

WATER AGENCIES' STANDARDS

Design Guidelines for Water and Sewer Facilities

SECTION 4.2 SEWER PLANNING

4.2.1 PURPOSE

This section outlines planning data to find demand factors, average and peak hour sewer flow rates, peaking factors, depth to diameter ratios, slope criteria, velocity criteria, and Manning's and Hazen William's coefficients.

- A. The purpose of this section is to identify general sewer planning and pre-design information for use in developing AGENCY Capital Improvement Program (CIP) projects and developer projects. This section will help develop uniformity and consistency in projects and to assist in providing uniform and workable facilities including pipelines and lift stations.
- B. The Engineer of Work incorporates the planning criteria presented in this section as a basis for design. Sometimes the criteria are given in ranges, in which case the final criterion is selected within the indicated range. In other cases, specific criteria have been given and are to be followed by the Engineer of Work.
- C. If the Engineer of Work desires to deviate from the criteria presented in this section only the Engineer can approve the change.

4.2.2 UNITS OF MEASUREMENT

Units of measurement to be used in design calculations are listed in Appendix B.

4.2.3 GENERAL

It is the responsibility of the user of these documents to make reference to and/or utilize industry standards not otherwise directly referenced within this document. The Engineer of Work may not deviate from the criteria presented in this section without prior written approval of the Agency Engineer.

4.2.4 PLANNING AREA AND SEWER FLOW GENERATION FACTORS

- A. Development Projects:
 - 1. Planning areas and other detailed information required for development projects shall be defined in SAMPs or may have been defined in an AGENCY's master plan. See Section 4.4 for undefined planning areas.
 - 2. Residential sewer generation factors are generally defined in terms of gallons per day per equivalent dwelling unit (GPD/EDU). As an example, an EDU is typically around 220 gallons per day and is arrived at by assuming 3 persons inhabit a household and each person uses just under 75 gallons per person per day.

3. In the absence of more refined sewer generation factors from the AGENCY, development projects shall use the following:

**Table 4-2-1
Sewer Generation Factors**

Category	Unit	Value
Residential	GPD/EDU	200-250
Commercial	GPD/Gross Acre	1,500
Industrial	GPD/Gross Acre	2,000
Institutional*	GPD/Gross Acre	200-1,200
Parks	GPD/Gross Acre	100-500

*The institutional category includes schools. An alternative method for sewer generation factors is to use 15 gallons per capita per day for elementary schools and 20 gallons per capita per day for junior and senior high schools.

The sewer generation factors were obtained for each land use category by compiling and analyzing data from ten (10) different sewer districts in San Diego County.

- B. AGENCY Capital Improvement Program Projects:
 1. For the majority of AGENCY CIP projects, the AGENCY has previously defined planning areas through master-planning or other means. When this is not the case for a CIP project, the AGENCY may have the Engineer of Work define the planning area.
 2. In the absence of more refined sewer generation factors from the AGENCY, CIP projects shall use those listed in Table 4-2-1.

4.2.5 LAND USE

The Engineer or Engineer of Work develops existing and ultimate land use data for the service area to define the following land use categories: residential, commercial, industrial, institutional, and parks. The commercial, industrial, institutional, and parks categories are defined as non-residential.

4.2.6 AVERAGE DAILY SEWER FLOW RATES

Average daily sewer flow rates are calculated as the sum of: (1) the residential sewer flow rates and (2) non-residential sewer flow rates for each land use category as follows:

- A. Average Residential Sewer Flow Rate (gallons/day)=Number of EDUs x 200 to 250 GPD/EDU.
- B. Average Non-Residential Sewer Flow Rate (gallons/day) = Gross acres x Sewer Generation Factor (gallons per day/gross acre) for each Land Use Category.
- C. Total Average Daily Sewer Flow Rate (gallons/day) = Average Residential Sewer Flow Rate + Average Non-Residential Sewer Flow Rate.

4.2.7 PEAK HOUR SEWER FLOW RATES AND INFILTRATION/INFLOW

- A. Peak hour sewer flow rates for residential systems shall be estimated using Figure 4-2-1. This curve was obtained from "Design and Construction of Sanitary Sewers" (ASCE, 1986).

- B. The residential peak hour sewer flow rates shown on Figure 4-2-1 are calculated as follows:

Peak Hour Sewer Flow Rate = Average Daily Sewer Flow Rate x Peak Hour Peak Factor.

- C. Combined residential/non-residential system peak hour sewer flow rates shall be estimated using the diurnal peaking factor curves listed in Figure 4-2-2. Figure 4-2-2 shows a series of 6 curves. Series 1 curve shall be neglected as that is accounted for using Figure 4-2-1. Series 2 through 6 curves shall be utilized for combined flows with the proportion of commercial and residential flow listed under each series on Figure 4-2-1. Generally, hydraulic modeling is required when evaluating combined systems.
- D. Peak hour sewer flow rates do not include infiltration or inflow (I/I). Infiltration is defined as the addition of groundwater into the sewer collection system and inflow is the addition of storm water into the sewer collection system. Because sewer collection system I/I is dependent on a number of factors including season, age of system, type of pipe material and joints, root intrusion, and presence of storm water system, the I/I flow rates will vary from system to system. The number will typically range between 5% and 50% of the unpeaked average sewer flow rate and is generally added to the peak hour sewer flow rate for analysis. See each AGENCY for I/I flow rates to use.

4.2.8 MANNING'S AND HAZEN-WILLIAMS COEFFICIENTS

The Manning's coefficients for gravity sewer pipelines shall be as follows:

Pipe Material	Manning's "n" Coefficients
ABS	0.011
ACP	0.011
DIP (Lined)	0.013
HDPE	0.011
PVC	0.011
VCP	0.013

The Hazen-William's coefficients for sewer force mains and inverted sewer siphons shall be as follows:

Pipe Material	Hazen William's "c" Coefficients
DIP (Lined)	120
HDPE	140
PVC	140

4.2.9 DEPTH TO DIAMETER RATIOS (d/D)

The depth to diameter ratios for gravity sewer pipelines during peak hour sewer flow rates with no infiltration/inflow considered shall be as follows:

Pipe Size	d/D Ratio
≤12 inch	0.50
>12 inch	0.75

4.2.10 SLOPE AND VELOCITY CRITERIA

- A. Minimum slope and velocity criteria are used for gravity sewer pipelines in order to provide velocities that resuspend solids under peak hour sewer flow rates. Maximum slope and velocity criteria for gravity sewer pipelines are used to prevent scour and liquid/solid separation. Slope and velocity criteria for gravity sewer pipelines shall be as listed or in the following ranges:

Pipe Diameter	Minimum Slope (%)	Minimum Velocity (ft/s)	Maximum Slope* (%)	Maximum Velocity** (ft/s)	@Min Slope Q(cfs)=
6	0.68	2.0	10.5	10	0.30
8	0.40	2.0	8.3	10	0.44
10	0.28	2.0	6.2	10	0.77
12	0.21	2.0	4.9	10	1.16
15	0.18	2.0	3.6	10	2.50
18	See Agency	See Agency	See Agency	See Agency	See Agency
21	See Agency	See Agency	See Agency	See Agency	See Agency

*Assumes sewer pipeline $d/D=1$. If pipeline Q is the same and d/D ratio is decreased, then the maximum slope increases. Engineer approval required for increasing maximum slope.

**Maximum velocity is based on calculated d/D ratio. Engineer approval required for increasing maximum slope.

- B. In the upper reaches of gravity sewer systems in residential areas it may not be possible to achieve the minimum peak hour velocity without substantially increasing slope of pipelines, which would create undesirably deep gravity systems. In those cases, a minimum slope of 1% shall be used until there are fifty (50) equivalent dwelling units tributary to the gravity system.
- C. Velocity criteria is used for pressure sewer pipelines (force mains) in order to provide velocities that resuspend solids when the duty pump is operating for a two-pump lift station or when two duty pumps are operating for a three-pump lift station. Maximum velocity criteria for pressure sewer pipelines are used to prevent scour, excessive water hammer, and minimize electrical usage. Velocity criteria for pressure sewer pipelines shall be as listed:

Pipe Diameter	Minimum Velocity (ft/s)	Maximum Velocity (ft/s)
Any Size	3.5	8

4.2.11 SEWER LIFT STATIONS

- A. Sewer lift stations shall be avoided whenever possible. Gravity sewer systems are considered much more reliable and less costly from an operation and maintenance perspective. Deep gravity sewer pipelines that are open cut constructed and/or installed using trenchless technologies are preferred over sewer lift stations. The Engineer of Work shall perform an alternative analysis for Engineer approval, and even if a sewer lift station is the most economical alternative, the Engineer has final authority on selecting preferred alternative.
- B. Sewer lift stations shall be designed to pump ultimate peak hour sewer flow rates. Figure 4-2-1 shall be used to obtain peak hour sewer flow rates.

- C. Sewer lift stations shall be designed to have 1 duty pump capable of pumping the ultimate peak hour sewer flow rate with a standby pump of equivalent capacity. When a three-pump configuration is used, two duty pumps shall be capable of pumping the ultimate peak hour sewer flow rate with a third pump acting as a standby pump. The standby pump capacity shall be equivalent to one duty pump.
- D. Sewer lift stations with a peak hour collection system inflow rate of less than 694 gpm (1 MGD) shall be equipped with pumps that have 1800 rpm motors. Lift stations larger than 1 MGD shall be equipped with pumps that have 1200 rpm motors or less, provided that good operational efficiencies are achieved.
- E. Sewer lift station wetwell volumes shall be calculated as follows:

$$V=(Q_{dsn}-Q_{min}) \times T$$
, where

$$V=$$
Volume of wetwell, gallons

$$T=$$
Minimum pump run time (5 minutes) (Maximum number of starts per hour=6)

$$Q_{peak}=$$
Ultimate peak hour sewer flow rate + Infiltration/Inflow (gallons per minute)

$$Q_{dsn} =Q_{peak} \times 1.35$$
 (gallons per minute)

$$Q_{min}=$$
Ultimate minimum average daily flow rate ($Q_{avg} \times 0.35$)
- F. All sewer lift stations shall be equipped with an emergency standby generator capable of supplying power to the duty pump(s) plus the lighting, power, and control loads.
- G. All sewer lift stations shall be equipped with an emergency bypass connection so that a portable pump can be mobilized to bypass the pump station.
- H. Sewer lift stations shall be on AGENCY-owned land with fee title ownership. Developer shall dedicate or cause to be dedicated the land for a sewer lift station.
- I. Sewer detention facilities (emergency storage) at lift stations shall be strongly considered, with the criteria equivalent to six (6) hours of ultimate average sewer flow volume. The detention facilities should be a separate structure with two pipes connected to the sewer lift station wet well. The high elevation pipe shall be used as a gravity pipe to convey sewage to the detention facility when there is a lift station failure and the low elevation pipe shall be used as a gravity pipe to convey sewage back to the sewer lift station wet well after the emergency. The low elevation pipe shall have a normally closed plug valve in between the detention facility and the sewer lift station wet well.

4.2.12 ON-SITE SEWER SYSTEMS

On-site sewer systems shall comply with the County of San Diego, Department of Environmental Health's Guideline for Maintaining Setbacks from On-Site Sewage Disposal Systems to Public Water Systems, February 9, 2001 or as revised.

4.2.13 REFERENCE

- A. Should the reader have any suggestions or questions concerning the material in this section, please contact one of the agencies listed.

B. The publications listed below form a part of this section to the extent referenced and are referred to in the text by the basic designation only. Reference shall be made to the latest edition of said publications unless otherwise called for. The following list of publications, as directly referenced within the body of this document, has been provided for the user's convenience. It is the responsibility of the user of these documents to make reference to and/or utilize industry standards not otherwise directly referenced within this document.

1. Water Agencies' Standards:

a. Design Guide:

1. Section 4.4, Sub Area Master Plans
2. Appendix B, Units of Measurement

2. County of San Diego, Department of Environmental Health's Guideline for Maintaining Setbacks from On-Site Sewage Disposal Systems to Public Water Systems, February 9, 2001 or as revised.

END OF SECTION