Chapter 3.0
WATER SYSTEM PLANNING CRITERIA

This chapter presents unit demands, peaking and planning criteria for the District's water distribution system. The information is used in Chapter 5 of the Master Plan to estimate water supply needs, evaluate the performance of the distribution system and determine what infrastructure improvements are required to serve the existing and future needs of the District. The planning criteria were developed based on the following:

- Review of VWD's historic water billing data and master planning documents, as referenced in Chapter 1, Section 1.3
- Comparison of District criteria to that of other southern California water purveyors
- Discussions with VWD staff to determine applicability to current conditions

3.1 Water System Unit Demands

Unit demands for various land uses within the District were developed from an assessment of the District's water meter billing database for 2007. The billing records were sorted into specific land use categories, consistent with the 2002 Master Plan, based on the billing code. Billing codes for residential and irrigation uses were applied to their respective category based on acreage and address. Codes for temporary and inter-agency uses, and accounts with no demands, were omitted. Of the 21,501 accounts provided by the District, 19,488 were utilized to calculate the measured unit demand factors.[1] Table 3-1 summarizes the data used to calculate the measured unit demand factors.

Calculating Water Demands for Standard Land Uses

Water unit demands were developed on a per acreage basis based on a detailed evaluation of actual water use for the District's different land uses. Current demand data was also compared to previous planning study data, and local agency standards. Table 3-2 presents the current 2008 Master Plan unit demand factors and the factors used in the previous planning studies. The water unit demands represent average water demands within the District and are used for general planning purposes. The calculation is expressed as:

(Acres of Base Land Use) x (2008 Unit Demand, Table 3-2) = Gallons per Day (gpd)

Calculating Generation Rates for Mixed Land Uses

Mixed use developments typically blend commercial or office land uses with stacked, high density residential units. For water use estimation, the uses are additive. Therefore the calculation adds the base land use totals to the residential totals. For the residential element, a unit demand rate of 200 gallons per day per unit shall be used. This demand rate is consistent with the high-density residential land use average duty factor, on a per unit basis, as measured from the District's 2007 water demand data. The District, at its discretion, may require higher residential unit rates if deemed appropriate. The calculation is expressed as:

(Acres of Base Land Use) x (2008 Unit Rate, Table 3-2) + (200 gpd/unit) X (# Units)] = gpd

[1] For VWD Billing Data and Unit Demand calculations, see Technical Memorandum No. 2, Appendix A.

Table 3-1 2007 Measured Unit Water Demands

No.	Land Use Category	Total Acres (ac)	2007 Average Consumption (gpd)			Number of Accounts		
			Non-Irrigation	Irrigation	Total	Non-Irrigation	Irrigation	Total
1	Hillside Residential (0.05-0.25 du/ac)	Included in Rural Residential Land Use Category						
2	Rural Residential (0.125-1.0 du/ac)	2,969	1,736,905	55,825	1,792,731	886	9	895
3	Residential (1-2 du/ac)	428	466,277	27,703	493,979	618	7	625
4	Residential (2-4 du/ac)	958	1,457,413	91,350	1,548,764	2,401	14	2,415
5	Residential (4-6 du/ac) [(1)]	0	0	0	0	0	0	0
6	Residential (4-8 du/ac)	1,923	4,587,078	182,180	4,769,258	9,606	36	9,642
7	Residential (8-12 du/ac)	509	1,341,078	126,400	1,467,478	3,818	20	3,838
8	Residential (12-15 du/ac)	58	157,039	44,193	201,232	261	5	266
9	Residential (15-20 du/ac)	153	416,009	145,768	561,777	98	15	113
10	Residential (20-30 du/ac)	106	415,544	115,161	530,705	54	18	72
10.1	Residential (30-40 du/ac)	28	124,291	8,437	132,728	10	3	13
10.2	Residential (40-50 du/ac)	13	65,748	47,692	113,440	6	11	17
11	Intensive Ag./Res. (0.125-0.5 du/ac)	798	1,125,980	20,667	1,146,647	55	4	59
12	Agricultural/Res. (0.125-0.5 du/ac)	365	288,937	1,322	290,259	26	1	27
13	Commercial	1,202	1,006,220	188,916	1,195,136	734	59	793
13.5	Hotel / Motel	5	30,920	1,439	32,359	5	1	6
14	Office Professional	11	8,906	0	8,906	10	0	10
15	Light Industrial	0	0	0	0	0	0	0
16	Industrial	223	216,500	35,656	252,156	116	12	128
17	Schools & Public Facilities	562	282,998	357,528	640,526	102	53	155
18	Palomar College	102	78,704	16,138	94,842	2	1	3
19	San Marcos State University	146	137,116	1,498	138,614	4	1	5
20	Parks /Golf Courses	621	96	742,631	742,727	1	233	234
21	Solid Waste Management	0	0	0	0	0	0	0
22	Open Space	722	0	1,040,872	1,040,872	0	166	166
23	Right-of-Way	4	0	19,245	19,245	0	6	6
99	Non-specified or Temporary Water Use				1,003,269	1,914	99	2,013
	TOTALS	**11,906**	**13,943,759**	**3,270,621**	**18,217,650**	**20,727**	**774**	**21,501**

[(1)] Hillside Residential (0.05 – 0.25 du/ac) and Residential (4-6 du/ac) densities overlap the Rural Residential and Residential (4-8 du/ac) categories, respectively. Billing data could not be separated.

Table 3-2 Unit Water Demands[1]

No.	Land Use Category	1991 Master Plan (gpd/ac)	1997 Master Plan (gpd/ac)	1997 Measured (gpd/ac)	2002 Measured (gpd/ac)	2002 Master Plan (gpd/ac)	2007 Measured (gpd/ac)	2008 Master Plan (gpd/ac)
1	Hillside Res. (0.05-0.25 du/ac)	1,000	1,000	-	1,030	1,000	-	1,000
2	Rural Res. (0.125-1.0 du/ac)	1,000	1,000	940	580	600	604	600
3	Residential (1-2 du/ac)	1,500	1,300	-	1,210	1,200	1,153	1,200
4	Residential (2-4 du/ac)	1,750	1,900	1,140	2,070	2,100	1,617	1,800
5	Residential (4-6 du/ac)	2,000	1,800	1,600	2,190	2,200	-	2,200
6	Residential (4-8 du/ac)	2,000	1,900	1,740	2,360	2,400	2,480	2,500
7	Residential (8-12 du/ac)	2,250	2,800	2,750	2,130	2,500	2,882	2,800
8	Residential (12-15 du/ac)	3,750	3,400	2,970	2,170	2,800	3,464	3,300
9	Residential (15-20 du/ac)	3,750	3,600	-	3,220	3,200	3,682	3,700
10	Residential (20-30 du/ac)	4,000	3,800	-	4,140	4,100	5,001	5,000
10a	Residential (30-40 du/ac)	-	-	-	-	-	4,763	7,000
10b	Residential (40-50 du/ac)	-	-	-	-	-	8,893	9,000
11	Intensive Ag./Res. (0.125-0.5 du/ac)	2,000	2,000	-	610	600	1,437	1,400
12	Agricultural/Res. (0.125-0.5 du/ac)	1,000	1,000	-	650	700	794	800
13	Commercial	1,250	1,200	1,190	1,720	1,700	995	1,500
13a	Hotel / Motel [3]	-	-	-	-	-	6,522	125 gpd/room
14	Office Professional	1,500	1,500	-	2,040	2,000	784	1,500
15	Light Industrial	1,500	1,500	150	1,760	1,800	-	1,800
16	Industrial	2,000	2,000	610	1,020	1,000	1,129	1,000
17	Schools & Public Facilities [2]	1,250	1,300	-	1,390	1,400	1,139	1,400
18	Palomar College [2]	2,250	2,300	-	N/A	2,300	931	1,200
19	San Marcos State University [2]	-	2,300	-	N/A	2,300	950	1,200
20	Parks/Golf Courses	1,250	1,300	-	1,710	1,700	1,195	1,700
21	Solid Waste Management	0	0	-	N/A	0	-	-
22	Open Space	0	200	-	N/A	200	1,442	200
23	Right-of-Way	0	0	-	N/A	200	5,178	200

(1) Unit demands shown in this table represent averages. Actual water use will vary based on the specific building plans and types of use. All new developments will be required to develop specific water demand estimates to be approved by the District. The District may, at its sole discretion, require higher generation rates once specific development plans are proposed.

(2) See Section 3.1 for calculation of water demand for mixed land uses, schools and universities.

(3) For Hotels/Motels with commercial space, the water demand will be based on the commercial area-based demand factor for the hotel's/motel's parcel area, plus 125 gpd/room.

Calculating Water Demands for Schools and Hotels

Water demands at schools, including Palomar College and California State University – San Marcos, shall initially be calculated based on the area-based duty factor given in Table 3-2. These demands shall be compared to water demands based on student capacity at a demand factor of 5 gpd/student. If the water demand based on student count is higher compared to the area-based demand, the District may utilize the higher demand figure.

The water demand for hotels and motels with commercial space will be based on the commercial area-based demand factor for the hotel's/motel's parcel area, plus 125 gpd/room. This figure is consistent with the hotel/motel demand factor utilized by other local water purveyors within the County. Without commercial, only the 125 gpd/room demand factor applies.

3.2 Water System Peaking

Water demands vary throughout the day and throughout the year. The size of the tributary area (for daily peaking) and the local climate (for seasonal peaking) are the two most prominent factors. When tributary areas are small, the peak-to-average ratio becomes greater. As the service area increases, there is a dampening effect and a reduction in peaking.

Distribution system assessment typically utilizes a number of peaked scenarios to assess system performance – these include maximum day, maximum day plus fire, and peak hour conditions. Peaking factors are used to convert average annual water usage to these specific conditions. The master plan assessment area includes the entire District. Therefore, the peaking factors used in the overall master plan hydraulic model are lower than what would be appropriate for a smaller area study, such as a specific development plan, or an individual pressure zone analysis (as outlined below).

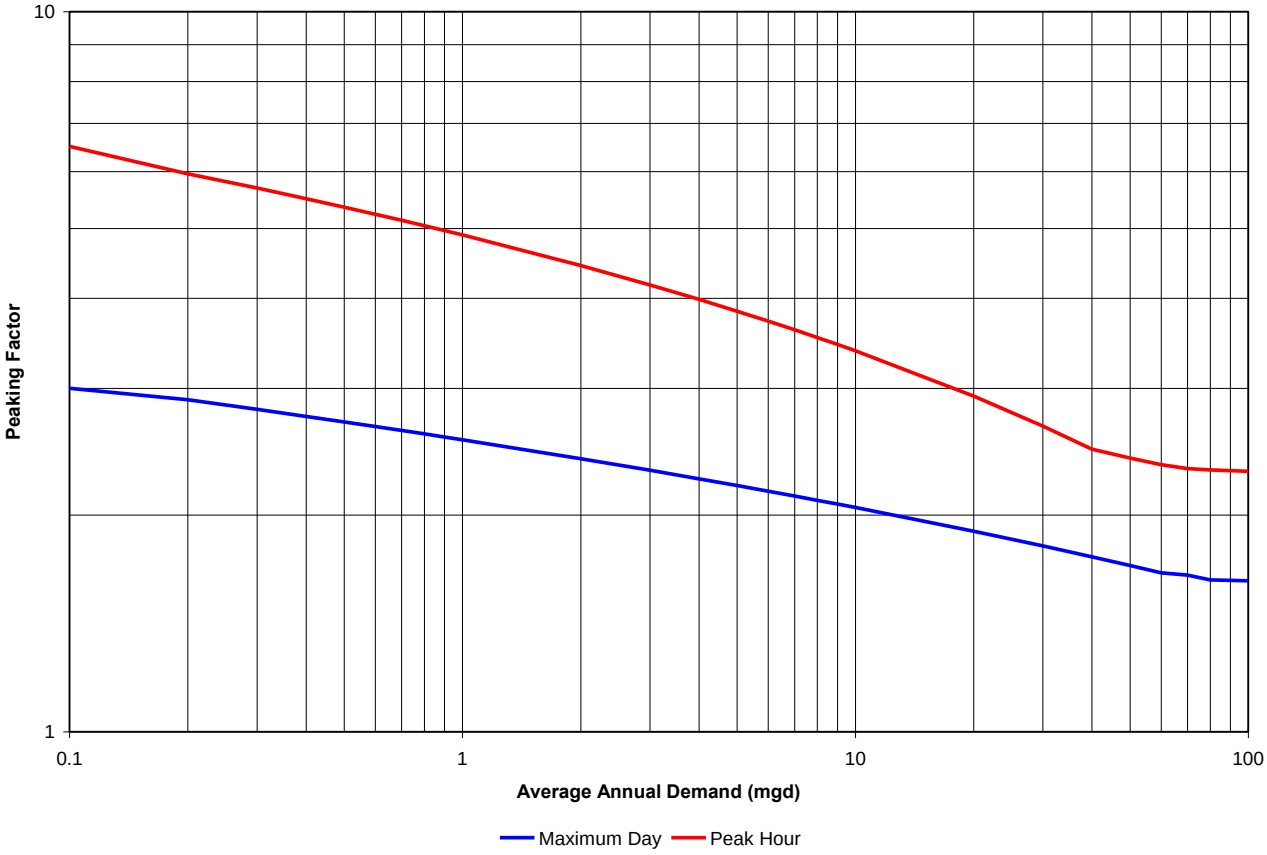
The following summarizes the master plan peaking factors utilized in the water distribution system analysis. These factors were developed based on billing records and operational data.[2]

- Minimum day – Representative of a low demand day and is typically used to assess water quality. A value of 0.5 times average annual use was used in the hydraulic analysis.
- Maximum day - Representative of the highest use day each year and is typically used to assess distribution system operation; often combined with fire flow scenarios. A value of 1.9 times average annual demands was used in the hydraulic analyses. In reviewing the available District data, this day occurred on September 26, 2007.
- Peak hour – Representative of the highest water use during one hour on the maximum day and is typically used in potable water systems to assess distribution system performance during peak water use. A value of 3.0 times average annual use was used in the hydraulic analysis.

[2] For Peaking Factor analysis, see Technical Memorandum No. 2, Appendix B.

The peaking factors for maximum day and peak hour demands are based on the District's 2007 average demand of 18.3 MGD and are representative of District-wide demands. To size individual development infrastructure, the District will use Figure 3-1 to determine the appropriate peaking factors. Figure 3-1 displays peaking factor curves used in this Master Plan. The corresponding peaking factors obtained from these curves are multiplied by the average water demands to determine the peak flows for individual developments.

Figure 3-1 Water System Peaking Curves



Peaking Factors for Individual Projects/Developments

Peaking factors for new developments are determined based on the average daily demand of the new development multiplied by the appropriate peaking curve factor, as shown in Figure 3-1. Analysis of major infrastructure may use reduced peaking factors (at the District's discretion) based on the average flows of the tributary area served by the facility.

3.3 Water Distribution System Criteria

Water system planning criteria establish the parameters within which the District plans to design and operate its water system infrastructure. Table 3-3 and the information below summarize the planning criteria established for VWD. Additional details about specific facility design requirements may be obtained from the District.

3.3.1 Easements

Ordinance 163, adopted in May 2009, establishes the District's easement policy[3]. The District prefers that pipelines be placed within an existing dedicated street or right-of-way and that open space areas are avoided. Pipelines (and certain facilities) may be located within an easement if no other reasonable alternate alignment exists. The minimum easement width has been established at 20 feet and the pipeline should be placed toward the center of the easement, but in no case closer than 5 feet to the edge of the easement. Easements shall be located along one parcel, adjacent to the property line so that the pipeline alignment does not straddle two properties, and should impact the fewest number of parcels as possible. Access easements must be provided for all facilities, including reservoirs and pump stations, and also main appurtenances.

3.3.2 Water Pipelines

Pipeline sizing criteria aims to minimize scouring of interior coatings, limit head loss in the system, and minimize wear on in-line valves. Pipeline velocities are limited to 7 feet per second (fps) for all operating conditions, including maximum day plus fire.

3.3.3 Water Pressure

The District is characterized by terrain ranging from 338 feet to 1,608 feet. This variation requires multiple pressure zones, and in certain areas, large pressure ranges. In general, the pressure criteria aims to: 1) provide a range of reasonable water pressures during a variety of water system conditions, 2) maintain minimum pressures during high flow fire conditions, and 3) limit maximum pressures to protect the water system infrastructure. Table 3-3 includes pressure criteria for the water system.

3.3.4 Fire Flows

Available fire flow is measured at the District's water main under maximum day demand plus fire flow conditions. The fire flow available at buildings or specific locations on private property, as required by the local fire agency, is the property owner's responsibility. Table 3-3 includes a summary of fire flow criteria based upon review of local fire agency requirements. Six local fire agencies provide fire protection services within the District: the municipal fire departments of the cities of San Marcos, Carlsbad, Vista, Escondido; the Vista Fire Protection District, and the Deer Springs Fire Department. With the exception of the City of Escondido Fire Department, the other agencies all use the 2007 California Fire Code.[4]

[3] For VWD Ordinance No. 163, see Technical Memorandum No. 2, Appendix C.
[4] For summary of meeting notes with local fire agencies, see Technical Memorandum No. 2, Appendix D.

Table 3-3 Water Infrastructure Criteria[5]

Item	Criteria
Pipe Criteria	
Maximum Velocity	7 fps
Maximum Velocity (Max Day + Fire Flow)	7 fps
Maximum Headloss/1,000 feet of pipe	15 ft
Minimum Diameter	8 inches
Hazen-Williams C-factor	130
Fire Flow Criteria	
Single Family Residential	1,500 gpm, 2 hours
Multi-Family Residential (or in areas the District deems susceptible to wildfires)	2,500 gpm, 2 hours
Commercial/Business	2,500 gpm, 2 hours
Industrial/Schools/Hospitals/High Rise Structures in the Richland Pressure Zone only	3,500 gpm, 4 hours
Pump Station Criteria (Zones with Reservoirs)	
Pumping Period	During SDG&E off-peak and semi-peak rates only
Pumping Capacity	Maximum Day Demand + 150 gpm Fire Storage replenishment
Minimum Number of Pumps	2 duty + 1 standby
Standby Power	Generator (permanent)
Hydropneumatic Pump Station Criteria (Zones without Reservoirs)	
Pumping Period	24 hours
Pumping Capacity	Peak Hour (or) Maximum Day Demand + Fire Flow, whichever is greater
Minimum Number of Pumps	4 (1 duty + 1 standby for domestic use plus 1 duty + 1 standby for fire flows)
Standby Power	Generator (permanent)
Storage Criteria – Summer Condition	
Operating Storage	150% of Average Day Demand
Fire Storage (= Fire flow X duration)	0.30 MG (all zones except Richland) 0.84 MG (Richland only)
In-Zone Emergency	300% of Average Day Demand
Total Summertime Condition	450% of Average Day Demand + Fire Flow
- or – (whichever is greater)	
Storage Criteria – Winter Condition	
SDCWA Aqueduct Shutdown	500% of Average Day Demand
Pressure Criteria at VWD meter/fire hydrant	
Maximum Allowable	150 psi
Minimum Desirable Static	65 psi
Minimum Pressure (Peak Hour)	40 psi
Minimum Pressure (Max Day + Fire)	20 psi

Note: Fire flows from survey of local agencies. Reductions possible on a case-by-case basis depending on agency requirements. Wildfire risk areas determined at District's sole discretion.

[5] For comparison of criteria among local agencies, see Technical Memorandum No. 2, Appendix E.

Where specific building plans are provided, Insurance Services Office (ISO) criteria can be used to calculate alternative fire flow requirements. ISO standards are specific to a particular building and based on several considerations, such as type of occupancy, type of construction and construction materials, distance from other structures, and other factors. In general, this information is not available at the development planning stage. Regardless, alternative fire flow calculations will require approval by the City or County, the appropriate fire agency, and ultimately the District.

3.3.5 Water Pump Stations (for Pressure Zones with Reservoirs)

Pump stations are critical components of the District's distribution system. They are designed to supply maximum day demands to higher elevation areas - areas that cannot be served by gravity via the District's aqueduct connections. Pump stations also provide backup supply to zones fed by a single supply source. Pump stations are the primary supply source to a number of zones in the District, and must therefore provide consistent, reliable service. They also consume large amounts of energy, and therefore need to be designed to operate efficiently throughout a large range of operating conditions. Table 3-3 includes minimum Pump Station planning criteria.

The District's pump station facilities are sized to provide an installed capacity, defined as firm capacity. The firm capacity equals the maximum day demand of the pressure zones supplied including any flows passing through the pressure zone that are once again pumped into higher zones, or regulated to lower elevations through pressure reducing facilities. In addition, 150 gallons per minute of capacity is included for fire storage replenishment (based on refilling a 2-hour, 2,500 gpm fire flow in approximately two days). Peak hour and fire flow demands in excess of maximum day demand are to be met from water stored within the operational reservoirs within each pressure zone. Standby pumping units with capacity equal to the largest unit in a pump station and permanent emergency backup power are required for each station.

Recognizing the need to conserve resources, the District requires that each pump station be designed with efficient pumps and motors. In addition, the District desires to operate each facility to avoid San Diego Gas & Electric (SDG&E) on-peak demand charges and on-peak energy costs. The requirement for off-peak pumping will be determined by the District, at its sole discretion. Considerations include pump capacity, available storage, and the ability of the specific pressure zone's distribution system to meet pressure requirements when the pumps are not operating.

3.3.6 Hydropneumatic Pump Stations (for Pressure Zones without Reservoirs)

Hydropneumatic pump stations serve high elevation areas where there is no reservoir or aqueduct connection serving the pressure zone. Since the facility is the only source of water, the facility must provide added reliability and redundancy. This redundancy includes dedicated back-up pumps for both domestic and fire systems, and a dedicated, onsite backup power generator sufficient to serve both the domestic and fire pumps. For hydro-pneumatic pressure zones, the pumping station facilities are sized to provide installed (firm) capacity equal to peak hour demand or maximum day plus fire flow, whichever is greater, of the zone served. Hydropneumatic stations also include a hydropneumatic tank, sized to limit the number of start/stop cycles experienced by the pumps during low demand periods.

3.3.7 Water Storage

Water storage is used to supply the following water system needs:

- Operational
- Fire flows
- In-Zone Emergency
- Aqueduct Shutdown

The first three storage elements (operational, fire, and in-zone emergency) are considered critical summertime criteria. Aqueduct shutdown storage is required during the wintertime. Therefore, the District determines storage requirements based on evaluating both summertime and wintertime storage needs. Storage for each pressure zone must be provided within the zone or located in a higher pressure zone. Storage located in higher pressure zones shall be connected to the lower zone via a pressure reducing station and have sufficient pipeline capacity to meet the minimum pressure requirements included herein.

Operational Storage

Transmission capacity to individual pressure zones is typically sized to provide either maximum week demands (supply sources), or maximum day demands (supply sources and pump stations). Operational storage within the zone is then used to supply the difference between peak hour demands and the maximum day or maximum week supply from the aqueduct connection or pump station. For typical systems, operational storage is used during the morning and sometimes in the early evening, when demands are highest. During low demands (midday and late evening) the operational storage volume is typically replenished. The District's operational storage requirement is 150 percent of the pressure zone's average daily demand.

Fire Storage

Fire storage for all pressure zones is sized for a 2-hour 2,500 gpm fire flow demand, which amounts to 300,000 gallons. One exception is the Richland Pressure Zone, a portion of which is in the City of Escondido and therefore subject to the City of Escondido Fire Code. To meet the Escondido criteria for the schools and industrial uses in this zone, fire storage in this zone is sized for a 4-hour, 3,500 gpm fire flow, which amounts to 840,000 gallons.

The Twin Oaks Reservoir site houses two buried reservoirs with a total storage volume of 73 MG adjacent to the SDCWA Twin Oaks Plant. The North Twin Oaks Reservoir is also shown on a hill in the background.

In-Zone Emergency Storage (Summertime Condition)

In-Zone Emergency Storage is required to supply the system during facility outages, such as a pipeline, pump station or regulating station failure. The District has established an in-zone

emergency criteria total of 300 percent of the pressure zone's average daily demand, which conservatively allows for repairs to be made within 3 days.

Aqueduct Shutdown Storage (Wintertime Condition)

The San Diego County Water Authority recommends that each member agency have backup facilities and/or be able to reduce demands allowing an aqueduct pipeline to be out-of service for up to 10 days. Aqueduct shutdowns are typically scheduled during lower wintertime demands. Therefore, each agency establishes an approach and criteria to meet this outage. Key considerations to setting these criteria include how diversified the agency's supply sources are and whether the agency wishes to ask customers to conserve water during these periods. Other considerations include costs and water quality (since large volumes of water in storage can have water quality issues during low demand periods). The District has established an aqueduct shutdown storage criteria of 500 percent of the average daily demand.

Total Storage Requirement

The District requires each pressure zone to have reservoirs sized for the greater of 450 percent of the average day demand (ADD) plus fire flow storage or 500 percent of the ADD. This is expressed as:

Summertime Condition:

Operational Storage		1.5 X Average Daily Demand
Emergency Storage	+	3.0 X Average Daily Demand
Fire flow Storage	+	0.30 MG (all zones except Richland Zone)
Fire flow Storage	+	0.84 MG (Richland Zone only)
	=	**Total Storage (Summertime Condition)**

Wintertime Condition:

Aqueduct Shutdown		5.0 X Average Daily Demand
	=	**Total Storage (Wintertime Condition)**

Storage for Densification Projects

The storage criteria and recommended storage totals included in this Master Plan are for approved land uses as of June 2008 only. Any future land use changes or densification projects (approved by the regulating land use agency) will require an evaluation by the District to determine the need for additional storage capacity.

Storage for Regional Emergencies

The San Diego County Water Authority has developed the Emergency Storage Program, which includes a plan for allocating regional storage to local water purveyors. Chapter 4 includes additional discussion on this program and supply implications.

3.3.8 Water Pressure Regulating Stations

Pressure reducing stations are utilized to reduce water pressure to lower elevation areas. Where pressure zones are served exclusively by pressure reducing stations, a minimum of two stations are required for redundancy. Each pressure reducing station will have a minimum of two regulating valves. The larger valve will provide the most critical flow condition (maximum day plus fire or peak hour). A smaller low flow valve will also be provided to deliver lower flows. Valves will be checked to ensure that they will operate outside cavitation ranges. The District also requires at least one station per zone to have a pressure relief valve with an above grade venting system. The relief valve is required to prevent over-pressurizing the downstream distribution system in the event of a regulating valve failure.

3.3.9 District's Discretionary Authority

The Vallecitos Water District reserves the right to modify any criteria as appropriate to address project-specific considerations or issues. All design criteria established in the 2008 Master Plan are minimums and may be adjusted at the District's discretion.

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