# WATER AGENCIES' STANDARDS

Design Guidelines for Water and Sewer Facilities

SECTION 4.1
WATER PLANNING

### 4.1.1 PURPOSE

This section outlines planning data to determine average, maximum day, and peak hour water demands, fire flows, pipeline velocities, system pressures, pump station capacities, and reservoir storage volumes.

A. The purpose of this section is to identify general water planning and pre-design information for use in developing AGENCY Capital Improvement Program (CIP) and developer projects. This section will help develop uniformity and consistency in projects and to assist in providing uniform and workable facilities including pipelines, pressure control facilities, pumping stations, and storage reservoirs.

B. The Engineer of Work shall incorporate 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.

### 4.1.2 UNITS OF MEASUREMENT

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

### 4.1.3 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.

### 4.1.4 PLANNING AREA AND WATER DEMAND GENERATION

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 Sub-Area Master Plan Development for undefined planning areas.

2. In the absence of more refined demand data from the AGENCY, development projects shall use the Residential Water Demand and/or Non-Residential Water Demand Tables 4-1-1 and 4-1-2, respectively.

B. AGENCY Capital Improvement Program (CIP) 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 demand data from the AGENCY, CIP projects shall use the Residential Unit Water Demand and/or Non-Residential Unit Water Demand Tables 4-1-1 and 4-1-2, respectively.

### 4.1.5 LAND USE

The Engineer of Work collects and organizes existing and ultimate land use data for the geographic area to define the following land use categories: residential, commercial, institutional, parks, hospitals, hotels, industrial, office, and schools. The local Cities or County can provide the information regarding zoning and dwelling unit density.

### 4.1.6 DWELLING UNIT DENSITY AND RESIDENTIAL UNIT WATER DEMAND

The Engineer of Work shall estimate the residential population in the service area based on existing and ultimate allowable land use. Unless otherwise provided by the AGENCY, unit water demands shall be estimated based on dwelling unit density in Table 4-1-1.

**Table 4-1-1**
**Dwelling Unit Density and Unit Water Demands**

| Dwelling Unit Density (dwelling units/gross acre) | Unit Density (persons/dwelling unit) | Population Density (persons/gross acre) | Unit Water Demand (gallons/gross acre-day) |
|---|---|---|---|
| 0.1 | 6.0 | 0.6 | 90 |
| 0.2 | 6.0 | 1.2 | 180 |
| 1 | 6.0 | 6.0 | 900 |
| 2 | 3.5 | 7.0 | 1050 |
| 3 | 3.5 | 10.5 | 1575 |
| 4 | 3.5 | 14 | 2100 |
| 8 | 3.5 | 28 | 4200 |
| 9 | 3.5 | 32 | 4800 |
| 14 | 3.2 | 45 | 6750 |
| 29 | 3.0 | 87 | 13050 |
| 43 | 2.6 | 112 | 16800 |
| 73 | 2.2 | 161 | 24150 |
| 109 | 1.8 | 196 | 29400 |
| 218 | 1.5 | 327 | 49050 |

### 4.1.7 NON-RESIDENTIAL UNIT WATER DEMAND

A. Unless more accurate unit water demand estimates are available from the AGENCY, the non-residential unit water demands in the service area shall be estimated based on the land use categories in Table 4-1-2.

**Table 4-1-2**
**Non-Residential Unit Water Demands**

| Land Use Category | Unit Water Demand |
|---|---|
| Commercial and Institutional | 5000 gallons/net acre-day |
| Landscaped Park* | 3000 gallons/net acre-day |
| Hospital** | 8000 gallons/net acre-day/floor |
| Hotel** | 7000 gallons/net acre-day/floor |
| Industrial | 4000 gallons/net acre-day |
| Office | 5000 gallons/net acre-day |
| School | 4500 gallons/net acre-day |

*Assumes zero recycled water demand on landscaped park area. For parks using recycled water, potable water usage=0 to 5% of unit water demand.

**For multiple story hospitals or hotels, multiply net area per floor by unit water demand by number of floors.

B. If net acres are not known for non-residential land use categories, use Table 4-1-3 to convert gross acreage to net acreage.

**Table 4-1-3**
**Gross Acreage to Net Acreage Conversion**

| Land Use Category | Gross Area | Net Area |
|---|---|---|
| Commercial and Institutional | 1 | 0.30-0.40 |
| Landscaped Park | 1 | 0.40-1.00 |
| Hospital | 1 | 0.35-0.65 |
| Hotel | 1 | 0.30-0.50 |
| Industrial | 1 | 0.25-0.35 |
| Office | 1 | 0.30-0.40 |
| School | 1 | 0.30-0.40 |

### 4.1.8 AVERAGE ANNUAL WATER DEMAND

Average daily water demands are calculated as the sum of: (1) the residential water demand and (2) non-residential water demand for each land use category as follows:

A. Average Daily Residential Water Demand (gallons/day)=Gross acres x Unit Water Demand (gallons/gross acre-day) for each Dwelling Unit Density.

B. Average Daily Non-Residential Water Demand (gallons/day) = Net acres x Unit Water Demand (gallons/net acre-day) for each Land Use Category.

C. Total Average Annual Day Water Demand (gallons/day) = Residential Water Demand + Non-Residential Water Demands.

On some projects, particularly large residential developments, using the unit water demands in Table 4-1-1 may generate unrealistically high estimates. For these large projects, the Engineer of Work may request that the Engineer approve an alternative approach. Similarly, the Engineer may also consider alternative unit water demand estimates for specific land use types where such estimates are based on detailed demand evaluations.

### 4.1.9 PEAK WATER DEMANDS

Peak hour and maximum day water demands are estimated using the peak factors presented in Figures 4-1-1 and 4-1-2. These peaking factors correspond to the AGENCY identified in Figure 4-1-3.

Peak water demands are calculated as follows:

A. Peak Hour Demand = Average Day of Year Water Demand x Peak Hour Peaking Factor.

B. Maximum Day Demand = Average Day of Year Water Demand x Maximum Day Peaking Factor.

### 4.1.10 HAZEN-WILLIAMS COEFFICIENTS

The Hazen-William's coefficients for water pipelines **equal to or less than 12-inch diameter** shall be as follows:

| Pipe Material | Hazen William's "c" Coefficients |
|---|---|
| DIP (Lined) | 120 |
| HDPE | 120 |
| PVC | 120 |
| Steel (CML&C) | 120 |

The Hazen-William's coefficients for water pipelines **greater than 12-inch diameter** shall be as follows:

| Pipe Material | Hazen William's "c" Coefficients |
|---|---|
| DIP (Lined) | 130 |
| HDPE | 130 |
| PVC | 130-140 (See Agency) |
| Steel (CML&C) | 130 |

### 4.1.11 FIRE DEMANDS

A. Before using Table 4-1-4 for fire flow rate, the governing fire department shall first be contacted to determine a rate. If the fire department cannot determine a rate, then minimum flows as set forth in Table 4-1-4 shall be used. The fire flow duration for planning purposes shall be two hours minimum.

**Table 4-1-4**
**Fire Demands for Design Purposes**

| **Development Type** | **Fire Demand** (gpm)(1) |
|---|---|
| Single family residential | 1,500 |
| Duplexes | 2,000 |
| Condominiums and apartments | 2,500 |
| Commercial | 3,500 |
| Industrial | 3,500 |
| Resorts | 5,000 |

(1) Fire Demands shall not include building sprinkler demands.

B. As an alternate method, the Engineer of Work may estimates fire demands flows by using the *Fire Suppression Rating Schedule*, Edition 6-80, Section 1 (Public Fire Suppression), published by the Insurance Services Office.

C. Should application of the ISO methodology result in figures lower than those shown in Table 4-1-3, the Engineer may approve the ISO figures on a case-by-case basis following submittal of supporting calculations.

D. To calculate the fire flow volume required in operational storage reservoirs, see paragraph 4.1.15.

E. The required fire flow demand shall be supplied from at least two fire hydrants (assumes ½ flow from each hydrant) within a maximum radius of 750 feet from the fire.

F. Maximum fire hydrant supply, in some cases, can be obtained from the AGENCY. The supply will be based on an actual flow test if fire hydrants are in the vicinity of the desired location and a calculated flow rate at 20 psi will be provided. If hydrants are not available, then hydraulic modeling is required.

### 4.1.12 PRESSURE CRITERIA

A. Static Pressures:

1. Static Pressure is defined as the pressure in the system with no demand occurring in the distribution system.

2. The basic pressure criteria for water system design are shown in Figure 4-1-4. It is desirable to have water distribution pipelines in each pressure zone capable of supplying a minimum static pressure of 65 psi.

3. Generally, it is undesirable to have a maximum static pressure that exceeds 80 psi without a house regulator or 150 psi in the distribution system with a house regulator. The maximum static pressure in reservoir systems is determined from reservoir overflow elevations and/or the discharge control setting on pressure reducing valves, whichever is greater. The maximum static pressure in pumped systems is determined from reservoir overflow elevations or pump shutoff head, whichever is greater. In some instances the AGENCY may require the developer to build a pressure reducing station and create a closed zone to meet the criteria. The AGENCY will be responsible for operation and maintenance of these stations.

B. Dynamic (Operating) Pressures:

1. In analyzing the supply to a pressure zone, the minimum hydraulic grade line elevation available from the water source shall be used; a level that typically occurs during peak hour demand conditions.

2. Operating pressures under peak hour demand conditions shall not fall more than 25 psi below the static pressure of 65 psi, equating to a residual water distribution pipeline pressure of 40 psi. Operating pressures are determined in the distribution system pipelines at the service connection or fire hydrant.

3. Water systems shall be designed to meet the pressure criteria with one critical source out of service. When analyzing a system with one source of supply (either a reservoir or a pipeline) out of service, pressures may fall more than 25 psi below the static pressure of 65 psi, but in no event may the pressure fall more than 40 psi (keeping the minimum dynamic pressure at 25 psi in the distribution pipeline).

C. Pressure Requirements During Fires:

1. For the simulation of fire conditions, a minimum operating pressure of 20 psi is required in the distribution pipelines in the vicinity of the fire. The residual pressure is determined given the fire demand concentrated at a hydrant within a radius of 750 feet of the fire.

2. For water systems, the residual pressures in the distribution system during a fire shall be maintained given the following conditions:

   a. The water level in the storage facility at the time of the fire is at the minimum operational level that typically occurs during peak hour demand conditions.

   b. The prescribed fire duration as determined by the governing fire department is coincident with the maximum day demand condition.

   c. All Agency booster pumps into and out of the pressure zone where the fire is occurring are off.

   d. Areas outside of the fire circumference in the same pressure zone maintain a minimum pressure of 20 psi.

### 4.1.13 VELOCITY CRITERIA

A. Transmission Pipelines:

1. Transmission pipelines are defined as larger diameter pipelines (typically 12" or 16") as defined by the Agency or pipelines **of any size** that do not have connections to them such as fire hydrants, water services, or distribution tees, which serve to transfer water from one region to another.

2. The maximum transmission pipeline velocity shall not exceed 8 feet per second under peak hour flow conditions.

3. There is no minimum transmission pipeline velocity criterion.

B. Distribution Pipelines:

1. The maximum distribution pipeline velocity shall not exceed 8 feet per second under peak hour flow conditions or 10 feet per second under maximum day plus fire flow conditions.

2. There is no minimum distribution pipeline velocity criterion.

C. Fire Hydrant Laterals

The maximum fire hydrant lateral velocity shall not exceed 15 feet per second under maximum day plus fire flow conditions.

### 4.1.14 PUMP STATION CRITERIA

A. Unless directed differently by the Agency, pumping stations that are connected to reservoirs shall be designed to pump the ultimate maximum day demand projected for the service area. Certain Agencies also require that for pumped zones that the ultimate maximum day demand plus fire flow recharge are met. See Agency for specific requirements.

B. Where pump stations are pumping in series, the first-lift pump station shall be designed to pump the ultimate maximum day demand for all service areas served. The ultimate maximum day demand shall be calculated by summing all of the average day demands of the service areas served, then peaking the average demand using the maximum day peaking factor curve listed in Figure 4-1-2. The ultimate maximum day demand shall **not** be calculated by summing the ultimate maximum day demand of each service area.

C. In some cases, it may be desirable to design a pump station with a higher capacity in order to receive better electrical energy rates. These energy periods have defined terms such as AL-TOU "Time of Use" by San Diego Gas and Electric Company. The AL-TOU and other rate structures allow AGENCIES to receive lower kilowatt-hour rates to pump water in a specified time. Many factors need to be considered when designing pump stations for the different rate structures including:

1. Storage volume
2. Pumping operation (On-off levels)
3. Peaking factors of a system
4. The on-peak hours demand
5. Pump characteristic curves
6. Seasonal demand

D. If a pump station is being designed to use limited hours of pumping, the Engineer of Work shall provide a hydraulic modeling analysis for approval by the Engineer.

E. Hydropneumatic pump stations shall be designed to pump ultimate peak hour demand (2 pumps, 1 duty, 1 standby each capable of pumping the peak hour flow rate) projected for the service area plus a fire flow pump capable of supplying the fire flow demand determined by the governing fire department. A general rule for sizing hydropneumatic tanks is to multiply the duty pump capacity in gallons per minute by 10. This will provide adequate unused, working, and safe limit volumes. In addition, certain Agencies require that a lower capacity pump equivalent to 30% of the average day demand be included in the design.

### 4.1.15 STORAGE CRITERIA FOR OPERATIONAL STORAGE RESERVOIRS

Unless directed differently by the Agency, the minimum operational storage volume within a pressure zone is the sum of three elements: operational storage, fire storage, and emergency storage.

A. Operational Storage:

1. Operational storage is defined as the volume of storage required to allow a reservoir's sources of supply to operate at a uniform rate throughout the day under ultimate peak hour conditions.

2. Based on analysis and Agencies' experience and observations, it has been determined that 30% of a maximum day's volume is generally needed to handle the ultimate peak hour fluctuations. For this reason, operational storage in reservoirs shall be designed for 0.3 x ultimate maximum day demand. An example follows:

Ultimate average day demand of service area = 300,000 gallons

Maximum day peaking factor = 2.7

Ultimate maximum day demand=300,000 x 2.7 = 810,000 gallons

Operational storage required = 0.3 x 810,000 = 243,000 gallons

B. Fire Storage:

1. The governing fire department shall provide the AGENCY with the fire flow rate and duration to determine fire storage. If a number cannot be obtained from the governing fire department, use the values listed in Table 4-1-4. Fire storage shall be provided in all reservoirs. Fire storage is equal to the product of the fire demand and the duration of the fire.

   An example to calculate required fire storage volume follows:

   Fire demand = 1500 gpm
   Fire Duration = 2 hours

   Fire storage = 1500 gpm x 2 hours x 60 minutes/hour
   = 180,000 gallons, or 0.18 million gallons

2. When a reservoir has a redundant source(s) of fire storage, the required storage volume may be shared between two reservoirs or put in one reservoir at the AGENCY's discretion.

C. Emergency Storage Component of Operational Reservoir:

1. The AGENCIES differ widely in terms of being able to treat and store water. Some have large raw water lakes and their own treatment facilities. Other AGENCIES are solely dependent on imported water from the Metropolitan Water District and the San Diego County Water Authority. Because of the many differences, potable water emergency storage varies among the AGENCIES. Another factor that influences potable water emergency storage in operational reservoirs is that the San Diego County Water Authority recommends each member be able to withstand a 10-day planned or unplanned outage of the potable water aqueduct.

2. Table 4-1-5 lists the recommended emergency storage component of an operational storage reservoir by AGENCY.

**Table 4-1-5**
**Emergency Storage Volume Required**
**In Operational Storage Reservoirs per AGENCY**

| **AGENCY** | **Volume Required (In terms of being multiplied by an ultimate maximum day demand in a pressure zone)** |
|---|---|
| Helix Water District | 0.2 |
| Lakeside Water District | 0.2 |
| Otay Water District | 1.0 |
| Padre Dam Municipal Water District | Gravity Zone 1.0, Pump Zone 1.5 |
| Ramona Municipal Water District | 1.0 |
| Riverview Water District | 0.2 |
| Sweetwater Authority | 0.7 |

An example on how to calculate emergency storage volume in a Helix Water District reservoir follows:

Ultimate average day demand of service area = 300,000 gallons

Maximum day peaking factor = 2.7

Ultimate maximum day demand=300,000 x 2.7 = 810,000 gallons

Emergency storage volume required = 0.2 x 810,000 = 162,000 gallons

D. Minimum Operational Storage Volume Requirement (Example for Helix):

Assuming the two-hour 1500 gpm fire flow volume is included in the reservoir, the total storage volume for the Helix reservoir would be 585,000 gallons (243,000 gallon operational, 180,000 gallon fire flow, and 162,000 gallon emergency storage volume).

### 4.1.16 STORAGE CRITERIA FOR EMERGENCY STORAGE RESERVOIRS

See each AGENCY for criteria regarding potable water emergency storage reservoirs and raw water reservoirs.

### 4.1.17 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. Fire Suppression Rating Schedule, Edition 6-80, Section 1 (Public Fire Suppression), published by the Insurance Services Office

2. Water Agencies' Standards:

   a. Design Guideline:

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