

Section 6: Water System Description and Planning Criteria

SBMWD's water distribution system consists of pipelines, storage reservoirs, pumping stations, hydroelectric generating stations, manual and automatic control valves, fire hydrants, and water meters located throughout the various individual pressure zones. SBMWD has 700 miles of pipeline varying in size from 2 inches to 78 inches in diameter, approximately 42,000 metered water services, 13,800 valves, and 4,000 fire hydrants. SBMWD has 44 water storage reservoirs containing a total of 112 million gallons of domestic water storage capacity. These reservoirs vary in size from 40,000 gallons to 12 million gallons and are located throughout many of the pressure zones.

Pressure zone reservoir elevations range from 1,249 feet to 2,100 feet mean sea level (msl) and are located at appropriate elevations necessary to provide adequate water pressure, 40 pounds per square inch (psi) to 120 psi throughout the pressure zone service area. SBMWD's pumping stations capacities range from 1,500 gpm to 14,000 gpm. In addition, most pressure zones have automated inter-zonal water transfer capabilities to improve water system reliability.

An updated SBMWD system schematic is included in Appendix C.

6.1 Pipelines

As previously discussed, the water distribution system network model was created using the Department's GIS converted into an Innowyze InfoWater network. The updated water system model is an "all-pipe" model, and contains a total of approximately 29,300 pipe segments. The hydraulic model includes all potable water mains 2-inches in diameter and greater, excluding laterals. A summary of the total length of pipes by diameter is shown in Table 6-1.

A comprehensive process for locating isolation pipelines/valves was performed as part of the hydraulic model construction task. Pipelines with closed isolation valves in the distribution system are identified in the model using the GIS information. Given the location of pressure zone boundaries, some additional isolation valves were assumed to be closed.

These various water facilities are modeled using the InfoWater hydraulic model based upon the GIS data and additional information provided by the Department. This basic information was supplemented with piping schematics, valve locations and settings, outlet elevations of tanks, and the operational controls for booster stations and production wells. A detailed description of the modeled facilities is included in a Customized Infrastructure Inventory Database developed as an element of this Water Master Plan project, and is included in Appendix C. A summary of the various water system facilities are discussed in the sub-sections that follow.

Table 6-1: Pipeline Summary

Diameter (inches)*	Length (miles)	%
2	4.7	0.6%
2.5	0.9	0.1%
3	5.3	0.7%
4	60.6	8.1%
4.5	1.9	0.3%
5	0.4	0.1%
5.5	1.1	0.1%
6	171.6	23.0%
8	178.0	23.8%
10	3.8	0.5%
12	159.0	21.3%
14	1.7	0.2%
16	55.3	7.4%
20	25.6	3.4%
22	1.7	0.2%
24	20.7	2.8%
26	0.5	0.1%
30	10.7	1.4%
36	8.6	1.2%
42	1.3	0.2%
48	2.8	0.4%
51	11.1	1.5%
60	1.5	0.2%
72	11.1	1.5%
78	6.7	0.9%
Total	746.6	100.0%

Source*: Department GIS database

6.2 Wells

The Department has approximately 54 groundwater production wells and 60 active monitoring wells. All of the Department's production wells are included in the hydraulic model. Each well is represented as a reservoir and a pump combination. The reservoirs represent the groundwater aquifer and are modeled as fixed grade reservoirs with an initial water level equal to the pumping groundwater level. These pumping levels are obtained from recent Department well reports, which are developed on a monthly basis. The pumps are modeled with multiple point curves, which are based upon the original pump curve modified to reflect the testing provided for the Department by Southern California Edison (SCE). The majority of the pump curves in the system have been imported from the 2007 Master Plan's hydraulic model as suggested by the Department. However, in some cases the pump curves have been updated with more current information provided by the Department. Table 6-2 shows the existing production wells in the distribution system.

Table 6-2: Existing Well Summary

Well	Zone	Annual Production 2012 (AF)
10Th & J Street	Lower	1,723
16Th & Sierra Way	Intermediate	2,487
17Th & Sierra Way	Intermediate	16
19Th St- 1	Upper	0
19Th St- 2	Upper	617
27Th & Acacia	Intermediate	435
30Th St	Lower	136
31St St & Mt. View	Lower	205
40Th & Valencia		181
7Th Street	Lower	216
Antil 6	Lower	0
Baseline & Califor	Upper	102
Cajon 2	Cajon	1,443
Cajon 3	Cajon	946
Cajon 4	Cajon	2,285
Cajon Canyon	Devore Meyers	220
Devil Canyon 1	Sycamore	892
Devil Canyon 2	Devil Canyon	665
Devil Canyon 3	Devil Canyon	0
Devil Canyon 4	Devil Canyon	3
Devil Canyon 5	Sycamore	210
Devil Canyon 6	Devil Canyon	196
Devil Canyon 6	Devil Canyon	81
EPA Ext Well 001	Lower	2,269
EPA Ext Well 002	Lower	2,680
EPA Ext Well 003	Lower	2,563
EPA Ext Well 004	Lower	1,874
EPA Ext Well 005	Lower	1,083
EPA Ext Well 006	Upper	551
EPA Ext Well 007	Upper	1,799
EPA Ext Well 108	Upper	2,256
EPA Ext Well 108-S	Upper	765
EPA Ext Well 109	Upper	1,430
EPA Ext Well 110	Upper	1,649
EPA Ext Well 111	Upper	2,206
EPA Ext Well 112	Upper	1,665
Gilbert St	Lower	222
IVDA Well 11	IVDA	84
Kenwood 1	Devore Meyers	1,400
Kenwood 2	Devore Meyers	1,362
Leroy	Lower	612
Lynwood	Upper	244
Lytle Creek 2	Lower	622

Well	Zone	Annual Production 2012 (AF)
Mallory No.3	Upper	667
Mill & D	Lower	398
Newmark 1	Upper	253
Newmark 2	Upper	741
Newmark 3 Ext	Upper	1,504
Newmark 4	Upper	1,573
Olive & Garner	Lower	1,113
Perris Hill 4	Intermediate	0
Perris Hill 5	Intermediate	0
Vincent	Devore Meyers	546
Waterman Ave.	Lower	1,570
Total Production		48,757
* This excludes stock water production at Mt. Vernon		

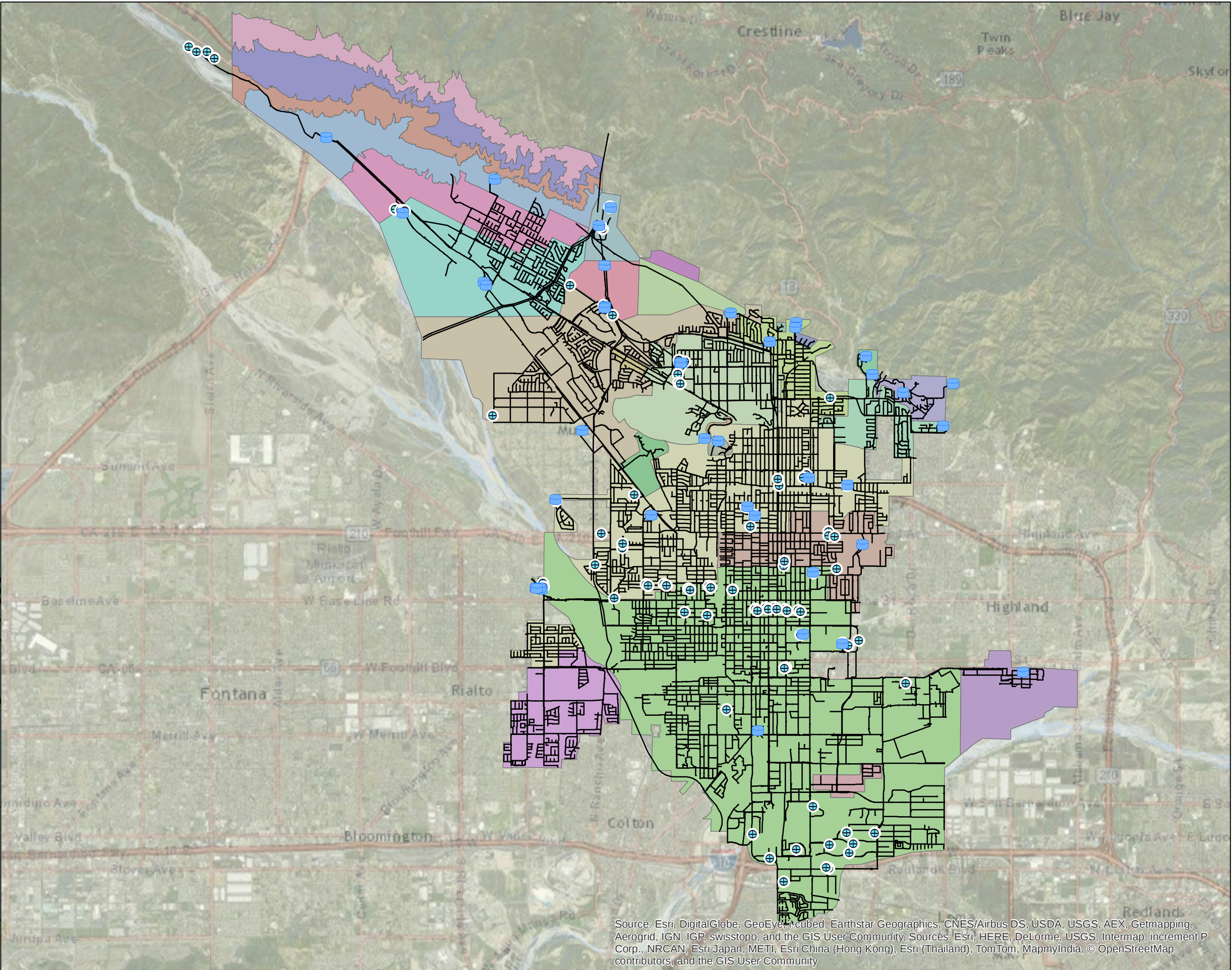
6.3 Booster Pumping Stations

The Department maintains 23 booster pump stations, and approximately 75 booster pumps. All of these pump stations and their corresponding booster pumps are included in the hydraulic model database. The database information for each booster pumping station includes head-capacity curve information for each pump that is developed from the actual pump manufacturer's curve data (if available), or from the SCE pumping test results, whichever is newer. The SCE pump test results are also used to update the pump curve data to account for the decrease in mechanical performance associated with age. The pump controls have been added to the hydraulic model database, based on information provided by the Department.

6.4 Storage Reservoirs

All 43 storage reservoirs in the distribution system are included in the hydraulic model. The model parameters of each tank (ground elevation, height, and diameter) are determined from the Department's GIS files and verified with the hydraulic model created for the previous master plan and data collected from Water Operations through the development of the Customized Infrastructure Inventory Database. The storage reservoirs are modeled as cylindrical tanks. Non-cylindrical tanks are modeled as variable area tanks. The existing system storage reservoirs are shown in Table 6-3. Figure 6-1 shows the graphical location of these facilities.

Path: Z:\Projects\SanBernardinoMunicipal\WD\Events\20150302 MasterPlan\Figs\Figure 6 1 Tanks.mxd



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Legend

- Tanks
- Production Well

Main Line

- Main Line

PZNAME

- 1880 Zone
- 2040 Zone
- 2300 Zone East
- 2500 Zone
- 2700 Zone
- 3000 Zone
- Cajon
- College / Palm
- College / Palm Sub-Zone A
- College / Palm Sub-Zone B
- Daley
- Del Rosa
- Devil Canyon
- Devil Canyon Dom
- Devore / Meyers
- IVDA Upper
- Intermediate
- Lower Sub-Zone
- Lower Zone
- Mountain
- Mountain Sub-Zone A
- Mountain Sub-Zone B
- Ridgeline
- Ridgeline Hydro
- Ridgeview
- Shandin Hills
- Sycamore
- Terrace
- Upper

N

0 5,000 10,000
Feet

Kennedy/Jenks Consultants

San Bernardino Water Facilities MP
San Bernardino, California

Water Distribution System With Storage Facilities Indicated

1383002*00
May 2015

Figure 6-1

Table 6-3: Existing Storage Reservoirs

No.	Pressure Zone	Facility	Elevation (Ft)	Year of Installation	Material	Shape Type	Capacity (Gallons)
1	Cajon	Cajon	1916	1982	Steel	Cylindrical	5,000,000
2	College/ Palm	Palm 1	1720	1980	Steel	Cylindrical	325,000
		Palm 2	1720	1982	Steel	Cylindrical	5,000,000
		Palm 3	1720	2010	Concrete	Cylindrical	4,000,000
		College	1720	1964	Steel	Cylindrical	2,580,000
3	Daley	Daley Canyon	1775	1972	Concrete	Rectangular	1,500,000
4	Del Rosa	Del Rosa 1	1513	1956	Steel	Cylindrical	460,000
		Del Rosa 2	1513	1957	Steel	Cylindrical	190,000
		Del Rosa 3	1513	1982	Steel	Cylindrical	3,000,000
5	Devore/ Meyers	Devore	2100	1982	Steel	Cylindrical	2,000,000
		Meyers Canyon	2100	1992	Steel	Cylindrical	2,000,000
6	Devil Canyon	Devil Canyon	1880	1932	Concrete	Rectangular	220,000
		Devil Canyon Domestic	1880	-	Steel	Cylindrical	10,000
7	Intermediate	17th and Sierra Way Forebay*	1311	1938	Concrete	Rectangular	108,500
		Perris Hill	1311	1962	Concrete	Rectangular	10,000,000
		27 th and Acacia Forebay	1311	1956	Concrete	Rectangular	247,000
8	IVDA	IVDA Elevated Mills and D Street	1294	1958	Steel	Spherical	250,000
9	Lower	Forebay	1000-1249	1934	Concrete	Rectangular	437,000
		Antil Forebay	1053	1953	Concrete	Rectangular	258,000
		Lytle Creek 1	1000-1249	1903	Concrete	Rectangular	3,500,000
		Lytle Creek 2	1000-1249	1957	Concrete	Rectangular	7,500,000
		7 th Street	1000-1249	1965	Concrete	Cylindrical	101,000
		17 th and Sierra Way Forebay*	1000-1249	1948	Concrete	Rectangular	108,500
		Waterman	1000-1249	1948	Concrete	Rectangular	10,000,000
		Medical Center Reservoir	1000-1249	2006	Concrete	Cylindrical	12,000,000
10	Mountain	Mountain 2	1633	1952	Concrete	Cylindrical	233,000
		Mountain 3	1633	1964	Steel	Cylindrical	2,000,000
11	Ridgeview	Ridgeview	1736	1963	Steel	Cylindrical	330,000
12	Ridgeline	Ridgeline	1751-52	1990	Steel	Cylindrical	100,000
		Ridgeline Hydro	1751-52	1990	Steel	Cylindrical	2,000
13	Shandin Hills	Shandin Hills	1612	1933	Concrete	Rectangular	219,000
14	Sycamore	Sycamore 1	1580	1959	Steel	Cylindrical	2,500,000
		Sycamore 2	1580	1965	Steel	Cylindrical	448,000
		Sycamore 3	1580	1985	Steel	Cylindrical	6,000,000
15	Terrace	Terrace 2	1312	1955	Steel	Cylindrical	1,160,000
		Terrace 3	1312	1958	Steel	Cylindrical	1,285,000
16	Upper	Newmark 2	1416	1955	Concrete	Rectangular	7,500,000
		Newmark 3	1416	1963	Concrete	Rectangular	5,500,000
		Newmark 4	1416	1968	Concrete	Rectangular	8,900,000

No.	Pressure Zone	Facility	Elevation (Ft)	Year of Installation	Material	Shape Type	Capacity (Gallons)
		Ogden	1416	2013	Concrete	Cylindrical	12,000,000
		Electric Dr.	1416	1937	Concrete	Rectangular	8,000,000
		Lynwood Forebay		1955	Concrete	Cylindrical	233,000
		Mallory Forebay		1959	Steel	Cylindrical	169,000
		19 th St. Forebay		1952	Concrete	Rectangular	258,000

*17th and Sierra Way Forebay serves both Lower and Intermediate pressure zones.

6.5 Pressure Regulating Stations and Transfer Valves

All pressure regulating stations and zone transfer valves within the Department's distribution system are included in the hydraulic model. Adjustments are made to the location of the stations so that they are consistent with the pressure zone boundaries. The pressure regulating valve and transfer valve settings and initial status (open/closed) are included in the model database.

6.6 Pressure Zones

There are 19 primary pressure zones within the Department's water distribution system. During the model development process, the Department's GIS was updated to incorporate zone designations for each pipeline. These zone designations are reviewed for accuracy and modified where necessary. Pressure zone designations are added to all model nodes based upon the pipelines that serve each node. Pipelines connecting two pressure zones are closed to prevent flow from a higher pressure zone to a lower pressure zone. Table 6-4 below presents the various pressure zones included as part of the hydraulic model. Detailed information related to the facilities and facility settings of each pressure zone is included in the Customized Infrastructure Inventory Database provided in Appendix C.

Table 6-4: Pressure Zone Summary

Number	Pressure Zone	Elevation (ft.)
1	Lower	1000-1249
2	Terrace	1312
3	Intermediate	1311
4	Upper	1416
5	Shandin Hills	1612
6	Del Rosa	1513
7	Daley	1775
8	Ridgeview	1736
9	Melvin Booster Zone	2300
10	Mountain	1633
11	Mountain Sub-Zone A	
12	Mountain Sub-Zone B	
13	Sycamore	1580
14	College/Palm	1720
15	College/Palm Sub-Zone A	1551
16	College/Palm Sub-Zone B	1663

Number	Pressure Zone	Elevation (ft.)
17	Cajon	1916
18	Devore/Meyers	2100
19	Devore/Meyers Sub-Zone	-
20	Ridgeline	1751
21	Ridgeline Hydro	1752
22	Devil Canyon	1880
23	IVDA	1294

6.7 Hydraulic Planning Criteria

Hydraulic planning criteria as established by the Department are used to evaluate the existing system, identify deficiencies, and to determine the size of new facilities. Based on discussions with the Department, a few of the criteria used in the 2007 Master Plan were updated to reflect more current planning criteria. Table 6-5 summarizes the criteria for distribution pipeline facilities, storage reservoirs, and pump stations. Subsequent sub-sections provide additional information on the use of these criteria in the Department's Water Master Plan.

Table 6-5: Summary of System Performance Criteria

Element	Description
Distribution System	Minimum Pressure:
	- 40 psi during maximum day
	- 20 psi during maximum day plus fire flow
	Maximum Allowable Velocity:
	- 10 ft/sec for existing pipes under Max Day conditions
	- 5.5 ft/sec for new pipes under Max Day conditions
	- 15 ft/sec under Max Day and Fire Flow conditions
	Maximum Allowable Head Losses:
	- 5 ft/1000ft under any conditions other than Fire Flow
	Fire Flow Requirements:
Storage Capacity	- These requirements are for water system master planning purposes. The Fire Department sets the specific requirements for individual subdivisions.
	- One fire at a time in zone (no simultaneous fires in the same pressure zone).
	Flow Rates and Durations:
	- Residential – 1,500 gpm for 2 hours
	- Commercial/ Industrial (Light) – 2,500 gpm for 2 hours
	- High Industrial – 4,000 gpm for 2 hours
	Operational Storage
	- 25 percent of the maximum day demand
	Fire storage:
	- The maximum FF required in a zone times the FF duration for that event

- Example: 4,000 gpm for 2 hours = 480,000 gallons

Emergency Storage:

- 30 percent of the maximum day demand
 - The total required storage is the sum of the above three components.
-

Pumping Capacity **Pumping Capacity:**

Convey Max Day Supply for a 24-hour period with the largest pump in the station out of service, also known as the “firm capacity”

The distribution system evaluation criteria specify how the pipes that make up the distribution system should perform. System pressures, velocities, and head losses are the major factors that impact system performance. Acceptable system performance is indicated by each of the elements of the distribution system evaluation meeting the required criteria.

System pressures are generally desired to be above 40 psi under normal and maximum day operation to allow for all users in the system to have adequate working pressures at their connections. Under maximum day and fire flow conditions, pressures as low as 20 psi are allowable to avoid oversizing the system.

System velocities and head losses are factors used for sizing new pipes and are designed to identify elements within the system which cause unnecessary energy costs and low pressures that are indicative of high velocity and head loss. High velocity and head loss conditions can also cause a number of other problems such as rapidly scouring or deteriorating pipelines and high pressure surges, both of which can shorten the lifespan of distribution system facilities.

The pressure analysis is applied only at demand junctions where customers are served. At non-demand junctions on system facilities like transmission mains or at pump station inlets, lower pressures are acceptable because customers are not being served at these locations. Junctions where pressures are not within the identified criteria are identified and presented as part of the evaluation of the distribution system.

6.7.1 Fire Flow Criteria

The fire flow requirements include the rate of flow in gpm and duration of flow in hours based on the type of land use or facility being protected. The system should be capable of providing the required fire flow under maximum day demand conditions. When storage is available in a zone, it is assumed that fire flows will be met using storage capacity first, rather than from pumping capacity. Where storage is not available, fire flow requirements are met by adequately sizing the pumping stations which serve that zone. When fire flow demands are to be met using a pumping station, that pumping station should be equipped with emergency back-up power generation capabilities.

Fire flow demands impose secondary criteria on each of the other evaluation elements. Pressures should be maintained at a minimum of 20 psi under maximum day plus fire flow demand conditions and velocities under fire flow conditions should not exceed 15 fps.

6.7.2 Storage Criteria

The required storage for a water system is the combination of three parts: operational, fire protection and emergency storage. These components are calculated individually for each zone and are then combined to determine the total required storage for that zone. These storage components are also analyzed on a system wide basis to determine how well the system meets storage criteria as a whole.

Operational storage is the quantity of water that is required to balance daily fluctuations in demand that occur on an instantaneous basis. Every water system coordinates production rates and the available storage capacity to provide a continuous supply of treated water. Often treatment systems are designed to produce the maximum day demands at a steady rate, with storage available to augment supply during the peak hour demand period, which typically occurs in the early morning and late afternoon. Operational storage is utilized during these daily peak demand periods and is replenished during off-peak periods such as the middle of the day and at night. Historically, operational storage requirements are typically between 20 and 30 percent of Maximum Day Demand (MDD). The criterion to be used for the Department's Master Plan is 25 percent of MDD.

Fire protection storage is calculated from the highest individual fire flow requirement within a pressure zone and the required duration of the fire flow. Pressure zones are analyzed under the premise of a single fire occurring at each location in the zone. The required fire protection storage must be large enough to serve the largest of those individual demands within each pressure zone.

Emergency storage is a calculation of the volume of water desired to serve customers during an emergency. Possible emergencies include earthquakes, water contamination, unplanned electrical outages, pipelines ruptures or other unplanned events. Since the magnitude of emergencies are difficult to predict, the emergency storage criterion is based on the estimated amount of time that is expected to lapse before an emergency can be corrected, which is a function of past experience and judgment. Emergency storage is typically expressed as a percentage of the maximum day demand. The quantity of emergency storage needed is also a function of the reliability of the sources that serve the system. Since the Department relies completely on groundwater, which gives it operational flexibility to supply water from multiple sources, as opposed to relying on water from an outside source, this criterion was updated from the 2007 Master Plan and established as 30 percent of MDD for the analysis performed herein.

6.7.3 Pumping Criteria

In general, pumping facilities should be constructed to operate with a minimum of two pumping units and a third unit provided for backup purposes. Pumping facilities are sized to convey maximum day supply transfer between zones over a 24 hour period, with the largest pump in the station out of service. For analyzing a zone with multiple pumping facilities, only the largest pump among all of the pumping facilities serving that zone is considered to be out of service. This is referred to as the firm capacity.