Chapter 3: SYSTEM ANALYSIS

3.1 INTRODUCTION

This section presents Sunnyside's design standards, system inventory and analysis, legal and physical capacity, and water quality. It concludes with a summary of system deficiencies/needs and discussion of possible improvements.

3.2 SYSTEM DESIGN STANDARDS

This section presents the City's Design Standards which have been developed to ensure that a consistent minimum level of service is maintained throughout the system and to facilitate planning, design, and construction of water system projects.

3.2.1 SUPPLY

Source facilities shall meet the maximum day demand (MDD) and be sufficient to replenish storage within three days of fire or emergency drawdown during MDD conditions. The supply will be provided at a hydraulic grade line (HGL) that meets replenishment needs of storage facilities. The City will begin to seek new source capacity when the existing wells are operated for more than 18 hours /day (not including the emergency well).

3.2.2 STORAGE

Sufficient storage shall meet seasonal and diurnal variations in demand, fire flows, and emergency demands such as during power outages or equipment failures. These design standards utilize DOH guidelines as criteria for determination of reasonable treated water storage required in each pressure zone, as well as for the system as a whole.
The five storage components listed below will be considered for each pressure zone:

- Operational storage
- Equalizing storage
- Standby (emergency) storage
- Fire suppression storage
- Dead storage, if any

Only effective storage (total storage – dead storage) will be considered in determining available storage volume unless booster pumps are provided. Equalizing and standby storage must be able to provide a minimum of 30 psi to the highest customer in the pressure zone, and fire storage must provide at least 20 psi. The City fire department has agreed to permit "nesting" of the standby and fire storage which allows using the larger of the two volumes to be used in total capacity calculations. A copy of the fire department's agreement letter is in provided in Appendix 2.

Operational Storage

The volume of operational storage should be sufficient to prevent excess pump cycling. The City actively manages its selection of which sources to use based on water demand. Since it is desirable to allow large well pumps to operate for at least 10 minutes/cycle, and five of the eight wells produce 750 gpm or less, an operational storage capacity of 7500 gallons will be used in storage capacity calculations.

Equalizing Storage
Equalizing storage capacity is utilized to meet the daily (diurnal) variations in demand. Peak use periods typically occur during the morning and evening hours. Water is typically withdrawn from storage during these peak demand periods and replenished during lower demand periods. DOH guidelines recommend the following equation be used to estimate equalizing storage:

Equalizing Storage (gal) = 150 x (PHD – Q_S)

Where:
PHD = Peak Hour Demand (gpm)
Q_S = Source production rate (gpm)

When Q_S is greater than the PHD it results in a negative value for equalizing storage. A value of 5 percent of the MDD will be assumed as a minimum.

Standby (Emergency Storage)
The purpose of standby storage is to provide a measure of reliability should a source or well pump fail. The volume of emergency storage required is dependent upon the reliability of the sources of supply and the ability to provide alternative supplies. If the system or zone has multiple sources of supply, the volume of water produced by the remaining supply sources (after assuming the largest source is out of service) can reduce the standby storage requirement.
For the City, the largest source (Well 9; 1500 gpm) is taken out of production before the storage volume is calculated.
For systems with multiple sources, DOH recommends standby storage be based on the following equation:

SBTMS = (2 days)[(ADD)(N) - tm (QS - QL)]

Where:
SBTMS = Total standby storage component for a multiple source water system; in gallons
ADD = Average day demand for the design year, in gpd/ERU
N = Number of ERUs
QS = Sum of all installed and continuously available supply source capacities, except emergency sources, in gpm. See Section 9.1.1 for the definition of a continuously available source
QL = The largest capacity source available to the water system, in gpm
tm = Time the remaining sources are pumped on the day when the largest source is not available, in minutes. Unless restricted otherwise, assume 1,440 minutes

Although DOH's standby volume is intended to satisfy the requirements imposed by water system customers for unusual situations (WAC 246-290-420), DOH recommends that SB volume be no less than 200 gallons/ERU.

The larger of the amount calculated between the equation above, or 200 gallons × number of ERUs, is used for standby emergency storage in this analysis.

Fire Storage
Fire flow storage is provides water to meet fire fighting requirements specified by the local fire authority while maintaining 20 psi pressure throughout the distribution system. The City has adopted the

Insurance Services Office fire flow requirements. The City Fire Department has determined the largest fire flow requirement is 5,500 gallons per minute for 4 hours and is required at 4th Street and Otis Ave., directly south of the City's Wastewater Treatment Plant. These flows are used in storage capacity analysis and were used in hydraulic modeling of the distribution system.

3.2.3 DISTRIBUTION

The distribution system shall provide no less than 30 psi pressure to all customers during peak-hour demands with equalizing storage depleted. During fire-fighting events, the minimum residual pressure permitted at the fire location will be 20 psi, while maintaining at least 20 psi system pressure throughout the rest of the distribution system with fire storage depleted and under maximum day demand hydraulic conditions.

Pipelines

The following design criteria apply to water system pipelines:

- The minimum pipe size for water mains is 8 inches, this includes any pipeline designed to provide fire flow.
- In general, pipes will be sized such that velocities are limited to a maximum of 8 feet per second (fps) under maximum day demand (MDD) conditions. Maximum velocities greater than 8 fps may occur in short sections of mains or in piping associated with pumping and valves under fire flow conditions.
- Pipelines will be looped where possible.
- As a minimum, pipe materials must be ductile iron or polyvinyl chloride (PVC) and meet applicable American Water Works Association (AWWA) standards.
- All water mains must have a minimum cover of 36 inches over the top of the pipe.
- Minimum separation distances between water mains and sanitary sewer mains will be 10 feet horizontally when the mains are parallel, and the water main shall be a minimum of 1.5 feet above the sanitary sewer when crossing. Adjustments to these requirements may be allowed if the proposed adjustments are within the latest guidelines published by DOH.
- A minimum separation distance of 5 feet horizontally must be maintained between water mains and storm sewer systems. Lesser separations will be allowed if it is shown that it is not feasible to locate the water main further away.
- All new piping will be pressure tested to a minimum of 150 psi for one and a half hours
- All new piping will be disinfected before being placed into service.

Valves

A sufficient number of valves will be installed in the system to allow isolation of the system for maintenance and repair.

As a guideline, valves should be located at all tees and crosses, and have a maximum spacing of 500 feet. The minimum number of valves to be installed at an intersection is N-1, where N is the number of pipes intersecting. Two-inch minimum air and vacuum release valves must be installed at all high points in the piping system.
All valves shall meet applicable AWWA standard.

Fire Hydrants

The following design criteria apply to fire hydrants:

- Fire hydrants must be 6 inches or larger and meet AWWA standards.
- Hydrant spacing must not exceed 800 feet between hydrants. In closely built areas, 600 feet between hydrants is preferred.
- Hydrant type must be dry-barrel construction.
- Fire hydrant type, features, and spacing included in the design of any water system improvement must be approved by the City Fire Department.

Pressure Zones

Pressure zones are determined by evaluating ground elevation as it relates to available hydraulic gradient. The static pressure at the lowest elevation will generally not be greater than 100 psi. Pressure at the highest elevation in a pressure zone must be sufficient to ensure that the pressure is not less than 30 psi at peak hour demand flow conditions.

Booster Pump Stations

A minimum of two pumps are required at each booster pump station to provide flexibility and system redundancy. Each pump must be able to meet MDD design conditions. To increase emergency reliability, at least one pump in each booster pump station must be supplied with on-site standby power or have the capability to connect to a portable power supply. This capability allows some emergency supply capacity, even during a general power outage.

3.3 SYSTEM INVENTORY

The Sunnyside water system has grown to meet the needs of the City over the last 106 years with the development wells and reservoirs in the system beginning with the first well in 1910. The distribution as routinely been expanded to serve new customers. The existing system is shown on Figure 3-1 and the systems hydraulic schematic is shown on Figure 3-2.

Figure 3-1 Existing System Map

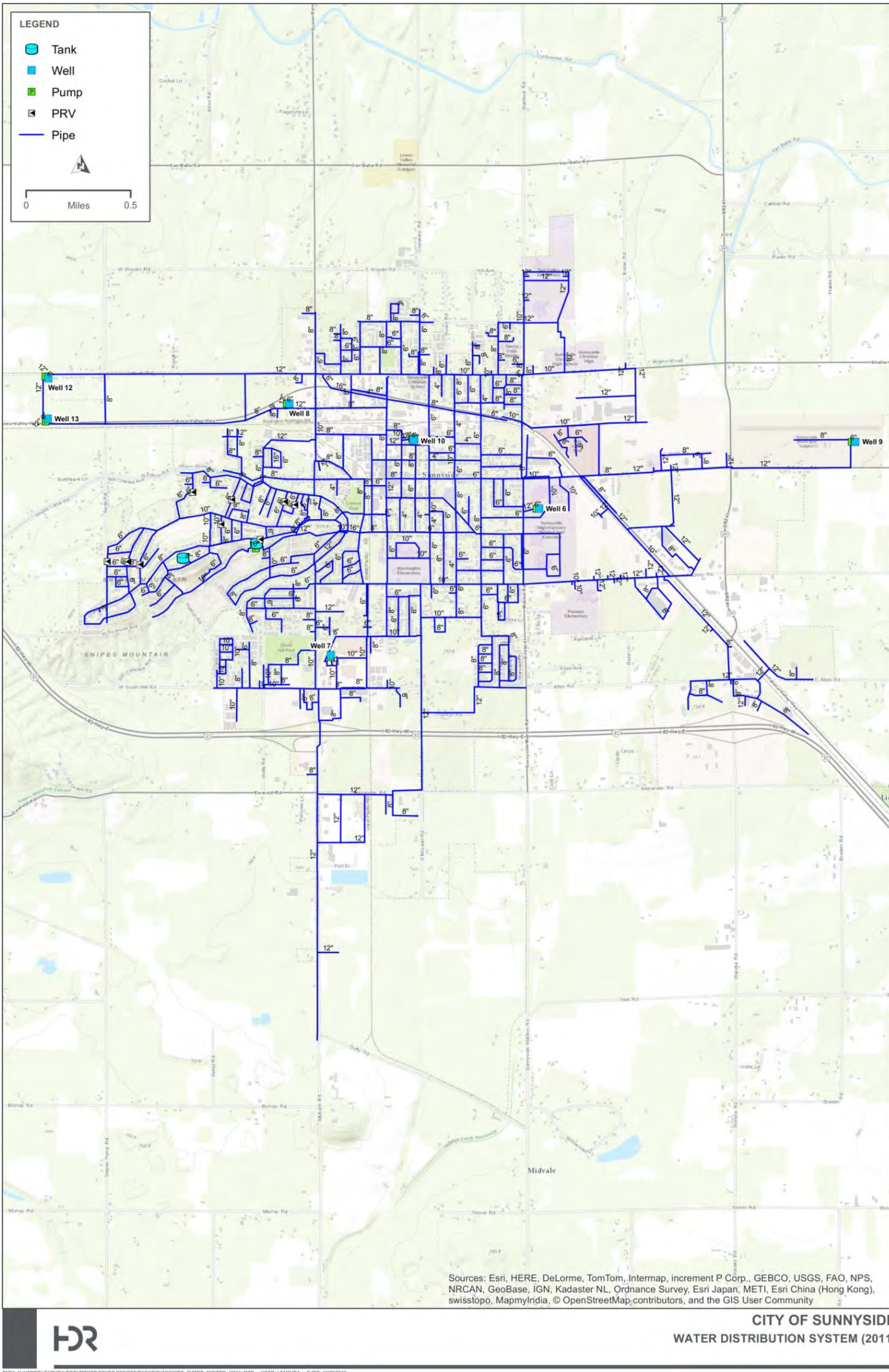
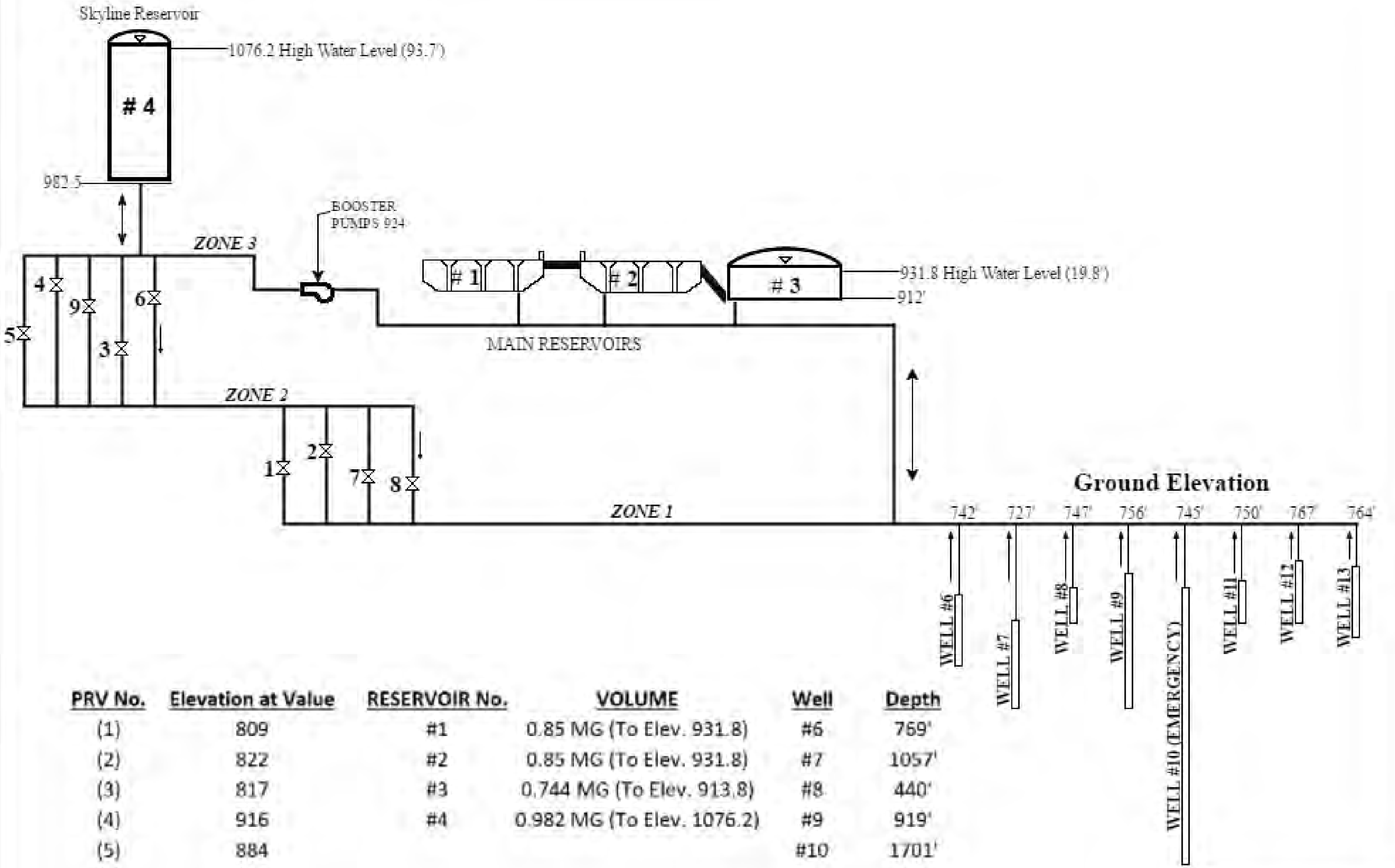


Figure 3-2 Water System Schematic



PRV No.	Elevation at Value	RESERVOIR No.	VOLUME	Well	Depth
(1)	809	#1	0.85 MG (To Elev. 931.8)	#6	769'
(2)	822	#2	0.85 MG (To Elev. 931.8)	#7	1057'
(3)	817	#3	0.744 MG (To Elev. 913.8)	#8	440'
(4)	916	#4	0.982 MG (To Elev. 1076.2)	#9	919'
(5)	884			#10	1701'
(6)	914			#11	435'
(7)	803			#12	397'
(8)	802			#13	431'
(9)	909				

FIGURE 5.2
Water System Schematic
2016

3.3.1 SOURCE

The City of Sunnyside is located in the Lower Yakima Valley between the major geologic features known as the Rattlesnake Mountains to the north and the Horse Heaven Hills to the south. In terms of geology, the area is in the West Central Columbia Plateau Province which is an area underlain by the Columbia River Basalt Groups. The basalts are overlain by an assorted mixture of sediments, including fluvial, glacial, and catastrophic flood deposits. Both the basalts and sediments in the Sunnyside area serve as aquifers suitable for groundwater production. The three major basalt formations are the Saddle Mountain, Wanapum, and Grande Ronde Basalts which form the Yakima Basalt Subgroup.

The basalt units were formed by successive eruption events resulting in a relatively thick sequence of individual lava flows. The thickness of individual flows ranges from a few feet to several hundred feet and is characterized by columnar jointing and fractures. At the top and bottom of the individual flows, a rubbly zone, made up of broken rock, generally occurs due to rapid cooling of the lava. Groundwater occurs predominately in the rubbly zone between flows and, to some extent, within fractures in the basalt. Sedimentary interbeds (typically sand, silt and gravel) between the lava flows are also capable of providing water. The City's deepest well (Well 10) is located in the Wanapum Basalt flow and contains hydrogen sulfide and methane and is maintained as an emergency well. Other municipal wells in the Yakima Valley in this aquifer also experience the same water quality issues. The City's other deep wells (Wells 6, 7, and 9) penetrate the Saddle Mountain Basalt flow group, and provide excellent water quality.

The sediments overlying the Saddle Mountain Basalt are comprised of clay, sand and gravel that are recharged within the Yakima basin by precipitation, irrigation canals, Yakima River, large irrigation using deeper aquifers and possibly "leakage" from deeper wells that have artesian flow. Wells 8, 11, 12 and 13 are developed in these unconsolidated materials.

Table 3-1 provides a summary of each well. Well logs and other construction information for these wells are provided in Appendix 3.

Table 3-1 Well Data

Well No. (DOH Source Number)	DOE Well Tag Number	Date Drilled	Depth	Ground Elevation (ft MSL)	Type Well	Depth to First Open Interval (feet)	Tested Capacity (gpm)	Original Developed Capacity (gpm)	Current Pumping Rate (gpm)
1		1907-08	166	740	Alluvium		420	490	Decommissioned
2		1927-29	833	740	Rock		230	350	Decommissioned
3		1939-40	1,162	746	Rock		930	780	Decommissioned
4		1944-46	1,576	746	Rock		1,200	1,000	Decommissioned
5		1953-54	458	740	Alluvium		1,400	1,400	Decommissioned
6 (S06)	AFL811	1962-63	769	742	Rock	523	1,570	1,380	650
7 (SO7)	ABR059	1972-74	1,057	727	Rock	541	1,000	1,000	1,100
8 (SO8)	AFL812	1994	440	747	Alluvium	325	800	800	750
9 (S09)	AFK905	1997	919	756	Rock	471	N/A	1,500	1,500
10 (S10)	AFL815	1998	1701	745	Rock	1202	2000	1,000	Emergency Use
11(S11)	AKN517	2005	435	750	Alluvium	380	800	500	500
12 (S12)	ALM337	2007	397	767	Alluvium	383		350	350
13 (S13)	BAL875	2010	431	764	Alluvium	351	850	650	650
									Total
									5,500

Wells 1-5 have been decommissioned due to either declining production, contamination or cascading water between the unconsolidated aquifer and the Saddle Mt. Basalt. Well 10 is considered an emergency well, and is not routinely used. Wells 12 and 13 are in close proximity to each other and withdraw from the same aquifer. The water from each well comes together for chlorination prior to their single entry into the distribution system; therefore they are considered a wellfield (DOH Source Number S14).

Table 3-2 documents the annual withdrawal from each well. Data is lacking for several months over the years due to problems with either the source meters or the old SCADA system. These difficulties have been corrected with the replacement and upgrade of all source meters and the SCADA system in 2012 and 2013. The difference between the City's Annual Water Report data and the WUE reported dated is attributed to the different time periods of each report. The annual report accounts for water from the 1st of each month through the last day of that month, whereas the WUE report is adjusted to be consistent with the service meter readings that occur in middle of the month. It should also be noted that the reporting year for 2009 WUE Report was June 15 - May 15 and therefore is not shown on Table 3-2. The difference between the 2015 source readings and the WUE reporting figure is less than 1%.

Table 3-2 Annual Water Production History by Well (Million Gallons)[1]

	Well Number											
Year	**6**	**7**	**8**	**9**	**10[2]**	**11**	**12**	**13**	**Total**	**WUE**	**Total-WUE**	**%**
2003	113.02	302.02	298.92	262.22	-	-			976.18			
2004	32.04	267.69	64.37	572.59	-	-			936.69			
2005	85.36	272.96	102.33	588.04	0.00	-			1048.69			
2006	57.35	337.19	158.47	344.07	0.00	126.73			1023.81			
2007[3]	8.85	250.86	182.71	384.39	0.00	134.12			960.93			
2008	38.83	175.71	302.60	360.61	0.00	98.30			976.05			
2009	46.88	209.99	287.37	254.39	0.00	210.77			1009.4	920.960	88.44	8.8%
2010[4]	1.18	42.68	110.70	495.42	0.00	167.91			817.89	940.940	-123.05	-15.0%
2011	18.023	114.80	326.02	466.87	0.00	37.93			963.65	964.527	-.877	-.09%
2012	7.33	226.07	241.40	388.41	0.00	225.28			1088.49	984.650	103.84	9.5%
2013[5]	6.65	38.72	172.90	344.22	0.00	90.87			653.36	740.838	-87.478	-13.3%
2014	5.78	48.71	166.67	563.11	0.00	60.72	41.89	105.05	991.93	948.453	43.48	4.4%
2015	3.06	166.79	112.12	268.11	0.00	117.07	111.21	243.44	1021.80	1,020.873	0.927	0.09%

[1] Data Source: 2003-2010: HDR 2012 Draft Water System Plan; 2011-2013 City's Annual Water Report spreadsheet
[2] Well No. 10 is an emergency well
[3] Omits production data from November 2010
[4] Omits production data from December 2007 and 2010
[5] Missing data for parts of August and October, and all of November, and December 2013

Auxiliary power generation is available at wells number 8, 9, 10, 11, 12 and 13.

All of the wells are capable of pumping 24 hours per day (7.92 million gallons) which would meet projected maximum day demands until about 2034 without WUE savings, and a few years after 2035 with WUE savings. While it capacity exists, it is undesirable to stress the wells at this level. The City's design standard calls for initiating a detailed study of additional sources with maximum day demand exceeding an 18 hour pumping day. That level of pumping (5.94 MGD) is projected to occur in 2018 without WUE savings. The desirable pumping duration of 20 hours per day (6.6 MGD) will be reached about 2024 without WUE savings and 2029 with WUE savings. Therefore an additional source of supply should be available between 2024 and 2028 depending on the success of reaching the WUE goal.

3.3.2 TREATMENT

All of Sunnyside's sources are chlorinated before entering the distribution system. Wells 6, 7, 8, and 9 utilize gas chlorine. Sodium hypochlorite is generated on-site at Well 11 for Wells 10 and 11. Liquid sodium hypochlorite is trucked from Well 11 to Well 12, which also serves as the injection point for Well 13. The City plans to move the unused on-site generator from the wastewater treatment plant to Well 12 in 2017.

Because Well 6 is located near the high school, the City intends to replace the gas chlorination system with an on-site liquid hypochlorite storage tank and injector in 2017. Similar tanks and injectors are planned to be installed at both Grandview and Skyline reservoirs sites for emergency chlorination in 2021 and 2022.

Additional disinfection equipment will be installed with the addition of additional sources in the future

3.3.3 STORAGE

Sunnyside's reservoir storage consists of four tanks totaling 3.426 million gallons of storage, not all of which is useable due to service connections near the Skyline tank. This volume is less than noted in previous reports because of a change in operations which provides a greater safety factor above the high pumping level. Between that level and the overflow level there is an alarm level, which provides 24 hour notifications if there is a control problem and the water level is still rising above the pumping level and allows time for manual shut down of the pumps before the tanks are overflowing.

Three side-by-side concrete tanks located on Harrison Hill are designated as the Grandview 1, 2 and 3 Reservoirs. The three are interconnected so they share a common water level with a total volume of 2.444 MG when the level is at elevation 931.8. Grandview Reservoirs 1 and 2 were built in 1942 and Grandview Reservoir 3 was constructed in 1962. These reservoirs serve Zone 1 directly as well as being the source for the booster pump station delivering water to the Skyline Reservoir located at the top of Harrison Hill. The area around the Grandview Tanks is served by pressure Zone 2. There are a few water services at the upper level of Zone 1 on Riverside Ave. whose pressure may drop below the design pressure of 30 psi if the storage in Grandview reservoirs would drop significantly. The City is planning to switch these customers to a higher pressure zone in 2019.

The Skyline Reservoir, built in 1962, has a volume of .982 MG when filled to elevation 1,076.2 and provides water service to pressure Zone 3 and then to Zone 2 through nine pressure reducing stations. Only 255,630 gallons is available to provide 30 psi at the base and 497,753 gallons at 20 psi. These volumes are available to not only pressure Zones 2 and 3, but if needed, to the entire system through the pressure reducing stations between Zone 2 and 1. The Skyline Reservoir is a standpipe and is in need of seismic and other structural upgrades.

For analysis and forecasting purposes, effective storage of 2.444 MG and .256 MG for a total of 2.7 MG will be used for the entire system storage evaluation since required standby storage is greater that fire flow requirements. Even though the fire flow requirement for Zones 2 and 3 is greater than the standby requirement, they can be met using the 30 psi volume of the Skyline tank.

Table 3-3 Existing Storage Components

Tank	Volume (Million Gallons)
Grandview #1	.85
Grandview #2	.85
Grandview #3	.744
Grandview Total	2.444
Skyline	.982 (.498 above 20psi; .256 above 30 psi
Total	3.426 (2.7 above 30psi in Skyline Tank

All of the tanks are cleaned and inspected on a regular basis with the next work scheduled for 2017. A Reservoir Assessment Technical Memorandum was completed by HDR consults in 2011 made several recommendations to address issues that were identified. The City has addressed many of the recommendations and will be repainting and making structural improvements to the Skyline Reservoir within the next few years. Other minor repairs to the concrete tanks remain to be made.

A detailed analysis of the storage capacity required to serve the entire system shows a deficit shortly after 2025 without WUE savings and without another source of supply. If the WUE goal can be met, the deficit isn't realized until about just before 2030. The details of this analysis are presented in Table 3-6.

For pressure Zones 2 and 3 that are served by the Skyline tank, an excess storage capacity of over 56,000 gallons exists at the end of the 20 year planning period at the 30 psi volume. This does not take into account any water that by be discharged to the pressure Zone 1 through the lower set of pressure reducing valves. These calculations are shown in Table 3-7.

Figure 3-3 and Figure 3-4 show the various storage components for each reservoir using figures from Table 3-4 and Table 3-5.

Figure 3-3 Grandview Tank*

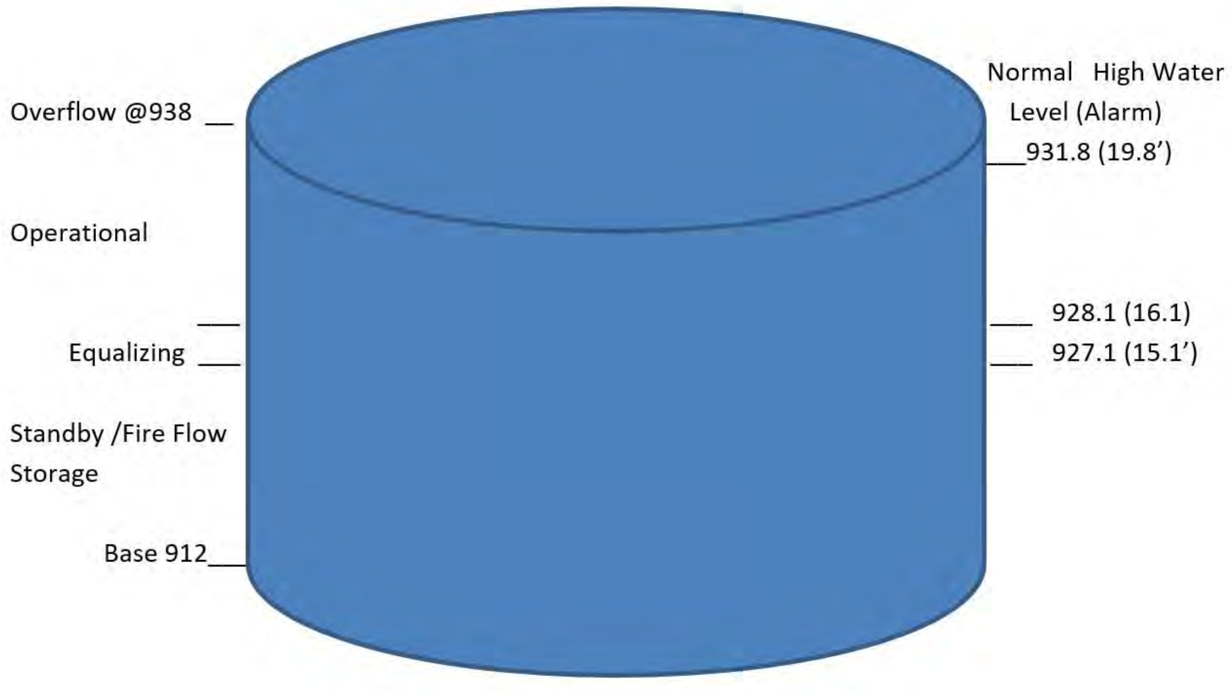


Table 3-4 Based on Total Number of Connections (Zones 1, 2, and 3)

Current Storage Requirement[1]	Volume (gallons)	Feet
Dead Storage	0	
Fire Flow	0[2]	
Standby	1,866,000[3]	15.1
Equalizing	125,100	1.0
Operational	7,500	0.1
Total Required	1,998,600	16.2
Available from Grandview Tanks	444,437	3.6

* The dimensions of Grandview tanks 1 and 2 are unknown at this time. Liquivision Technology Inc. measured the interior after the 2017 cleaning, but their report was not available as this WSP was being finalized. Tank volumes were estimated assuming one 2.444 MG circular tank.

Figure 3-4 Skyline Tank

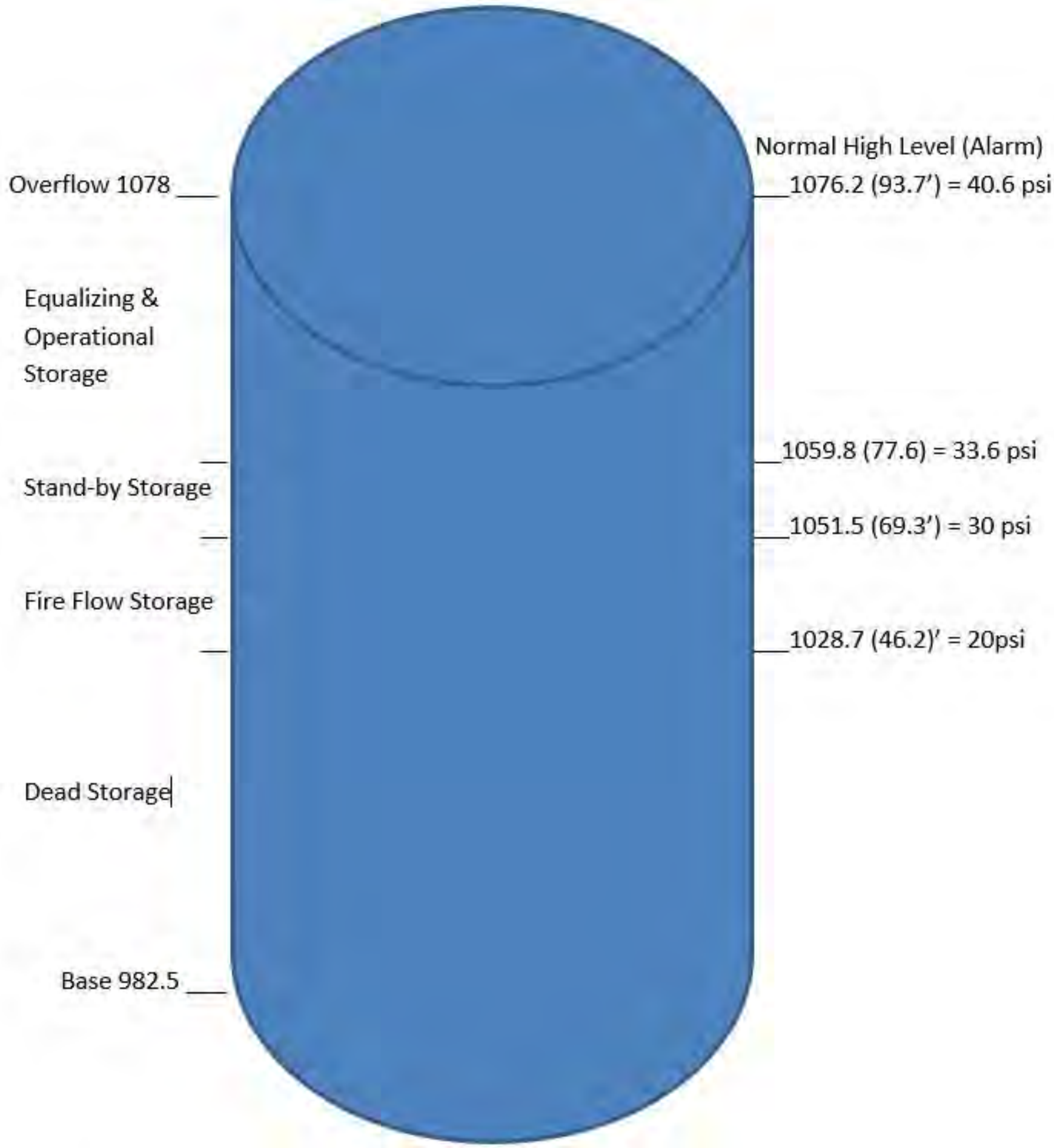


Table 3-5

Current Storage Requirement[1]	Volume (gallons)	Feet
Dead Storage	487,391	46.2
Fire Flow	180,000	17.2
Extra fire storage to provide 30psi standby	61,841	5.9
Standby	86,800	8.3
Equalizing	12,907	1.2
Operational	1,510	.2
Total Required	830,449	79.0
Available >30psi	154,078	14.7

3.3.4 Booster Pump Station

A five pump booster pump station is located at the Grandview tank site which pumps water through the high pressure zone (Zone 3) distribution system to the Skyline reservoir. The booster pump operation is controlled by the water elevation in the Skyline Reservoir and is varied throughout the year based on anticipated daily water demand in pressure Zones 2 and 3. The station is supplied with an emergency generator to provide auxiliary power. Table 3-8 lists basic data for the booster pumps.

Table 3-6 Storage Capacity

Year	ERUs	gpd/ERU	Fire[1]	Standby[2]	Equalalizing[3]	Operational[4]	Total	Existing[5]	Remaining
2015	9,330	297.4	1,320,000	1,866,000	125,100	7,500	1,998,600	2,700,000	701,400
2020	10,301	297.4	1,320,000	2,060,200	208,200	7,500	2,275,900	2,700,000	424,100
2020	10,301	272.4	1,320,000	2,060,200	122,700	7,500	2,190,400	2,700,000	509,600
2025	11,373	297.4	1,320,000	2,275,000	322,350	7,500	2,604,850	2,700,000	95,150
2025	11,373	272.4	1,320,000	2,275,000	223,800	7,500	2,506,300	2,700,000	193,700
2030	12,557	297.4	1,320,000	2,511,000	443,700	7,500	2,962,200	2,700,000	-262,200
2030	12,557	272.4	1,320,000	2,511,000	325,500	7,500	2,844,000	2,700,000	-144,000
2035	13,864	297.4	1,320,000	2,773,000	558,150	7,500	3,338,650	2,700,000	-638,650
2035	13,864	272.4	1,320,000	2,773,000	457,200	7,500	3,237,700	2,700,000	-537,700

[1] 5,500 gpm x 4 hours = 1.32 MG

[2] 200 gallons x ERU (larger volume than DOH recommended equation of 2(ADD x ERU) – 1440 x (5,500-1,500))

[3] (PHD-$Q_{s)}$ x 150 minutes = (PHD-5,500) x 150minutes

[4] 750 gpm x 10 minutes = 7,500

[5] 2.444 MG from the Grandview Tanks and .498 MG from Skyline Tank (water above 20 psi level)

Table 3-7 Zone 2 & 3 Storage with and without WUE Savings (Gallons)

Year	ERUs	gpd/ERU	Fire[1]	Standby[2]	Equalalizing[3]	Operational[4]	Total	Existing (30psi)	Remaining
2015	434	297.4	180,000	86,800	12,907	1,510	194,417	255,630	61,213
2020	479	297.4	180,000	95,800	14,088	1,510	195,598	255,630	60,032
2020	479	272.4	180,000	95,800	12,933	1,510	194,443	255,630	61,197
2025	529	297.4	180,000	105,800	15,705	1,510	197,215	255,630	58,415
2025	529	272.4	180,000	105,800	14,319	1,510	195,829	255,630	59,801
2030	584	297.4	180,000	116,800	17,319	1,510	198,831	255,630	56,799
2030	584	272.4	180,000	116,800	15,705	1,510	197,215	255,630	58,415
2035	645	297.4	180,000	129,000	18,938	1,510	200,448	255,630	55,182
2035	645	272.4	180,000	129,000	17,552	1,510	199,032	255,630	56,598

[1] 1500 gpm x 2 hours = 180,000 MG

[2] 200 gallons x ERU (larger volume than DOH recommended equation of 2(ADD x ERU) – 1440 x (1,693 – 800))

[3] (PHD-Q_5) x 150 minutes = (PHD – 1,693 x 150 minutes) Where flow available exceeds PHD, use 5% MDD

[4] 151 gpm x 10 minutes = 1,510 gallons

Table 3-8 Booster Pump Capacity

Pump No.	HP	Design Capacity (gpm)
1	40	800
2	20	457
3	10	167
4	10	118
5	10	151
Total		**1,693**

The 1,693 gpm pumping capacity of the booster pump station exceeds the 2035 anticipated peak hour demand of 533 gpm. Minor concrete repairs were identified in the Reservoir Assessment memorandum and will be addressed when the concrete tank refurbishing is done.

3.3.5 PRESSURE ZONES

The City utilizes three pressure zones to provide water throughout their service area. All of the well sources pump directly into Zone 1 and the Grandview storage tanks. The booster station moves water from the Grandview tanks through Zone 3 to the Skyline tank. Five Pressure Reducing Stations lower the pressure from Zone 3 to Zone 2, and 4 stations allows water from Zone 2 to flow back into Zone 1 if the demand warrants. Some of these stations have combination pressure reducing / pressure sustaining valves that not only reduces the higher inlet pressure to a steady lower pressure regardless of changing flow rate or varying inlet pressure, but also protects against loss of upstream pressure should excessive flow occur through the valve. Table 3-9 provides information on the locations, elevations and pressure characteristics of each of the pressure reducing valves and Figure 3-5 shows the pressure zone boundaries.

Figure 3-5 Static Pressure Zone Map

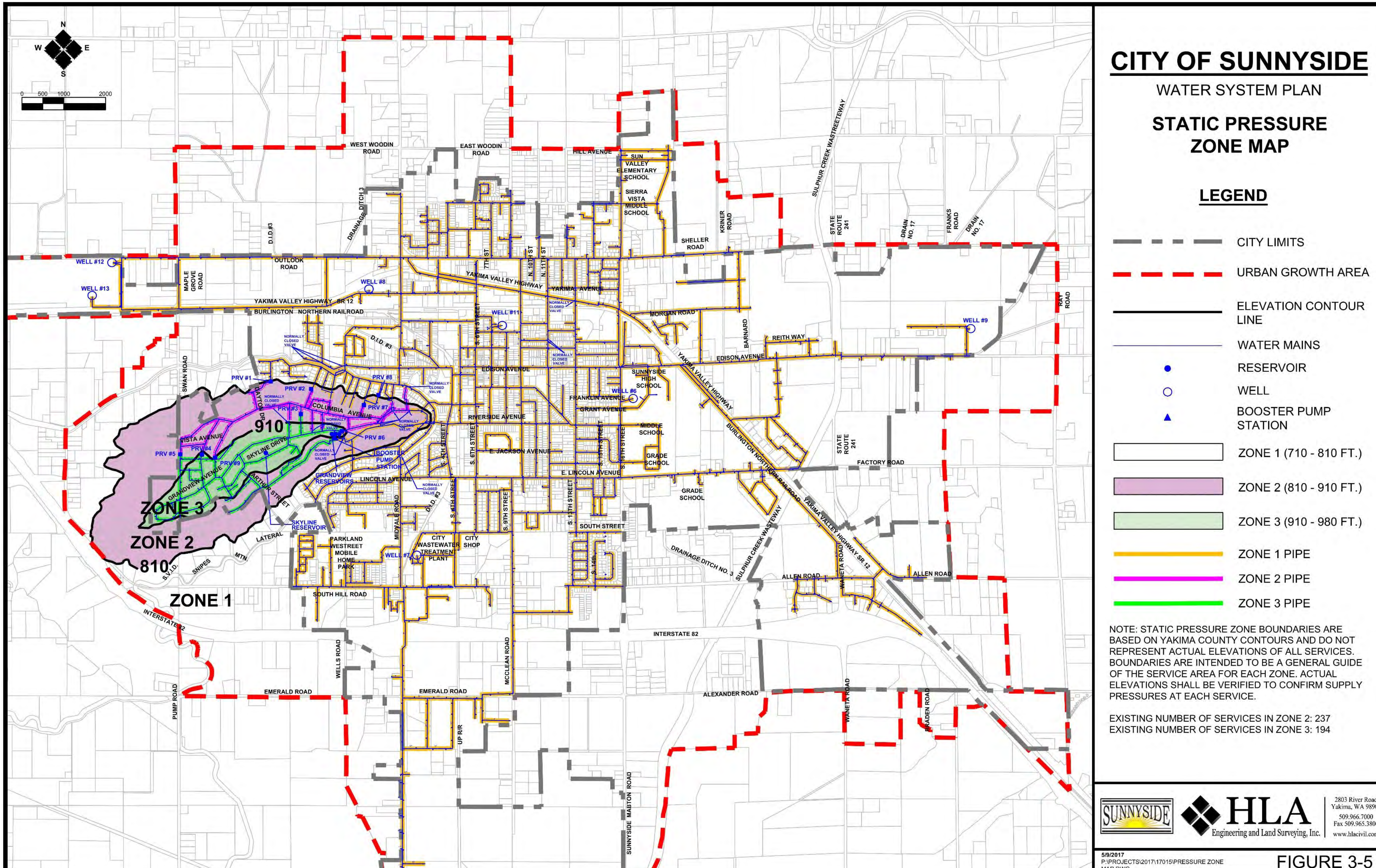


Table 3-9 Existing Pressure Reducing Valves (PRVs)

PRV No.	Location of PRV	Elevation	Valve Size	*Cla-Val Model No.	Inlet PSI	Outlet PSI	Sustaining PSI
Zone 3 → Zone 2							
3	Terry & Columbia Ave.	871	6”	90G-01AB	83	58	
4	Upland & Vine	915.9 916.4	1 ½” 6”	90G-01AS 90G-01AB	68 68	47 42	
5	Swan Rd & Vine	883.6	6”	92G-01B	80	55	50
6	328 Grandview	914.3 912.2	1 ½” 6”	90G-01AS 90G-01AB	65 65	45 40	
9	Vine & Taylor	908.8 909	1 ½” 6”	90G-01AS 90G-01AB	67 67	50 50	
Zone 2 → Zone 1							
1	Darrin Court & Dayton Dr.	809.9 810.1	1 ½” 6”	90G-01AS 92G-01B	98 98	53 48	65 65
2	545 Terry	822.2	6”	92G-01B	83	58	50
7	San Clemente & S. Lookout	803.4 803.6	2” 6”	92G-01BS 92G-01BCS	102 102	57 52	60 60
8	South Lookout	802.0 802.2	2” 6”	92G-01BS 6" 92-01	102 102	58 53	60 60

3.3.6 DISTRIBUTION SYSTEM

The distribution system consists of over 80 miles of pipelines from 1 inch to 16 inches in diameter. The City has been replacing and updating various components of the distribution system annually (including replacement of old and defective mainline valves, fire hydrants and corroded pipelines) and eliminating some of the hydraulic restrictions that have been identified in past hydraulic modeling. The most recent larger project was the 12” transmission line from the new wellfield (Wells 12 and 13) to the main distribution system.

Based upon the extensive modeling performed for the approved 2005 WSP, the draft 2012 WSP, and recent updates for the wellfield project, DOH has granted the City’s request not to include another hydraulic model in this WSP. All previously identified piping deficiencies that have not yet been addressed are included in the recommended Capital Improvement Program (CIP) presented in Section 8 of this plan. The corrective projects are sorted by fire flow deficiencies and desired looping of the distribution system to improve reliability.

Previous hydraulic models used Haestad’s WaterCad Version 6 (2005 WSP) and WaterGEMS software. Both models were calibrated / validated by comparing actual fire flow tests at various locations throughout the distribution system with computer generated results.

3.3.7 DISTRIBUTION SYSTEM LEAKAGE

Distribution system leakage (DSL) is defined as the difference between the water produced and the authorized water used during a twelve month time period. All of the City's water services are metered, as is authorized water used by contractors and city departments from fire hydrants. Sanctioned water use by fire department is tracked and estimated and is considered "authorized". The annual DSL is shown in Table 3-10. The current rolling three year average of 2.3% is less than the DOH standard of 10%.

Table 3-10 Distribution System Leakage[1]

Year (Jan.-Dec.)	Production (Gallons)	Authorized Consumption (Gallons)	Distribution System Leakage (Gallons)	Annual Distribution System Leakage (Percent)	3 year Average Distribution System Leakage (Percent)
2007					
2008	888,823,000	841,601,764	47,221,236	5.4%	
2009	920,960,000	902,686,559	18,273,441	2.0%	4.8%
2010	940,939,500	919,682,456	21,257,044	2.3%	3.2%
2011	964,527,000	935,163,812	29,363,188	3.0%	2.4%
2012	954,650,000	920,962,288	33,687,712	3.5%	2.9%
2013[2]	740,838,472	750,163,216	-9,324,744	-1.3%	2.9%
2014[2]	948,453,000	930,841,868	17,611,132	1.9%	2.8%
2015	1,020,873,000	1,005,157,164	15,715,836	1.5%	2.3%

[1] Data Source: WUE Annual Performance Report

[2] 2013 and 2014 data are not complete due to lack of data and data loss while making meter and SCADA changes

3.3.8 CONTROL SYSTEM

The City of Sunnyside's water system is controlled by a Supervisory Control and Data Acquisition (SCADA) system that was installed in 2013. The system in located in the water system division's office at 4th and Lincoln Ave. The control center has an emergency generator that will keep the SCADA operational in event of a power outage in the main grid. The system is being updated yearly with the new control centers at major facilities. The Grandview Booster Pump Station was upgraded in 2016, and Well 7 is scheduled for an upgrade in 2017.

The system monitors water levels Grandview and Skyline water reservoirs, as well the flow rates at each well and the Grandview Booster Pump Station. Pump operation is controlled by reservoir level set points which are adjusted according to anticipated water demands. Likewise, the pump sequencing is varied throughout the year based on anticipated daily water demand.

3.4 SYSTEM CAPACITY ANALYSIS

Future water demands have been calculated for the ERU projections using a 2% annual growth rate. This method was chosen rather than using individual customer classes because of the potential large impact of commercial growth and its unpredictability. The 2015 commercial demand of 535 MG is 15% greater than the 2010 demand of 466 MG as reported by HDR. This impact of this growth is further shown by the 2015 commercial share of the total demand being 54%, as compared to the 2010 share of 48%. The total demand is the critical factor, and not the projected demands by each classification.

DOH's Water System Design Manual (WSDM) presents a method of identifying capacity limitations by calculating the number of ERUs supported by available source and storage facilitates. Using the formulas on Table 6-1 of the WSDM, the number of ERUs for source and various types of storage were calculated and presented in Table 3-11. The table shows the various capacities for both the current ERU value of 297.4 and the WUE goal value of 272.4 and the approximate year that the identified ERU is projected to occur, along with the projected ERUs for that year.

Table 3-11 Source and Storage Capacity

ERU Value	Current Component	ERUs	Year & ERU	If 500 gpm Additional Source is available		If 1000 gpm Additional Source is available	
				ERUs	Year & ERU	ERUs	Year & ERU
297.4 g/ERU	Source –Annual Average	22,562	>2035				
	Source – Peak Day	11,281	2024 - 11,150	12,105	2028 – 12,069	13,114	2032 -13,064
	Equalizing Storage	11,680	2027 – 11,833	11,932	2028 – 12,069	12,184	2029 – 12,311
	Standby Storage*	11,713	2027 – 11,833	11,963	2028 – 12,069	12,213	2029 – 12,311
	Total Capacity Related Storage	11,709	2027 – 11,833	11,959	2028 – 12,069	12,210	2029 – 12,311
272.4 g/ERU	Source –Annual Average	24,633	>2035				
	Source – Peak Day	12,316	2029 – 12,311	13,216	2032 – 13,064	14318	>2035
	Equalizing Storage	12,040	2028 – 12,069	12,315	2029 – 12,311	12,535	2030 – 12,557
	Standby Storage*	12,038	2028 – 12,069	12,288	2029 – 12,311	12,563	2030 – 12,557
	Total Capacity Related Storage	12,035	2028 – 11,833	12,292	2029 – 12,311	12,550	2030 – 12,557

* Includes Skyline Reservoir storage above the 30 psi level

In addition to showing the year that new source and storage facilities are required, three important observations are revealed:

- The importance in achieving the WUE goal of reducing the ERU value in delaying the year improvements are required by a year.
- The importance is securing a new well on line by 2024 for not only meeting peak day demands, but in also delaying the need for an additional reservoir.
- The importance of tracking annual growth and related ERUs, especially with respect to commercial growth where one large customer may be equivalent to 2 or more years of projected ERU growth.

3.5 WATER QUALITY ANALYSIS

The City monitors water quality at each of the sources and within the distribution system as required by DOH and the SDWA regulations. These regulations establish both primary (health related) maximum contaminate levels (MCLs) and secondary levels (non-health related). The secondary levels address items such as color, taste, and odor. The current water quality monitoring schedule as provided by DOH is located in Appendix 8. Sunnyside's water quality is consistently below the primary water quality levels (MCLs). Because of high levels of hydrogen sulfide, iron, and manganese Well 10 exceeds some of secondary MCLs. Although these chemicals do not have health related MCLs, they are undesirable due to taste and odors and staining. For these reasons, Well 10 is maintained as an emergency well. Water from this well has not entered the distribution system since about 2000.

3.5.1 SOURCE MONITORING

Several of the individual chemicals can be analyzed in a group (test Panel) while others must be tested individually (Analyte). Each source has its own schedule which reflects previous monitoring history or susceptibility to contamination. Because Wells 12 and 13 have been designated as a wellfield, one sample may be taken from tap after the water from the wells are co-mingled. DOH has issued waivers to the standard required monitoring frequency for many of the chemicals due to their lack of use in the area or past results showing the levels to be consistently below levels of concern.

City staff collects all of the required samples and submit them to Washington State Certified laboratories for analysis and reporting to the City and DOH.

Source monitoring requirements include the following test panels and analytes as shown in Table 3-12.

Table 3-12 Source Monitoring

Test Panel / Analyte	General Frequency	Location
Nitrate	Annually	After treatment, before first customer
Complete Inorganic Chemicals (IOC)	Standard - 3 years Waiver - 9 years	After treatment, before first customer (includes Nitrate) Some chemicals are required to be monitoring every three years, and others every 9 years.
Volatile Organic Chemicals (VOC)	Standard - 3 years Waiver - 6 years	After treatment, before first customer
Herbicides	Waiver - 9 years	After treatment, before first customer
Pesticides	Waiver - 9 years	After treatment, before first customer
Soil Fumigants	Waiver - 3 years	After treatment, before first customer
Radium 226	Standard – 3, 6 year	After treatment, before first customer
Radium 228	Standard – 3, 6 years	After treatment, before first customer
Gross Alpha	Standard 6 years	After treatment, before first customer
E-coli	Following a positive coliform result in a routine distribution sample	Before treatment

The water quality results in all of the City's operating wells are well below the regulatory limits.

3.5.2 Distribution System Monitoring

Distribution system water quality is monitored for various parameters as required by the regulations and shown in Table 3-13. Samples are collected from various locations within the distribution system in accordance with sample plans that the City has developed for each parameter. The frequency of these samples is based on the population served by the system. The coliform monitoring plan has been recently updated to include the Revised Total Coliform Rule and Groundwater Rule requirements.

Table 3-13 Distribution System Monitoring

Analytes	Current Frequency	Location
Colilform	15 / month	Identified in the 2016 monitoring plan
Lead and Copper	30 / 3 years	Identified on Pb & Cu sampling map and address list*
Disinfection By-Products (TTHMs and HAA5s)	Reduced 1 / yr.	Identified in the 2004 D/DDP Compliance Program.
Asbestos	1 / 9 yrs.	Area served by transite (Asbestos Cement) pipe
Chlorine Residual	Daily	Continuous monitoring with low level alarms at Grandview Reservoirs, and at wells 11,12, and 13. Daily grab samples (Monday-Friday) at all operating wells (basis of monthly DOH report)

* City plans to review the monitoring sites and revised as necessary which may include adding additional sites and/or replacing

The City experienced two total coliform detections in July and September 2016 however all repeat and groundwater samples were satisfactory. The coliform present samples were collected from a sink used for cleaning the area where raw beef is handled. This site has been replaced with a more representative site for routine sampling in the most recent Coliform Monitoring Plan.

3.5.3 Recent and Possible Future Water Quality Regulation Changes

Recent changes to the water quality regulations include the Groundwater Rule (GWR) and the Revised Total Coliform Rule (RTCR). Both of these rules have been incorporated into the City's operational plans and the Coliform Monitoring Plan. The Lead Free Act of 2011 reduced the allowable lead content of materials used in public water supplies to less than .25% and was effecting in January 2014. The City is complying with the new provisions.

Possible future regulations include revisions to the Lead and Copper Rule and a change to the Chromium maximum contaminate level.

3.6 Summary of System deficiencies

This section summarizes the deficiencies identified in Sections 3.2 thru 3.4.

- Source: Additional water supply will be required to meet projected maximum day demands. The timing of the additional source(s) is dependent on ERU growth and the effectiveness of achieving the WUE goal.
- Treatment: For safety reasons, the gas chlorinator at Well 6 (near the high school) needs to be replaced. Emergency chlorination equipment at both reservoir sites is desirable.
- Storage: Additional storage will be required to meet standby and equalizing demands. The timing will depend on ERU growth, the effectiveness of achieving the WUE goal, and the addition of new source(s) of supply. Improvements to all of the tanks need to be made to improve safety and extend their useful life.
- Booster Pumps: Minor pump vault improvements are required.
- Pressure Zones: Adjustment of the pressure zone boundary between Zone 1 and 2 is needed to address lower pressures in a portion of Zone 1 near the Grandview Tanks.
- Distribution System: Continue to address fire flow and looping issues previously identified.
- Control System: Upgrade the SCADA controls in Well 7.
- Water Quality: The Lead and Copper Monitoring Plan is in need of updating.

3.7 Analysis of possible improvement projects

Many of the deficiencies identified in Section 3.5 are relatively straight forward, and do require an extensive evaluation alternative with the expectation of additional source and storage.

3.7.1 Additional Water Supply Alternatives

The alternative sources of supply include:

- Re-evaluating Well 10 to determine current conditions. If it still pumps water that will be objectionable, consider a relative long pump (i.e. 7 days) to waste to determine the effect on water quality. Revisit the 2007-08 engineering work for possible treatment of this well and update the treatment alternative with desktop analysis of available treatment techniques and costs (both capital and O&M). There would be value in utilizing this well since it is in the Wanapum Basalt Flow and its pumping would not affect the other city wells that utilize different aquifers. Other wells in the Wanapum Basalt Flow in the Yakima Valley exhibit similar water quality problems.
- Obtaining and converting an existing well for use as a potable water supply

- Obtaining new well site(s) and drilling new well(s).

In addition to the actual future demands, the number of new sources required will depend on the volume of each new source. If new wells are to be drilled, a hydrogeological study would need to be conducted to determine the optimum location, size, and depth of the new wells. From a water distribution viewpoint, new sources south of Interstate 82 would be desirable because of the amount of land available for future commercial growth/demand. A well in this location would also reduce the possible head loss in the north side distribution system due to increased flows if all the identified distribution looping projects are not completed by the time a new source is put on line.

The water right component of the additional water supply is discussed in Chapter 4.3.

3.7.2 Additional Storage Alternatives

The questions regarding additional storage include how much volume is required, the location and type of storage, and the timing. Because of the potential of major growth south of Interstate 82 it would be desirable to locate the new storage in that area. Unfortunately the only higher elevation is at the very south end of the future service area (and perhaps just outside). Locating tank in a more central portion would require either a standpipe, composite elevated tank, or a ground level tanks with booster pumps. As the City approaches the date when an additional tank is needed, an engineering report to further investigate these alternatives will be required.