APPENDIX C

WSSC Design Criteria for Sewer Systems

a. System Requirements

1) General

a) Design the flow capacity of sewers and the flow through the associated manholes and junction structures (especially for trunk sewers) to convey the ultimate flow within the area tributary to the sewer, unless the WSSC determines that a lesser requirement is suitable.

b) Determine wastewater flow from the tributary area based upon development plans and the most current master plan information.

(1) Master Planning Areas can be obtained by accessing the Maryland-National Capital Park and Planning Commission's web site.

(2) Sewer service in master planning areas is determined by the corresponding County Ten-Year Water and Sewerage Plan. In order to obtain public sewer service from WSSC, the property or area in question must be in the appropriate service category for sewer service. Otherwise, an applicant/property owner must petition the appropriate county to approve, amend, and change the property's sewer category for public service. Private systems (those not connecting to the WSSC system, with the exception of private site utility system (on-site) private sewer mains serving commercial and some large residential properties in the WSSC service area) are regulated and approved by the appropriate County.

c) Whenever feasible, design sewers to function by means of open channel gravity flow. Wastewater pumping stations, force mains, grinder pump systems, and pressure sewers may be used only when deemed appropriate and approved by WSSC.

(1) Grinder pump systems must meet standards by the *WSSC Grinder Systems Policy and Guidelines* (WSSC SP ENG 04-10, approved January 26, 2005). See Part Two, Section 25 (Grinder Pump, Pressure Sewer System) for design guideline.

(2) Wastewater Pumping Stations (WWPS) and force mains must meet design guidelines set by those in the WSSC Design Manual (DG-07& DG-08).

(3) The design flow for a WWPS is based on the amount of flow projected in 20 years, rather than the flows from ultimate build out of the area.

2) Flows

a) Design the sewers to have a scour velocity of 2.5 ft/sec at half flow capacity, see Table "19" for minimum slope of sewer pipes.

(1) Size the sewers to convey the design flow (DF) (as derived in 3-d) and determine the sewer capacity using Manning's equation with n = 0.013 and the slope of the sewer.

(2) Ensure, where practical, that the proposed design will attain scouring velocities at the initial peak flow condition at the beginning of the design period. Where this is not practical, present calculations to WSSC demonstrating that it is impractical and describing how the proposed

design will address deposition of solids and the generation of hydrogen sulfide.

(3) Design sewers with some reserve capacity. This will ensure the functionality of the design and allow for future reductions in conveyance efficiencies, possible increases in infiltration/inflow (I/I), unanticipated maintenance problems, and limited land use/development changes. The reserve capacity will be attained by use of a factor of safety as shown in 3-d below.

b) Give consideration to the potential for hydrogen sulfide generation and release as result of the proposed design. Design the sewer systems to minimize the production and release of hydrogen sulfide in the sewer lines, see the Part Two, Section 28 (Hydrogen Sulfide (H_2S) Control) for design considerations.

TABLE "19"

Minimum Slope of Sewer Pipelines

Sewer Diameters	Minimum Slope	Capacity at Minimum Slope	Sewer Diameters	Minimum Slope	Capacity at Minimum Slope
8-inch	0.60%	0.60 mgd	21-inch	0.14%	3.80 mgd
10-inch	0.46%	0.95 mgd	24-inch	0.12%	5.00 mgd
12-inch	0.34%	1.32 mgd	27-inch	0.11%	6.60 mgd
15-inch	0.24%	2.02 mgd	30-inch	0.10%	8.50 mgd
18-inch	0.19%	3.00 mgd	36-inch	0.07%	10.60 mgd

b. Determining Flows

1) Design Flows (DF).

a) Design the sewers to convey the Design Flow (DF) that will originate from the area tributary to the sewer.

b) Estimate the design Base Sanitary Flow (BSF) for specific development using the factors in Tables "19a", "19b" and "19c".

TABLE "19a"

Development Flow Factors – By Dwelling Type

By Dwelling Type	BSF/DU (gpd)	AWF/DU (gpd)
Single-family Detached	210	300
Townhouses	130	185
SFDU (composite)	180	260
Garden Apartments	130	185
High-Rise Apartments	120	170
MFDU (composite)	130	180
Household (composite)	142	205

DU= Dwelling Unit

TABLE "19b"

Development Flow Factors – By Employee Type

By Employment Type	BSF/Employee (gpd)	AWF/Employee (gpd)
Bi-county (WSSD)	28	40
Montgomery County	20	30
Prince George's County	40	60

TABLE "19c"

Development Flow Factors – By Specific Use

By Specific Use	Unit	BSF/Unit (gpd)	AWF/Unit (gpd)
Airport	passenger	5	7.2
Assembly Halls	seat	2	2.88
Auto Dealerships	gross sq. ft.	0.078	0.112
Bakery	gross sq. ft.	0.15	0.216
Banks	gross sq. ft.	0.044	0.063
Barber Shop	gross sq. ft.	0.20	0.288
Car Wash without recycle	gross sq. ft.	4.9	7.056
Carry-out – except major chains	gross sq. ft.	0.20	0.288
Carry-out – major chain	number of seats	10	14.4
Church	number of seats	4	5.76
Dept. Store without lunch counter	gross sq. ft.	0.04	0.057
Dept. Store with lunch counter	gross sq. ft.	0.08	0.115
Drug Stores	gross sq. ft.	0.13	0.187
Dry Goods Stores	gross sq. ft.	0.048	0.069
Garage (auto & truck repair)	gross sq. ft.	0.014	0.02
Hospitals	number of beds	346	498
Hotels	gross sq. ft.	0.256	0.368
Laundries & Cleaners	gross sq. ft.	0.31	0.446
Laundromats	gross sq. ft.	3.68	5.29
Laboratory/Office Facilities	gross sq. ft.	0.167	0.24
Library	gross sq. ft.	0.10	0.144
Medical Office Building	gross sq. ft.	0.62	0.892
Motels	gross sq. ft.	0.224	0.322
Nursing Homes	number of beds	130	187
Office Building in CDB/Transit Area	gross sq. ft.	0.20	0.288
Office Building	gross sq. ft.	0.093	0.133
Pool without hot showers	number of members	4	5.76
Pool with hot showers	number of members	6	8.64
Racket or Tennis Club	number of courts	300	432
Restaurants	number of seats	24.2	34.8
Retail Stores	gross sq. ft.	0.048	0.069
Schools, Elementary	capita	15	21.6
Schools, Middle	capita	20	28.8
Schools, High	capita	25	36
Shopping Centers	gross sq. ft.	0.172	0.247
Service Stations	gross sq. ft.	0.18	0.259
Supermarkets	gross sq. ft.	0.20	0.288
Theaters	number of seats	1	1.44
Warehouses	gross sq. ft.	0.021	0.03

2) Future Flows.

   a) Estimate future flow from other parcels tributary to the sewer that may be developed based on the current zoning of those parcels. For zoning flow factors see Tables "19d", "19e", "19f" and "19g".

TABLE "19d"

Non-Residential Flow Factors By Zoning For Montgomery County

By Montgomery County Zone	BSF/Acre (gpd)	AWF/Acre (gpd)
C-O Commercial Office	7,500	10,800
C-1 Convenience Commercial	2,000	2,880
C-2 General Commercial	6,000	9,216
C-3 Highway Commercial	7,000	10,080
C-I Country Inn	2,000	2,880
C-P Commercial Office Park	2,000	2,880
C-T Commercial Transition	2,000	2,880
I-1 Light Industrial	2,000	2,880
I-2 Heavy Industrial	4,000	5,760
I-3 Industrial Park	4,000	5,760
O-M Office Building – moderate density	2,000	2,880

TABLE "19e"

Non-Residential Flow Factors By Zoning For Prince George's County

By Prince George's County Zone	BSF/Acre (gpd)	AWF/Acre (gpd)
C-O Commercial Office	7,500	10,800
C-1 Local Commercial, Existing	2,000	2,880
C-2 General Commercial, Existing	6,400	9,216
C-A Ancillary Commercial	2,000	2,080
C-C Community Commercial, Existing	6,400	2,880
C-G General Commercial, Existing	2,000	9,216
C-H Highway Commercial, Existing	2,000	2,880
C-M Commercial, Miscellaneous	4,200	2,880
C-S-C Commercial Shopping Center	4,200	6,048
E-I-A Employment and Institutional Area	4,000	5,760
I-1 Light Industrial	8,000	11,520
I-2 Heavy Industrial	4,000	5,760
I-3 Planned Industrial/Employment Park	4,000	5,760
I-4 Low-Intensity Industrial	4,000	5,760

TABLE "19f"

Residential Flow Factors By Zoning For Montgomery County

By Montgomery County Residential Zone		Dwelling Unit/Acre	BSF/Acre (gpd)	AWF/Acre (gpd)
R-10	Multi-family High Density	43.50	5,220	7,520
R-150	One-family Detached	2.60	550	790
R-20	Multi-Family Medium Density	21.70	2,820	4,060
R-200	One-Family Detailed	2.00	420	600
R-30	Multi-Family Low Density	14.50	1,890	2,720
R-40	Semi-Detached and Two-Family	8.50	1,100	1,590
R-4plex	Four-plex	12.50	1,625	2,340
R-60	Single Family	5.00	1,100	1,500
R-90	Single family	3.60	750	1,080
R-CBD	Multi-Family, CBD	290.00	34,800	50,112
R-D-T	Rural Density Transfer	0.04	8	12
R-H	Multi-Family, High-Rise Planned	43.50	5,220	7,520
R-M-H	Mobile Home Development	7.00	910	1,310
R-C	Rural Cluster	0.20	42	60
RE-1	Residential Estate	1.00	210	300
RE-2	Residential Townhouse	0.40	84	120
RT-10	Residential Townhouse	10.00	1,300	1,870
RT-12.5	Residential Townhouse	12.50	1,625	2,340
RT-6	Residential Townhouse	6.00	780	1,120
RT-8	Residential Townhouse	8.00	1,040	1,500
Rural	Rural Zone	.020	42	60

TABLE "19g"
Residential Flow Factors By Zoning for Prince George's County

By Prince George's County Residential Zone	Dwelling Unit/Acre	BSF/Acre (gpd)	AWF/Acre (gpd)
M-X-T Mixed Use - Transportation Oriented		7,800	11,232
O-S Open Space	0.20	42	60
R-10 Multi-family High Density	48.00	5,760	8,300
R-18 Multi-Family Medium Density	20.00	2,600	3,744
R-20 One-Family Triple Attached	16.33	2,123	3,057
R-30 Multi-Family Low Density	12.00	1,560	2,250
R-35 One-Family Semi-Detailed	12.44	1,620	2,330
R-55 One-Family Detailed	6.70	1,400	2,030
R-80 One-Family Detailed	4.50	945	1,360
R-A Residential - Agriculture	0.50	105	150
R-E Residential - Estate	1.08	230	330
R-H Multi-Family, High-Rise Apartment	48.40	5,810	8,370
R-L Residential Low Development	1.50	315	450
R-M Residential Middle Development	7.90	1,660	2,390
R-M-H Planned Mobile Home Community	7.00	910	1,310
R-P-C Planned Community	8.00	1,680	2,400
R-R Rural Residential	2.17	455	655
R-S Residential Suburban Development	3.50	735	1,050
R-T Townhouse – Three-Family	12.20	1,560	2,250
R-U Residential Urban Development	16.00	2,080	3,000
V-L Village Low Development	1.30	280	390
V-M Village Medium Development	2.00	420	600

3) Type of Flows.

a) Base Sanitary Flow (BSF). Flow that is expected to be returned by the customer to the wastewater collection system.

b) Average Wastewater Flow (AWF). Base sanitary flow plus an allowance for infiltration and inflow. The current "Sewage Flow Factor Analysis" calculates the AWF using the following equation.

AWF = 1.44 x BSF**

** The equation shown above shall be used to provide a minimum allowance for infiltration and inflow. Additional allowance for infiltration and inflow may be made upon verification of evidence or approval of operational data or flow measurement.

c) Peak Wastewater Flow (PWF). Is used to evaluate available capacity in existing sewers as well as a step in determining the Design Flow for new sewers. It is the flow that can be expected during a 10-year storm. The Maryland Peaking Equation (See page 1-7 "Design Guidelines for Sewerage Facilities", Technical Bulletin M-DM HH-EHA-S-001, 1978, Environmental Health

Administration, Department of Health and State of Maryland) is used to calculate the PWF as follows:

PWF = (4 * AWF), where the AWF < 0.25 mgd

PWF = [3.2 * $(AWF)^{5/6}$] where the 0.25 mgd <AWF <16 mgd

PWF = (2 * AWF) where the AWF > 16 mgd

The middle equation shown above **must** be in units of million gallons per day.

d) Design Flow (DF). Is used to design new sewers. It includes the Peak Wastewater Flow, the reserve capacity which will be attained by a factor of safety to cover any future land use changes, plus a pool flow if applicable. The Pool Flow allowance is currently 0.1 mgd to cover the surge in flow when swimming pool filters are backwashed. The Pool Flow should be omitted where no swimming pools are located upstream from the sewer. Where two or more pools are located upstream of the sewer, it should be assumed that only one pool would be backwashed at any time. This flow should be added to DF if applicable. Design Flow should be calculated using following equations.

DF = PWF * Factor of Safety +0.1 mgd of pool flow if applicable

DF = (PWF *1.5) + 0.1 mgd of pool flow if applicable when PWF<=3.75 mgd

DF = (PWF *1.1) + 0.1 mgd of pool flow if applicable when PWF>3.75 mgd

4) Determining Existing Flow Existing flow is needed to calculate total flow.

Total BSF = Existing BSF +Future BSF
Total AWF = Existing AWF +Future AWF

a) Existing Base Sanitary Flow can be estimated by the water usage report called "SM039". The SM039 report shows water usage by minibasin, and within each minibasin, breaks down the usage by development. The daily average consumption (DAC) is a weighted average and computed based on the customer’s meter readings. The April DAC best represents the BSF. For the April report the maximum influence would have been exerted by actual water consumption during December, January, February & March. All of these are months in which the consumptive losses are expected to be at their minimum.

For small residential areas, the existing flow can be estimated by counting the parcels upstream from a limiting capacity pipe and calculating the base sanitary flow.

b) Average Wastewater Flow for large areas can be measured by flow monitoring.

c) Once total AWF is calculated, DF can be derived using peaking factors, and factor of safety as described above.

c. Hydraulic Design

1) Gravity Flow:

a) Sewer size/capacity shall be determined using Manning's equation and with "n" value equal to 0.013.

$$Q = \frac{.000039748}{n} D^{2.66666667} \sqrt{S}$$

Where:

Q = the capacity in mgd, n = the Manning n (n=.013)
D = the diameter of the pipe in inches S = the sewer slope in percent.

2) Pumped flows.

a) Includes a variety of different flows, including flows pumped from private site utility 1`system (on-site), such as swimming pool filter backwash flows and grinder pump systems and WSSC wastewater pumping stations.

b) Wastewater flows are calculated as follows:

Design gravity flow + instantaneous peak pump rates (when applicable)

c) Sewage pump selection: At least one (1) standby pump must be provided and available for service at all times. Pumps must be of such capacity that with the largest unit out of service, the remaining units will be capable of delivering the peak flow described under item (b).

d) Sewers shall be sized to carry the peak hydraulic flow at two-thirds full (i.e., the hydraulic grade line will be at d/D = .67). Sewers with peak wastewater flows greater than 3.5 mgd shall be sized to carry the peak hydraulic flow at 91% full.

e) Force main velocities shall be a minimum of 2.0 feet per second and a maximum of 6.0 feet per second. The system shall be designed to minimize water hammer for normal operation situation and unusual circumstances such as power outages. The system must be designed to avoid column separation. Column separation is the most serious consequence of down surge and must be avoided. Refer to Part Two, Section 24 (Force Main Design).

3) Grinder Pumps and Pressure Sewers

a) Least preferable method by WSSC for providing sewer service. Please see WSSC Standard Procedure number ENG 04-10 for policy and guidelines. Detention time in the pressure sewer prior to discharge to the gravity system should be less than 2 hours. Proposed systems that do not meet these specifications will require additional information from the Applicant and further review/assessment by the Commission.

b) Non-residential development will be allowed service via dedicated grinder systems only when such a system is dedicated to a single customer. No other customers will be permitted to connect to the low-pressure main.

c) For new grinder pump systems, applicants should follow manufacturer's directions for designing the systems. The WSSC will verify that the system is feasible and that the pumps to be installed are of an approved manufacturer.

d) Additions to existing grinder pump systems, if permitted, must use the same make and similar pump model to those in the existing system. Consult the WSSC for information on the available capacity in this situation.

e) When modeling flows from grinder pump units in the downstream gravity systems, use the rate of 11 gallons per minute for each grinder pump unit for the Environment/One brand pumps. Please be aware that other manufacturers' pumps may have different flow rates. For example, a WSSC-approved F.E. Myers unit pumps at a rate of 20 gallons per minute or gpm.

4) Checking Downstream Capacity

a) To determine the limiting capacity of the downstream sewers, use the Sewer Model or the as built plans. From the slope and size of the main, determine which pipe will be the limiting capacity pipe.

b) To determine if the downstream capacity is adequate, add the report flow to the mini-basin flow (the April DAC from SM039 report), also add the flow from other mini-basins which drain into the mini-basin, if applicable.

c) Calculate Peak Wastewater Flow (PWF) as shown on page Appendix C-6, item 3)(c), and add instantaneous peak pump rates (when applicable). If this number is less than the limiting capacity, then the downstream sewers are adequate.