

**PIERCE COUNTY DEPARTMENT OF PUBLIC WORKS AND UTILITIES
SEWER UTILITY DIVISION**

**Calculation of Minimum Pipe Slopes to Obtain
Self-Cleaning Velocities in Sanitary Sewers**

The following design parameters must be used when providing supporting self-cleaning velocity calculations for sanitary sewer pipes designed at less than 1% slope. These parameters are not meant to be used for pipe sizing calculations.

- I. Design Parameters:
 - a. Minimum Self-Cleaning Velocity = 2 ft/sec
 - b. Use Peak Dry Weather Flow (PDWF), therefore, assume Inflow/Infiltration = 0 gpd.
 - c. Residential Equivalent = 1.0 R.E. = 220 gpd Average Dry Weather Flow (ADWF)
 - i. Single-family dwelling units = 1.0 R.E.
 - ii. Duplex and multi-family dwelling units = 0.83 R.E.
 - d. Assume Open Channel Flow for gravity pipes. Use Manning's Equation (report from hydraulic design software is acceptable).
 - e. Manning's Roughness Coefficient = $n = 0.013$ (for all pipe types).
 - f. $PDWF = ADWF \times \text{Peaking Factor}$
 - g. Use Figure 1 (attached) to determine the appropriate Peaking Factor. If ADWF < 0.033 MGD, use a peaking factor of 6.0.
 - h. The off-site sewage contribution, in R.E.'s, should be estimated by multiplying the tributary area (not including roads and critical areas) by the maximum dwelling unit density allowed by current zoning. For commercial zoning, use a contribution factor of 1,000 gallons per acre. Developed residential properties less than 1 acre in area should be counted as fully developed.
 - i. If the pipe in question is 8 inches in diameter (nominal), then the Engineer may simply reference Figure 2 (attached) to determine the minimum allowable pipe slope for an estimated number of R.E.'s within the tributary area.

II. Example:

A new development proposes 67 single family residences, 42 multi-family dwelling units, and 5 acres of commercial development. The applicant proposes an 8-inch diameter off-site PVC sewer main with a slope of 0.45% to bring sewer service to the property. There is also 40 acres of undeveloped MSF zoned property tributary to the proposed off-site sewer main. Is the proposed slope adequate to obtain a minimum self-cleaning velocity at full build-out of the tributary area?

$$\begin{aligned} \text{ADWF} &= (37 \text{ sfr} \times 1.0 \text{ RE/sfr} \times 220 \text{ gpd/RE}) + (32 \text{ mfd} \times 0.83 \text{ RE/ mfd} \times 220 \text{ gpd/RE}) \\ &\quad + (5 \text{ ac} \times 1000 \text{ gpd/ac}) + (40 \text{ ac} \times 6 \text{ du/ac} \times 1.0 \text{ RE /du} \times 220 \text{ gpd/RE}) \\ &= 71,783.2 \text{ gpd} \end{aligned}$$

From Figure 1, Peaking Factor = 4.70

$$\text{PDWF} = 71,783.2 \text{ gpd} \times 4.35 = 337,381 \text{ gpd}$$

Assuming an n-value of 0.013,

Manning' Equation calculates a mean velocity of 2.47 fps > 2.0 fps

Therefore, an 8-inch diameter PVC sewer main with a slope of 0.45% is acceptable.

Report from Hydraulic Design Software

Worksheet Worksheet for Circular Channel

Project Description	
Project File	c:\fmw\project1.fm2
Worksheet	test
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.013
Channel Slope	0.004500 ft/ft
Diameter	8.00 in
Discharge	0.337381 mgd

Results		
Depth	4.67	in
Flow Area	0.21	ft ²
Wetted Perimeter	1.16	ft
Top Width	0.66	ft
Critical Depth	0.34	ft
Percent Full	58.38	
Critical Slope	0.007077	ft/ft
Velocity	2.47	ft/s
Velocity Head	0.09	ft
Specific Energy	0.48	ft
Froude Number	0.77	
Maximum Discharge	0.87	cfs
Full Flow Capacity	0.81	cfs
Full Flow Slope	0.001866	ft/ft
Flow is subcritical.		

09/13/06
10:35:54 AM

Haestad Methods, Inc. 37 Brookside Road Waterbury, CT 06708 (203) 755-1666

FlowMaster v5.10
Page 1 of 1

Figure 1

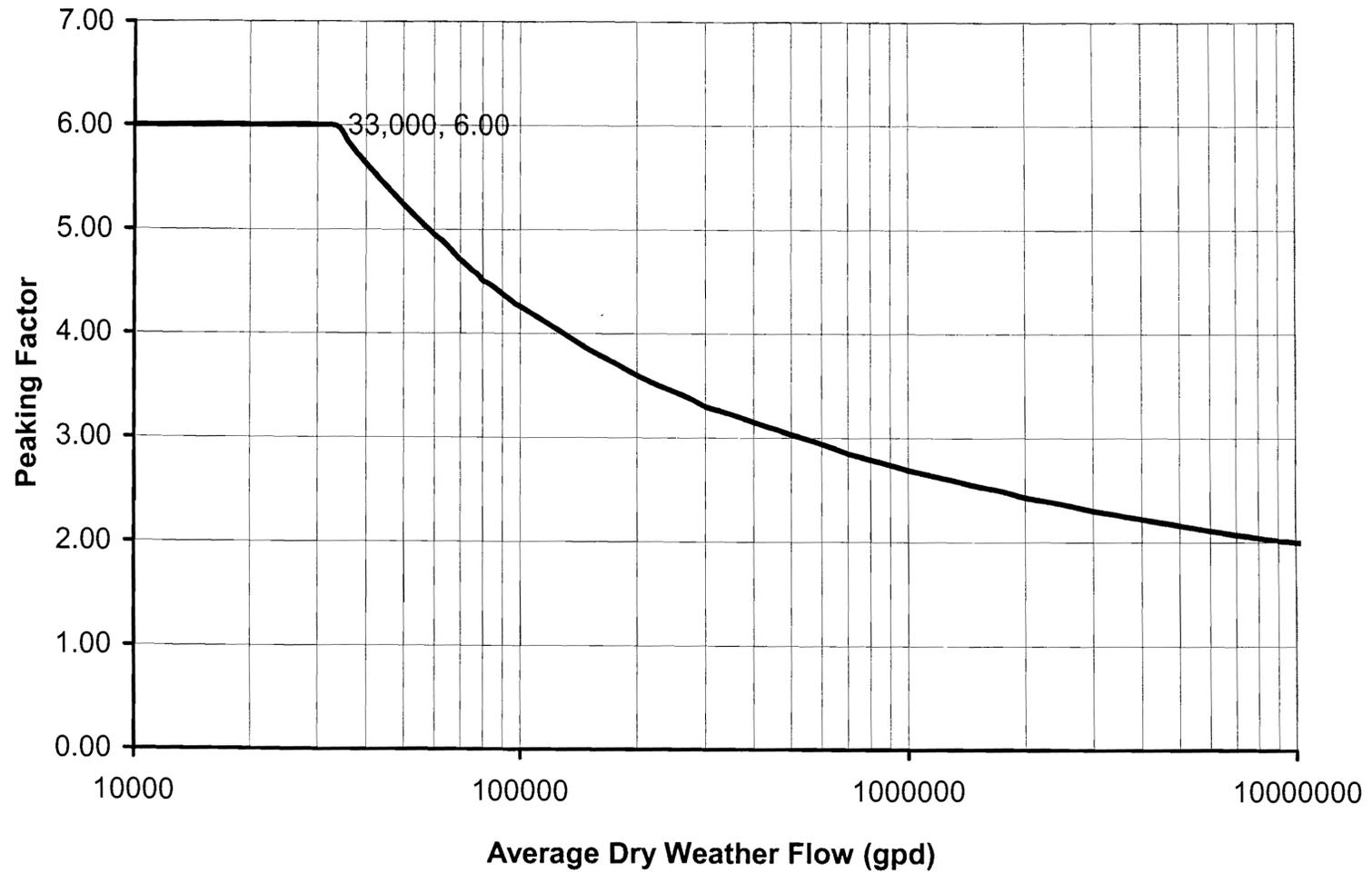


Figure 2

**Pierce County Department of Public Works and Utilities - Sewer Utility Division
Minimum Allowable Slope vs. Tributary Residential Equivalents (R.E.)**

