MTBMs cannot be changed-out during a drive due to lack of access to the cutterhead. Intercepting fouled cutterheads with additional shafts and hand mining is time consuming and expensive.
- e. Shaft design and thrust blocking for tunneling machine and groundwater control are the responsibility of the Contractor. However shaft design criteria and performance requirements for shafts shall be provided in the contract documents.

E. Pipeline and Structure Rehabilitation

1. General

Pipeline rehabilitation becomes necessary when the pipeline and/or pipeline structures and appurtenances become greatly reduced in capacity or structurally deteriorated. Pipeline and structure rehabilitation techniques include pipe cleaning, flow control, television inspection, pipe joint testing, pipe joint sealing, sewer manhole sealing, sewer manhole rehabilitation, sewer manhole lining, slip-lining, cured-in-place pipe lining, pipe and fitting replacement, and sewer manhole replacement.

Prior to performing any pipeline and structural rehabilitation techniques, all lines must be cleaned, tested and inspected in accordance with the Standard Specifications. All materials utilized for rehabilitation shall be in accordance with the Standard Specifications. The information provided within this manual does not address specific design procedures that pertain to any specific pipeline renewal method. It does provide a reference of rehabilitation technologies that the DPW recognizes as viable options for specific applications.

2. Pipeline Renewal Methods

Multiple trenchless methods have been developed for renewal of existing pipeline systems. All methods described can be used for water or sewer applications, either gravity or pressure systems. All renewal methods shall be installed in accordance with the applicable ASTM specification. The required pipeline renewal technique applied depends on a variety of issues such as:

- The type of existing pipeline materials
- The structural condition of the existing pipeline material
- The hydraulic and operating requirements for the rehabilitated main
- The length of time the pipeline can be taken out of service
- The cost effectiveness of the renewal technique

The Designer shall take into consideration these and any other applicable criteria when determining the appropriate rehabilitation technique for a specific system.

a. Slip-lining

Slip-lining 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 to the Standard Specifications. All annular spaces between the liner and existing pipe shall be filled with grout after installation of the liner is complete. For thin wall sewer liners, external hydrostatic load due to high water table or flood condition may determine the minimum pipe liner thickness required.

All slip-lining materials shall be installed in accordance with the following standards:

- ASTM F1947 Standard Practice for Installation of Folded Poly (Vinyl Chloride) (PVC) Pipe into existing sewers and conduits
- ASTM F1606 Standard Practice for Rehabilitation of Existing Sewers and Conduits with Deformed Polyethylene (PE) Liner

b. Cured-in-Place Pipe Lining

Cured-in-place pipe (CIPP) lining is a process that 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 cools down when the circulating water is re-cooled. Prior to installing this type of pipeline rehabilitation, the pipeline shall be cleaned and inspected. CIPP lining techniques are primarily used for sewer main rehabilitation. The National Sanitary Foundation (NSF) must approve any CIPP for use in water main rehabilitation for potable water systems.

The primary components utilized in a CIPP involve a flexible fabric tube as well as a thermosetting resin system. The materials used in this type of rehabilitation shall meet the requirements of the Standard Specifications and the manufacturer's material specification and installation procedure if approved by the DPW.

The Designer shall submit a hydraulic analysis to the DPW showing that the capacity of the rehabilitated pipeline will be equal to or greater than the capacity of the original pipe. The rehabilitated pipeline section shall be tested according to the Standard Specifications.

All CIPP materials shall be installed in accordance with ASTM F1743 Standard Practice for Rehabilitation of Existing pipelines and Conduits by pulled in place Installation of Cured In Place Thermosetting Resin Pipe (CIPP).

c. Pipe Bursting

Pipe bursting is a trenchless technique where the existing pipe is broken into fragments by a bursting device being pulled through it. The fragments of the existing pipe are forced into the surrounding soil. New pipe is then pulled through behind the bursting machine. Unlike some other means of pipe replacement, pipe bursting allows the existing pipe to be replaced by pipe of equal or greater size.

Pipe bursting allows for the replacement of existing pipe with minimal or no impact on surrounding utilities and structures greater than 3 feet away. If pipe bursting will be performed within 3 feet of another pipeline or underground structure, the utility must be exposed and soil excavated between the existing pipeline to prevent the transmission of bursting forces to the adjacent structure or utility. Pipe bursting is most effective in areas with compacted soils, where surrounding areas will not be affected by vibration.

The bursting device can be one of three types, depending on the method used to burst the existing pipe: static head, pneumatic head or hydraulic head. The static head has no moving parts. The head is simply pulled through the existing pipe by a pulling device. Pneumatic heads burst the existing pipe using pulsating air pressure. Hydraulic heads expand as they are pulled through the pipe. Hydraulic heads are most effective for bursting cast iron pipe.

High Density Polyethylene (HDPE) is the most common material utilized for the replacement pipe. Other pipeline materials such as Vitrified Clay Pipe (VCP) or Ductile Iron Push Pipe can be used with the approval of the DPW. See the Standard Specifications for material requirements. The minimum HDPE pipe wall thickness for pipe bursting shall be standard dimension ratio (SDR) 17. The Designer shall ensure that the maximum installation length for a given pipe material, thickness and installation condition is not exceeded. The pipeline thickness shall be increased if engineering calculations indicate a lower SDR is required due to anticipated service or installation loads or service pressures.

d. Point Source Repair

Point source repairs are required when isolated locations within the system require either structural repair or have leaking joints.

When structural damage and leakage are of concern, point cured-in-place pipe lining methods utilizing the same materials and methodologies previously described in Section 5.14.E.2.b, "Cured-in-Place Pipe Lining," can be implemented. Chemical grouting of joints is a technique used when joint leakage is of primary concern. Since chemical grouts typically have low compressive strengths, the surrounding pipeline must be structurally sound or the chemical grout repair must be supplemented by structural repair.

5.15 Pipeline Design in Wetlands, Stream Crossings and Tree Protection

A. General

The design of pipelines requiring stream crossings and wetland disturbances shall be minimized. In particular the installation of a pipeline within a non-tidal wetland shall be avoided if at all possible. See Section 5.14, "Alternate Installation Technologies" for installation methods that may be applicable to minimizing impacts within stream crossing and wetland areas. The Designer shall be responsible for all permitting, coordination and other requirements established by regulatory agencies that result from wetland or stream crossings.

B. Stream Crossings

The selection of a stream crossing location shall be based primarily upon minimizing any anticipated environmental impacts as well as the ability to maintain a stabilized channel at the utility crossing location. At all stream crossings, the Designer shall consider such items as pipe flotation, stream meandering, stream scouring and infiltration. The Designer shall include such protective measures in the design as encasement, riprap, special pipe and/or joints. See the Standard Details for stream crossing and protection of stream bank details for water mains and sewer mains.

Locations with severe channel instability problems shall be avoided for stream crossings. Crossing alignments shall be strategically located to minimize the adverse effects of channel instability. The following are guidelines for selecting locations for stream crossings:

1. Where sewer pipes cross streams, the crossing angle should be as near to 90 degrees as possible and the crossing pipe should be set at an elevation to provide a minimum of three feet of cover over the pipe.
2. Where a sewer parallels a watercourse, the Designer shall ensure that the design depth is such that the proposed sewer will facilitate future crossings of the stream.
3. In the proximity of meandering channel bends, where stream flow velocities can severely erode channel banks and scour holes on the channel bottom, the crossing shall be placed approximately midway between two adjacent meandering bends or upstream of the meandering bend.
4. Abrupt drops in the stream channel bed or flow depth and riffles or localized scour holes indicate existing or potential channel bed instability. The alignment of the pipeline shall not be placed in close proximity to and especially downstream of these locations.
5. In the proximity of flow constrictions, e.g., due to bridge construction or channelization, the crossing shall be placed upstream of these locations.

6. Stream channels that show noticeable increase in channel widths, meandering, steeply sloped channel banks and lack of vegetation indicate existing or potential problems with channel widening and changes in channel position. If the pipeline alignment parallels the stream channel, a buffer width between the nearest channel bank and the limit of disturbance shall be provided. The buffer width shall be determined on a case-by-case basis. The minimum buffer width required by the State of Maryland, Department of Natural Resources, is 25 feet from the limit of construction area to the top of the nearest stream bank.
7. Sediment traps and storm water control ponds can drastically reduce sediment supply and increase channel bed and bank erosion in downstream channels. A pipeline crossing shall not be placed in close proximity downstream of these structures, if possible.
8. Activities such as channel dredging or cleaning can cause channel bed erosion due to decrease in flow depth and increase in flow velocity. A pipeline crossing should not be placed in close proximity upstream of these activities.
9. Alteration of the stream flow path and/or stream direction by others, due to construction activities and channel work, can drastically affect stream hydraulics. A pipeline crossing shall not be placed in close proximity upstream or downstream of these locations.

C. Wetlands

Every effort shall be made to avoid crossing wetlands when selecting the pipeline alignment. When this is not possible, the crossing distance shall be kept to a minimum. The limits of the nontidal wetland buffers (25 feet) and the 100-year flood plain shall be indicated on the plans. It is important that the following items are considered in the design of a pipeline in wetlands.

1. Disturbance to the wetlands during construction shall be kept to a minimum and the native material excavated out from the wetland shall be placed back as much as possible. Excess material and construction debris should be disposed outside of the limits of the nontidal wetland buffers and the 100-year flood plain.
2. Temporary construction structures, staging areas, and stockpiles shall not be located within the limits of the nontidal wetland buffers or the 100-year flood plain.
3. Proper bedding and side support materials shall be provided for the pipe.
4. In addition to the above, the Designer shall follow the latest guidelines of the MDE's "Best Management Practices For Work in Nontidal Wetlands and Wetlands Buffer." These practices shall be placed on the plans as directed by the Howard Soil Conservation District. If the Designer elects to use stone bedding, as the guidelines

suggest, the Designer shall design a means of blocking the seepage of groundwater along the pipeline at sufficient intervals to prevent the draining of the wetland.

D. Tree Protection

1. There shall be no removal of trees within construction strips, unless approval is obtained from the DPW.
2. Tree protection is provided to protect desirable trees from mechanical and other injury while the contractor installs the pipeline, appurtenances and related structures.
3. Tree protection shall be used whenever the construction area is within the drip line of any tree that will require protection. If tree protection is required for a project, the Designer shall include notes on the plans and designate areas on the plan where protection of trees is required.
4. For additional information, see the Standard Details for “Tree Protection” and the latest edition of the “Maryland Standards and Specifications for Soil Erosion and Sediment Control” for “Tree Protection.”

5.16 Soil Erosion and Sediment Control

A. General

Erosion and sediment control will be required when any area is disturbed. Disturbing activity shall mean any earth movement and land changes that may result in soil erosion from water, wind or the movement of sediment into the State of Maryland waterways or adjacent lands. These activities include but are not limited to clearing, grading, excavating, stripping, filling and related activities and the covering of land surfaces with an impermeable material.

B. Design Criteria

The design of soil erosion and sediment control measures shall comply with the applicable requirements and procedures set forth by the Maryland Department of the Environment (MDE) in the latest editions of the “Maryland Standards and Specifications for Soil Erosion and Sediment Control” and the “Maryland’s Waterway Construction Guidelines.” The design of sediment control measures shall also be in accordance with the provisions of the Standard Specifications.

C. Sensitive Areas, Unique Project Requirements

1. Sensitive areas include but may not be limited to the following:
 - a. Non-tidal wetlands
 - b. Any Park Property
 - c. Streams, especially Class III and Class IV, and stream buffers
 - d. Steep slopes, especially wooded steep slopes

- e. Historical and archaeological sites
 - f. Forested areas and watershed areas (serving water supply reservoirs)
 - g. Designated scenic roads
2. It is the Designer's responsibility for becoming aware of these sensitive areas in or adjacent to the project site. Additional erosion and sediment control measures may be required to protect these sensitive areas to the greatest extent possible.
 3. The Designer will be responsible for designing and specifying additional sediment control techniques or facilities for portions of the project, which are unique and for which the sediment control provisions of the Standard Specifications may not be adequate. These additional sediment control techniques or facilities shall be shown on the plans and included in the Special Provisions referencing the sheet number showing the unique portions of the project.

D. Work Outside the Limit of Disturbance

1. When water and sewer mains are constructed beyond the limits of mass grading of a development project or some other kind of larger construction project, the following UTILITY NOTE shall be shown conspicuously on the plan:

UTILITY NOTE:

- a. Contractor shall open only that section of trench that can be backfilled and stabilized each day. If the trench must remain open longer than one day, silt fence shall be placed below (down slope of) the trench.
 - b. Place all excavated material on the uphill side of the trench.
 - c. Any sediment controls disturbed by utility construction are to be repaired immediately.
2. If the utility construction extends more than 150 feet beyond the Limits of Disturbance of the primary project area, the Designer will also be required to provide physical sediment control measures for the utility construction on the plans.
 3. The Designer must pay due regard to section 5.16 C, "Sensitive Areas, Unique Project Requirements" in designing controls for extended lengths of pipeline running directly or diagonally downhill. Lengths of silt fence, no longer than 100 feet, placed alongside the excavation and curled upwards at the downhill end and super silt fence placed at the extreme downhill end of the pipeline are techniques that may be employed along with others at the Designer's discretion.

E. Howard Soil Conservation District

The Designer shall be fully responsible for coordinating each project directly with the Howard Soil Conservation District and obtaining their approval.

5.17 Permits and Approvals**A. General Requirements**

Upon completion of the plans and specifications for a project and before construction can be authorized, authorization and approval must be received from all governmental agencies who have jurisdiction over the project. These approvals take the form of permits. Very often the permits issued by an agency are contingent upon construction details and conformance with design features and working conditions that may require modifications to the normal plans and specifications. The Designer is responsible for coordinating all such requirements within the construction plans and specifications.

B. Federal Agencies

When grants are involved through Federal or State agencies, such as the Environmental Protection Agency, then these agencies exercise a separate right of approval over the construction documents.

C. Listing of Permits

1. Soil Erosion and Sediment Control:
Construction plans must be reviewed and approved by the Howard Soil Conservation District for compliance with the “Maryland Standards and Specifications For Soil Erosion and Sediment Control”.
2. Stormwater Management:
Construction plans must be reviewed and approved by the DPZ for compliance with the Design Manuals Volume I - Storm Drainage. The stormwater management inspection schedule, reports and requirements during construction must be in compliance with County Code Section 18.904 and the stormwater management maintenance and maintenance agreement must be in compliance with the County Code Section 18.905 and the Development Process Procedures.
3. Wetlands, Waterways and Floodplain:
 - a. Projects involving impacts to the 100-year floodplain as defined by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMS) and/or Howard County authorized floodplain studies require review and approval by the Maryland Department of the Environment (MDE), Wetlands and Waterways Program.

- b. Projects that impact waterways, streams, Waters of the United States, tidal and nontidal wetlands must be authorized by the State of Maryland and the U.S. Army Corps of Engineers. The State of Maryland also regulates a 25-foot nontidal wetland buffer, extending 25 feet landward of the wetlands boundary. Water and sewer projects with temporary impacts are generally authorized under the “Maryland State Programmatic General Permit (MDSPGP-1) by the MDE, Wetlands and Waterways Program. MDSPGP-1 projects usually do not require independent review by the U.S. Army Corps of Engineers. In some circumstances these projects will be authorized individually by the Baltimore District of the U.S. Army Corps of Engineers.
 - c. Wetlands must be reported in accordance with all County Code and Land Development Regulations.
 - d. To satisfy all wetland permits, the wetlands must be delineated in the field and validated by the permitting agency.
4. Forest Conservation:
Projects involving the removal of trees must be reviewed and approved for compliance with the State of Maryland Forest Conservation Act, as administered through the Howard County Landscape Manual and Howard County Forest Conservation Ordinance. The State forest conservation program is administered by the Maryland Department of Natural Resources through the DPZ. Forest Conservation may require a Forest Stand Delineation (FSD) and Forest Conservation Plan (FCP) for afforestation/reforestation.
5. Non-Point Pollutant Discharge Elimination System:
Projects involving “construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale” must file a Notice of Intent (NOI) form to the MDE Water Management Administration to comply with the “General Permit for Construction Activity for Stormwater Discharges.”
6. Water/Wastewater Construction Permit Application:
The following major water and wastewater facilities require a permit from the MDE Water Management Administration:
 - a. Major Water Facilities: water mains larger than 15-inch diameter, pumping or booster stations with average daily flow greater than 5,000 gpd, elevated tanks, storage tanks, water treatment facilities and utilization of well water for public water supply.
 - b. Major Wastewater Facilities: gravity sewers larger than 15-inch diameter, pumping stations with average daily flow greater than 5,000 gpd, force mains, Wastewater treatment facilities, community or multi-use septic tank systems in which a pumping station and a force main are included.

7. Grading Permit: A grading permit issued by the DILP will be required before construction starts.
8. Depending on the particular project, a permit may also be required from the Maryland State Highway Administration and the various public utility companies such as electric, telephone, cable, railroad and pipeline companies.

5.18 Cost Estimates

A. General

A cost estimate is to accompany each plan submittal or as required by the County. At the conclusion of the design phase of a project, and as part of the submittal of the final plans and specifications, the Designer shall prepare an estimate of the value of the work included in the contract. The estimate shall be prepared using a format provided by the County or a proposal form completed in the same manner as a bidding Contractor.

B. Method

Estimates shall be based on unit prices provided by the County or on current bid prices for comparable work in the locale of the project considering soil conditions, water table, presence of rock, etc., and shall reflect quotations from suppliers of equipment and materials whenever appropriate.

All cost estimates shall be referenced with a current Engineering News Record (ENR) Construction Cost Index. Cost estimates shall be updated annually or semi-annually by the Designer, if requested by the County.

C. Contingent Item Costs

Contingent items, if required by the County, shall also be estimated by the Designer for each project based on individual site conditions and proposed construction methods. Unit prices for contingent items shall be as provided by the DPW and included in the total estimated construction costs.

D. Engineer's Estimate Differs with Low Bid

For Capital Projects, should the actual low bid for construction differ from the Engineer's estimate by more than 15%, the Designer may be required to re-analyze the Engineer's estimate, together with the low bid, to account for the variance. A written report detailing and explaining the discrepancies may be required by the DPW.

5.19 Standard Details

Standard details for water and sewer design and construction practices are regularly used on water and sewer projects in Howard County. These details are published in the Standard Details and can be used whenever the design parameters of the detail cover the particular applications on a project. Whenever standard details are modified or a substitution is made, a design analysis and detailed plans are required for DPW review and approval.

CHAPTER 6

WASTEWATER PUMPING STATION DESIGN

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WASTEWATER PUMPING STATION DESIGN

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CHAPTER 6 WASTEWATER PUMPING STATION DESIGN

6.1 Introduction

This Chapter outlines the design standards of wastewater pumping stations to meet the needs and operational responsibilities of the Department of Public Works (DPW). This Chapter includes the criteria and guidelines for designing all wastewater pumping stations within the Howard County public sewer system. Drawings showing details and conceptual plans are included in the Appendix K, “Wastewater Pumping Station Design Figures.” The type of pumping stations permitted are generally divided into two categories:

- A. Pumping stations with ultimate capacities above 500 gpm or wet well depths greater than 25 feet.
- B. Pumping stations with ultimate capacities below 500 gpm and wet well depths less than 25 feet.

Stations with ultimate capacities greater than 500 gpm or wet well depths greater than 25 feet shall be designed as conventional wet well/dry well type stations. Stations with ultimate capacities less than 500 gpm and wet well depths less than 25 feet may be designed as suction lift stations, submersible stations or package stations as later discussed in this chapter. Due to the unique characteristics and circumstances associated with each station, the DPW will make the final determination on the type of wastewater pumping station to be used in each application.

The Designer shall consult with the DPW to determine the applicability of these design standards to planned wastewater pumping stations. It is the responsibility of the Designer to integrate all applicable criteria and guidelines into the design of wastewater pumping stations, which are to be incorporated into the Howard County public sewer system.

To the extent practical, wastewater pumping station designs shall conform to the design standards given herein. The design standards shall be applied to design conditions in a careful and thoughtful manner. Deviations from the design standards must be brought to the attention of the DPW. Waivers of the Design Manual must be justified to the DPW, in writing, from an engineering evaluation standpoint and include consideration of life cycle costs and ease of maintenance. Approval or denial of the waiver request will be by return letter signed by the Chief of the Bureau of Engineering.

All standards and regulations referenced in this chapter shall conform to the latest publications.

6.2 Abbreviations

Abbreviations used in this chapter or other chapters are located in Chapter 1 of this manual.

6.3 Definitions

Design Flow Rate: The design flow rate is the peak demand volume for the service area plus the infiltration and inflow (I/I) allowance, expressed in gpm or mgd. The calculation of the design flow rate requires the computation of the average day rate for the facility, the application of an appropriate peaking factor, plus the appropriate I/I, as described in Chapter 4.

6.4 Regulations

Wastewater pumping stations must satisfy the regulations of agencies having jurisdiction. Wastewater pumping stations shall conform to the “Design Guidelines for Sewerage Facilities,” 1978 edition or latest addenda or edition as published by the Maryland Department of Health and Mental Hygiene, now the Maryland Department of the Environment (MDE). Buildings shall comply with applicable BOCA and Howard County building code requirements as well as any permitting requirements of the Howard County Department of Planning and Zoning (DPZ) and the Department of Inspections, Licenses, and Permits (DILP). Other regulations governing facilities and construction shall be adhered to, including regulations published by the Occupational Safety and Health Administration (OSHA), the National Fire Protection Association (NFPA), National Electric Code (NEC), Howard County Plumbing Code and others as applicable.

6.5 Permits and Approvals

See Section 5.17, “Permits and Approvals” in this manual for applicable permit requirements. In addition, for any above ground structure, the Designer shall make all applications for and obtain the required building and grading permits prior to bidding of the project.

6.6 Design Phases

A. Design Report

The Master Plan shows the location of all wastewater pumping stations that have been planned for the respective systems. The design report shall be in conformance with the Master Plan, approved facility plan and/or any preliminary reports supplied by the County.

The design report shall also include the description of design criteria to be utilized, preliminary flow computations, design calculations, calculated system curves, surge protection analysis/recommendation, identification of land acquisition and easement requirements, 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 design criteria shall be developed:

1. Site Development
2. Structural Design
3. Architectural Design
4. Hydraulic Analysis
5. Mechanical Design
6. Electrical Design
7. Process and Instrumentation Control
8. Corrosion Control
9. Odor Control
10. Noise Control
11. Secondary Power Supply

Once the design report has been approved by the DPW, design of the facilities may proceed. Milestone submittals of design plans and specifications shall be made at 30%, 60%, 95% and Final Design.

B. Design Plans & Specifications

At a minimum, the following information shall be supplied at the milestone submittals:

- 30% Submittal: Site Plan, Design Schematics (showing station layout and major equipment), Specification Table of Contents
- 60% Submittal: Complete civil, mechanical and structural design plans and preliminary technical specifications
- 95% Submittal: Complete design for all disciplines including electrical and architectural plans and details. Complete specifications including front end documentation. This phase should represent complete, bid-ready contract documents from the Designer.
- Final Design: The 95% Submittal with the DPW's final comments incorporated

C. Cost Estimate

At each formal submittal and at the conclusion of the design process, the Designer shall prepare a detailed cost estimate for the pumping station. This estimate shall be developed for each major category of work including civil, mechanical, electrical, structural, architectural work and contingent cost. This cost breakdown shall be made available to the DPW as required and shall be updated annually. See Chapter 5.18, "Cost Estimates," for additional information.

6.7 Types of Wastewater Pumping Stations and Selection

Howard County wastewater pumping stations are divided into two categories, small (less than 500 gpm and less than 25 feet wet well depth) and conventional (greater than 500 gpm or greater than 25 feet wet well depth). Small pumping stations can be designed as one of

three possible configurations: Suction Lift, Submersible or Package. Conventional pumping stations are wet well/dry well type stations that are custom designed. The types of stations allowed are described below along with acceptable selection criteria.

Conventional: Conventional pumping stations are defined here as pumping stations in which the wet well and dry well structures are formed and poured on site (cast-in-place concrete construction). All of the piping and valving is assembled on-site by the Contractor.

Suction Lift: Suction Lift stations are defined as stations where the pumps are located above the water level of the wet well and hence must employ some means of lifting the wastewater to the pumps in order for the pumps to be primed. Suction lift stations shall not be used for suction lifts (water level in wet well to centerline of pump volute) greater than 18 feet or motor sizes greater than 20 Hp.

Submersible: Submersible stations are defined as stations where the pumps are “submerged” in the wet well. Because the pumps operate under water in the wet well, there is no need for a separate pump room.

The pumps can be raised and lowered out of the wet well by means of a jib crane located at the top of the wet well. Guide rails enable the pump to be raised and lowered into place without requiring entry by personnel under normal circumstances. Submersible stations shall not be used for wet well depths greater than 25 feet or motor sizes greater than 20 Hp.

Package: Package pumping stations are defined as wet well/dry well pumping stations in which the pumps, suction and discharge piping, pump dry well, electrical equipment and connections are pre-assembled by a single manufacturer and then erected on-site by the Contractor.

Package pumping stations with metal dry well chambers are not acceptable. Only pre-cast concrete dry well chambers will be permitted. The pumping station wet well may or may not be supplied by the package manufacturer. Package pumping stations shall not be used for wet well depths greater than 25 feet or flows greater than 500 gpm.

6.8 Hydraulic Computations

A. Design Flow Rate

Wastewater pumping stations must satisfy the design flow rate. The design flow rate is the peak flow rate for the service area plus the I/I allowance. The design of wastewater pumping stations shall consider existing and projected peak flow rates and wastewater composition. Wastewater pumping stations shall be designed to pump the peak flow for existing and future users plus the I/I allowance. In developed areas,

population shall be determined by house count and non-domestic user inventory with allowances made for remaining undeveloped tributary areas. Population densities and per capita flows shall be as established by Facility Plans or in their absence, in agreement with the Master Plan or as instructed by the DPW. Institutional, commercial and industrial flows shall be determined by a study of the establishment. The DPW shall be consulted for future domestic and non-domestic land use and population densities. Flow rate computations shall follow guidance given in Chapters 2, "Engineering Reports" and Chapter 4, "Sewer Main Design," of this manual. A drainage area map and tabulation of the design flow shall appear on the plans. The map and tabulations shall show initial and ultimate drainage areas and wastewater flows.

B. Planning Period

Wastewater pumping station design flow rates shall, at minimum, accommodate a 20-year planning horizon. For all pumping stations, consideration shall be given to future upgrading flexibility necessary to accommodate flows beyond the normal planning horizon. This is especially important for larger stations.

C. Wastewater Composition

Wastewater composition can vary widely depending upon the proportion of design flow generated by non-domestic users. Non-domestic user wastewater composition shall be investigated. Adequate consideration and all necessary provisions shall be taken to ensure that wastewater pumping station equipment and materials are suitable for the anticipated composition of the wastewater. Consultation with the DPW is required in the event that the wastewater composition affects standard material and equipment requirements.

D. Number of Pumps

Wastewater pumping stations shall be capable of pumping the design flow rate with the largest single pump out of service.

E. Hydraulic Analysis

Wastewater pumping stations must satisfy the hydraulic conditions of the system. The Designer shall perform a complete hydraulic analysis of each wastewater pumping station. The hydraulic analysis shall consider potential impacts on existing force mains, gravity sewers and pumping stations when the new pumping station is added to the system. See Chapter 4, "Sewer Main Design," for force main design requirements and analyses that must be performed in conjunction with the pumping station design. Wastewater pumping stations shall be designed to operate at the appropriate discharge head and flow rate.

F. Pump and System Curves

System curve (Head vs. Flow) characteristics shall be determined by the Hazen-Williams formula for piping head loss. The pump/system curve shall be shown on the plans to scale. The pump/system curve shall show the following information at a minimum:

- Static Head
- Pipe Friction Losses
- Pump Curve
- Pump Horsepower, Efficiency and RPM

Pump / system curves shall be shown for single pump operation, as well as for multiple pump operation in stations having three or more pumps. Hazen-Williams "C" factors used in evaluating pump and system curves shall be in accordance with the guidelines given in Section 4.6A, "Hydraulic Calculations," of this manual for various pipe materials.

G. Water Hammer

The potential impact of water hammer shall be evaluated. If the combined effects of static head and water hammer do not exceed the weakest piping system component working pressure by a safety factor of 1.1, no special provisions need to be included to control water hammer. Where the maximum water hammer pressure exceeds the weakest piping system component working pressure by a safety factor of 1.1, strengthen those elements affected, reevaluate pipe size and velocities or select an appropriate device to control water hammer. Hydraulically operated, time adjustable, pump check service valves and spring type, oil-cushioned elbow hydraulic surge relief valves at a minimum are the preferred choices of the DPW. No pressure vessel/surge tank type devices will be acceptable. The decision to strengthen piping system components instead of utilizing a water hammer control device or different pipe size shall be based upon a life cycle cost economic comparison.

H. Pump Selection Criteria

Provide proper wet well design and suction line design per Hydraulic Institute Standards to avoid cavitation. The Designer shall perform a net positive suction head available (NPSHA) analysis and include this information in the pump specification. The NPSHA shall be calculated for the expected design flows and shall exceed the pump manufacturer's requirements by an added margin of safety of not less than five (5) feet. Pumps shall be selected to have their maximum efficiency at the operating point. Under no circumstances shall a pump be specified to operate outside of its published recommended range. Examples would be pumps operating at very low flows and high heads, near shutoff heads, or "runout" conditions (maximum possible flow rate of the pump). These conditions can result in excessive hydraulic loading or

cavitation damage to impellers, casings and shafts, rapid bearing and mechanical seal wear, and high vibration. The Designer shall avoid the selection of pumps whose curves are flat (i.e. small changes in head resulting in large changes in flow rate).

6.9. Design Criteria for Conventional Wastewater Pumping Stations (greater than 500 gpm or greater than 25 feet wet well depth)

Conventional wastewater pumping stations shall be engineered to meet the requirements of these guidelines, as well as any supplemental guidelines imposed by the DPW on a case-by-case basis. These stations will have a wet well/dry well configuration and be of cast-in-place concrete construction. Conventional pumping stations shall be designed as long-term (greater than 20 years) facilities. The design of conventional stations shall include room for anticipated expansion. The following guidelines and features shall be incorporated in the design of these stations:

A. Site Design

1. Location: Wastewater pumping stations shall be located as far as possible from populated areas. Natural screening and remoteness of the site shall be primary elements of site selection wherever possible. Where pump stations are sited in proximity to developed areas, the architecture of the station shall be compatible with the surrounding area. Predominant wind direction for potential odor dispersion and building aspects such as generator exhaust and ventilation fan noises shall be considered. Similarly, building setbacks shall be considered to provide minimal impact to neighboring properties.
2. Land Acquisition: Land required for pumping stations, including necessary vehicular access routes to an existing or proposed public roadway shall be owned in fee simple by Howard County. As part of this process, a boundary survey of the property is required together with a record plat and a metes and bounds description of the parcel. In determining the space requirements for the facility, particular attention shall be given to the width provided for the access road to ensure adequate space for grading and drainage within the access road right-of-way. DPW Procedure 501.4, "Standards for Preparation of Land Acquisition Documents," shall be followed in the preparation of documents necessary for land acquisition.
3. Site Plan: The site design and location must conform to applicable portions of the Subdivision Regulations and satisfy the DPZ's requirements for site development plans. Wherever possible, land acquisition shall provide generous space around the building to permit landscaping to minimize the impact of the station on the neighborhood. All plans applicable to the site (site and grading, landscaping, sediment control, etc.) shall be prepared on a scale of 1"=20' and shall meet all requirements of the Howard County DPZ. The location of all proposed facilities required for the pumping station site shall be clear and concise to permit complete field stakeout from plan information. A stake out table listing all components of the proposed facility along with their corresponding survey coordinate locations

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shall be provided on the plans. As an alternative to using coordinates to stake out the pumping station, the location of proposed facilities may be projected from a base line established from the traverse shown on the plan. The base line shall be located so that it will not be interrupted by the proposed construction. The location of proposed facilities shall not be referenced from other proposed facilities for stakeout purposes.

4. Topography: Sewers tributary to wastewater pumping stations commonly dominate site selection. Adjacent drainage areas potentially served by the wastewater pumping station must also be considered. Wastewater pumping station site selection shall also be compatible with suitable site access, and soil capability with respect to land grading in conjunction with site development. Existing contours and other topography shall be shown for the entire site including a 100-foot minimum width outside of the proposed property boundary. Contour interval shall be one-foot, unless otherwise approved by the DPW.
5. Floodplain: Wastewater pumping stations shall be sited to remain operational and permit access during a 100-year return frequency flood. The pumping station top slab elevation shall be set a minimum of two-feet above the 100-year floodplain elevation. The access road shall be above the 10-year return flood level elevation.
6. Wetlands: Avoid direct impacts wherever possible and minimize impacts to wetland buffer areas. Buffer areas include the first 25 feet beyond non-tidal wetlands.
7. Grading: Wastewater pumping station grades for paved areas shall prevent local ponding, provide positive drainage away from structures and generally be limited to no greater than 4 percent slopes. Stone surfaces around paved areas shall provide proper site drainage at slopes 10 percent or less. Land grading outside of the wastewater pump station perimeter fence shall not exceed 3 to 1 slopes; 4 to 1 slope maximums are desirable. Lesser slopes wherever possible are preferred. Site grading design shall be compatible with slope stability for the soils encountered. Slope stabilization shall be appropriate for the degree of slope and soil conditions. The use of retaining walls on or adjacent to the wastewater pumping station site is not permitted.
8. Sediment Control: A sediment control plan shall be provided in accordance with the Subdivision Regulations. Design requirements for sediment control devices shall be as described in section 5.16, "Soil Erosion and Sediment Control" of this manual.
9. At least two test borings shall be taken at the building location to determine soil types, rock, water table elevations, soil bearing values, etc. When in soil, standard penetration tests shall be taken at intervals not to exceed five (5) feet. When in rock, the rock shall be cored with a double tubed core barrel sized NWX and length of individual core runs shall not exceed five (5) feet. Borings shall be

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taken to a depth of not less than fifteen (15) feet below the bottom of the proposed structure. Borings shall be taken deeper as necessary, depending on soil conditions.

10. Landscaping: Landscaping must meet all DPZ requirements and be certified by a Landscape Architect registered in the State of Maryland. All wastewater pumping station sites shall be screened as appropriate from surrounding development. A 4-foot wide planting bed shall be placed outside of the fence line, for planting shrubs to screen the site. Shrubs shall consist of various types and shall be selected based on maximum height, foliage thickness, compatibility with existing surrounding foliage and required maintenance. Where extensive clearing is involved during construction, or where otherwise applicable for aesthetic purposes, new trees shall be planted. A landscaping plan shall be prepared showing planting arrangement of shrubs and trees, identifying each by both genetic names as well as common names, and specifying size and planting information. Landscaping materials should be aesthetically pleasing and require minimal maintenance (watering, fertilizing, trimming, etc.).
11. Site Security: Pumping station sites shall be fenced with black vinyl coated chain-link fencing, black vinyl coated post and black hardware, and a 12-foot wide double leaf locking gate for vehicle access. Where the entrance gate is more than 100 feet from the public roadway, a second gate shall be provided at the driveway entrance to the station access road. Additional property line fencing may be required as determined by the DPW. The pumping station building shall have exterior lighting controlled by motion detectors. Pumping station doors shall be bulletproof steel with locks keyed as specified by the DPW. The building shall be provided with an entry alarm connected to the station telemetry.
12. Paving: Pumping station sites shall have a paved access road and a minimum of two parking spaces. The access road shall have sufficient room and turn-around area so as to allow access to the wet well by maintenance and vacuum trucks. The turning area in a pumping station site shall have a minimum turning radius of 48 feet. Paving shall conform to the P-2 pavement section of the Standard Details. Pumping station access roads shall be used exclusively for pumping station maintenance and access.
13. Exterior Lighting: The need for and quantity of exterior lighting shall be determined on a case-by-case basis.
14. Station Sign: A permanent sign shall be provided at each pumping station stating the station name, street address and emergency telephone number.
15. Pumping stations shall not be located downstream of any stormwater management facility.

B. Structures

1. Wet Well Design: Wet wells shall be considered a hazardous environment, classified as NEC Class I, Division I for explosive gases. Wet wells shall be designed and constructed to be as hazard free as possible, and corrosion-resistant materials shall be used throughout. All materials and equipment used in wet wells shall meet NEC Class I, Division I standards, with the exception of control floats. Conduits between the junction box and control building shall be sealed at the junction box with explosion-proof seals. Conduits carrying float cables between the junction box and the wet well shall be sealed with explosion-proof seals.
 - a. Structure: Wastewater pumping station wet wells shall be constructed of reinforced concrete. Wastewater pumping station wet wells shall have poured-in-place, reinforced concrete base slabs, riser sections/walls and top slabs. Wet wells shall have an interior epoxy paint finish and exterior elastomeric membrane waterproofing. The bottom of the wet well shall be grouted to a minimum slope of 45 degrees toward the pump suction inlet. Wet wells shall be adequately designed to prevent flotation. The wet well size and depth shall be as required to accommodate the influent sewer, as well as pump suction submergence as recommended by Hydraulic Institute Standards. The required working volume and preferred intervals between influent sewer and control elevations shall be determined as follows:

Wet wells shall be designed for a minimum pump cycle time of 10 minutes as defined by the following formula:

$$T = 4V/Q$$

where:

T = Pump Cycle Time (time between pump starts) in minutes

V = Volume of wet well between the lead pump start and pump stop elevations, in gallons

Q = Pump rate of the lead pump, in gallons per minute

The detention period for wastewater in the wet well shall not exceed 30 minutes at the average flow rate for the initial, intermediate and ultimate design years. When initial average flows are insufficient to actuate the pumps within a 30-minute period, temporary removable appurtenances shall be placed in the wet well or the liquid level control points for pump start shall be lowered. Wet wells shall be deep enough to accommodate the control elevation points described in paragraph 6.9.D.4, "Controls & Alarms."

- b. Access: Wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36-inch by 36-inch minimum size and as large as necessary to allow removal of equipment from

the wet well. A platform spanning the length of the wet well made of aluminum grating shall be provided inside the wet well above the influent sewer. Sections of the platform shall be removable as directed by the DPW to provide access to the bottom. The platform shall be accessible via a ladder with safety handrails and intermediate landings as required by OSHA. A ladder leading from the platform to the bottom of the wet well shall also be provided. Access ladders shall be equipped with safety extension poles.

- c. Ventilation: Wet wells shall be provided with a separate ventilation system and shall be sized to provide a minimum of 30 complete air changes per hour. In addition to manual control, time clock operation of fans shall be provided to allow a minimum of two (2) complete air changes per hour. Ventilation shall be accomplished by the introduction of fresh air into the wet well under positive pressure. The fan shall be installed outdoors. The fan assembly and housing shall be corrosion-resistant and weatherproofed. The entrance hatch to the wet well shall be provided with a limit switch to energize the fan whenever the hatch is open. The fan shall be direct drive.
2. Dry Well Design: Dry wells shall be of poured-in-place reinforced concrete construction. Dry wells shall have exterior elastomeric membrane waterproofing. The dry well floor shall be sloped to a sump. A sump pump with piping to the wet well shall be provided. Sump pump piping shall contain a check valve to prevent siphoning from the wet well. Wastewater pump suction piping shall be connected to the dry pit sump to enable one of the pumps to be used for dewatering of the dry pit. The valve for opening this dry-pit suction connection as well as the pump suction isolation valve shall have hand wheels with operating stems extending up to the control room. The hand wheels shall be marked with an open arrow. A surge relief valve, if required, shall be placed on the discharge header before the pipe leaves the station. Surge relief piping shall be piped to the wet well.
 - a. Access: Dry well access shall be via a staircase with all necessary landings and handrails per OSHA requirements. Equipment hatches for the pumps shall be located in the top slab and directly above the pumps. Traversing monorails with cranes of adequate capacity shall be provided above the dry well to facilitate removal of the pumps, motors, valves and all other related equipment. Grating (catwalks) shall be provided in the dry well to facilitate access to all piping without climbing over pipes, equipment, etc.
 - b. Ventilation: Dry wells shall be provided with a separate ventilating system and shall be sized to provide a minimum of 10 complete air changes per hour. In addition to manual control, time clock operation of fans shall be provided to allow a minimum of four (4) complete air changes per hour. Ventilation shall be accomplished by the introduction of fresh air into the dry well under positive pressure. The dry well ventilation system shall under no circumstances be connected to the wet well ventilation system.

3. **Influent Manhole:** An influent manhole collecting all of the gravity sewers that flow to the pumping station shall be provided. The influent manhole shall be located on the pumping station site. A gravity sewer shall carry wastewater from the influent manhole to the wet well. The influent manhole shall be capable of being isolated from the pumping station wet well by means of a yard valve.
4. **Influent Grinder:** An influent wastewater grinder shall be provided. The influent grinder shall be of the vertical twin rotor type and be located in either the influent manhole or in the wet well. The influent grinder shall be capable of being lifted out of the wet well or manhole by means of stainless steel guide rails without entering. The influent grinder motor shall be explosion proof and rated NEMA 4X.
5. **Pumping Station Building Design/Architectural Standards:** The pumping station building shall be of brick and block design with pitched roof and wooden roof trusses. Pumping station buildings shall not be provided with slate roofs. Pre-cast or pre-fabricated buildings are not acceptable. There shall be no exposed woodwork on the outside of the building. All exterior woodwork shall have vinyl or aluminum coating. The building shall be constructed over the dry well. Stairs shall be provided for access to the pumps and piping. The wet well shall be accessed only from the outside. The building shall have a lightning protection system. Doors shall be heavy duty, bulletproof metal with deadbolts and locks keyed to the DPW Bureau of Utilities system. Exterior lights shall be wall-mounted, vandal proof high-pressure sodium type controlled by an on-off switch. The finished floor and all electrical equipment shall be located at least two feet above the 100-year flood elevation. Ventilation openings shall be protected with aluminum louvers with bird screens. Floors shall be sloped to floor drains piped to the influent manhole or wet well. The building shall be furnished with a service sink with both hot and cold water, outside non-freeze hose bibb, small desk with chair, telephone line and toilet room with waste piped to the influent manhole or wet well. The building shall conform to all Howard County building codes and zoning regulations.

a. Control Room

Electrical equipment shall be located above grade in a control room above the dry well. The control room shall be designed with adequate space to accommodate future upgrades.

b. Toilet Room

A toilet room shall be provided with toilet, lavatory, hot water heater, towel dispenser, soap dispenser and mirror.

c. Generator Room

A separate generator room shall be provided for housing the emergency generator and fuel tank. The generator room floor shall be located a minimum of two (2) feet above the 100-year flood elevation. The generator room shall have a roll-up metal garage door for access and shall be equipped with a floor drain outside the fuel containment area, piped to the influent manhole or wet well. The generator room shall be supplied with hose bibb, hose rack and 50-feet of rubber hose.

6. Pumping Station Building Heating and Ventilation: The building shall be heated by electric unit heaters with integral thermostats sized to maintain a minimum inside temperature of 55 degrees Fahrenheit. Ventilation shall be by means of wall mounted exhaust fans with backdraft dampers operated by thermostats and freezestats and intake louvers with motor operated dampers. Ventilation shall be designed for a minimum of six (6) air changes per hour. Provisions shall also be made, if applicable, to ensure against condensation forming on controls and other major items of equipment.

C. Equipment

1. Yard Valves: Yard valves shall be buried resilient seat gate valves (Baltimore Standard, Open Right) complying with the Howard County Standard Specifications and Details for Construction with operating nut and roadway valve box at grade.
2. Station Bypass: Wastewater pumping stations shall be provided with an auxiliary force main connection downstream of the station in addition to the influent manhole described above to enable the station wet well to be taken off-line for periodic maintenance or repairs. The connection shall use a plug valve or resilient seat gate valve for isolation. See Figure 6.17, "Pumping Station Bypass Connection Detail," in the Appendix. The point of connection shall be conveniently located with respect to the wet well.
3. Interior Piping: All interior wastewater piping shall be DIP, Class 53, with flanged fittings. Flanges shall be integrally cast on pipe or factory assembled screwed-on with proper bonding compound. Manifolds shall include flexible couplings for make-up and for expansion and contraction of the piping system. Flexible couplings shall be provided on the suction and discharge of each pump. Arrangement of piping and equipment within the station shall be made with adequate space for maintenance, repair, removal or replacement of equipment, as well as to safeguard personnel working in the station. Piping shall be adequately supported. Control and instrumentation piping shall be copper or stainless steel.

4. Valves: Each wastewater pump shall have isolation valves on the suction and discharge to permit the removal or maintenance of the pumps without affecting the operation of the remaining pumps. Interior isolation valves shall be resilient seat gate valves (Open Left). The pumping station isolation valve shall be provided with a handwheel, extension stem and operating nut to allow access from the Control Room floor. The handwheel shall be marked with an open arrow. Each pump shall have a hydraulically operated, time adjustable pump check service valve or a swing check valve to prevent backflow through inoperative pumps. In accordance with the criteria for water hammer control, pump check service valves shall be of the type and strength required to eliminate water hammer damage. Isolation and check valves may be located either inside the pumping station building or in a separate valve vault. Pump isolation or check valves shall not be located in the wet well. Spring type, oil cushioned elbow surge relief valves, when required, shall be provided on the discharge header of the station and be piped to the wet well.
5. Pressure Gauges: Pressure gauges for direct reading of line conditions shall be placed on both the suction and discharge of each pump and on the main discharge header piping after the last pump. Pressure gauges shall be oil-filled type, have a minimum 3 1/2-inch diameter face and be equipped with snubbers and diaphragms. Accuracy shall be to within 0.5% of pressure. Pressure gauges shall have a range such that the normal operating pressure is near the middle of the gauge.
6. Flow Metering: All wastewater pumping stations shall have polyurethane lined magnetic type flow meters with a replacement spool piece or bypass line provided to enable the pumping station to operate when the meter is being serviced. Magnetic flow meters shall be provided with grounding rings and isolation valves. Accuracy shall be to within 1% of flow. All flow meters shall have an adequate straight run of pipe both upstream and downstream of the meter in accordance with the manufacturer's recommendations. A 30-day strip chart, with totalizer, and indicator recorder in units of gpm shall also be provided.
7. Pumping Units: Wastewater pump suction and discharge shall be a 4-inch minimum diameter. All wastewater pumps shall rotate clockwise as viewed from the motor end. Wastewater pumps shall be centrifugal non-clog solids handling pumps capable of passing a 3-inch sphere and meet all requirements of MDE. The pump bearings shall have a minimum 100,000 hours ABMA-10 bearing life. The pump motors shall operate on 460 volt, 3 phase, 60 cycle electrical service and at a speed no higher than 1780 rpm. The pump motor horsepower shall be sufficient to prevent motor overload under all possible conditions. The pumps shall meet the vibration performance specifications of the Hydraulic Institute (HI). All wastewater pumps shall be factory witness tested and approved prior to shipment. All wastewater pumps must pass an on-site vibration test performed by an independent vibration testing company prior to acceptance. Wastewater pumps and motors shall be suitable for continuous duty. Pumps shall be of the types listed below.

- a. Dry Well Wastewater Pumps (conventional and package stations only): Pumps shall be of the dry pit submersible design. The pump casing/volute, impeller, support base, suction elbow, seal housing/motor adapter and motor housing shall be of cast iron construction. The pump's casing and impeller shall be fitted with replaceable hardened stainless steel wear rings to maintain sealing efficiency between the volute and the impeller. At the option of the DPW, other pump materials may be required to suit a particular application. Each pump discharge volute casing and suction elbow shall be provided with an inspection and clean out opening.
- b. Dry pit submersible wastewater pumps shall have the following additional features:
 - 1) One piece backhead and motor adapter with impeller adjustment cap screws
 - 2) Solid full diameter stainless steel shaft with no shaft sleeve or solid large diameter high strength alloy steel shaft with stainless steel shaft sleeve having a tapered end with a keyway to receive the impeller
 - 3) Double mechanical shaft seals cooled and lubricated by potable water through a cleanable seal filter assembly and provided with a mechanical seal vent with petcock
 - 4) Premium Efficiency motors shall be specified (where commercially available) for all three-phase pump motors

Dry Pit submersible wastewater pumps shall be designed for continuous operation in air for application in a dry well. The motors for dry pit applications shall be capable of a minimum of eight (8) starts per hour in air. The pumps/motors shall also be designed to function continuously in a submerged condition should the dry well become flooded. Motor cooling shall be via cooling water jacket, submersible-rated air-over motor cooling fan or positively forced oil cooling.

D. Electrical and Controls

1. Electrical Design: All electrical designs and components shall be in strict accordance with all applicable National Codes, County Codes and BGE requirements. Electrical design shall be such that phase out protection shall be provided so that the power will automatically switch off in the event of a loss of any one phase. Incoming electrical service shall be underground with electric meters installed inside the pumping station building. The electrical plans shall include, but not be limited to, the following:
 - a. Complete plan layout indicating all conduit, wire sizes and equipment locations including lighting and other appurtenances. Incoming electrical

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- service on the pumping station site shall be underground and within concrete encased conduits.
- b. Installation details of equipment that are wall mounted, or suspended from the ceiling or otherwise required for clarity.
 - c. Single line diagrams incorporating all electrical components required for operation of the facility.
 - d. Complete lighting schedule noting model, size, location and installation data as well as appurtenances. Vandalproof exterior lighting shall be provided.
 - e. Complete control and telemetry diagrams.
 - f. Elevation of control panels with equipment and mounting dimensions and notes identifying each component.
 - g. Complete circuit breaker schedule indicating size and identifying each circuit.
 - h. Ventilation schedule noting fan size, operating conditions, location, model, installation data, etc. The ventilation schedule shall also outline louver data including size, material, fixed or motorized.
 - i. Secondary power facilities and alarm equipment shall be designed so that they may be manually activated for periodic maintenance checks to ensure proper operation.
 - j. Provide a legend of all symbols used for the above.
2. Lightning and Surge Protection: The Designer shall provide lightning and surge protection at the wastewater pumping station. The lightning and surge protection shall comply with the latest editions of all applicable codes and standards.
 3. Backup Power: All wastewater pumping stations shall be provided with either emergency generators or a secondary power feed with automatic transfer switches as described in MDE guidelines. Emergency generators shall be sized to maintain full station operation. Emergency generators shall be diesel driven with fuel storage on the underside of the generator in a belly tank or outside the building in an above ground storage tank. Fuel spillage protection shall be provided. Tank size shall be suitable for 24 hours of generator operation at full load. Emergency generators shall be located inside the pumping station building, mounted on vibration isolators, with a fuel tank fill connection to the outside. Generator engine exhaust shall be provided with a critical grade silencer and piped to the outside of the control building. Generator exhaust shall face away from nearby neighbors. If this is not possible, a baffle wall shall be constructed in front of the generator exhaust to deflect the noise.
 4. Controls & Alarms: The pumps shall be controlled by means of an ultrasonic level transmitter. The transmitter shall be programmed to turn the pumps on or off at various levels in the wet well as shown on the figures in the Appendix and as described below.

Wet wells shall be designed to have not less than 2 feet between the lead pump on and pump off elevations. For stations with two pumps, the high water alarm

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elevation and the lag pump on elevation shall be the same and shall be set at a minimum one (1) foot below the influent sewer invert elevation. The float switch back-up shall be set a minimum six (6) inches below the influent sewer invert elevation. There shall be a minimum 1-foot interval between all other control elevations and alarm points. Wet wells shall be designed with an additional 2-foot of depth as a safety factor to accommodate future increases in station capacity.

The lead and lag pumps shall alternate automatically with every pumping cycle. Ultrasonic level transmitter sensors shall be mounted near the top of the wet well and be removable without entering the wet well. The transmitter shall also report the level in the wet well on an indicator located inside of the station. The pumping station shall also have a back-up mercury float switch control system with floats for turning the individual pumps on and off if the ultrasonic level transmitter malfunctions. Pumps shall have back-up floats to maintain the “safe pumping capacity” (i.e. largest pump out of service) of the station. The back-up floats shall be wired directly into the pump motor starters. The controls shall be designed so that upon a malfunction of the ultrasonic level transmitter control system, control shall be transferred to the back-up float control system and an alarm transmitted to the Bureau of Utilities. Pump control shall then continue to operate on the float control system until manually reset back to the primary ultrasonic level system.

A separate manual control shall also be provided so that the pumps may be manually activated or shut down, thereby overriding the automatic controls. An exception to this override shall occur when the station shuts down due to a loss of phase from the primary or secondary power sources. Each control system shall have an individual circuit breaker.

All equipment shall be provided with pilot lighting indicating “on” and “off” operating status and lights shall be green and red, respectively, and be located at a central control panel. Indicator lights for the pumps shall be located on the outside of each starter cabinet.

5. Telemetry: At a minimum, the following telemetry shall be provided at each pumping station:
 - a. Pump On (each pump)
 - b. Pump Failure Alarm (each pump)
 - c. Control Valve Failure Alarm (each control valve)
 - d. High Wet Well Water Level Alarm
 - e. Low Wet Well Water Level Alarm
 - f. Loss of Primary Power Alarm
 - g. Generator/Secondary Power On
 - h. Building Intrusion Alarm
 - i. Telemetry Failure Alarm

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A minimum of five (5) spare inputs and five (5) spare outputs shall be provided with the telemetry system. The DPW may require additional telemetry and SCADA communications at a particular station.

The Designer shall elicit from the DPW any information necessary for proper system communication, which may be applicable. RTUs shall be programmable logic controller (PLC) based and complimentary to the DPW SCADA system.

The Designer shall specify that it is the Contractor's responsibility to provide screen displays to the existing human-machine interface (HMI) computers, which meet the DPW's requirements. The DPW will provide direction to the Contractor regarding the graphics required for the screen displays.

Communication baud rates shall be matched with the existing SCADA system communication rates.

E. Painting and Coating

All exposed piping, pump equipment and appurtenances shall be painted with epoxy coating. All pumping station control rooms shall be painted. Pumping station dry wells shall not be painted. Wet wells shall be coated as described in previous sections of this chapter. Painting system and colors shall be submitted to the DPW for approval. All pumping station floors shall have floor hardeners.

F. Miscellaneous

1. Odor Control: An odor control system shall be provided at all wastewater pumping stations. The type of odor control system to be used at a particular station must be approved by the DPW prior to design. Odor control systems shall be designed to mitigate odors from the wet well and influent manhole. Acceptable methods include, but are not limited to: Carbon adsorption (air scrubbing), chemical addition to sewers and force mains upstream of the station, chemical addition at the wet well or influent manhole, and soil odor filters. Wastewater pumping stations should be designed to minimize the possible formation of odors by limiting wet well detention times and avoiding turbulence in manholes and wet wells which cause odors to be released.
2. Operations and Maintenance Manual: Two (2) complete operations and maintenance manuals shall be provided for each pumping station. Manuals should contain approved shop drawings, catalog cut sheets, description of operation including various control sequences or any other special operational details incorporated in the pumping station design, equipment model and serial numbers, installation instructions, maintenance schedules, list of recommended spare parts, warranties, names and telephone numbers for local equipment representatives, for each item of equipment.

6.10 Design Criteria for Small Wastewater Pumping Stations (less than 500 gpm and less than 25 Ft Wet Well Depth)

A. General

Design criteria for small wastewater pumping stations shall be the same as for conventional stations described above except where specifically stated otherwise.

B. Suction Lift Stations

1. Pumping Station Configuration: Suction Lift pumping stations shall be designed with the pumps mounted directly above the wet well and shall have suction pipes that are straight. Suction Lift stations shall satisfy pump NPSH requirements. Suction Lift stations shall have suction lift no greater than 18 feet. Two-stage pumping is not acceptable. The pumping station building shall contain all electrical and control equipment and a toilet room as described in the preceding sections of this chapter. The wet well and pumps shall be located adjacent to the pumping station building. The wet well and pumps shall be covered by a canopy roof structure that is attached to the pumping station building and is of the same construction as the pumping station building roof. A jib crane shall be provided to facilitate pump removal. The emergency generator shall be located outside of the pumping station building in a weatherproof, sound insulated enclosure.
2. Wet Well Design: Suction Lift pumping station wet wells shall be designed for pre-cast concrete construction. Wet well coating and design features shall be the same as described for conventional pumping stations except as described below.
 - a. Access: Wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36-inch by 36-inch inches minimum size and as large as necessary to allow removal of equipment from the wet well.
 - b. Ventilation: Wet well ventilation for suction lift pumping stations shall be the same as for conventional pumping stations.
3. Suction Lift Wastewater Pumps: Pump volute, impeller and motor housing shall be of cast iron construction. The pump volute casing and impeller shall be fitted with replaceable stainless steel wear rings to maintain sealing efficiency between the pump volute and impeller. At the DPW's option, other special pump materials may be required for a particular application. All nuts, bolts and screws shall be stainless steel. Both vacuum prime and self-priming suction lift pump styles are acceptable.
4. Flow Meter Vault: A flow meter meeting all the same requirements as for conventional pumping stations shall be located in a pre-cast concrete vault located

on the pumping station site with adequate straight run of pipe both before and after the vault as required by the flow meter manufacturer. The flow meter vault shall be coated on the outside with elastomeric membrane waterproofing. The flow meter vault shall be equipped with an aluminum access hatch and an access ladder to the bottom. The access ladder shall have safety extension poles at the top. Ventilation shall be by means of two gooseneck openings at the top of the vault. The floor of the flow meter vault shall be sloped to a sump with a drain open to gravel.

C. Submersible Stations

1. **Pumping Station Configuration:** Submersible pumping stations shall be designed with an equipment hatch in the top slab for pump removal, mounting base for a swinging jib crane, stainless steel guide rails and manway hatch. Pumps shall be of the wet pit submersible type. The pumping station building shall contain all electrical and control equipment and a toilet room as described in the preceding sections of this chapter. The wet well and pumps shall be located adjacent to the pumping station building. The wet well and pumps shall be covered by a canopy roof structure that is attached to the pumping station building and is of the same construction as the pumping station building roof. A jib crane shall be provided to facilitate pump removal. The emergency generator shall be located outside of the pumping station building in a weatherproof, sound insulated enclosure.
2. **Wet Well Design:** Submersible pumping station wet wells shall be designed for pre-cast concrete construction. Wet well coating and design features shall be the same as described for conventional pumping stations except as described below.
 - a. **Access:** Wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36-inch by 36-inch minimum or as large as necessary to allow removal of pumps from the wet well.
 - b. **Ventilation:** Wet well ventilation for submersible pumping stations shall be the same as for conventional pumping stations.
 - c. **Size:** The wet well size and depth shall be as required to accommodate the influent sewer, as well as for complete pump submergence.
3. **Wet Pit Submersible Wastewater Pumps:** Pump volute, impeller and motor housing shall be of cast iron construction. The pump volute casing and impeller shall be fitted with replaceable stainless steel wear rings to maintain sealing efficiency between the pump volute and impeller. At the DPW's option, other special pump materials may be required for a particular application. The motor shaft shall be a single piece heat-treated high strength alloy steel or high strength stainless steel having a tapered end with keyway to receive the impeller. All nuts, bolts and screws shall be stainless steel. The motor shall be Class F insulated

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(minimum) and sealed from the pump by independent double mechanical seals. The upper and lower mechanical seal shall run in an oil chamber. The upper seal shall be a stationary tungsten-carbide seal with rotating carbon ring. The lower seal shall be one stationary and one positively driven rotating tungsten-carbide ring. All mating surfaces where watertight sealing is required shall be machined and fitted with a rubber O-ring. The machining of mating surfaces shall provide metal to metal bearing on sealing surfaces without crushing the O-ring.

4. Valve Vault: Pump check and isolation valves meeting all the same requirements as for conventional pumping stations shall be located in a pre-cast concrete vault adjacent to the wet well. The valve vault shall be coated on the outside with elastomeric membrane waterproofing. The valve vault shall be equipped with an aluminum access hatch and an access ladder to the bottom. The access ladder shall have safety extension poles at the top. Ventilation shall be by means of two gooseneck openings at the top of the vault. The floor of the valve vault shall be sloped to a sump with a drain open to gravel.
5. Flow Meter Vault: A flow meter meeting all the same requirements as for conventional pumping stations shall be located in a pre-cast concrete vault located on the pumping station site with adequate straight run of pipe both before and after the vault as required by the flow meter manufacturer. The flow meter vault shall be coated on the outside with elastomeric membrane waterproofing. The flow meter vault shall be equipped with an aluminum access hatch and an access ladder to the bottom. The access ladder shall have safety extension poles at the top. Ventilation shall be by means of two gooseneck openings at the top of the vault. The floor of the flow meter vault shall be sloped to a sump with a drain open to gravel.

D. Package Stations

1. Pumping Station Configuration: Package pumping stations shall be of a wet well / dry well configuration. Electrical equipment shall be located at grade in a pumping station building erected above the pump chamber. Access hatches for the pumps shall be located in the floor slab of the pumping station building. Pumps shall be of the dry-pit submersible type. Jib cranes or a traversing monorail with hoist shall be provided to facilitate pump removal. The pumping station building shall contain all electrical and control equipment and a toilet room as described in the preceding sections of this chapter. An emergency generator shall be located outside of the pumping station building in a weatherproof, sound insulated enclosure.
2. Wet Well Design: Package pumping station wet wells shall be designed for pre-cast concrete construction. Wet well coating and design features shall be the same as described for conventional pumping stations except as described below.

Wastewater Pumping Stations (less than 500 gpm)

- a. Access: Wet well access shall be through a top slab opening with aluminum hatch cover and frame. The top slab access hatch shall be 36-inch by 36-inch minimum size and as large as necessary to allow removal of equipment from the wet well. A ladder shall be provided to access the bottom of the wet well. The access ladder shall be equipped with safety extension poles.
 - b. Ventilation: Wet well ventilation for package pumping stations shall be the same as for conventional pumping stations.
3. Dry Well Design: Dry wells shall be of pre-cast reinforced concrete construction. Dry wells shall have exterior elastomeric membrane waterproofing. The dry well floor shall be sloped to a sump. A sump pump with piping to the wet well shall be provided. Sump pump piping shall contain a check valve to prevent siphoning from the wet well. A surge relief valve, if required, shall be placed on the discharge header before the pipe leaves the station. Surge relief piping shall be piped to the wet well.
 - a. Access: Dry well access shall be via a circular staircase with all necessary landings and handrails per OSHA requirements. Equipment hatches for the pumps shall be located in the top slab and directly above the pumps. Portable jib cranes shall be provided above the dry well to facilitate removal of the pumps. Grating (catwalks) shall be provided in the dry well to facilitate access to all piping without climbing over pipes, equipment, etc.
 - b. Ventilation: Dry well ventilation for package pumping stations shall be the same as for conventional pumping stations.

CHAPTER 7

WATER PUMPING STATION DESIGN

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CHAPTER 7

WATER PUMPING STATION DESIGN

7.1 Introduction

This Chapter outlines the design standards of water pumping stations to meet the needs and operational responsibilities of the Department of Public Works (DPW). This Chapter includes the criteria and guidelines for designing water pumping stations within the Howard County water distribution system. Drawings showing details and conceptual plans are included in Appendix L, “Water Pumping Station Design Figures.” The only type of water pumping station permitted is the custom built configuration.

The Designer shall consult with the DPW to determine the applicability of these design standards to planned water pumping stations. It is the Designer’s responsibility to integrate all applicable criteria and guidelines into the design of water pumping stations incorporated into the Howard County public water system.

To the extent practical, water pumping station designs shall conform to the design standards given herein. The design standards shall be applied to design conditions in a careful and thoughtful fashion. Deviations from the design standards must be brought to the attention of the DPW. Requests for waivers of the design manual must be justified to the DPW, in writing, from an engineering evaluation standpoint and include consideration of life cycle costs and ease of maintenance. Approval or denial of the waiver request will be by return letter signed by the Chief of the Bureau of Engineering.

All standards and regulations referenced in this Chapter shall conform to the latest publications.

7.2 Abbreviations

Abbreviations used in this chapter or other chapters are located in Chapter 1 of this manual.

7.3 Definitions

Average Day Demand: The volume of water used in the year divided by 365 days, expressed in gallons or million gallons.

Average Day Rate: The water used during the Average Day Demand expressed in gallons per day (gpd) or million gallons per day (mgd) or divided by 1,440 minutes and expressed in gallons per minute (gpm).

Design Flow Rate: The minimum flow rate required to satisfy the following demand and pressure conditions during a 24-hour period, expressed in gpm or mgd:

Maximum Day Demand:	40 psi minimum at curb
Peak Hour Demand:	30 psi minimum at curb
Maximum Day Rate	
+ Fire Flow Rate:	20 psi minimum at curb

Fire Flow Rate: The flow rate of water necessary to fight a fire in a given service area as determined by the guidelines in Chapter 3 of this manual.

Maximum Day Demand: The largest volume of water used in one day during the year, expressed in gallons or million gallons.

Maximum Day Rate: The volume of water used during the Maximum Day Demand expressed in gallons per day (gpd) or million gallons per day (mgd) or divided by 1,440 minutes and expressed in gallons per minute (gpm).

Peak Hour Demand: The largest volume of water used in one hour during the year expressed in gallons or million gallons. The Peak Hour Demand usually occurs during Maximum Day Demand.

Peak Hour Rate: The Peak Hour Demand volume divided by 60 minutes, expressed in gpm or multiplied by 24 hours, expressed as mgd.

7.4 Regulations

Water pumping stations must satisfy the regulations of agencies having jurisdiction. Water pumping stations shall comply with all relevant guidelines issued by the Maryland Department of the Environment (MDE). Buildings shall comply with applicable BOCA and Howard County building codes as well as permitting requirements of the Howard County Department of Planning and Zoning (DPZ) and Department of Inspection, Licenses and Permits (DILP). Other regulations governing facilities and construction shall be adhered to, including regulations published by the Occupational Safety and Health Administration (OSHA), the National Fire Protection Association (NFPA), National Electric Code (NEC), Howard County Plumbing Code and others as applicable.

7.5 Permits and Approvals

See Section 5.17, "Permits and Approvals", in this manual for applicable permit requirements. In addition, for any above ground structure, the Designer shall make all applications for and obtain the required building and grading permits prior to bidding of the project.

7.6 Design Phases

A. Design Report

The Master Plan shows the location of all water pumping stations that have been planned for the respective systems. The design report shall be in conformance with the Master Plan, approved facility plan and/or any preliminary reports supplied by the DPW.

The design report shall also include the description of design criteria to be utilized, preliminary flow computations, design calculations, calculated system curves, surge protection analysis/recommendation, identification of land acquisition and easement requirements, 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 design criteria shall be developed:

1. Site Development (identify any conflicts with DPZ requirements, identify conditions and requirements necessary for development)
2. Conflicts with Existing Utilities
3. Structural Design
4. Architectural Design (evaluate compatibility with surrounding community)
5. Complete Hydraulic Analysis (Pump and system curves, design conditions, operating scenarios). The analysis shall include 24 and 48 hour extended period simulations of the water distribution system performance using average day demand, maximum day demand and peak hour demand for both current and full development, including fire flow.
6. Pump Selection (type of pumps, number of pumps, size of pumps for initial and ultimate design conditions)
7. Pump Controls (constant or variable speed controls, on/off controls, telemetering, etc.)
8. Power Requirements (availability, cost to provide service, etc.)
9. Corrosion Control
10. Noise Control
11. Secondary Power Supply
12. Construction Timeline

Once the design report has been approved by the DPW, design of the facilities may proceed. Milestone submittals of design plans and specifications shall be made at 30%, 60%, 95% and Final Design.

B. Design Plans & Specifications

At a minimum, the following information shall be supplied at the milestone submittals:

30% Submittal:	Site Plan, Design Schematics (showing station layout and major equipment), Specification Table of Contents
60% Submittal:	Complete civil, mechanical and structural design plans and preliminary technical specifications
95% Submittal:	Complete design for all disciplines including electrical and architectural plans and details. Complete specifications including front end documentation. This phase should represent a complete, bid-ready contract documents from the Designer.
Final Design:	The 95% Submittal with the DPW's final comments incorporated

C. Cost Estimate

At each formal submittal and at the conclusion of the design process, the Designer shall prepare a detailed cost estimate for the pumping station. This estimate shall be developed for each major category of work including civil, mechanical, electrical, structural, architectural work and contingent cost. This cost breakdown shall be made available to the DPW as required and shall be updated annually. Refer to Chapter 5.18, "Cost Estimate," for additional information.

7.7 Hydraulic Computations

A. Planning Period

Water pumping station design conditions shall, at minimum, accommodate a 20-year planning horizon. For all pumping stations, consideration shall be given to future upgrading flexibility necessary to accommodate design conditions beyond the normal planning horizon. This is especially important for larger stations.

B. Maximum and Average Day Demands

Water pumping stations shall be designed to pump the flow at the pressure determined by house count and non-domestic user inventory with allowances made for remaining undeveloped areas. Population densities and per capita demands shall be as established by facility plans or in their absence, in agreement with the Master Plan or instruction of the DPW. Institutional, commercial and industrial demands shall be determined by a study of the establishment. The DPW shall be consulted for future domestic and non-domestic land use and population densities. Demand computations shall follow guidance given in Chapter 2, "Engineering Reports", and Chapter 3, "Water Main Design" of this manual. A service area map and tabulation of the design flow shall appear on the plans. The map and tabulations shall show initial and ultimate service areas.

C. Hydraulic Analysis

Water pumping stations must satisfy the hydraulic conditions of the system. A complete hydraulic analysis of each water pumping station is required. During the study phase, the Designer shall consult with the DPW for the requirements of the hydraulic analysis. At a minimum, the Designer shall perform 24 and 48 hour extended period computer simulations using average day demand, maximum day demand and peak hour demand for both current and full development conditions. Fire flows shall be analyzed during maximum day rate for both initial and full development conditions.

The hourly demand ratios used in the 24 and 48 hour extended period simulations for average day demand and maximum day demand shall be based on actual Howard County average day demand and maximum day demand records, or as directed by the DPW. Hourly demand ratios shall be calculated by dividing each hour's water demand by that day's average hourly water demand. The highest hourly ratio experienced during the maximum day demand is the peak hour demand ratio for that water pressure zone. The hourly demand ratios may differ between water pressure zones. During the extended period simulations, all water pressure zones shall be connected to allow modeling of pumping station suction pressures and storage tank refill rates. Fire flows shall be modeled as a single event assuming a maximum day demand ratio of 1.0 and a 2-hour fire event at 1,500 gpm with all water storage facilities assumed empty.

D. Design Flow Rate and Pressure

The design flow and pressure for water pumping stations shall meet the following requirements during the 24 and 48-hour extended period computer simulations:

Maximum Day Demand:	40 psi minimum at curb
Peak Hour Demand:	30 psi minimum at curb
Maximum Day Rate + Fire Flow Rate:	20 psi minimum at curb

E. Pump and System Curves

The Designer shall show pump and system curves on the plans to scale. System curve characteristics for each design condition shall be determined by the Hazen-Williams formula for piping head loss in conjunction with the Howard County water model. The pump selection shall be reviewed for both the initial and design year conditions. The following pump and system curves shall be shown on the plans:

1. System Curve for Maximum Day Demand for the design year.
2. System Curve for Average Day Demand for the design year.
3. System Curve for Average Day Demand for the initial year of station operation.

4. Pump Curve for single pump operation and multiple pump operation where station has three or more pumps.

In addition, the Designer shall list next to the curves the pump design criteria including pump motor horsepower, efficiency, NPSHR at design points and RPM. Pump and system curves shall be shown for new water main conditions. Hazen-Williams "C" factors used in evaluating pump and system curves shall be in accordance with the guidelines given in Chapter 3 of this manual for various pipe materials.

F. Number of Pumps

Water pumping stations shall be capable of pumping the maximum day demand with the largest single pump out of service.

G. Pump Selection Criteria

Avoid applications where pumps must operate in an adverse area of their performance curve. Design for maximum efficiency at the operating point. Examples would be pumps operating at very low flows and high heads, near shutoff heads or "runout" conditions. These conditions can result in excessive hydraulic loading or cavitation damage to impellers, casings and shafts, rapid bearing and mechanical seal wear and high vibration. Under no circumstances shall a pump be specified operating outside of its recommended range.

H. Variable Frequency Drives (VFDs)

VFDs or other methods approved by the DPW may be used to achieve minimum flow conditions below the full speed operating range of the pumps.

I. Water Hammer

The potential impact of water hammer shall be evaluated. If the combined effects of static head and water hammer do not exceed the weakest piping system component working pressure by a safety factor of 1.1, no special provisions need to be included to control water hammer. Where the maximum water hammer pressure exceeds the weakest piping system component working pressure by a safety factor of 1.1, the Designer shall strengthen those elements affected, re-evaluate pipe size and velocities or select an appropriate device to control water hammer. Hydraulically operated, time adjustable pump check service valves and spring type, oil-cushioned elbow hydraulic surge relief valves are the preferred choices of the DPW for controlling the effects of water hammer. No pressure vessel/surge tank type devices will be acceptable. The decision to strengthen piping system components instead of utilizing a water hammer control device or different pipe size shall be based upon a life cycle cost economic comparison.

7.8 Design Criteria for Water Pumping Stations

All water pumping stations shall be of the type in which the structures are formed and poured on site (cast-in-place concrete construction) with a masonry superstructure. All of the piping and valving shall be assembled on site by the Contractor. The pumps, piping, controls, electrical gear and emergency generator shall be housed in a single building. Water pumping stations shall be designed as long-term (greater than 20 years) facilities and shall include room for anticipated expansion.

A. Site Design

1. Location: Water pumping stations shall be located as far as possible from populated areas. Natural screening and remoteness of the site shall be primary elements of site selection wherever possible. Where pump stations are sited in proximity to developed areas, the architecture shall be compatible with the surrounding area. Building aspects such as generator exhaust and ventilation fan noises shall be considered. Similarly, building setbacks shall be considered to provide minimal impact to neighboring properties.
2. Land Acquisition: Land required for pumping stations, including necessary vehicular access routes to an existing or proposed public roadway shall be owned in fee simple by Howard County. As part of this process, a boundary survey of the property is required together with a record plat and a metes and bounds description of the parcel. In determining the space requirements for the facility, particular attention should be given to the width provided for the access road to insure adequate space for grading and drainage within the access road right-of-way. DPW Procedure 501.4, "Standards for Preparation of Land Acquisition Documents," shall be followed in the preparation of documents necessary for land acquisition.
3. Site Plan: The site design and location must conform to applicable portions of the Subdivision Regulations and satisfy the DPZ's requirements for site development plans. Wherever possible, land acquisition shall provide generous space around the building to permit landscaping to minimize the impact of the station on the neighborhood. All plans applicable to the site (site and grading, landscaping, sediment control, etc.) shall be prepared on a scale of 1"=20' and shall meet all requirements of the Howard County DPZ. The location of all proposed facilities required for the pumping station site shall be clear and concise to permit complete field stakeout from plan information. A stake out table listing all components of the proposed facility along with their corresponding survey coordinate locations shall be provided on the plans. As an alternative to using coordinates to stake out the pumping station, the location of proposed facilities may be projected from a base line established from the traverse shown on the plan. The base line shall be located so that it will not be interrupted by the proposed construction. Location of proposed facilities shall not be referenced from other proposed facilities for stakeout purposes.

4. Topography: Adjacent areas potentially served by the water pumping station must also be considered. Water pumping station site selection shall also be compatible with suitable site access and soil capability with respect to land grading in conjunction with site development. Existing contours and other topography shall be shown for the entire site including a 100-foot minimum width outside of the proposed property boundary. Contour interval shall be one-foot, unless otherwise approved by the DPW.
5. Floodplain: Water pumping stations shall be sited to remain operational and permit access during a 100-year return frequency flood. The pumping station top slab elevation shall be set a minimum of two-feet above the 100-year floodplain elevation. The access road shall be above the 10-year return flood level.
6. Wetlands: Avoid direct impacts wherever possible and minimize impacts to wetland buffer areas. Buffer areas include 25 feet beyond non-tidal wetlands.
7. Grading: Water pumping station grades for paved areas shall prevent local ponding, provide positive drainage away from structures and generally be limited to no greater than 4 percent slopes. Stone surfaces around paved areas shall provide proper site drainage at slopes 10 percent or less. Land grading outside of the water pump station perimeter fence shall not exceed 3 to 1 slopes; 4 to 1 slope maximums are desirable. Lesser slopes wherever possible are preferred. Site grading design shall be compatible with slope stability for the soils encountered. Slope stabilization shall be appropriate for the degree of slope and soil conditions. The use of retaining walls on or adjacent to the water pumping station site is not permitted.
8. Sediment Control: A sediment control plan shall be provided in accordance with the Subdivision Regulations. Design requirements for sediment control devices shall be as described in section 5.16 "Soil Erosion and Sediment Control" of this manual.
9. At least two test borings shall be taken at the building location to determine soil types, rock, water table elevations, soil bearing values, etc. When in soil, standard penetration tests shall be taken at intervals not to exceed five (5) feet. When in rock, the rock shall be cored with a double tubed core barrel sized NWX and length of individual core runs shall not exceed five (5) feet. Borings shall be taken to a depth of not less than fifteen (15) feet below the bottom of the proposed structure. Borings shall be taken deeper as necessary, depending on soil conditions.
10. Landscaping: Landscaping must meet all Howard County DPZ requirements and be certified by a Landscape Architect registered in the State of Maryland. All water pumping station sites shall be screened as appropriate from surrounding development. A 4-foot wide planting bed shall be placed around, and outside of,

the fence line for planting shrubs to screen the site. Shrubs shall consist of various types and shall be selected based on maximum height, foliage thickness, compatibility with existing surrounding foliage and required maintenance. Where extensive clearing is involved during construction, or where otherwise applicable for aesthetic purposes, new trees shall be planted. A landscaping plan shall be prepared showing planting arrangement of shrubs and trees, identifying each by both genetic names as well as common names, and specifying size and planting information. Landscaping materials shall be aesthetically pleasing and require minimal maintenance (watering, fertilizing, trimming, etc.).

11. **Site Security:** Pumping station sites shall be fenced with black vinyl coated chain-link fencing, black vinyl coated post and black hardware, and a 12-foot wide double leaf locking gate for vehicle access. Where the entrance gate is located more than 100 feet from the public roadway, a second gate shall be provided at the driveway entrance to the station access road. Additional property line fencing may be required as determined by the DPW. The pumping station building shall have exterior lighting controlled by motion detectors. The pumping station doors shall be bulletproof steel with locks keyed as specified by the DPW. The building shall be provided with an entry alarm connected to the station telemetry.
12. **Paving:** Pumping station sites shall have a paved access road and a minimum of two parking spaces. The access road shall have sufficient room and turn-around area to allow access by maintenance trucks. The turning area in a pumping station site shall have a minimum radius of 48 feet. Paving shall conform to the P-2 pavement section of the Standard Details. Pumping station access roads shall be used exclusively for pumping station maintenance and access.
13. **Exterior Lighting:** The need for and quantity of exterior lighting shall be determined on a case-by-case basis.
14. **Station Sign:** A permanent sign shall be provided at each pumping station stating the Station Name, Street Address and Emergency Telephone Number.
15. The pumping station shall not be located downstream of a stormwater management facility.

B. Structures

1. **Pumping Station Design/Architectural Standards:** Pumping stations shall be architecturally compatible with surrounding structures and shall not have slate roofs. Pumping stations shall be of brick and block design with a pitched roof and wooden roof trusses. Pre-cast or pre-fabricated buildings are not acceptable. The building shall be designed to be vandal-proof. There shall be no exposed woodwork on the outside of the building. All exterior woodwork shall have a vinyl or aluminum coating. The pumping station shall have a lightning protection system. Provisions shall be made in the structure for traversing bridge cranes of adequate capacity to facilitate the removal of pumps, motors, valves and all other

related heavy equipment. Doors shall be bulletproof and constructed of heavy duty metal with deadbolts and locks keyed to the Bureau of Utilities system. Exterior lights shall be vandal proof, wall-mounted, high-pressure sodium type controlled by an on-off switch. Pumping stations shall be provided with outside non-freeze hose bibb. Ventilation openings shall be protected with aluminum louvers with birdscreens. Buildings must comply with applicable BOCA and Howard County building codes and the latest revisions thereof.

a. Pump Room

Pumps and piping shall be located below grade with parallel suction and discharge headers. Pumps shall be of the horizontal style placed on individual concrete bases. Floor shall be sloped to floor drains piped to a sump. Each water pump shall have a floor drain located next to it. Pump baseplate drains shall be piped to adjacent floor drains. A building sump with duplex sump pumps with piping leading to the nearest sewer shall be provided, if a sewer is available. The pump room shall be furnished with a service sink with both hot and cold water, and inside hose bibb.

All electrical and control equipment shall be located on a mezzanine level at least two (2) feet above the 100-year flood elevation. Stairs shall be provided for access to the pumps and piping.

b. Office Room

An office room shall be provided with a desk, chair, filing cabinet and telephone service. The office shall have a window facing the pumps. The office room floor shall be a minimum of two (2) feet above the 100-year flood elevation and shall have a doorway to the electrical equipment and controls.

c. Toilet Room

A toilet room shall be provided with toilet, lavatory, hot water heater, towel and soap dispensers and mirror.

d. Generator Room

A separate generator room shall be provided for housing the emergency generator and fuel tank. The generator room floor shall be located a minimum of two (2) feet above the 100-year flood elevation. The generator room shall have a roll-up metal garage door for access and shall be equipped with a floor drain located outside the fuel spillage containment area, piped to the building sump. The generator room shall be supplied with hose bibb, hose rack and 50 feet of rubber hose.

2. Heating and Ventilation: The pump, control and generator rooms shall be heated by electric unit heaters with integral thermostats sized to maintain a minimum inside temperature of 55 degrees Fahrenheit. The office and toilet rooms shall be heated by electric baseboard heaters with integral thermostats to maintain a minimum temperature of 70 degrees Fahrenheit. Ventilation shall be by means of wall or ceiling mounted exhaust fans with backdraft dampers operated by thermostats and freezestats and intake louvers with motor operated dampers. Ventilation shall be designed for a minimum of six (6) air changes per hour. The office, toilet, pump, control and generator rooms shall each have their own exhaust fans. Ventilation shall be sufficient to remove heat generated by the pump motors and controls. Provisions shall be made to insure against condensation forming on controls and other major items of equipment.

C. Equipment

1. Yard Valves: Yard valves shall be buried resilient seat gate valves (Baltimore Standard, Open Right), complying with the Standard Specifications with operating nut and roadway valve box at grade.
2. Station Bypass: Water pumping stations shall be provided with bypass connections in the form of two (2) fire hydrants, one on each of the suction and discharge lines of the station. Hydrants shall be labeled suction and discharge, respectively. The hydrants shall be located adjacent to the parking area and shall be no more than 50 feet apart for easy setup of temporary pumps for pump around capability.
3. Interior Piping: All interior water piping shall be ductile iron, thickness Class 53, with flanged fittings. Flanges shall be integrally cast on pipe or factory assembled screwed-on with proper bonding compound. Manifolds shall include flexible couplings for ease of installation and removal and also for expansion and contraction of the piping system. Arrangement of piping and equipment within the station should be made with adequate space for maintenance, repair and removal or replacement of equipment, as well as to safeguard personnel working in the station. Piping shall be adequately supported. Control and instrumentation piping shall be copper or stainless steel.
4. Interior Valves: Each water pump shall have isolation valves to permit the removal or maintenance of the pumps without affecting the operation of the remaining pumps. Isolation valves shall be resilient seat gate valves (Standard, Open Left). Valves larger than 6-inch shall have geared operators with handwheels. Handwheels shall be marked with an open arrow. Each pump shall have a hydraulically operated, time adjustable pump check service valve to prevent backflow through inoperative pumps. In accordance with the criteria for water hammer control, pump check service valves shall be of the type and strength required to eliminate water hammer damage. Surge relief valves shall

also be provided on the suction and discharge headers of the station and piped to the nearest stormwater management pond.

5. Pressure Gauges: Pressure gauges for direct reading of line conditions shall be placed on both the suction and discharge of each pump, on the main discharge header piping after the last pump, and on the suction header as it enters the building. Pressure gauges shall be oil-filled type, have a minimum 3½-inch diameter face and be equipped with snubbers. Accuracy shall be to within 0.5% of pressure. Pressure gauges shall have a range such that the normal operating pressure is near the middle of the gauge.
6. Flow Metering: All water pumping stations shall have a venturi type flow meter utilizing differential pressure for reading flow. Accuracy shall be within 0.5% of flow range. Magnetic flow meters may also be used with the approval of the DPW, where adequate straight runs of pipe are unavailable for installation of a Venturi flow meter. All flow meters shall have an adequate straight run of pipe both upstream and downstream of the meter in accordance with the manufacturer's recommendations. A 30-day strip chart, with totalizer, and indicator recorder in units of gpm shall also be provided.
7. Pumping Units: All water pumps shall rotate clockwise as viewed from the motor end. Pump bearings shall have a minimum 100,000 hours ABMA-10 bearing life. Pump motors shall operate on 460 volt, 3 phase, 60 cycle electrical service and at a speed no higher than 1780 rpm. Pump discharge velocities shall be between 5 and 15 feet per second. Pump inlet pressure shall be maintained at a sufficient level to avoid cavitation. Pump motor horsepower shall be sufficient to prevent motor overload under all possible conditions. Water pumps and motors shall be suitable for continuous duty. All pumps shall be factory witness tested and approved prior to shipment. Water pumps shall meet the requirements of the Hydraulic Institute for vibration. Vibration tests shall be performed on site by an independent laboratory and the results submitted to the DPW for approval. Pumps shall be one of the following types:

In-Line Split Case (Horizontal)

End Suction (Horizontal)

The pump casing/volute, impeller, seal housing and motor housing shall be of cast iron construction. Impeller shall be cast iron or bronze. The pump's casing and impeller shall be fitted with replaceable hardened bronze or stainless steel wear rings to maintain sealing efficiency between the volute and the impeller. At the DPW's option, other pump materials may be required to suit a particular application.

Pumps shall have the following additional features:

- a. Stainless steel shaft
- b. NSF approved fusion bonded epoxy coating (interior)
- c. Flexible shaft coupling and removable OSHA-compliant shaft guard
- d. Mechanical shaft seals cooled and lubricated by the pumped fluid
- e. Premium efficiency motors shall be specified (where commercially available) for all three-phase pump motors

D. Electrical and Controls

1. Electrical Design: All electrical designs and components shall be in strict accordance with all applicable National Codes, County Codes and BGE requirements. Electrical design shall be such that phase out protection shall be provided so that the power will automatically switch off in the event of a loss of any one phase. The electrical plans shall include, but not be limited to, the following:
 - a. Complete plan layout indicating all conduit, wire sizes and equipment locations including lighting and other appurtenances. Incoming electrical service on the pumping station site shall be underground and within concrete encased conduits.
 - b. Complete plan layout showing motor control center (MCC), size and location of all motor starters, circuit breakers and automatic transfer switch (ATS).
 - c. Installation details of equipment that are wall mounted or suspended from the ceiling, or otherwise required for clarity.
 - d. Single line diagrams incorporating all electrical components required for operation of the facility.
 - e. Complete lighting schedule noting model, size, location and installation data as well as appurtenances. Vandal-proof exterior lighting shall be provided.
 - f. Complete control and telemetry diagrams.
 - g. Elevation of control panels with equipment and mounting dimensions and notes identifying each component.
 - h. Complete circuit breaker schedule indicating size and identifying each circuit.
 - i. Ventilation schedule noting fan size, operating conditions, location, model, installation data, etc. The ventilation schedule shall also outline louver data including size, material, fixed or motorized.
 - j. Secondary power facilities and alarm equipment shall be designed so that they may be manually activated for periodic maintenance checks to ensure proper operation.
 - k. Provide a legend of all symbols used for the above.

2. Lightning and Surge Protection: The Designer shall provide lightning and surge protection at the water pumping station. The lightning and surge protection shall comply with the latest editions of all applicable codes and standards.
3. Backup Power: All water pumping stations shall be provided with emergency generators or a secondary independent power feed with automatic transfer switches. Emergency generators shall be sized to provide full station operation. Emergency generators shall be diesel driven with fuel storage on the underside of the generator in a belly tank if practical or in a separate storage tank. Fuel spillage protection shall be provided. Tank size shall be suitable for 24-hours of generator operation at full load. Emergency generators shall be located inside the pumping station building, mounted on vibration isolators, with a fuel tank fill connection to the outside. Generator engine exhaust shall be provided with a critical grade silencer and piped to the outside of the generator room. Generator exhaust shall face away from nearby neighbors. If this is not possible, a baffle wall shall be constructed in front of the generator exhaust to deflect the noise.
4. Controls & Alarms: The pumps shall be controlled by one of the following means depending on the service for which the station is intended:

Tank Level
Pressure
Flow Rate

Tank Level controlled stations employ the use of pressure transducers to turn pumps on and off depending on level in a water storage tank.

Pressure controlled stations employ the use of pressure transducers to turn pumps on and off to maintain a desired system pressure. The controller shall turn pumps on and off, and vary speed as necessary, to maintain adequate discharge pressure out of the station.

Flow Rate controlled stations employ the use of flow meters to turn pumps on and off to maintain a desired flow rate.

All water pumping stations shall have high discharge pressure and low suction pressure pump cut-out switches that will shut all pumps down regardless of operating mode if either of the two settings are encountered. An alarm signal to the telemetry system shall be transmitted for either of the two conditions.

Stations may be designed with more than one method of control depending on the specific requirements of the service area. For example, a Tank Level controlled station may also be designed with a pressure control system to enable that station to maintain a certain pressure in the system when the tank is out of service. The method of station control shall be approved by the DPW prior to design.

5. Telemetry: At a minimum, the following telemetry shall be provided at each pumping station:
 - a. Pump On (each pump)
 - b. Pump Fail Alarm (each pump)
 - c. High Tank Level Alarm (for Tank Level controlled stations)
 - d. Low Tank Level Alarm (for Tank Level controlled stations)
 - e. Low Suction Pressure
 - f. High Discharge Pressure
 - g. Loss of Primary Power
 - h. Generator/Secondary Power On
 - i. Building Intrusion Alarm
 - j. Pump Control Valve Failure
 - k. Telemetry Failure

The DPW shall specify the method of communications and the specific brands of hardware and software to be used. A minimum of five (5) spare inputs and five (5) spare outputs shall be provided with the telemetry system. The DPW may require additional telemetry and SCADA communications at a particular station.

The Designer will elicit from the DPW any information necessary for proper system communication, which may be applicable. RTUs shall be programmable logic controller (PLC) based as complimentary to the DPW SCADA system.

The Designer shall specify that it is the Contractor's responsibility to provide screen displays to the existing human-machine interface (HMI) computers, which meet the DPW's requirements. The DPW will provide direction to the Contractor regarding the graphics required for the screen displays.

The RTU shall utilize either the Modbus or the DF-1 protocols as directed by the DPW. Communication baud rates shall be matched with the existing SCADA system communication rates.

E. Painting and Coating

All exposed piping, pump equipment and appurtenances shall be epoxy painted. Painting systems and colors shall be submitted to the DPW for approval. All interior walls of the pumping station building that are above grade shall be painted. Interior walls that are below grade shall be left unpainted.

F. Miscellaneous

1. Operations and Maintenance Manual: Two (2) complete operations and maintenance manuals shall be provided for each pumping station. Manuals should contain approved shop drawings, catalog cut sheets, description of operation including various control sequences or any other special operational

details incorporated in the pumping station design, equipment model and serial numbers, installation instructions, maintenance schedules, list of recommended spare parts, warranties, names and telephone numbers for local equipment representatives, for each item of equipment.

CHAPTER 8

ALTERNATE SEWER SYSTEMS

**CHAPTER 8
ALTERNATE SEWER SYSTEMS**

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CHAPTER 8 ALTERNATE SEWER SYSTEMS

8.1 Shared Septic Systems

A. Purpose

The purpose of these guidelines is to provide information regarding the requirements of the Howard County Health Department and the Howard County Department of Public Works for design and construction of shared septic systems. This document is not intended to supersede the existing regulations set forth in the Annotated Code of Maryland or the Howard County Code. Instead, it is designed to introduce the process by which a shared septic system may be proposed and approved.

B. Abbreviations

For standard abbreviations, see Section 1.2, “Abbreviations” of this manual.

C. Definitions

Health Department: Howard County Health Department

MDE: Maryland Department of the Environment

Shared Facility: a wastewater system which serves more than one lot of land or more than one user on a single lot of land with wastewater systems owned and operated by the DPW and located on parcels held in trust. Shared facilities shall serve only rural residential or rural cluster developments.

User: a single-family residence that is served by the shared facility

D. Approval Procedures

The following are the general preliminary procedures for obtaining approval for a community septic system.

1. A sketch plan of the proposed development/subdivision shall be submitted to the DPZ who will distribute the plans to the DPW and the Health Department.
2. Percolation tests shall be conducted to determine the optimal subsurface disposal area in accordance with the Health Department requirements.
3. An individual application for percolation test with appropriate fees set by the Health Department, shall be required for each proposed dwelling unit using the shared septic facility. Percolation test applications, submitted to the Health Department, shall contain the following:

- a. Topographic plan with two (2) foot contours, USDA Soil Conservation Service Soil designations, proposed house locations, proposed shared septic subsurface disposal area or individual disposal area, and all well locations.
 - b. An MDE Groundwater Appropriations Permit must be issued for the project. Applications are available at and should be returned to the Health Department for processing.
4. After percolation testing has been completed, a percolation certification plat shall be prepared and submitted to both the Health Department and the DPW for review. A preliminary meeting shall be arranged to discuss the suitability of a shared septic system.
 5. Where the onsite system flow equals or exceeds 5000 gal/day maximum daily flow for the total project, whether utilizing one or more than one treatment unit or disposal field, the plans are required to be jointly approved by the Water Management Administration (WMA-MDE) and the Howard County Health Department.

E. Design of Shared Septic System

Should a shared septic system be considered suitable for the project by the appropriate agencies, the following minimum requirements will apply:

1. The design of the subsurface disposal system shall be subject to the requirements of the Health Department as outlined in the appropriate COMAR Sections of the MDE Regulations.
2. The design, construction and operation of the shared septic system shall be subject to the requirements of the DPW as outlined in the Howard County Code under Title 16, Title 18 and Title 20.
3. The design of all on-site wastewater disposal systems operated as a shared facility require the review and approval of the Water Management Administration (WMA-MDE), the County Health Department, and the DPW.
4. The subsurface disposal area shall contain the larger of either 1.) a contiguous usable area of not less than 10,000 square feet per user of the shared facility, or 2.) total area sufficient for the initial disposal system plus two (2) replacement fields.
5. Placement of the subsurface disposal system will be dependent on the location of the approved wastewater disposal area; however, it shall be located on a designated preservation parcel.
6. The subsurface disposal area shall be a single, contiguous area located on the preservation parcel without encroachment (by easement) on any buildable lots.

7. The land designated for the subsurface disposal system may not have any permanent structures erected that would affect the operation or performance of the system. The MDE, the Health Department and the DPW must approve any use of the land above the disposal system.
8. All wastewater conveyed from individual lots shall be untreated and collected at a common headworks, located on the same preservation parcel as the subsurface disposal facility.
9. Treatment at the headworks facility, prior to subsurface disposal, shall at a minimum consist of:
 - a. Influent manhole for transition from pressure to gravity flow prior to conveyance to septic tanks.
 - b. Isolation gate valve(s), between the influent manhole and septic tank(s), allowing for isolation of tanks and/or emergency bypass pumping.
 - c. Septic tanks sized (total capacity) for a minimum volume equal to 1250 gallons per 4-bedroom house, with an additional 250 gallons for each additional bedroom. Septic tank volume shall be equal to the sum of all lots served. If multiple tanks are required, they may be placed in either series or parallel configuration, with proper approved balancing valves to allow for equal flow distribution.
 - d. Septic tanks shall be concrete with top seams, hydrostatically tested after installation, with inlet/outlet sanitary tees accessible from above and located outside of paved areas. Alternative construction materials or methods must be approved by both the Health Department and the DPW.
 - e. Should septic tank effluent be pressure dosed or require other lift pumping, pump chambers separate from the septic tanks, and not considered as part of the septic tank volume, shall be provided.
 - f. Septic tanks shall be provided with effluent screens to minimize solids carryover.
 - g. Concrete distribution boxes shall be provided at the effluent end of the septic tank, prior to gravity subsurface disposal. All septic tank effluent shall be collected within the distribution box. The box shall be sized to accommodate the flows, and shall have a minimum inside height of 3 ½ feet to accommodate maintenance. Each lateral to an individual absorption trench shall have a resilient seated gate valve (RSGV) and cleanout assembly located just outside the box. Each lateral shall be equipped with a speed leveler, inside the box, for proper liquid level balancing. The distribution box shall be equipped with an at-grade Bilco type hatch for access.

- h. Manifolds for future repair areas whose later construction would interfere with operating absorption trench laterals shall be installed in advance to a point outside of the active treatment area and in accordance with the repair areas shown on the plans.
 - i. Additional treatment units, such as sand filters, peat filters, aerobic treatment units or other polishing type devices may be required by either the Health Department or the DPW.
 - j. Any pump or other type control panels required shall be provided and housed above ground in a prefabricated building. All such structures shall be subject to the approval of the Health Department and/or the DPW.
10. Absorption trenches shall be designed for and consist of the following:
- a. The wastewater disposal area shall be sized sufficiently to accommodate three (3) systems at 100 % of design flow based on minimum trench size due to permeability rates and mounding calculations. Shared septic systems (residential lots only) will require a minimum of 10,000 square feet per lot.
 - b. Trenches shall be conventional, stone filled, 3 feet wide, 9 feet on center (minimum), maximum 5 feet deep. A minimum of 2 feet of washed stone shall be placed in the trench bottom under the disposal pipe. Geotextile filter cloth shall be placed over the pipe, and native backfill, if suitable, shall be used up to finished grade. Laterals shall be 4 inch perforated pipes with perforations in equal portions on the circumference. Above ground terminations, with openings to the trench bottom, shall be placed at the lateral ends.
 - c. Absorption trenches shall be designed so that there is a minimum of 4 feet of unconsolidated buffer between the trench bottom and seasonal high groundwater table, as determined by the Health Department and/or the DPW. Trenches shall be designed so that they may be installed level and follow the natural surface contour.
 - d. The absorption trenches shall be sized based on the result of percolation testing performed under the direction of the Health Department, with the following trench loading rates based on the Health Department guidelines:

<u>Percolation Rate</u>	<u>Ft²/Bedroom</u>	<u>Hydraulic Rate (gpd/ft²)</u>
2-7 minutes	180	0.83
8-15 minutes	210	0.71
15-20 minutes	240	0.63
20-30 minutes	300	0.50

The use of pretreatment, if required and approved by MDE, the Health Department and the Department of Public Works, may increase the hydraulic loading rate, but in no case higher than 1.2 gpd/ft².

- e. A deep trench system may only be used by direction of the Health Department and/or the DPW.
 - f. The use of Dry Wells (seepage pits) will not be allowed.
 - g. All shared septic systems, which equal or exceed 2500 gallons/day average daily flow (5000 gallons maximum daily flow) shall normally require low pressure dosing. Equalization to allow for dosing and resting shall be incorporated. Systems using low pressure dosing shall be sized with the initial system being 150% of design flow, with provisions for isolating the disposal area into at least three (3) separate areas with only two operating at any one time.
 - h. The use of any other innovative/alternative subsurface disposal systems may be considered with MDE, Health Department, and DPW approval.
 - i. Two (2) monitoring wells installed upstream and downstream of the disposal field and within the easement area, shall be required. Additional monitoring wells may be required by DPW within the absorption field.
11. The land designated for the subsurface disposal system may not be disturbed by earth moving or grading after percolation testing and approval.
 12. Paved access roads, with appropriate easements, will be required for all subsurface disposal areas. Any access road to the facility shall not be part of any common driveway or used by any other party.
 13. Fencing of the absorption field perimeter as well as access road gates shall be required by the DPW.
 14. Prefabricated buildings for testing and maintenance equipment storage may be required by the DPW.

F. Wastewater Flow Rates

All shared septic systems design flow rates shall be determined based on the following criteria:

1. Wastewater flow rates for shared systems shall be computed on a minimum of 150 gallons per day per bedroom, maximum daily flow. Average daily flow, which is defined as 50% of the maximum daily flow, shall be only used for nitrogen and hydrologic balance.

2. Shared systems with flow rates greater than 5,000 gallons/day maximum daily flow are subject to MDE “Guidelines for Large On-Site Sewage Disposal Systems”, as revised on March 25, 1996 or the latest edition.
3. All shared septic systems shall be required to obtain a Local Wastewater Disposal System Permit from the Health Department and a Construction Permit from MDE.
4. All shared septic systems with an average daily flow rate of 10,000 gallons or greater shall be required to obtain an individual Maryland Groundwater Discharge Permit. All shared septic systems with an average daily flow rate equal to or greater than 5000 gallons but less than 10,000 gallons will be required to obtain an individual Discharge Permit until such time as MDE begins issuing General Discharge Permits. A shared septic system less than 5000 gallons per day average daily flow may be required to obtain an individual Discharge Permit if in the opinion of MDE, the County Health Department, or the DPW the project contains specific characteristics that warrant such monitoring. All shared systems shall require a local (County Health Department) sanitary construction permit.
5. If the average daily wastewater flow rate exceeds 2500 gallons/day (5000 gallons/day maximum flow rate), the Developer must retain the services of an experienced design consultant. All systems over 2500 gallons per day average daily flow must have an analysis performed of effluent mounding beneath the disposal field. All systems over 5000 gal/day average daily flow (10,000 gallon maximum daily flow) shall have a hydraulic balance and nitrogen capacity analysis performed in conformance with MDE regulations. Systems less than 5000 gal/day average daily flow may be required to satisfy the nitrogen capacity analysis and hydraulic capacity analysis if required by MDE, the County Health Department, or the DPW. The Design Consultant shall be subject to the approval of MDE, the County Health Department, and the DPW.

G. Acceptable Collection Systems

Acceptable collection systems shall consist of conventional gravity or low pressure sewers. All wastewater from connected lots shall be conveyed to a centralized treatment facility. Treatment shall consist of conventional septic tanks and subsurface disposal. The MDE, the Health Department or the DPW may require additional advanced treatment.

Collection System design shall be subject to “Design Guidelines for Sewerage Facilities,” 1978 Edition (Technical Bulletin M-DHMH-ERA-S001) and the Howard County Design Manual Volumes II and IV.

H. Design Submissions

The Developer shall submit to both the Health Department and the DPW a general design plan for both the collection and subsurface disposal of the proposed shared

septic system. The general design plan shall contain all necessary soil suitability data, mounding study results and analysis, design calculations, and all piping/treatment layouts. The DPW shall require design review fees in accordance with approved procedures of the DPZ's Land Development Division.

The Developer shall submit the Preliminary Plan to the DPZ concurrently with the general design plan.

Upon approval of the Preliminary Plan and receipt of comments on the general design plan, the Developer may complete final design and specification preparation. Original plans shall be submitted to the DPZ's Development Engineering Division for signature.

After final signature of the original construction plans by the Health Department and the DPW, the Developer shall submit complete plans and specification to MDE for approval. This requirement is only for shared septic systems greater than 5,000 gallons per day.

Any application for an MDE Construction Permit, if required, shall be prepared by the Developer and submitted through the DPZ's Development Engineering Division. The Developer shall be required to enter into a Developer's Agreement with the DPW under which the shared facility will be constructed. A Record plat shall be prepared and submitted to the DPZ for signature and recordation.

I. Construction Inspection and Post Construction Surety

The DPW will require full-time on-site inspection of the collection and disposal system by a qualified inspection firm. The selection of the Inspection firm shall be subject to approval by the Health Department and the DPW.

The DPW will require a maintenance surety for the construction/operation of the shared system commencing from the time of 90% occupancy for a period of one (1) year.

An individual Health Department Septic System installation permit will be required for each house. Inspections will be performed at the disposal field as well as individual home septic tanks.

8.2 Public Low Pressure Sewer Systems

A. General

The purpose of this section is to provide a policy and design guidelines for Public Low Pressure Sewer Systems (LPSS). The use of a public LPSS is subject to the review and approval of the DPW. All uses of public LPSSs are reviewed on a case-by-case basis and shall be considered as a system of last resort.

A public (County owned and maintained) LPSS is defined as a LPSS serving more than one property or lot with the LPSS conveyance pipeline located within a County owned right-of-way or easement. All pumps pumping into the public LPSS pipeline shall be privately owned and located on private property. Pump units shall not be placed within public utility easements.

B. Policy

This policy is for the use of public LPSSs that convey wastewater from privately owned and operated on-site pumping units.

1. The use of public LPSSs will only be permitted with the approval of the DPW.
2. Public LPSSs will only be permitted in minor subdivisions of 4 lots or less when gravity sewer service is unobtainable under the following conditions:
 - a. LPSSs may be permitted in areas where there is no existing gravity sewer available (the topography of the area to be served is lower than the existing gravity sewer system), and where there is no additional upstream sewer service area to be served, and where no permanent public pumping facilities are planned.

or

 - b. LPSSs may be permitted when easements for gravity sewer service are unobtainable and where there is no additional upstream sewer service area to be served. In this instance, written documentation shall be provided through an attorney licensed to practice law in the State of Maryland that a fair and reasonable effort has been made to acquire the necessary easements and that negotiated settlements for the required easements are unobtainable.
3. An engineering study showing the existing drainage area, the surrounding sewer system and all wastewater options available to the property to be served shall be prepared and submitted to the DPW for review and consideration.
4. If the use of a public LPSS is approved, the cost of Developer constructed LPSSs will not be refunded under a major facility agreement or rebated under a developer agreement.
5. Temporary Use: LPSSs are not to be used on an interim basis in anticipation of conventional facilities being installed in the future.
6. Ownership and Maintenance: The DPW will be responsible for the operation and maintenance of the LPSS pipeline located within a County owned right-of-way or easement. All ownership and maintenance responsibilities for LPSS piping and pumps located on private property shall be the responsibility of the property owner. The property owner is not required to but is encouraged to obtain a maintenance contract with the pump supplier. The property owner is responsible

for all electrical costs associated with the operation of a LPSS. If the existing electrical service does not meet the power requirements for the pump, it shall be the property owner's responsibility to arrange and pay for any required electrical upgrades.

7. Inspection: Inspection of pump units and piping on private property are the responsibility of the Department of Inspection, Licenses and Permits (DILP).

C. Design Requirements

Design of all LPSS shall be performed in accordance with the applicable sections of this design manual, the details in the Standard Specifications, the pump manufacturer's recommendations and design guidelines, as well as other local, state, and federal regulations. Although the County will not own and maintain the physical pumping units in the LPSS, it is in the best interest of the homeowner that the following guidelines be followed so maintenance to the homeowner can be minimized. Sound engineering and hydraulic principles shall be used for all design and analysis of a LPSS.

1. Pump Types: All pumps connected to a public LPSS shall be semi-positive displacement grinder pumps. The designer shall determine the type and model of pump suitable for the system and shall state on the plans the manufacturer of the pumps for which the LPSS was designed.
2. Discharge Location
 - a. All public low pressure sewers shall discharge into a gravity manhole.
 - b. In no case shall a low pressure sewer be allowed to discharge directly into a conventional force main.
3. LPSS System Design:

The Designer is responsible for preparing and submitting a hydraulic analysis to the DPW for review and approval. This hydraulic analysis shall include a hydraulic profile with all assumptions made in its development including the number of simultaneous pumps operating; pump operating points along the curve; the design flow utilized for hydraulic computations and any applicable computer printouts.

The following are design guidelines that shall be considered for any LPSS design:

- a. All semi-positive displacement systems shall be designed in accordance with the manufacturer's recommendations. A typical positive displacement design methodology is described in detail in the E-OneTM "Design Handbook for Pressure Sewer Systems."

- b. The minimum flow velocity for a LPSS shall be greater than 3 ft/s for systems serving greater than two lots. For systems serving 2 lots or less, a minimum 2 ft/s velocity requirement shall be required.
- c. A Hazen Williams C-Factor of 140 shall be used for calculating all head-losses through the piping. All minor system losses shall be considered in calculating the total dynamic head of the system. Pumps located at the remotest part of the system, farthest from the point of discharge to the gravity system and pumps located at the lowest elevations of the system must be considered in pump selection for simultaneous operation.
- d. Operating Head: The LPSS pumps shall not operate at greater than 90% of the pumps shutoff head.
- e. The minimum size for pressure sewer piping shall be 1-¼ inches. The maximum size shall be 2-inches. All piping shall be SDR-21 PVC in accordance with the Standard Specifications.
- f. In-line flushing connections shall be installed for a public LPSS at four hundred-foot intervals along the pipeline. Terminal flushing connections shall be installed within the right-of-way at the terminal end of any LPSS. See the Standard Specifications for details of construction.
- g. A grinder pump service valve shall be installed at the right-of-way line for all grinder pump connections into a public LPSS. See the Standard Specifications for details of construction.
- h. The grinder pump tank shall not exceed 10 feet of bury and shall be installed within 20 feet of the right-of-way line.
- i. The LPSS shall be sized to handle both initial and full development stages for the development. The LPSS should not be designed for any future extensions beyond the 4-lot limit established for a minor subdivision.

8.3 Private Low Pressure Sewer Systems

A. General

The purpose of this section is to provide a policy and design guidelines for Private Low Pressure Sewer Systems (LPSS). The use of a private LPSS is subject to the review and approval of the DPW. All uses of private LPSSs are reviewed on a case-by-case basis and shall be considered as a system of last resort.

A private LPSS is defined as a LPSS providing sewer service to one lot, conveying wastewater into the County's gravity sewer system. The pump and pressure sewer are privately owned and maintained and are located entirely on the property being served by the private LPSS.

B. Policy

1. This policy is for the use of private LPSSs.
2. The use of private LPSSs will only be permitted with the approval of the DPW.
3. Private LPSSs may be permitted in areas where there is no existing gravity sewer available (the topography of the property or lot to be served is lower than the existing gravity sewer system).
4. The cost of design and installation of a private LPSS is the responsibility of the property owner.
5. Temporary Use: Private LPSSs are not to be used on an interim basis in anticipation of conventional facilities being installed in the future.
6. Ownership and Maintenance: All ownership and maintenance responsibilities for LPSS piping and pumps located on private property shall be the responsibility of the property owner. The property owner is not required to but is encouraged to obtain a maintenance contract with the pump supplier. The property owner is responsible for all electrical costs associated with the operation of a LPSS. If the existing electrical service does not meet the power requirements for the pump, it shall be the property owner's responsibility to arrange and pay for any required electrical upgrades.
7. Inspection: Inspection of pump units and piping on private property are the responsibility of the Department of Inspection, Licenses and Permits (DILP).

C. Design Requirements

Design of all private LPSSs shall be performed in accordance with the applicable sections of the pump manufacturer's recommendations and design guidelines, as well as other local, state and federal regulations. Sound engineering and hydraulic principles shall be used for all design and analysis of a LPSS.

1. Pump Types: Pumps in a private LPSS can be either semi-positive displacement or centrifugal grinder pumps. The Designer shall determine the type and model of pump suitable for the system.
2. Discharge Location
 - a. All private LPSSs must leave the property or lot under gravity flow prior to entering the County's gravity sewer system.
 - b. In no case shall a low pressure sewer be allowed to discharge directly into a conventional force main.

APPENDIX

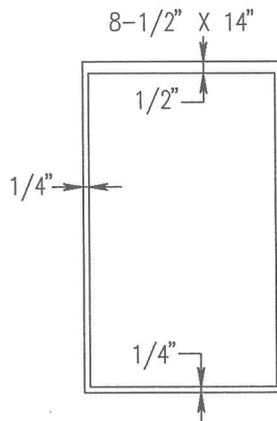
VOLUME II

HOWARD COUNTY DESIGN MANUAL

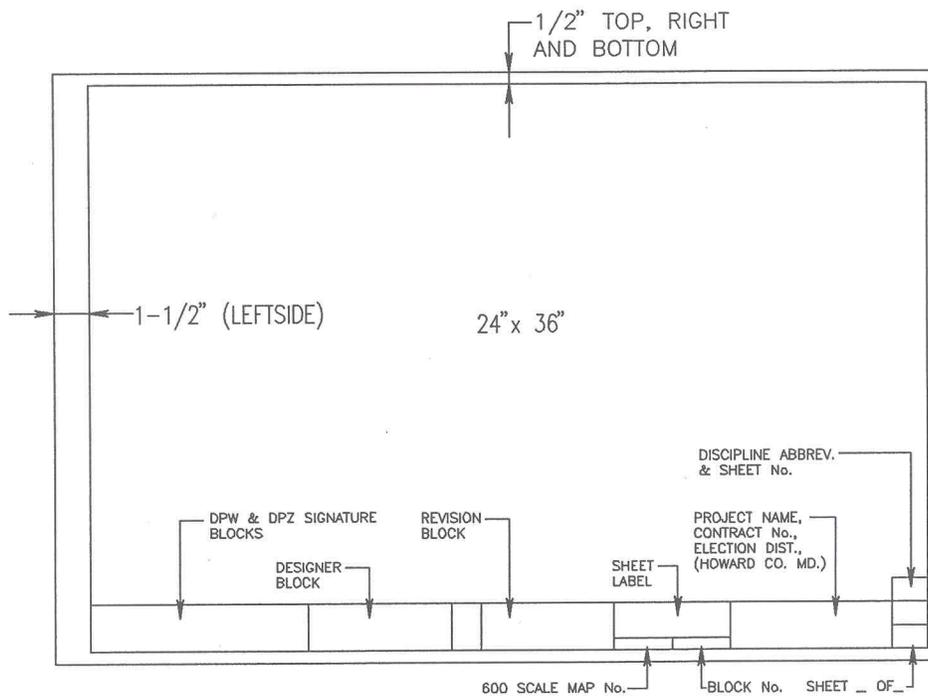
WATER AND SEWER

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FOR RIGHT - OF - WAY
EASEMENT PLATS, ONLY.



24" X 36" STANDARD SHEET SIZE FOR ALL DRAWINGS

NOTES:

ALL DESIGN DRAWINGS FOR WATER AND SEWER COVERED IN THESE STANDARDS SHALL BE ORIGINAL DRAWINGS SUBMITTED ON POLYESTER DRAFTING FILM (MINIMUM THICKNESS 0.004 INCHES) OF THE SIZES INDICATED ABOVE. THE DIMENSIONS SHOWN ARE THE OVERALL DIMENSIONS OF THE DRAWINGS. MATERIAL NOT FURNISHED BY DEPARTMENT OF PUBLIC WORKS. TITLE BLOCK SHALL BE SHOWN IN AREA AS OUTLINED ABOVE.

HOWARD COUNTY, MARYLAND
DEPARTMENT OF PUBLIC WORKS

STANDARD REFERENCE
PLAN

APPENDIX A

MAY 2003

Howard County Residential Water Demand Projection

Zoning	RC, RR	R-20	R-12	R-SC	R-MH,R-SA	RA-1	SF LD	SF MD	TH	Apt	Comm'l	Instit'l	Indust'l	Total
Average Flow / Acre (gpd)	68-148	503	859	1184	1955	2679	592	1184	2444	2679	(show design basis ¹)			
ARD Average Flow/Acre (gpd)	296	1481	1777	1955	2933	4465								

Design Point 1															
Projected Population per Acre															persons
Projected Dwelling Units per Acre															units
Projected Ave Flow per Acre @ 94 gpd															mgd
Maximum Day Peaking Factor ²															
Maximum Day Demand															gpd
Maximum Hour Peaking Factor ²															
Peak Hour Demand															mgd

Design Point 2															
Projected Population per Acre															persons
Projected Dwelling Units per Acre															units
Projected Ave Flow per Acre @ 94 gpd															mgd
Maximum Day Peaking Factor ²															
Maximum Day Demand															gpd
Maximum Hour Peaking Factor ²															
Peak Hour Demand															mgd

¹ See Table 3.2A: Average Day Water Demands

² See Table 3.2B: Maximum day and Peak Hour Peaking Factors

Howard County Sanitary Sewer Flow Tabulation

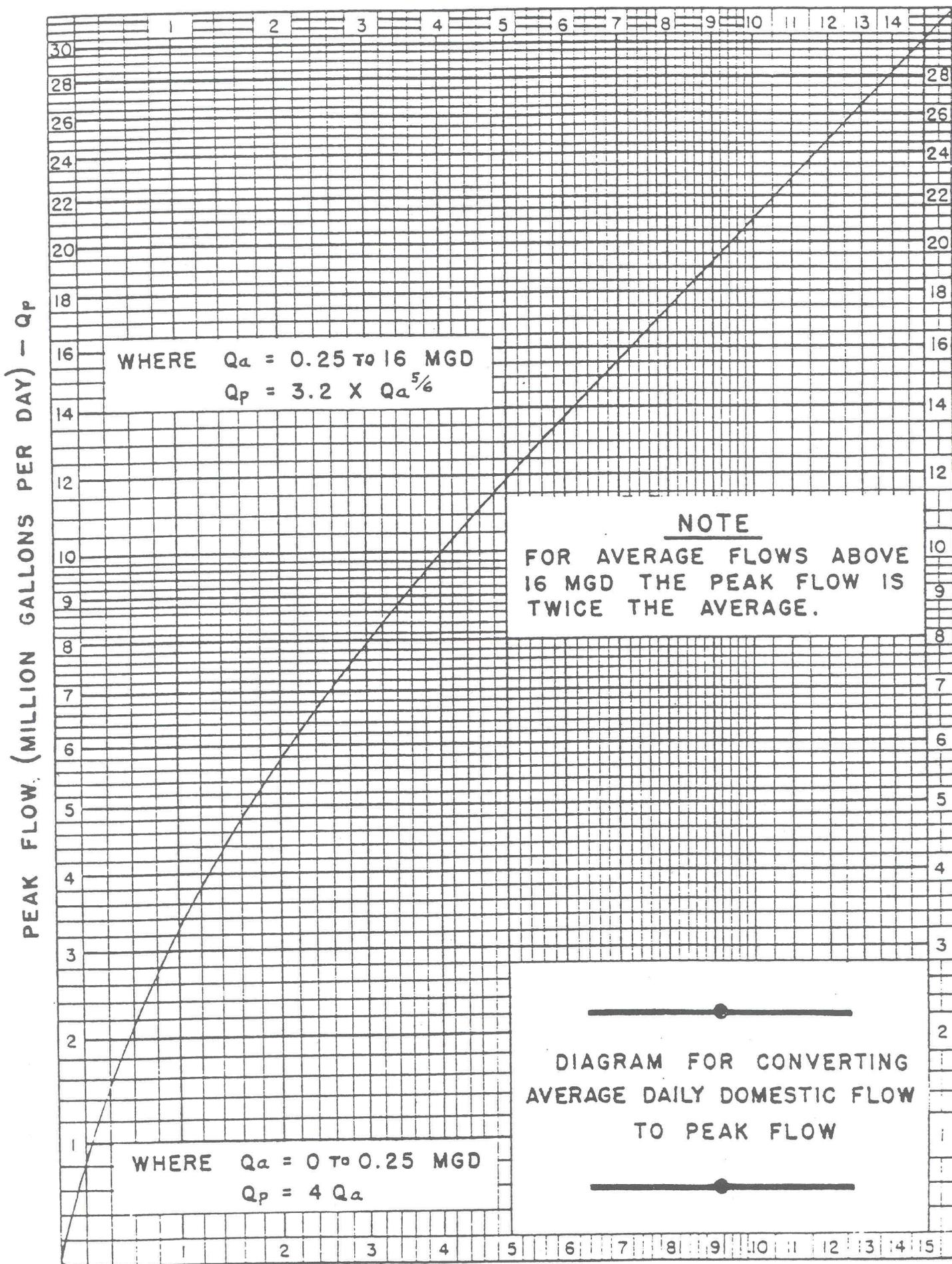
Zoning	RC, RR	R-20	R-12	R-SC	R-MH,R-SA	RA-1	SF LD	SF MD	TH	Apt	Comm'l	Instit'l	Indust'l	Total
Avg Flow / Acre (gpd)	52-113	386	658	749	1094	2052	454	907	1872	2052	(show design basis)			
ARD Avg Flow/Acre	227	936	123	1094	1642	2160								

Design Point 1														
Area														acres
Average Flow														mgd
Peak Flow Factor ¹														mgd
Peak Average Flow														mgd
Infiltration ²														mgd
Population														persons
Total Design Flow														mgd

Design Point 2														
Area														acres
Average Flow														mgd
Peak Flow Factor ¹														mgd
Peak Average Flow														mgd
Infiltration ²														mgd
Population														persons
Total Design Flow														mgd

¹From MD DH & MH Curves, Appendix D.01 and D.02

²See Table 4.2A: Average Day flows for Wastewater system



AVERAGE DAILY DOMESTIC FLOW (MILLION GALLONS PER DAY) - Q_a

**COMMERCIAL / INDUSTRIAL / INSTITUTIONAL
WASTEWATER FLOW PROJECTIONS**

**TABLE 1: FLOW PROJECTION BASED UPON
GALLONS PER PERSON PER DAY**

Type of Establishment	Gallons Per Person Per Day (Unless Otherwise Noted)
Airports (Per Passenger).....	5
Apartments-Multiple Family (Per Resident).....	60
Bathhouses and Swimming Pool.....	10
Camps:	
Campground with Central Comfort Stations.....	35
With Flush Toilets, No Showers.....	25
Day Camps (Night And Day) with Limited Plumbing.....	50
Luxury Camps.....	100
Cottages and Small Dwellings with Seasonal Occupancy.....	50
Country Clubs (Per Resident Member).....	100
Country Clubs (Per Non-Resident Member Present).....	25
Dwellings:	
Boarding Houses.....	50
Additional For Non-Resident Boarders.....	10
Luxury Residences and Estates.....	150
Multiple Family Dwellings (Apartments).....	60
Rooming Houses.....	40
Single Family Dwellings.....	75-100
Factories (Gallons Per Person, Per Shift, Exclusive of Industrial Wastes).....	35
Hospitals (Per Bed Space).....	350
Hotels with Private Baths (2 Persons Per Room).....	60
Hotels Without Private Baths.....	50
Institutions Other Than Hospitals (Per Bed Space).....	125
Laundries, Self-Service (Gallons Per Wash, i.e., Per Customer).....	50
Mobile Home Parks (Per Space).....	250
Motels With Bath, Toilet and Kitchen Wastes (Per Bed Space).....	50
Motels (Per Bed Space).....	40
Picnic Parks (Toilet Wastes Only) (Per Picnicker).....	5
Picnic Parks with Bathhouses, Showers and Flush Toilets.....	10
Restaurants (Per Seat).....	25
Restaurants (Toilet and Kitchen Wastes Per Patron).....	10
Restaurants (Kitchen Wastes Per Meal Served).....	3
Restaurants, Additional for Bars and Cocktail Lounges.....	2

May 2003

<u>Type of Establishment</u>	<u>Gallons Per Person Per Day (Unless Otherwise Noted)</u>
Schools:	
Boarding.....	100
Day, Without Gyms, Cafeterias or Showers.....	15
Day, with Gyms, Cafeterias or Showers.....	25
Day, with Cafeteria, but Without Gyms or Showers.....	20
Service Stations (Per Vehicle Served).....	10
Swimming Pools and Bathhouses.....	10
Theaters:	
Movie (Per Auditorium Seat).....	1
Drive-in (Per Car Space).....	5
Travel Trailer Parks Without Individual Water and Sewer Hook-ups (Per Space).....	50
Travel Trailer Parks with Individual Water and Sewer Hook-ups (Per Space).....	100
Workers:	
Construction (at Semi-permanent Camps).....	50
Day, at Schools and Offices (Per Shift).....	15

An alternative method used to project average daily flows generated from commercial establishments, public service buildings or dwelling units can be figured on the basis of total floor area, number of building units or service seats multiplied by a statistical factor. Guiding factors are given in Table II.

TABLE II
GUIDING FACTORS FOR FLOW PROJECTION RELATED
WITH COMMERCIAL ESTABLISHMENTS,
PUBLIC SERVICE BUILDINGS OR DWELLING UNITS

Office Buildings.....	Gross Sq. Ft. x 0.09 = _____ gpd
Medical Office Buildings.....	Gross Sq. Ft. x 0.62 = _____ gpd
Warehouses.....	Gross Sq. Ft. x 0.03 = _____ gpd
Retail Stores.....	Gross Sq. Ft. x 0.05 = _____ gpd
Supermarkets.....	Gross Sq. Ft. x 0.20 = _____ gpd
Drug Stores.....	Gross Sq. Ft. x 0.13 = _____ gpd
Beauty Salons.....	Gross Sq. Ft. x 0.35 = _____ gpd
Barber Shops.....	Gross Sq. Ft. x 0.20 = _____ gpd
Department Store with Lunch Counter.....	Gross Sq. Ft. x 0.08 = _____ gpd
Department Store without Lunch Counter.....	Gross Sq. Ft. x 0.04 = _____ gpd
Banks.....	Gross Sq. Ft. x 0.04 = _____ gpd
Service Stations.....	Gross Sq. Ft. x 0.18 = _____ gpd
Laundries & Cleaners.....	Gross Sq. Ft. x 0.31 = _____ gpd
Laundromats.....	Gross Sq. Ft. x 3.68 = _____ gpd
Car Wash Without Wastewater	
Recirculation Equipment.....	Gross Sq. Ft. x 4.90 = _____ gpd
Hotels.....	Gross Sq. Ft. x 0.25 = _____ gpd
Motels.....	Gross Sq. Ft. x 0.23 = _____ gpd
Dry Goods Stores.....	Gross Sq. Ft. x 0.05 = _____ gpd
Shopping Centers.....	Gross Sq. Ft. x 0.18 = _____ gpd

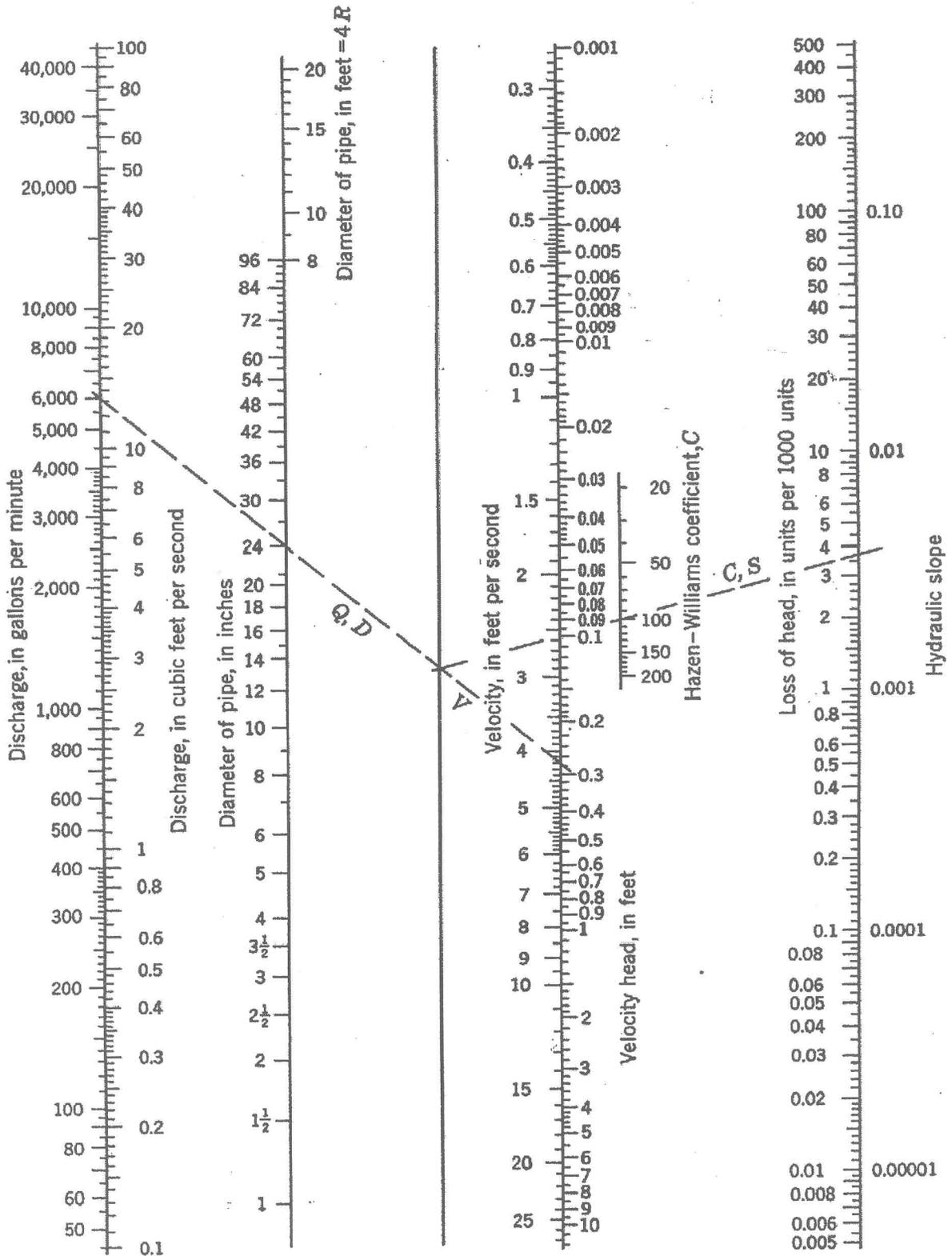
Flow Projection for country clubs or public parks may be made on the basis of plumbing fixtures. The related statistical flow figures per unit of plumbing fixture are shown in Table III and Table IV.

TABLE III
FLOW PROJECTION FOR COUNTRY CLUBS

Type of Fixture	Gallons Per Day Per Fixture
Showers.....	500
Baths.....	300
Lavatories.....	100
Toilets.....	150
Urinals.....	100
Sinks.....	50

TABLE IV
FLOW PROJECTION FOR PUBLIC PARKS
(During Hours When Park Is Open)

Type of Fixture	Gallons Per Day Per Fixture
Flush Toilet.....	35
Urinals.....	10
Showers.....	100
Faucets.....	15

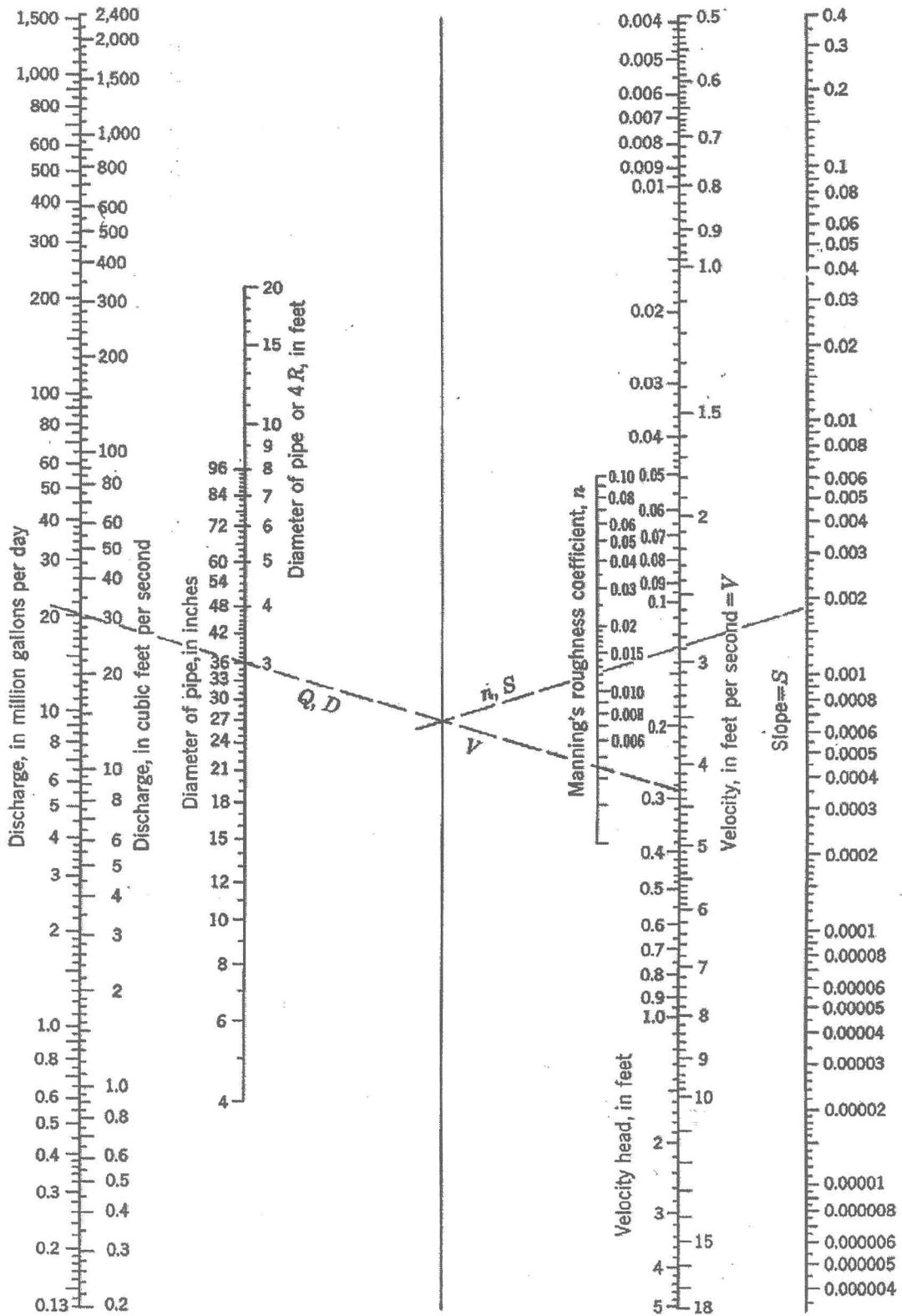


HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

HAZEN WILLIAMS NOMOGRAPH FOR
PIPE FLOW

MAY 2003

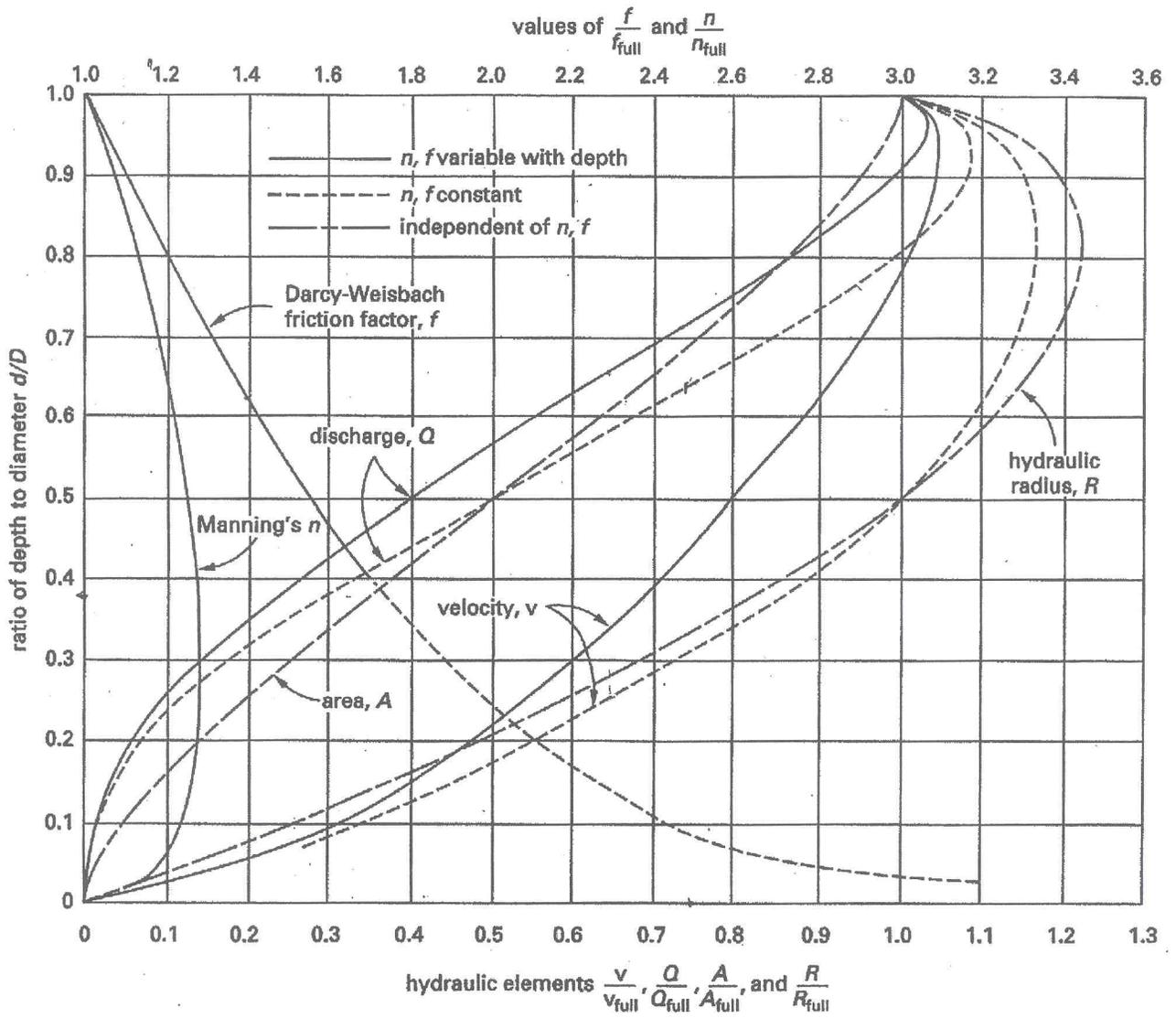
APPENDIX F



HOWARD COUNTY
 DEPARTMENT OF PUBLIC WORKS

MANNING FORMULA NOMOGRAPH
 FOR PIPE FLOW

MAY 2003 APPENDIX G



HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

HYDRAULIC ELEMENTS
FOR CIRCULAR CHARTS

MAY 2003

APPENDIX H

DEPARTMENT OF PUBLIC WORKS OF HOWARD COUNTY
3430 Court House Drive
Ellicott City, Maryland 21043

POLICY ON PUBLIC AND PRIVATE
WATER AND SEWER SYSTEMS

The Department of Public Works reviews its existing policies and procedures for providing water and sewer service to all lots and buildings. As a result of this review, the following policies have been established:

I. SINGLE FAMILY RESIDENTIAL

- A. All lots shall front on and shall be directly connected to the public water and sewer system.

II. MULTI-FAMILY RESIDENTIAL

- A. All lots shall front on and shall be connected to the public water and sewer system.

- B. Single family detached or semi-detached dwelling units on bulk parcels (commonly called townhouses):

1. All fire hydrants and the water main leading there to shall be public. Other water mains on site will be private.
2. Each dwelling unit shall be connected independently to the outside water main.
3. All sewer systems shall be private, except for those sewer mains serving other parcels, but each dwelling unit shall be connected directly to the outside independent sewer system.
4. No water or sewer system, public or private, shall run under one dwelling unit to serve another dwelling unit.

- C. Garden apartments and high rise apartment buildings:

1. All fire hydrants and the water main leading thereto shall be public. Other water mains on site will be private.
2. Each building shall be connected independently to the outside water main.

3. All sewer systems shall be private, except for those sewer mains serving other parcels, but each building shall be connected independently to the outside sewer system.
4. No water or sewer system, public or private, shall run under one building to serve another building.

III. COMMERCIAL AND INDUSTRIAL DEVELOPMENT

- A. All lots shall front on and shall be connected to the public water and sewer system.
- B. Attached or semi-detached commercial units on bulk parcels (commonly called commercial townhouses):
 1. All fire hydrants and the water main leading thereto shall be public. Other water mains on site will be private.
 2. Each unit shall be connected independently to the outside water main.
 3. All sewer systems shall be private, except for those sewer mains serving other parcels, but each unit shall be connected directly and independently to the outside sewer system. Each independent sewer connection to the outside sewer system shall be long enough, and shall be positioned, so as to provide room for future installation of a standard manhole or grease/oil separator which is easily accessible to maintenance vehicles and equipment. Installation of a manhole or grease/oil separator may be required by the Department of Public Works for each unit discharging waste either controlled under Section 18.122A of the Howard County Code, or subject to a high strength surcharge under Section 20.306 of the Howard County Code.
- C. Buildings on bulk parcels:

The requirements are the same as those outlined in Section 11-B.
- D. Buildings which are or will be internally subdivided for lease to more than one tenant, and which are located on parcels zoned for commercial or industrial use:
 1. All fire hydrants and the water main leading thereto shall be public. Other water mains on site will be private.
 2. All sewer systems shall be private, except for those sewer mains serving other parcels which shall be public.

3. Each portion of the building (bay, rental unit, etc.) which can be occupied by a separate tenant shall comply with one of the following requirements:

Each unit may be connected independently and directly to an outside sewer main. Each independent sewer connection to the outside sewer main shall be long enough and shall be positioned so as to provide room for future installation of a standard manhole or grease/oil separator which is easily accessible to maintenance vehicles and equipment. Installation of a manhole or grease/oil separator may be required by the Department of Public Works for each unit discharging waste either controlled under Section 18.122A of the Howard County Code, or subject to a high strength surcharge under Section 20.306 of the Howard County Code.

OR

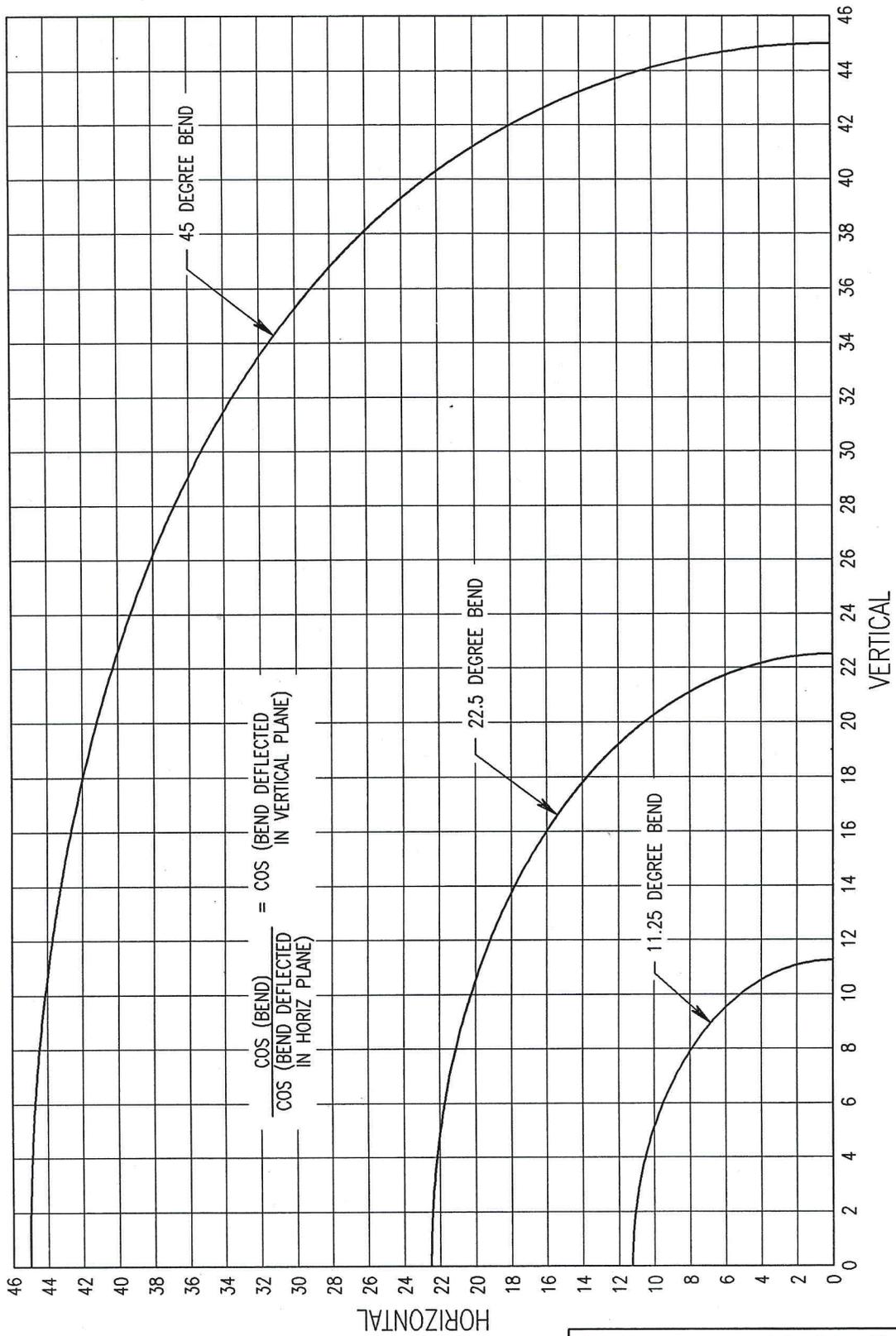
The sewer main serving each building unit may be located under the building floor slab, and shall be positioned so that the sanitary drainage system serving each unit can be extended and connected to an outside standard manhole or grease/oil separator, if required, prior to connection to the underslab sewer main. Installation of a manhole or grease/oil separator may be required by the Department of Public Works for each unit discharging waste either controlled under Section 18.122A of the Howard County Code, or subject to a high strength surcharge under Section 20.306 of the Howard County Code. The standard manhole or grease/oil separator shall be easily accessible to maintenance vehicles and equipment.

OR

4. In cases where the tenant of a building unit is identified prior to construction, and that tenant will discharge waste either controlled under Section 18.122A of the Howard County Code, or subject to a high strength surcharge under Section 20.306 of the Howard County Code, the design of the sewer system serving that tenant shall provide for construction of an outside standard manhole or grease/oil separator if required by the Department of Public Works.

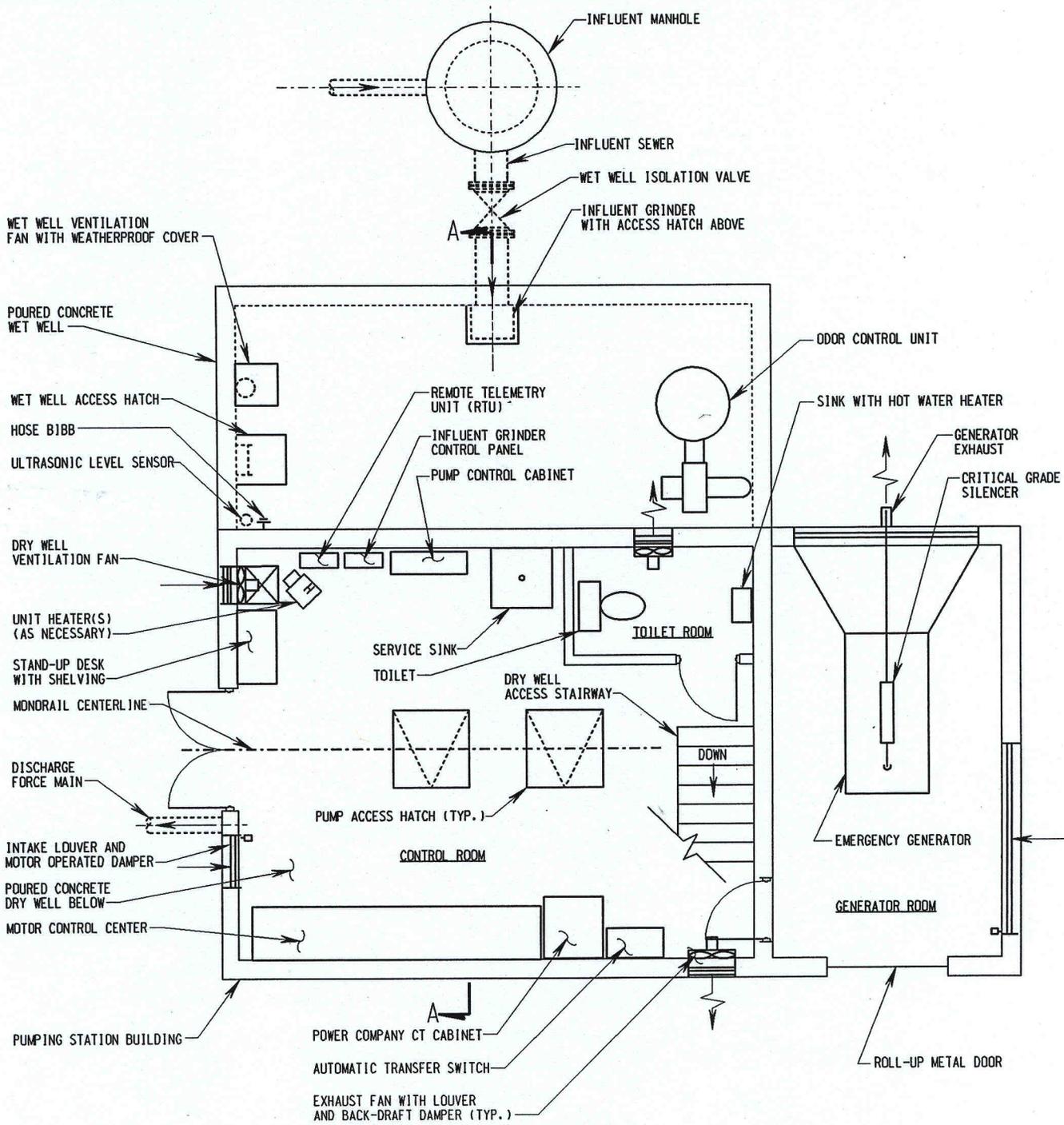
All public water and sewer systems shall be constructed under the terms of a developer agreement between the County and the developer. The plan for private water and sewer system shall be included in the site plan of the development. The design of the public water and sewer systems shall conform with Howard County Standard Specifications and Details of Water Mains and Sanitary Sewers. In the event there is a conflict, the more stringent criteria will govern.

CHANGE IN VERTICAL PLANE CORRESPONDING TO A CHANGE IN HORIZONTAL PLANE



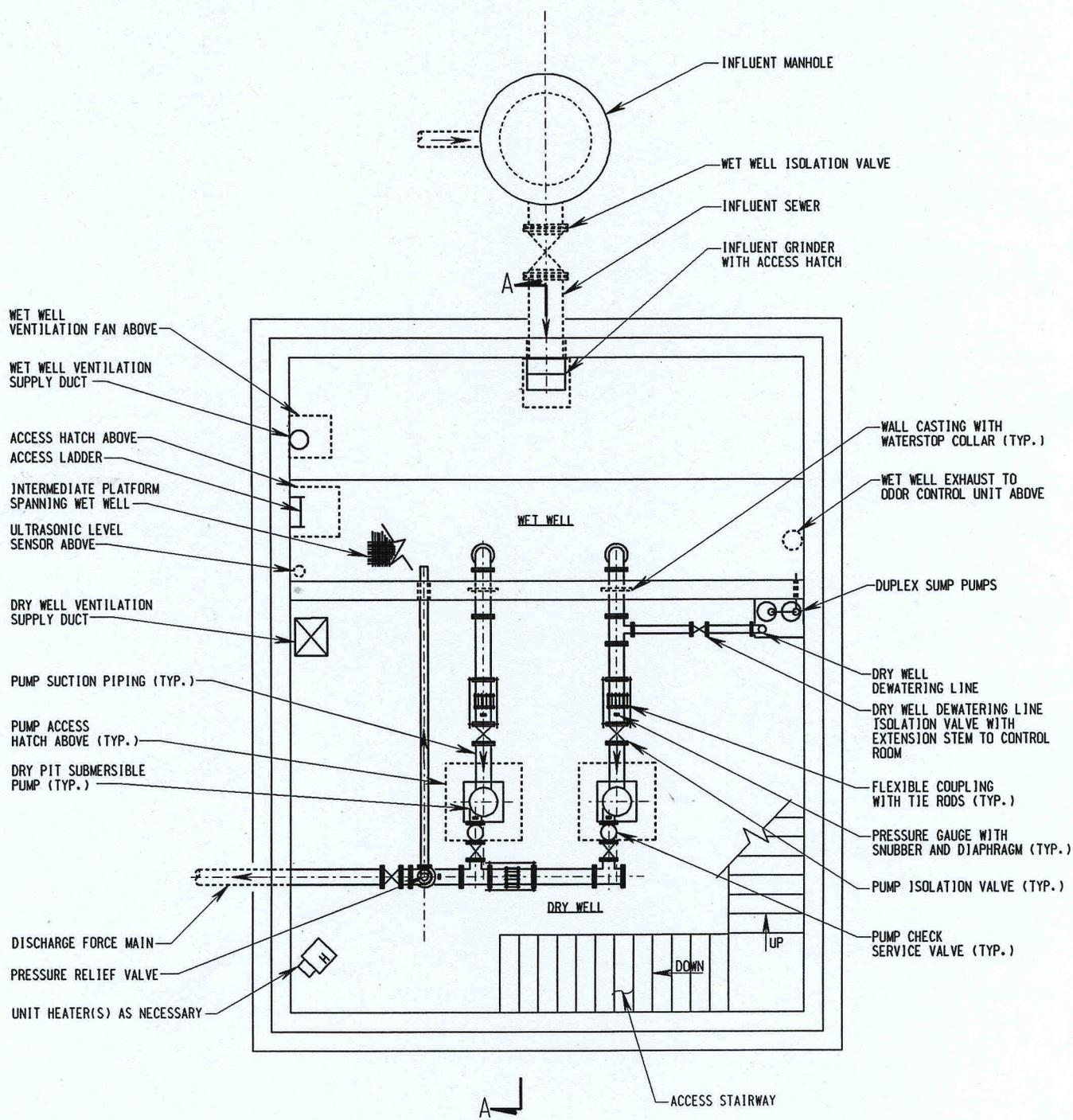
APPENDIX K

**WASTEWATER PUMPING STATION
DESIGN FIGURES**



NOTE: DRAWING NOT TO SCALE. PUMPS NOT SHOWN. PLAN IS ONE OF SEVERAL POSSIBLE LAYOUTS AND IS FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY
 DEPARTMENT OF PUBLIC WORKS
 TYPICAL PLAN FOR CONVENTIONAL
 PUMPING STATION
 MAY 2003 APPENDIX K.1



WET WELL VENTILATION FAN ABOVE
 WET WELL VENTILATION SUPPLY DUCT
 ACCESS HATCH ABOVE
 ACCESS LADDER
 INTERMEDIATE PLATFORM SPANNING WET WELL
 ULTRASONIC LEVEL SENSOR ABOVE

DRY WELL VENTILATION SUPPLY DUCT
 PUMP SUCTION PIPING (TYP.)
 PUMP ACCESS HATCH ABOVE (TYP.)
 DRY PIT SUBMERSIBLE PUMP (TYP.)

DISCHARGE FORCE MAIN
 PRESSURE RELIEF VALVE
 UNIT HEATER(S) AS NECESSARY

INFLUENT MANHOLE
 WET WELL ISOLATION VALVE
 INFLUENT SEWER
 INFLUENT GRINDER WITH ACCESS HATCH

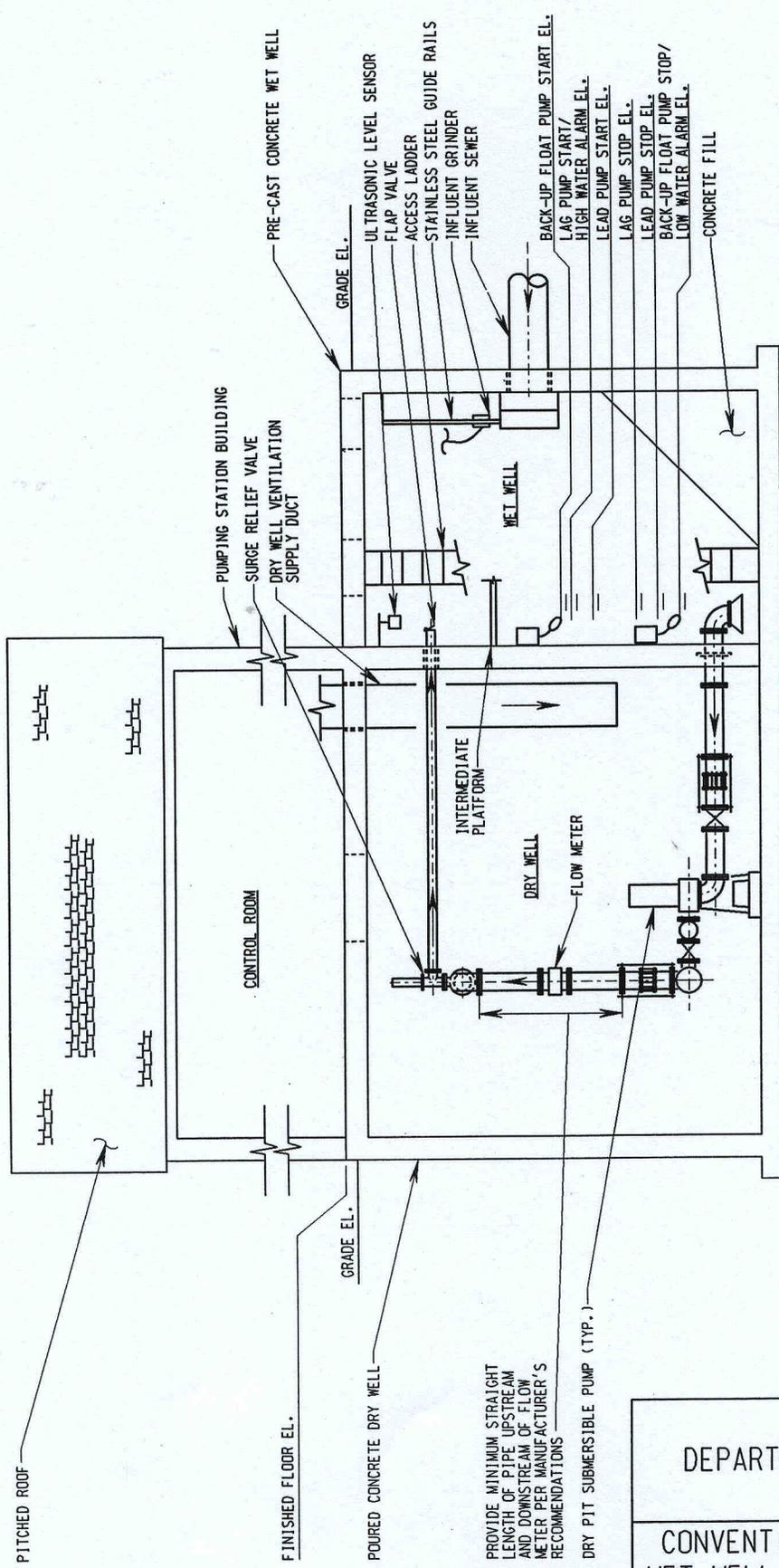
WALL CASTING WITH WATERSTOP COLLAR (TYP.)
 WET WELL EXHAUST TO ODOR CONTROL UNIT ABOVE

DUPLEX SUMP PUMPS
 DRY WELL DEWATERING LINE
 DRY WELL DEWATERING LINE ISOLATION VALVE WITH EXTENSION STEM TO CONTROL ROOM
 FLEXIBLE COUPLING WITH TIE RODS (TYP.)
 PRESSURE GAUGE WITH SNUBBER AND DIAPHRAGM (TYP.)
 PUMP ISOLATION VALVE (TYP.)
 PUMP CHECK SERVICE VALVE (TYP.)

ACCESS STAIRWAY

NOTE: DRAWING NOT TO SCALE.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
CONVENTIONAL PUMPING STATION WET WELL & DRY WELL PLAN	
MAY 2003	APPENDIX K.2

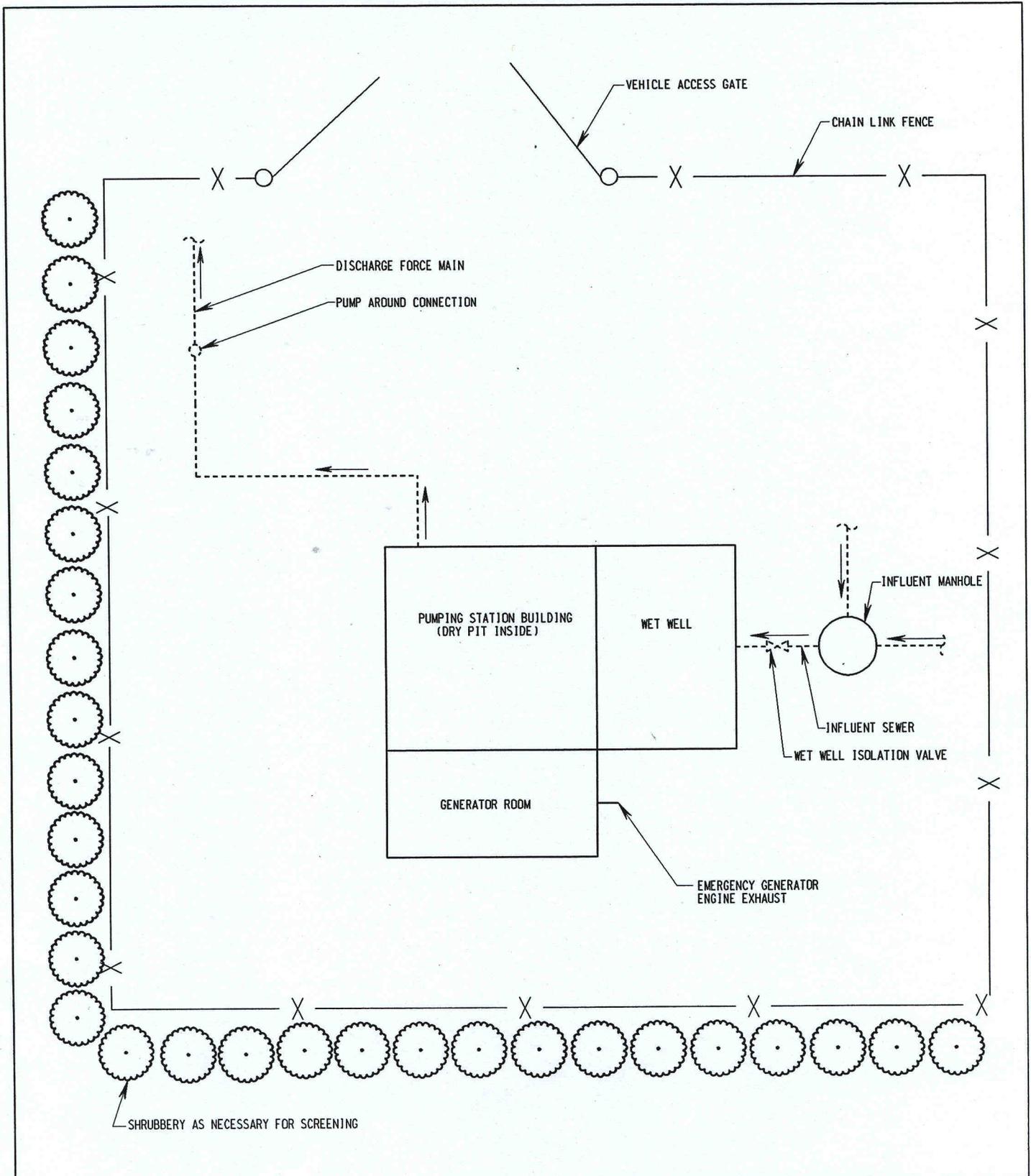


NOTE-DRAWING NOT TO SCALE. CONTROL ROOM EQUIPMENT NOT SHOWN. ODOOR CONTROL UNIT NOT SHOWN. DRY WELL ACCESS STAIRWAY NOT SHOWN.

HOWARD COUNTY
 DEPARTMENT OF PUBLIC WORKS

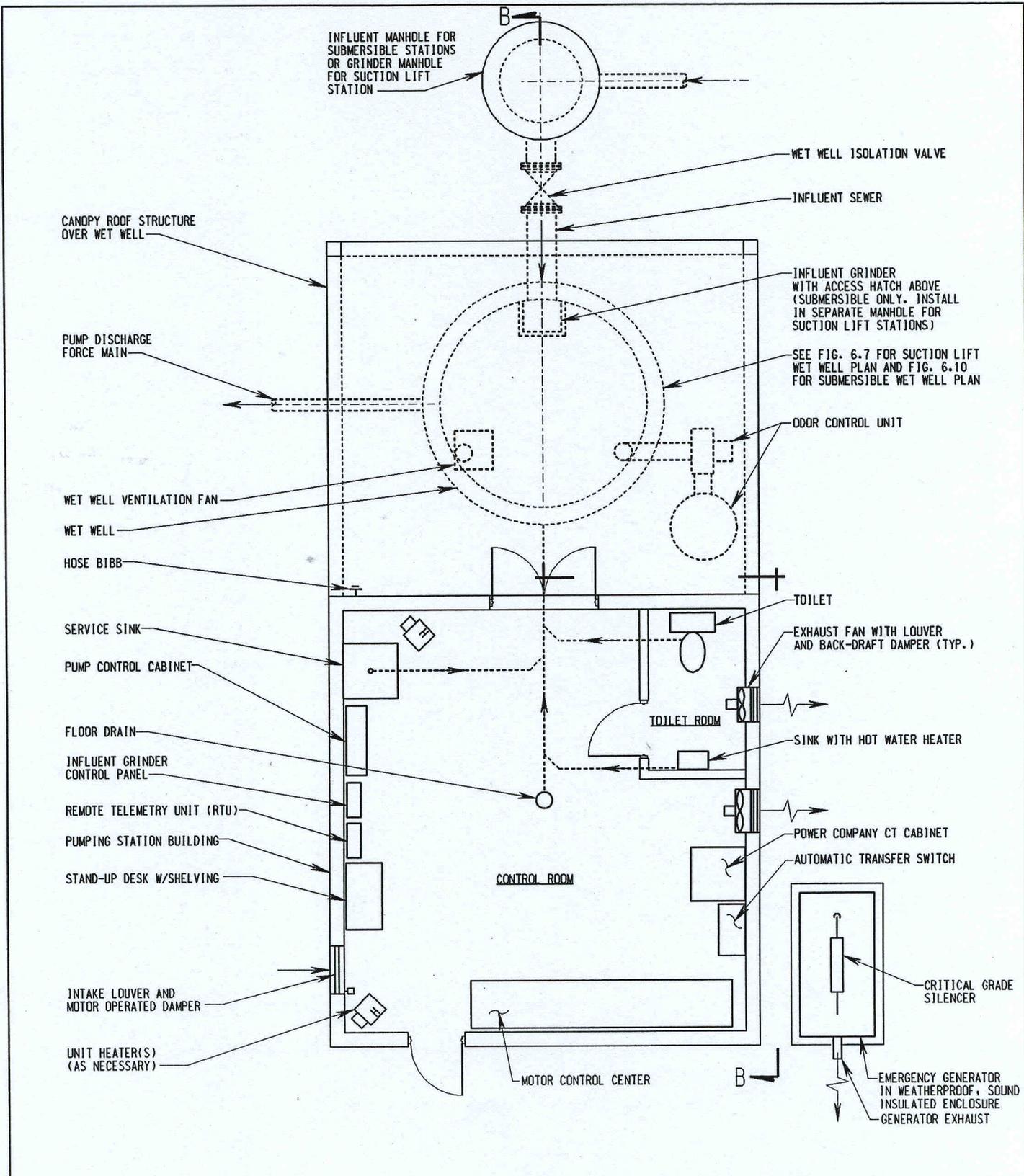
CONVENTIONAL PUMPING STATION
 WET WELL & DRY WELL SECTION A-A

MAY 2003 APPENDIX K.3



NOTE: DRAWING NOT TO SCALE. SITE LAYOUT SHOWN IS ONLY ONE POSSIBILITY AND IS INTENDED FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
CONVENTIONAL PUMPING STATION SITE PLAN	
MAY 2003	APPENDIX K.4

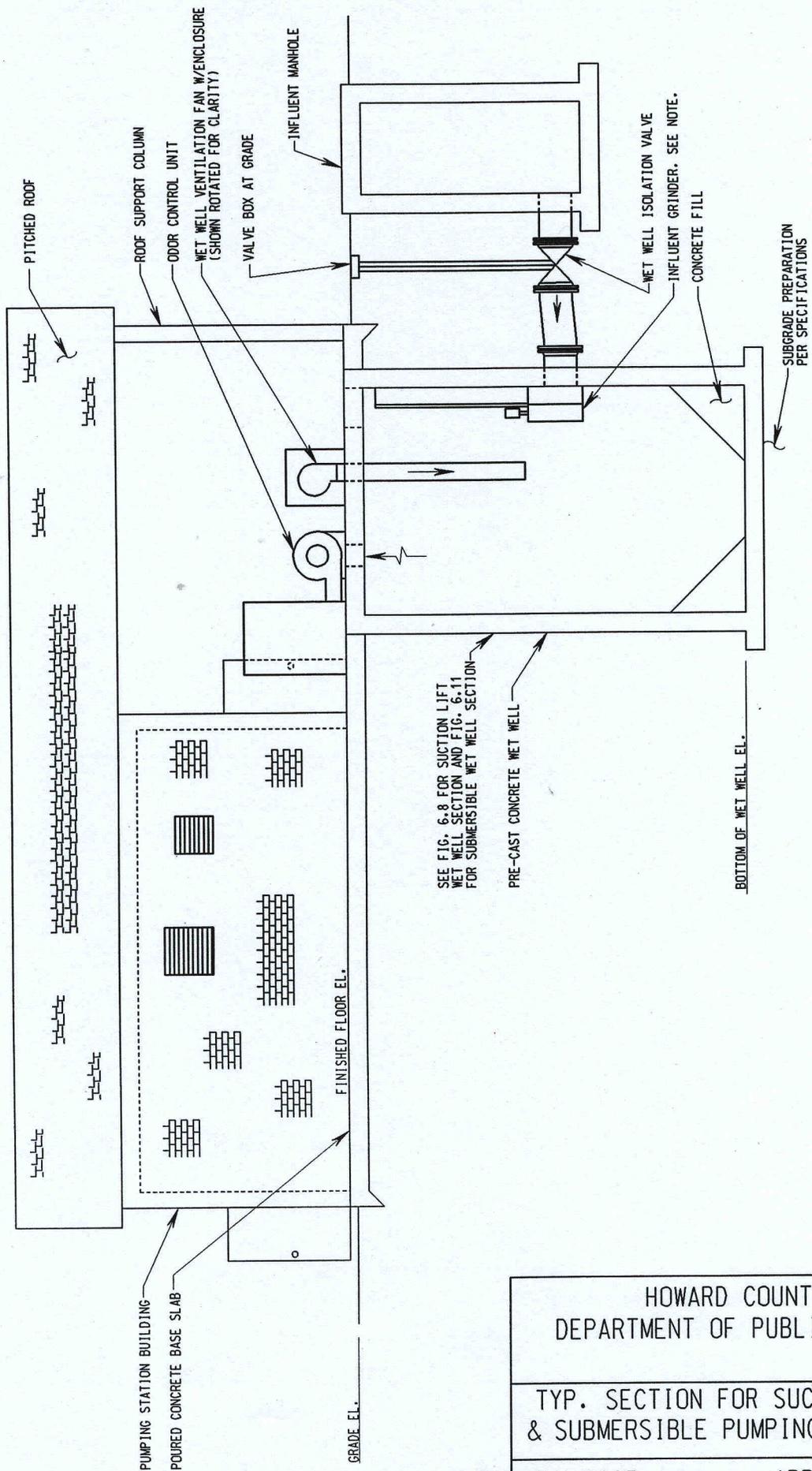


NOTE: DRAWING NOT TO SCALE. PUMPS NOT SHOWN. PLAN IS ONE OF SEVERAL POSSIBLE LAYOUTS AND IS FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

TYPICAL PLAN FOR SUCTION LIFT &
SUBMERSIBLE PUMPING STATIONS

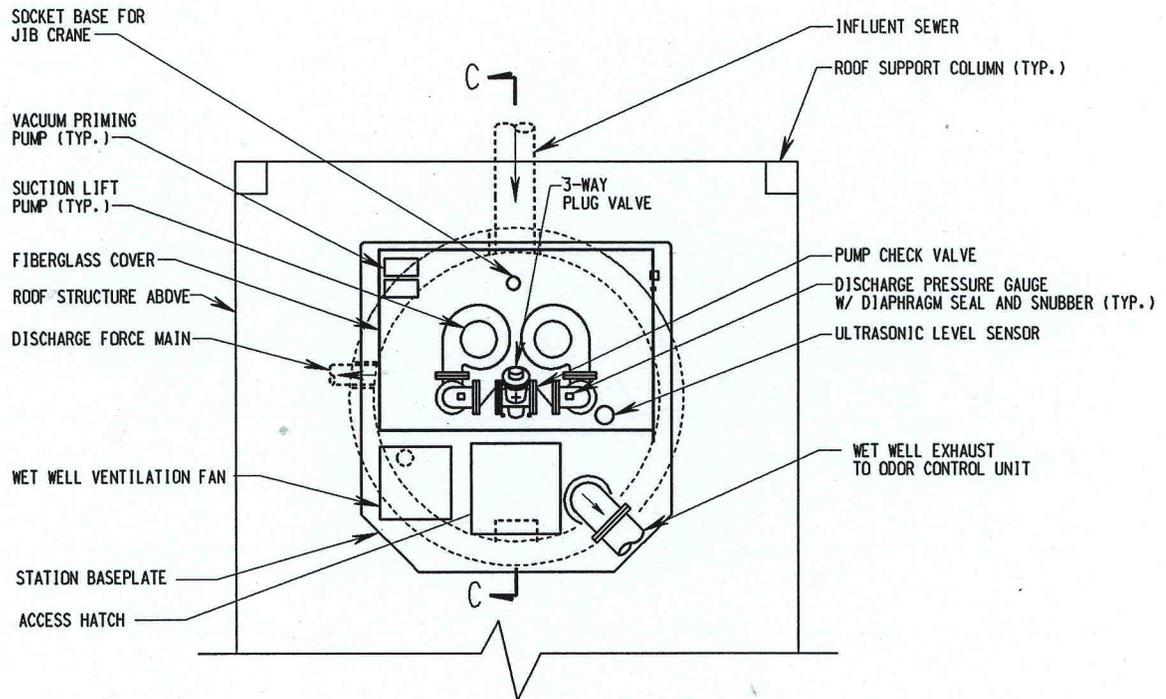
MAY 2003
APPENDIX K.5



SECTION B-B

NOTES: DRAWING NOT TO SCALE. PUMPS NOT SHOWN. SEE FOLLOWING FIGURES FOR WET WELL PLANS AND SECTIONS. INFLUENT WASTEWATER GRINDER IS SHOWN FOR SUBMERSIBLE STATION, INSTALL WASTEWATER GRINDER IN SEPARATE MANHOLE FOR SUCTION LIFT STATIONS.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
TYP. SECTION FOR SUCTION LIFT & SUBMERSIBLE PUMPING STATIONS	
MAY 2003	APPENDIX K.6



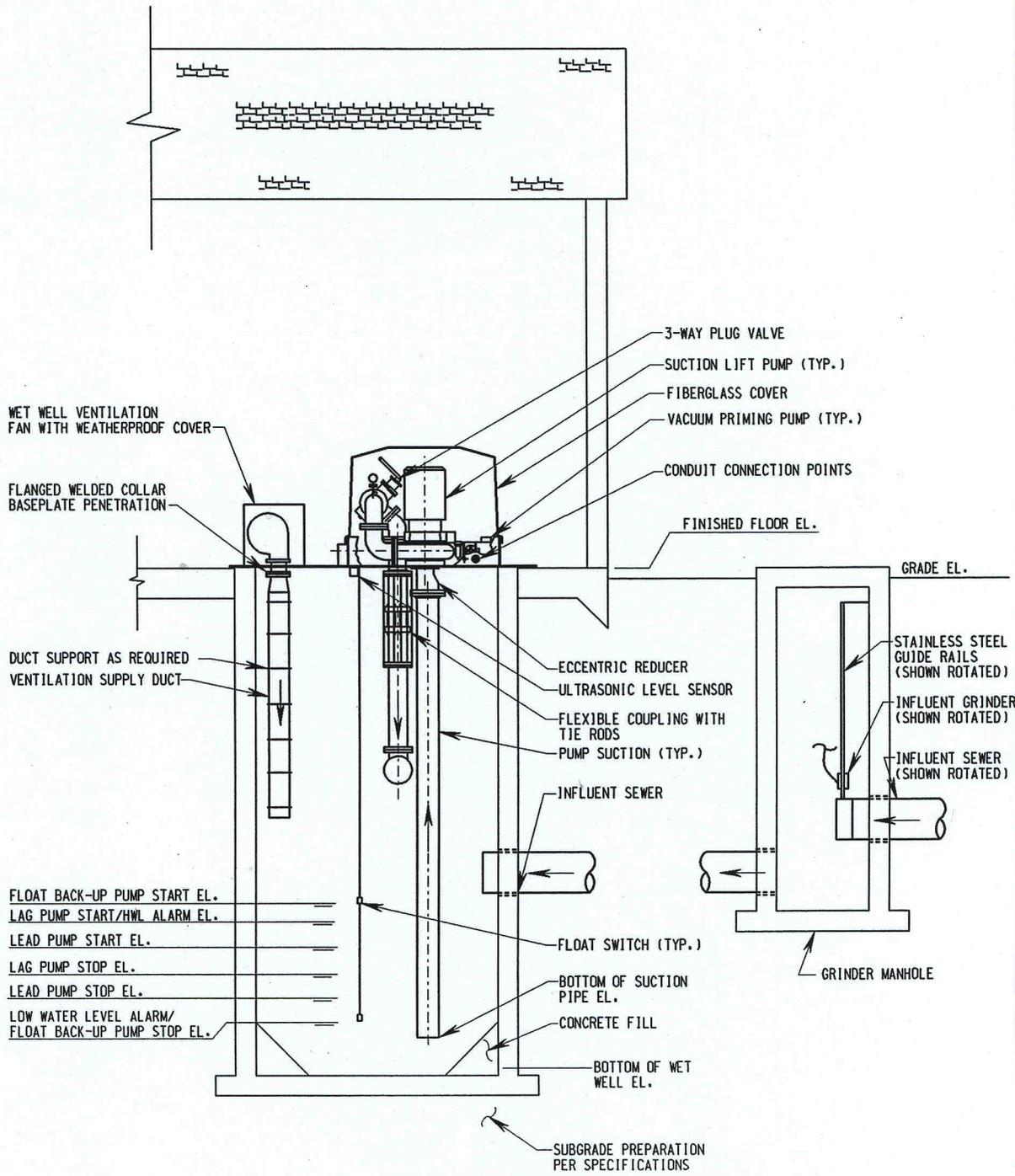
NOTE: DRAWING NOT TO SCALE.

HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

SUCTION LIFT WET WELL PLAN

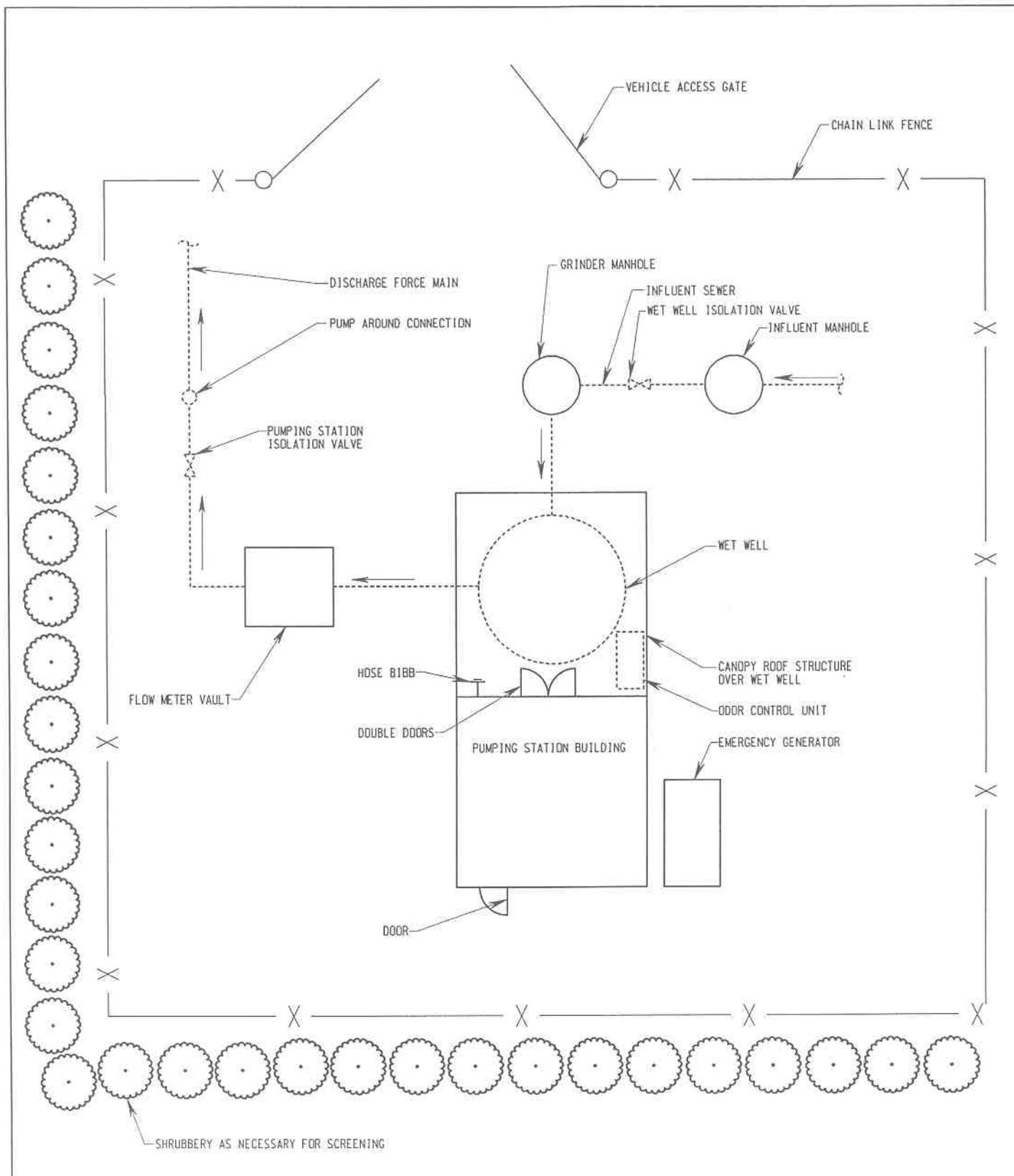
MAY 2003

APPENDIX K.7



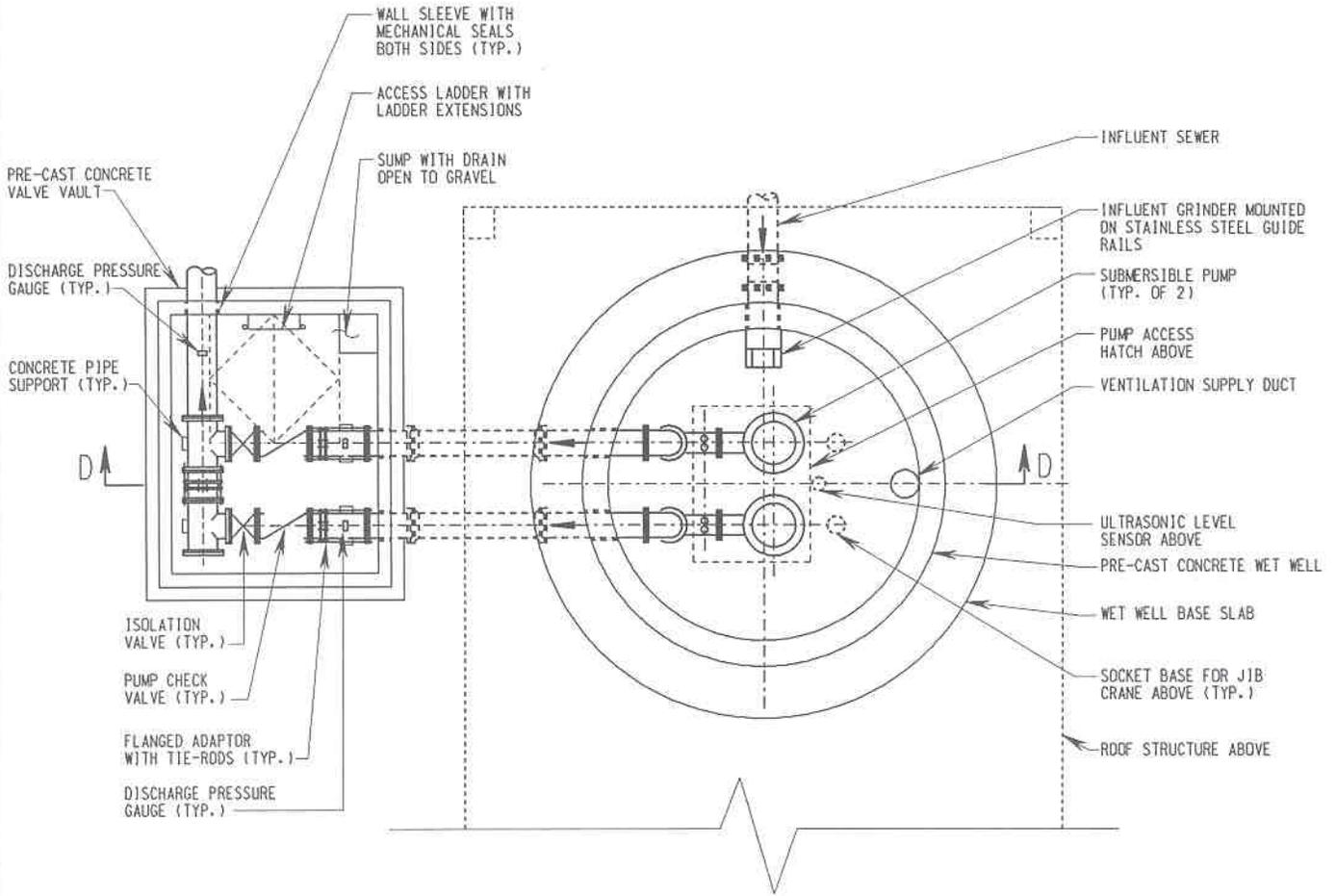
NOTE: DRAWING NOT TO SCALE.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
SUCTION LIFT WET WELL SECTION C-C	
MAY 2003	APPENDIX K.8



NOTE: DRAWING NOT TO SCALE. SITE LAYOUT SHOWN IS ONLY ONE POSSIBILITY AND IS INTENDED FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
SUCTION LIFT PUMPING STATION SITE PLAN	
MAY 2003	APPENDIX K.9



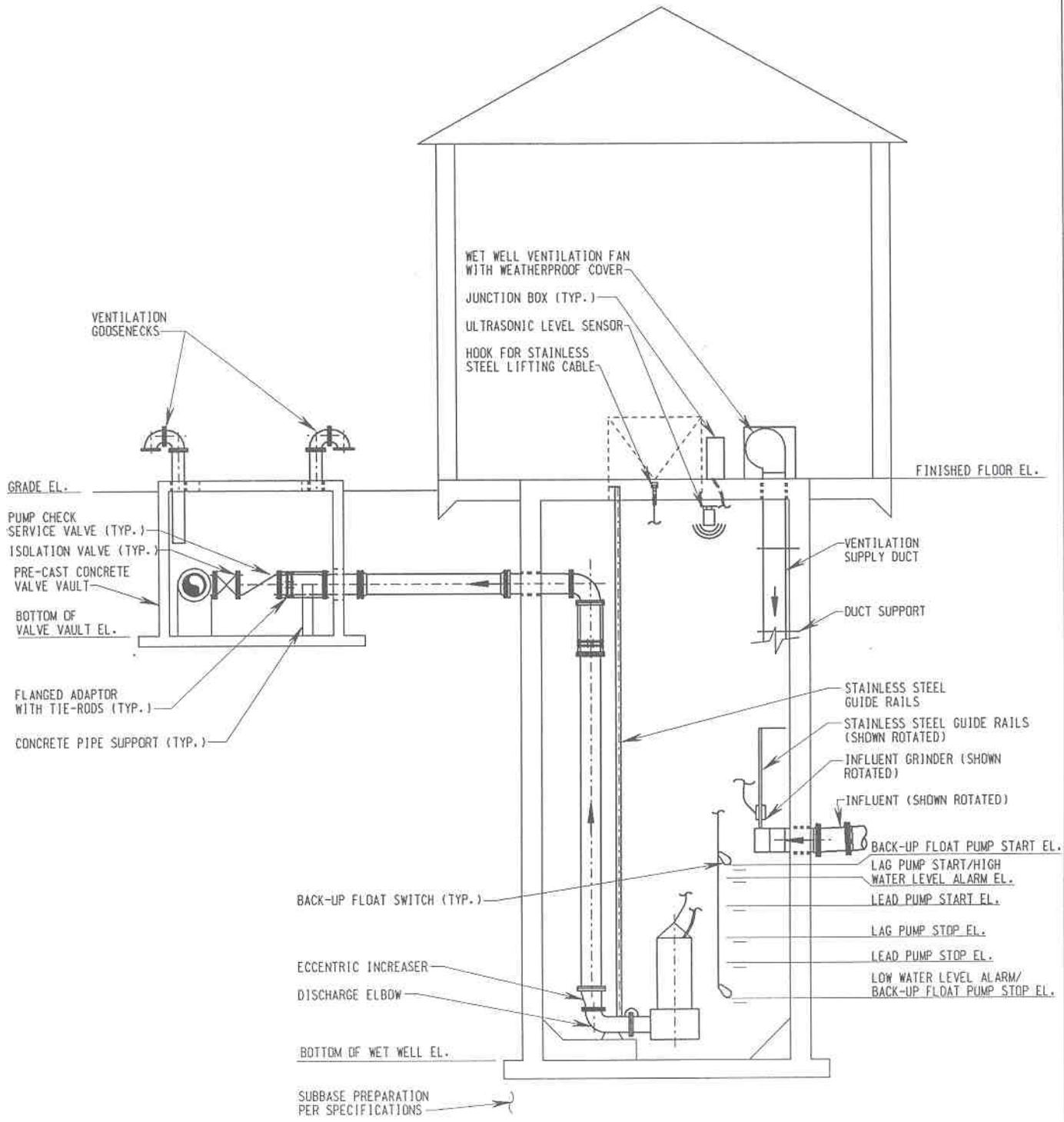
NOTE: DRAWING NOT TO SCALE. PUMPING STATION BUILDING AND CANOPY ROOF STRUCTURE NOT SHOWN.

HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

SUBMERSIBLE PUMPING STATION
WET WELL & VALVE VAULT PLAN

MAY 2003

APPENDIX K.10

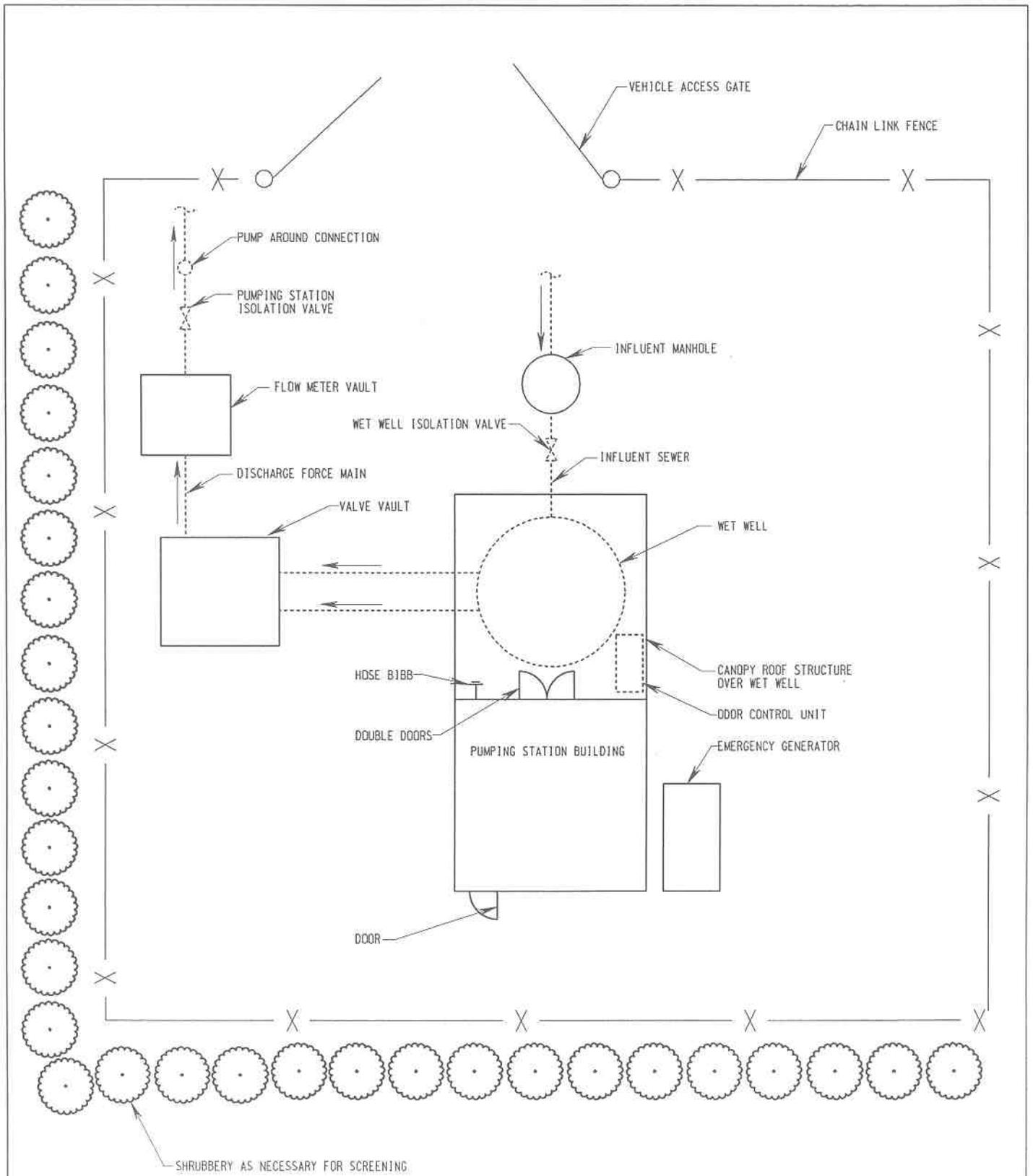


NOTE: DRAWING NOT TO SCALE. JIB CRANE NOT SHOWN.

HOWARD COUNTY
 DEPARTMENT OF PUBLIC WORKS

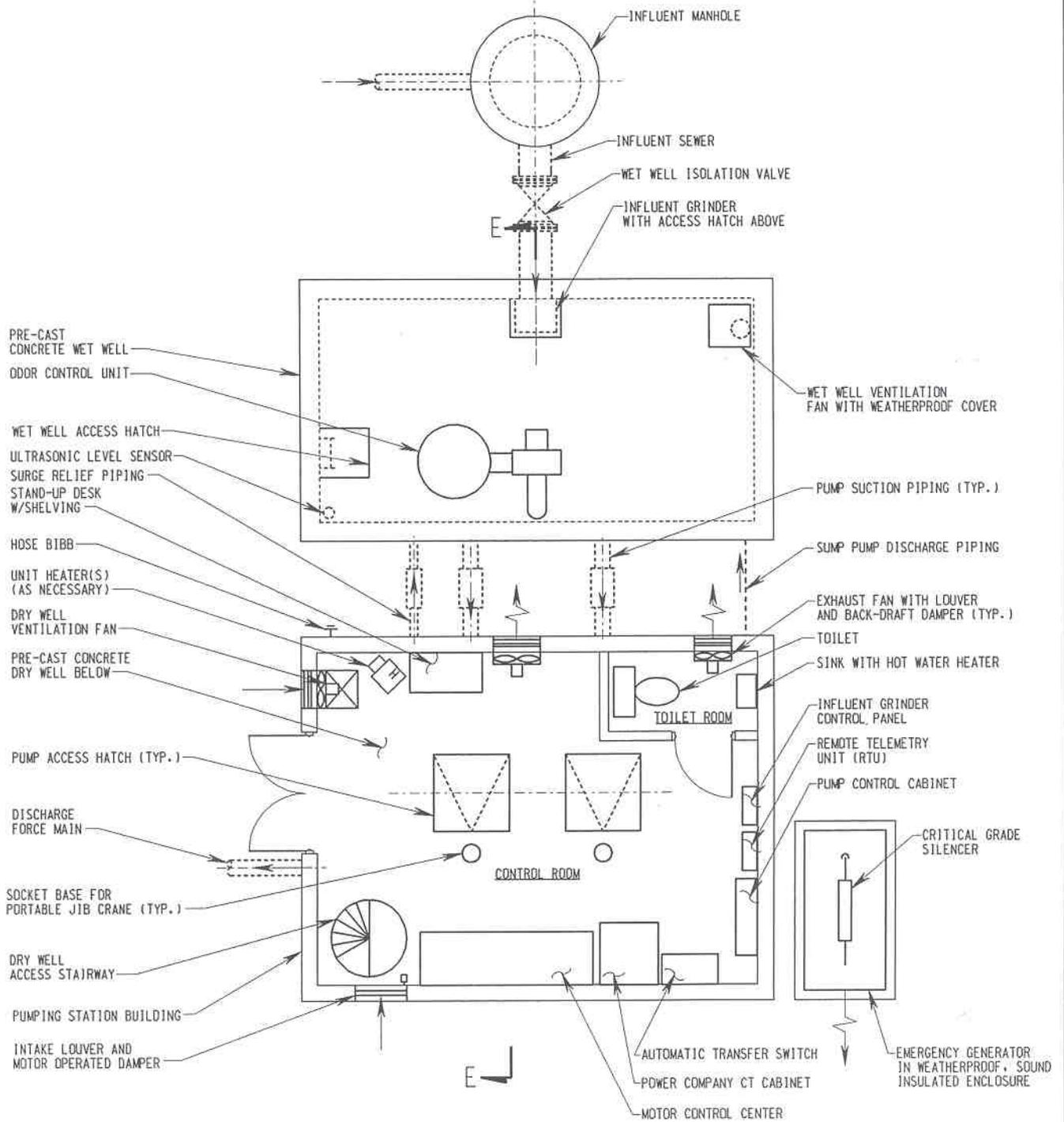
SUBMERSIBLE PUMPING STATION WET WELL & VALVE VAULT SECTION D-D

MAY 2003 APPENDIX K.11



NOTE: DRAWING NOT TO SCALE. SITE LAYOUT SHOWN IS ONLY ONE POSSIBILITY AND IS INTENDED FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
SUBMERSIBLE PUMPING STATION SITE PLAN	
MAY 2003	APPENDIX K.12



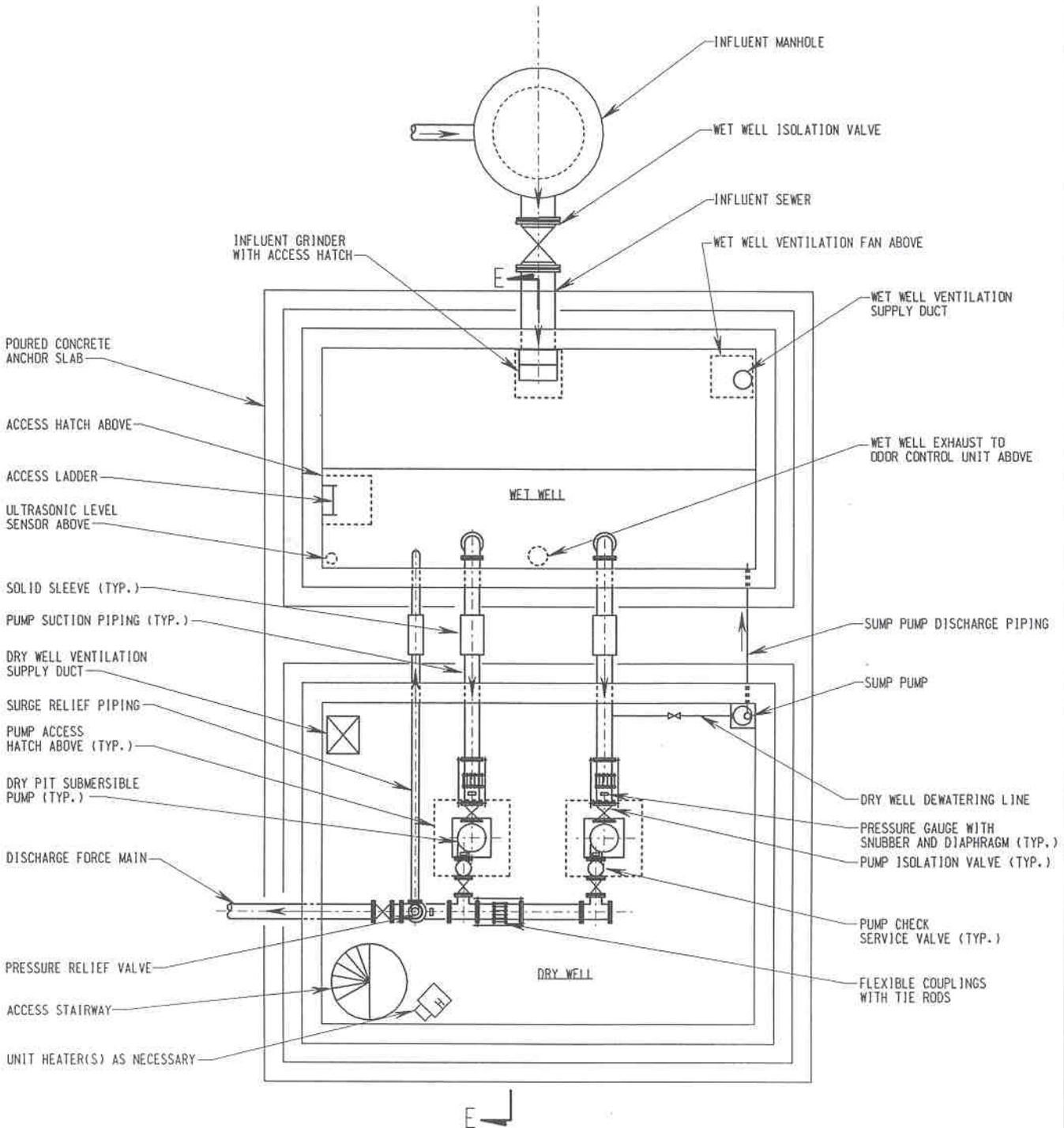
NOTE: DRAWING NOT TO SCALE. PUMPS NOT SHOWN. PLAN IS ONE OF SEVERAL POSSIBLE LAYOUTS AND IS FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

TYPICAL PLAN FOR PACKAGE
PUMPING STATION

MAY 2003

APPENDIX K.13



POURED CONCRETE ANCHOR SLAB

ACCESS HATCH ABOVE

ACCESS LADDER

ULTRASONIC LEVEL SENSOR ABOVE

SOLID SLEEVE (TYP.)

PUMP SUCTION PIPING (TYP.)

DRY WELL VENTILATION SUPPLY DUCT

SURGE RELIEF PIPING

PUMP ACCESS HATCH ABOVE (TYP.)

DRY PIT SUBMERSIBLE PUMP (TYP.)

DISCHARGE FORCE MAIN

PRESSURE RELIEF VALVE

ACCESS STAIRWAY

UNIT HEATER(S) AS NECESSARY

INFLUENT MANHOLE

WET WELL ISOLATION VALVE

INFLUENT SEWER

INFLUENT GRINDER WITH ACCESS HATCH

WET WELL VENTILATION FAN ABOVE

WET WELL VENTILATION SUPPLY DUCT

WET WELL EXHAUST TO OODR CONTROL UNIT ABOVE

WET WELL

SUMP PUMP DISCHARGE PIPING

SUMP PUMP

DRY WELL DEWATERING LINE

PRESSURE GAUGE WITH SNUBBER AND DIAPHRAGM (TYP.)

PUMP ISOLATION VALVE (TYP.)

PUMP CHECK SERVICE VALVE (TYP.)

FLEXIBLE COUPLINGS WITH TIE RODS

DRY WELL



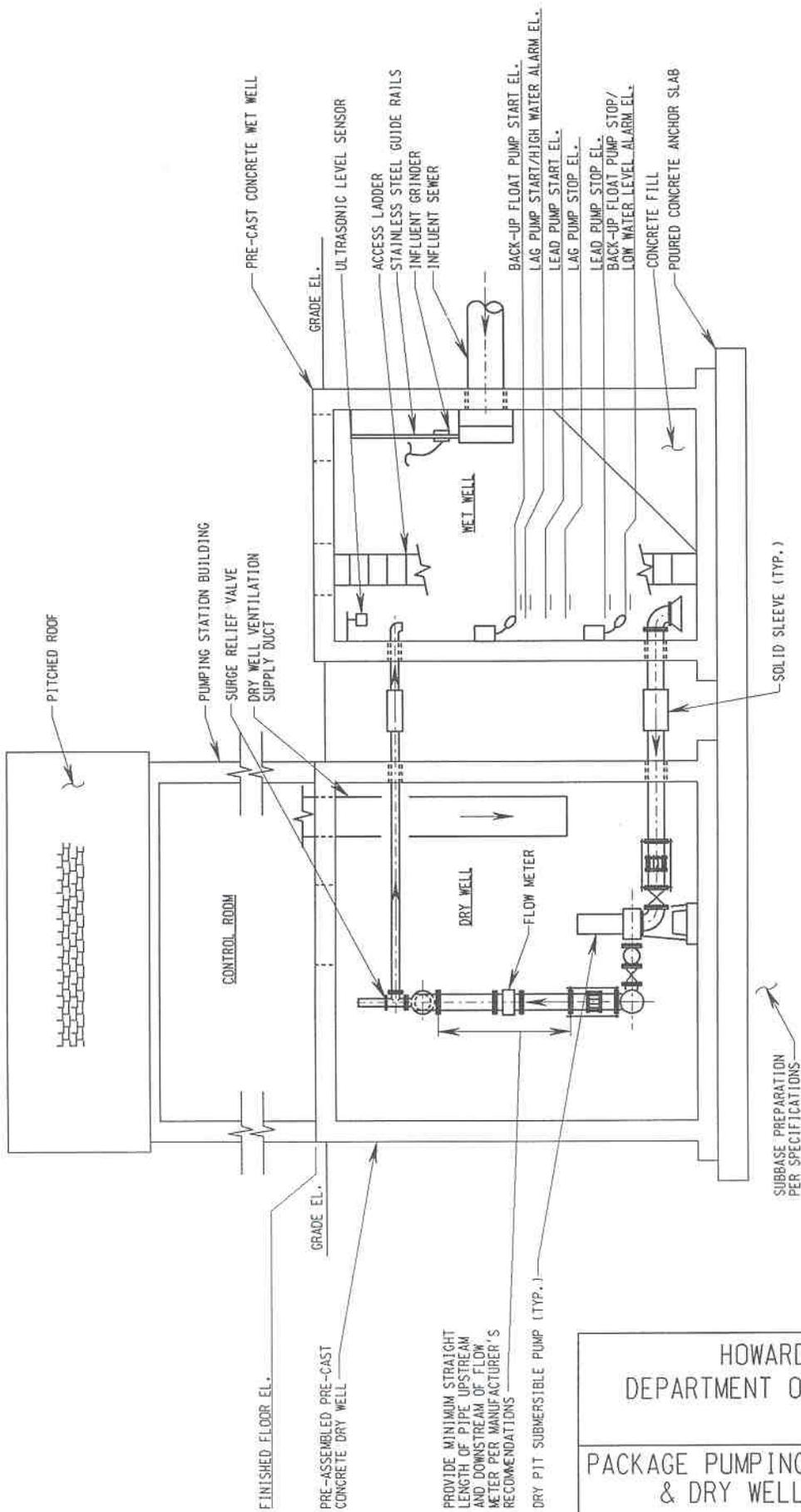
NOTE: DRAWING NOT TO SCALE.

HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

PACKAGE PUMPING STATION
WET WELL & DRY WELL PLAN

MAY 2003

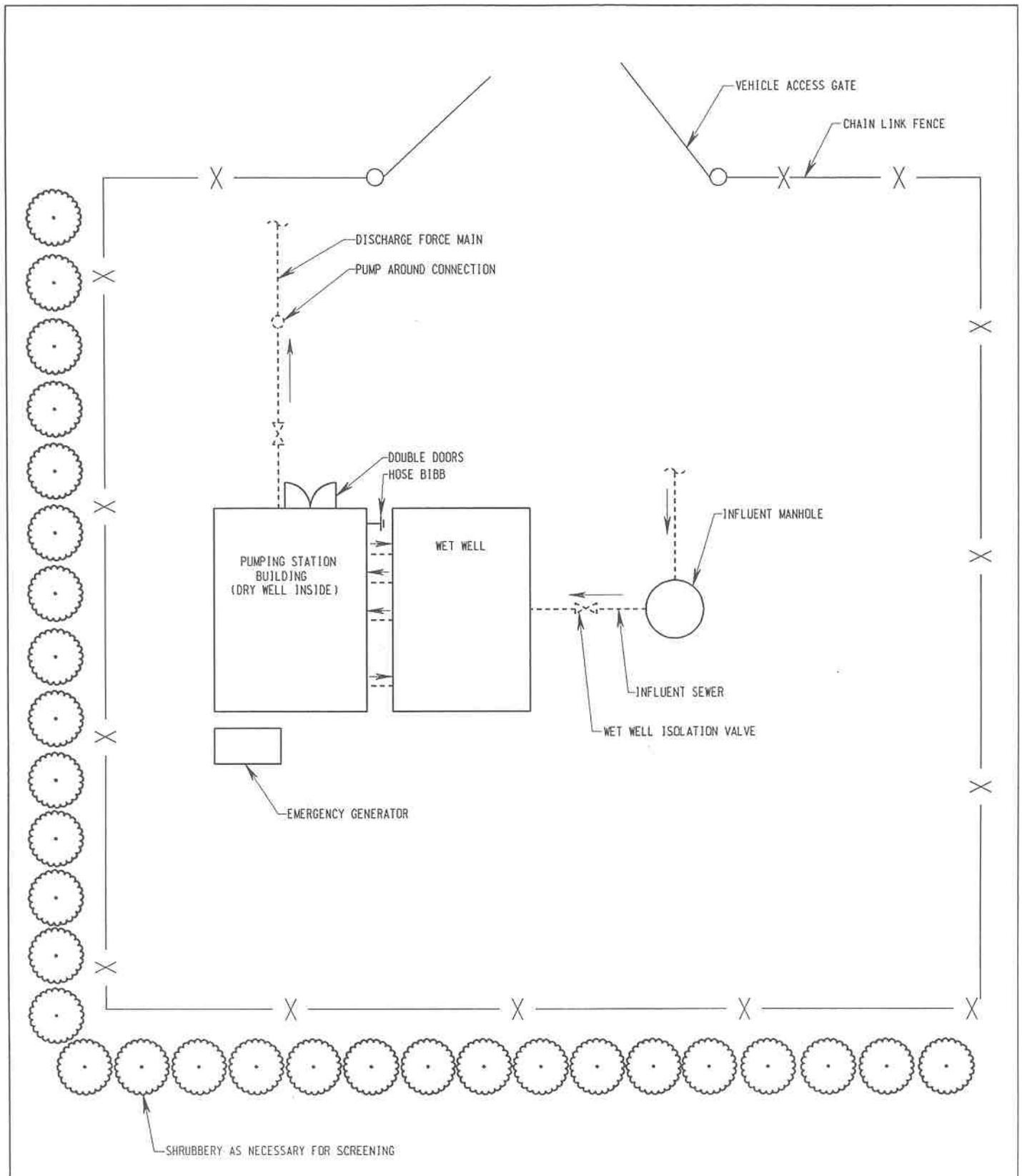
APPENDIX K.14



PROVIDE MINIMUM STRAIGHT LENGTH OF PIPE UPSTREAM AND DOWNSTREAM OF FLOW METER PER MANUFACTURER'S RECOMMENDATIONS

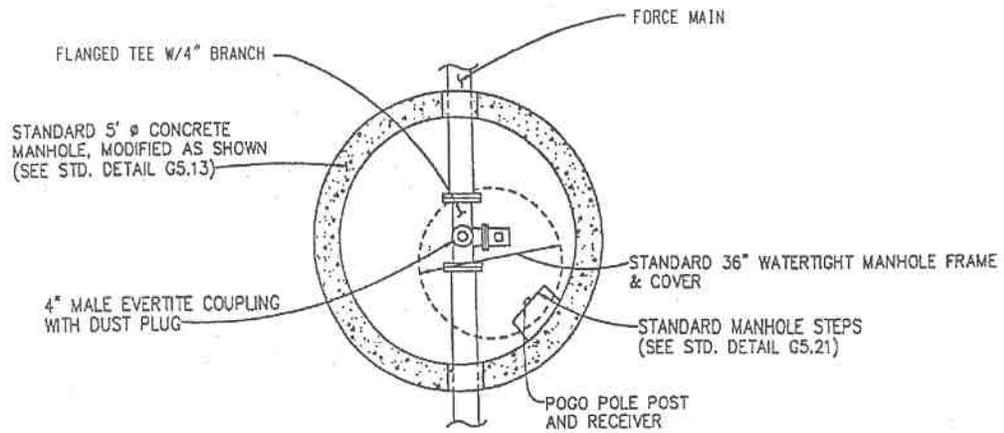
NOTE: DRAWING NOT TO SCALE. CONTROL ROOM EQUIPMENT NOT SHOWN. DRY WELL ACCESS STAIRWAY NOT SHOWN.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
PACKAGE PUMPING STATION WET WELL & DRY WELL SECTION E-E	
MAY 2003	APPENDIX K.15

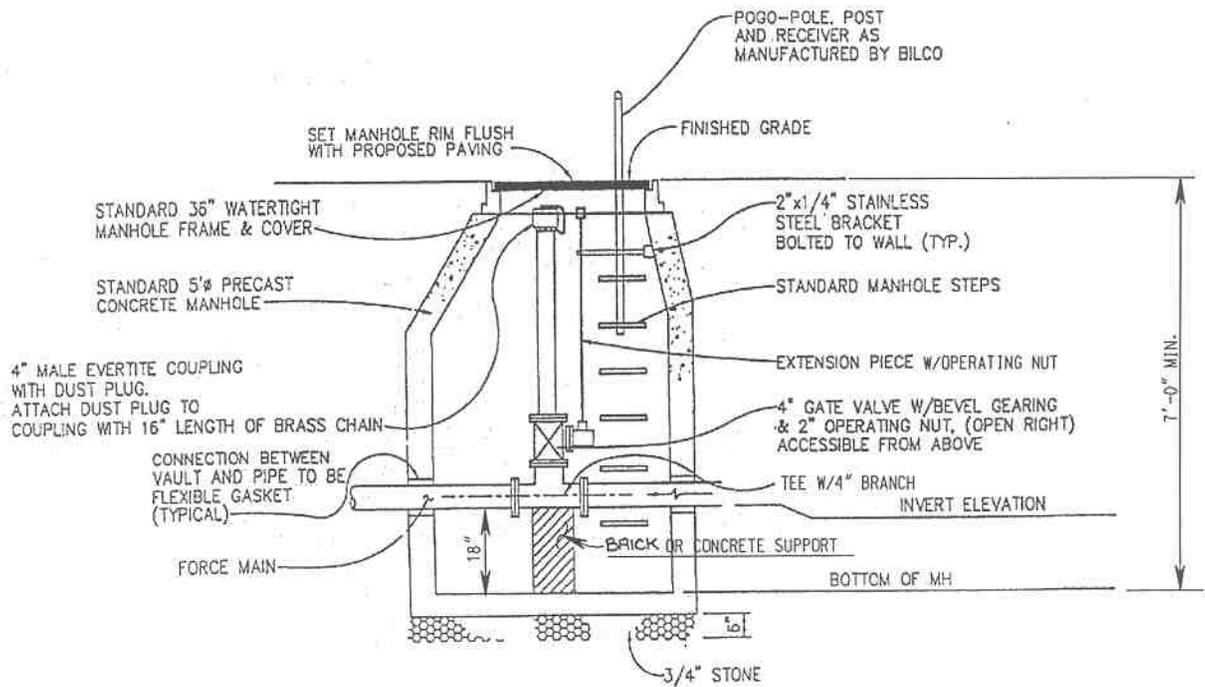


NOTE: DRAWING NOT TO SCALE. SITE LAYOUT SHOWN IS ONLY ONE POSSIBILITY AND IS INTENDED FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
PACKAGE PUMPING STATION SITE PLAN	
MAY 2003	APPENDIX K.16



PLAN
N.T.S.



ELEVATION
N.T.S.

NOTE: DRAWING NOT TO SCALE.

HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

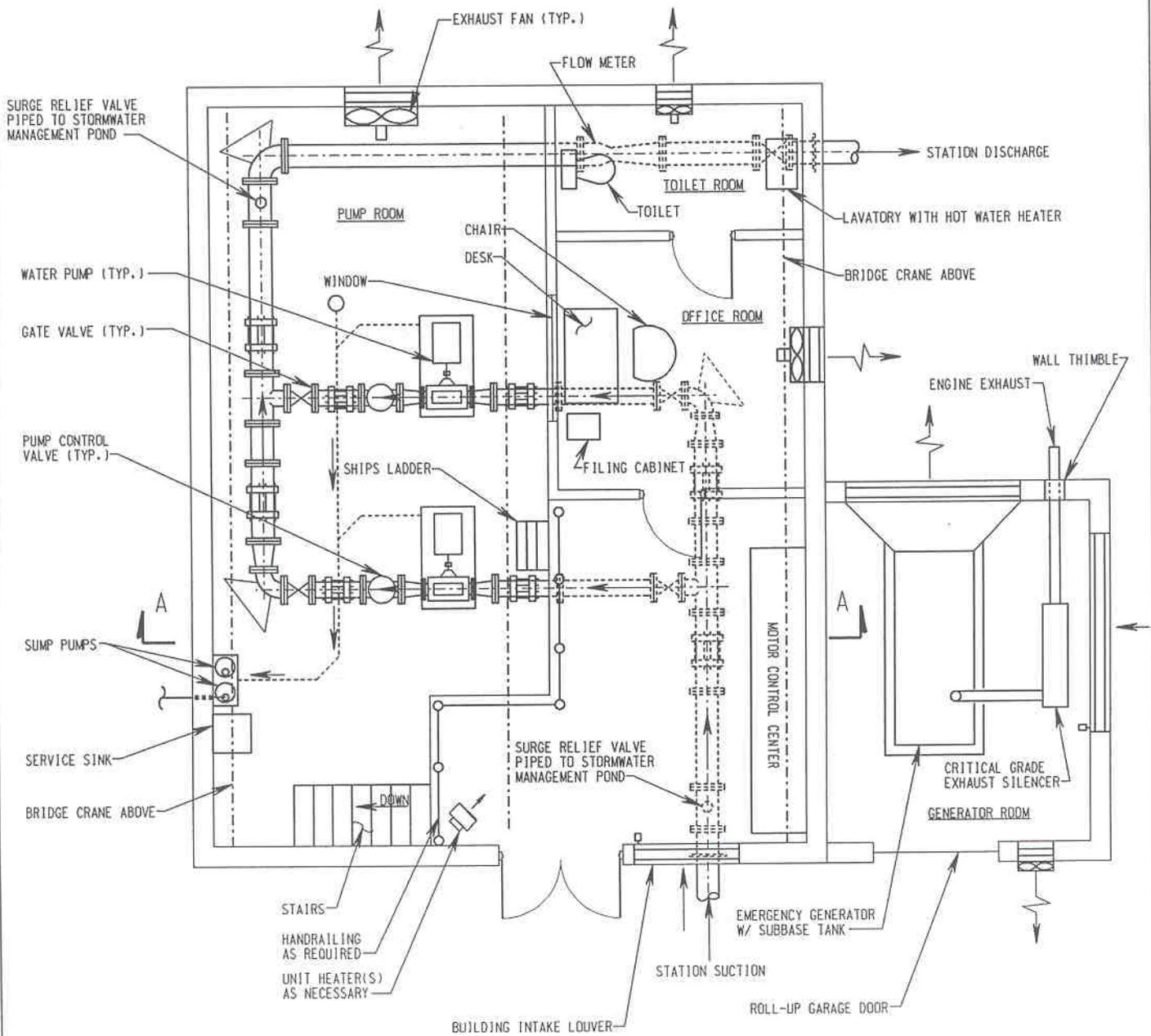
PUMPING STATION BYPASS
CONNECTION DETAIL

MAY 2003

APPENDIX K.17

APPENDIX L

**WATER PUMPING STATION
DESIGN FIGURES**



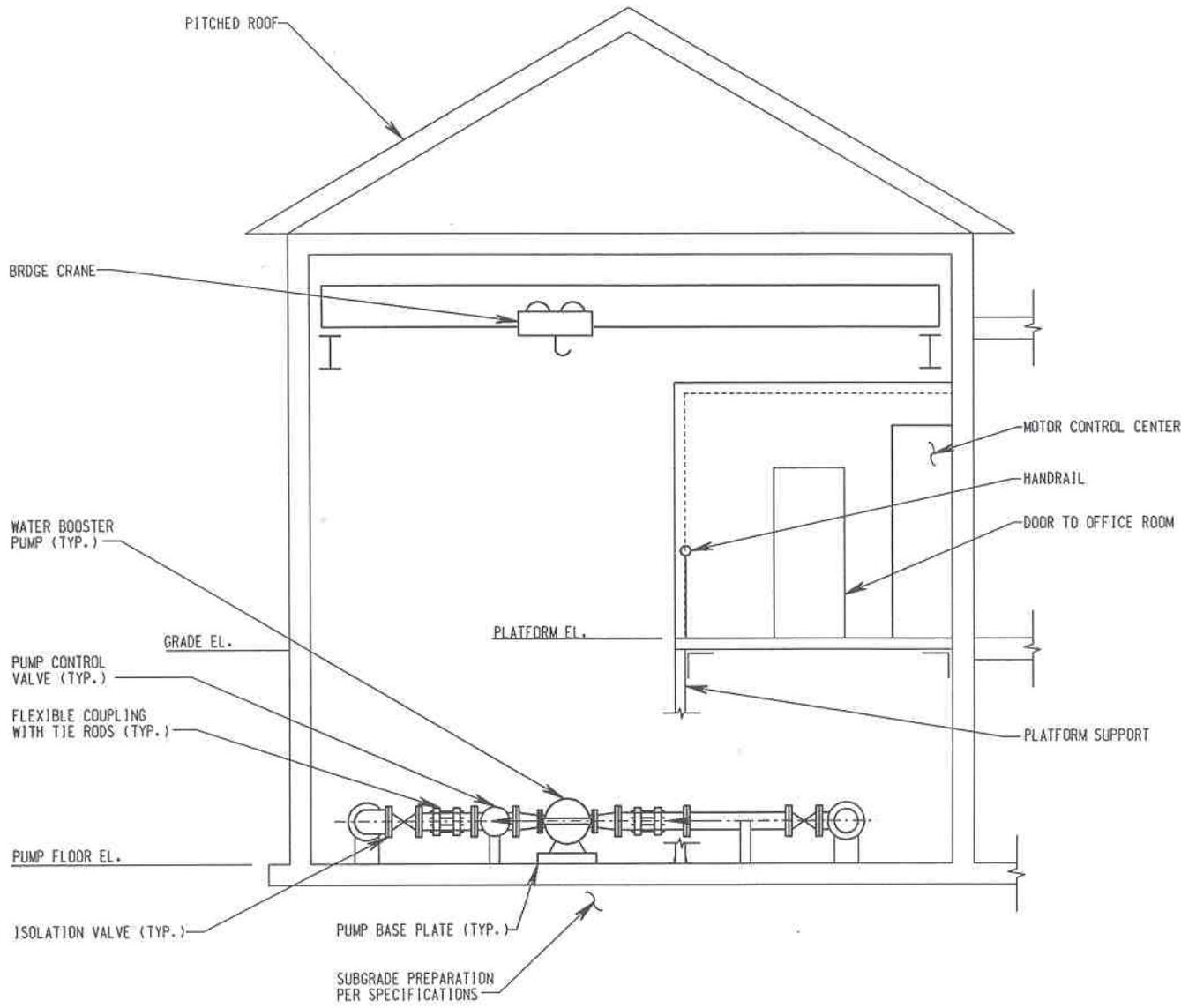
NOTE: DRAWING NOT TO SCALE. NOT ALL EQUIPMENT SHOWN. LAYOUT SHOWN IS ONLY ONE POSSIBILITY AND IS SHOWN FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY
DEPARTMENT OF PUBLIC WORKS

TYPICAL PLAN FOR WATER
PUMPING STATIONS

MAY 2003

APPENDIX L.1



BRIDGE CRANE

PITCHED ROOF

WATER BOOSTER PUMP (TYP.)

GRADE EL.

PUMP CONTROL VALVE (TYP.)

FLEXIBLE COUPLING WITH TIE RODS (TYP.)

PLATFORM EL.

PUMP FLOOR EL.

ISOLATION VALVE (TYP.)

PUMP BASE PLATE (TYP.)

SUBGRADE PREPARATION PER SPECIFICATIONS

MOTOR CONTROL CENTER

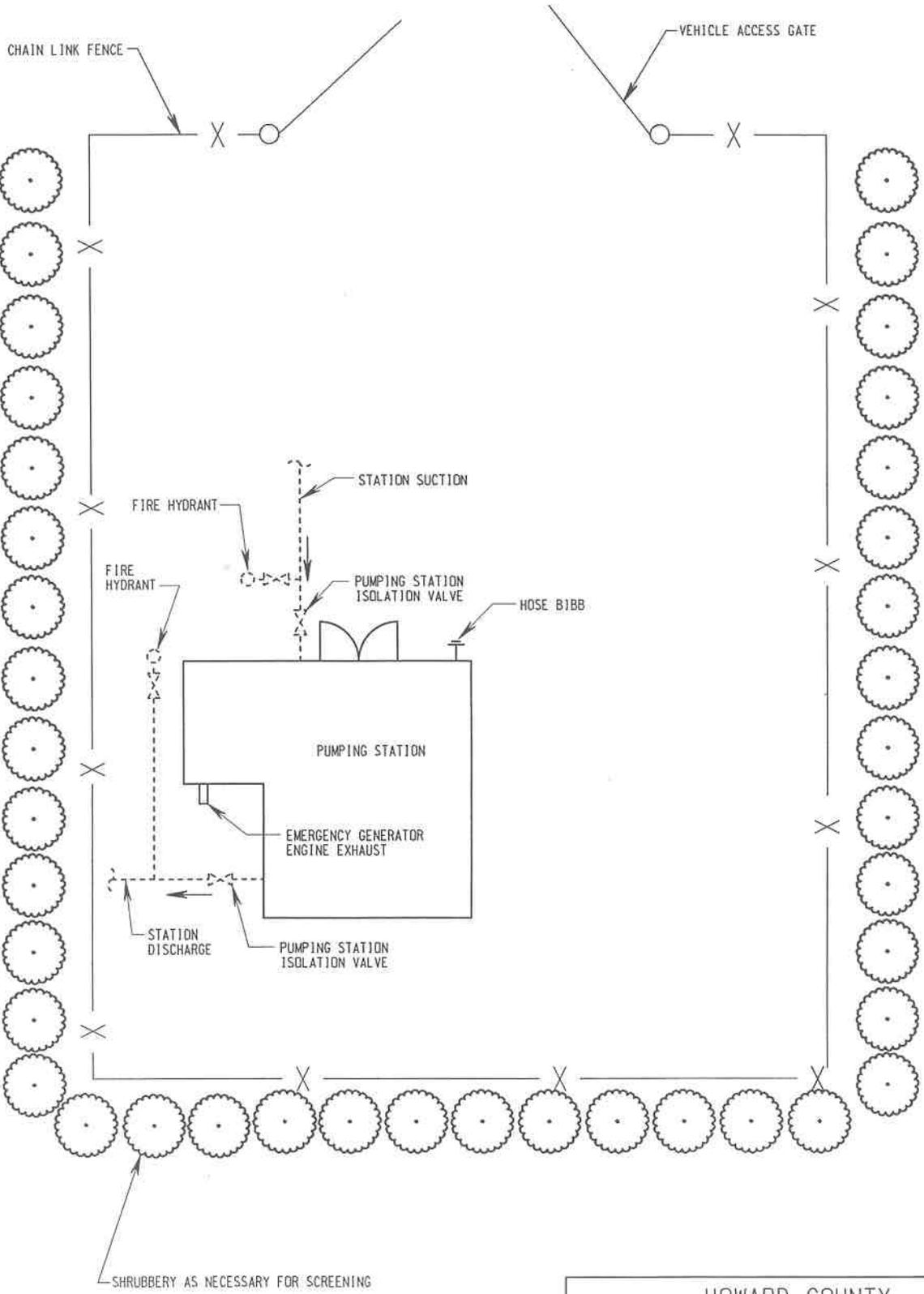
HANDRAIL

DOOR TO OFFICE ROOM

PLATFORM SUPPORT

NOTE: DRAWING NOT TO SCALE.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
WATER PUMPING STATION SECTION A-A	
MAY 2003	APPENDIX L.2



NOTE: DRAWING NOT TO SCALE. SITE LAYOUT SHOWN IS ONLY ONE POSSIBILITY AND IS INTENDED FOR ILLUSTRATIVE PURPOSES ONLY.

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS	
WATER PUMPING STATION SITE PLAN	
MAY 2003	APPENDIX L.3