Chapter 6 - Potable Water System Analysis

Chapter 6

POTABLE WATER SYSTEM ANALYSIS

This chapter presents an overview of the City's existing and future potable water distribution systems, water supplies, and storage facilities. In this chapter, the water systems are identified and evaluated. Then, based on the system evaluation results, improvement projects are identified to address the identified deficiencies. This chapter is divided into the following sections:

- **Existing System Description:** This section discusses the facilities that make up the existing potable water system.
- **Potable Water Model Description:** This section describes the hydraulic model including hydraulic model updates, as well as model demands.
- **Existing System Analysis:** This section presents the findings and improvement recommendations for the potable water system under existing demand conditions. Additionally, the findings from the facility condition assessment are presented in this section.
- **Future System Analysis:** This section presents the findings and improvement recommendations for the potable water system under future demand conditions with the existing system recommendations in place.
- **Proposed Improvements:** This section summarizes the improvement recommendations, which are prioritized and phased in the capital improvement program (CIP) described in Chapter 10 of this One Water 2050 Plan.

6.1 Existing Potable Water System

The existing potable water system facilities include five pressure zones, four groundwater wells, seven storage reservoirs, six booster pump stations (PSs), three pressure reducing valves (PRVs), and approximately 83 miles of pipeline. Information regarding the existing potable water system is discussed in further detail in the sections below.

6.1.1 Water Supply Sources

The City potable water is supplied from groundwater wells, purchased water from the City of Pasadena, and from Metropolitan Water District (MWD) water on an as needed basis. The City overlies the Main San Gabriel Groundwater Basin.

The City's main water source is well water, and South Pasadena's four groundwater wells are listed in Table 6.1. Well water and/or MET water supplies the Central Pressure Zone; from there, water is pumped to the customers in the Bilicke, Magnolia, and Raymond Pressure Zones. The Pasadena Pressure Zone is a closed loop pressure zone supplied solely by water purchased for the City of Pasadena. In emergency situations, South Pasadena can supply the Pasadena Pressure Zone by opening a valve between the Raymond Pressure Zone and the Pasadena Pressure Zone. This would merge the Raymond and Pasadena Pressure Zones.

Additionally, South Pasadena has an interconnection with the City of Alhambra, which hasn't been used in the past 30 years, based on the 30 years of historical supply records analyzed in Chapter 3. A more in-depth description of South Pasadena supply sources, historical water supply, and water quality is provided in Chapter 5.

Table 6.1 Existing Groundwater Wells

Name	Groundwater Basin	Supply to Zone	Capacity (gpm)	Well Status
Graves Well 2	Main San Gabriel Basin	Central	800	Active
Wilson Well 2	Main San Gabriel Basin	Central	1,200	OOS
Wilson Well 3	Main San Gabriel Basin	Central	1,900	Active
Wilson Well 4	Main San Gabriel Basin	Central	1,100	Active
Total Well Capacity	**N/A**	**N/A**	**3,800** (1)	**N/A**

Notes:
Abbreviation: Out of Service (OOS)
(1) The total capacity for active wells only.

As shown in Table 6.1, the City has three active wells in the Main San Gabriel Basin. The City's total potable supply capacity from groundwater is approximately 3,800 gpm or 21.5 mgd. Most of the City's groundwater is produced at the Wilson Well Field. At both the Wilson Well Field and at the Graves Well, groundwater is pumped, treated, and stored at the onsite Reservoirs, where it can be stored or boosted into the distribution system as needed. Wilson Well 2 stopped operating due to collapse in 1992; a new casing was installed in 2008; and the well was rehabilitated in 2015. Based on previous analysis, South Pasadena estimates that the well is capable of pumping 800 to 1,000 gpm. There is currently no pump installed on Wilson Well 2.

6.1.2 Water Distribution System

This section describes the existing distribution system facilities and provides an understanding of the existing system operations. The following sections provide a description of the system pressure zones and water system facilities that comprise the City's distribution system, including booster pump stations, reservoirs, PRVs, and pipes. A map of the City's distribution system is presented on Figure 6.1. More detailed maps for each of the City's facilities are included in Appendix E.

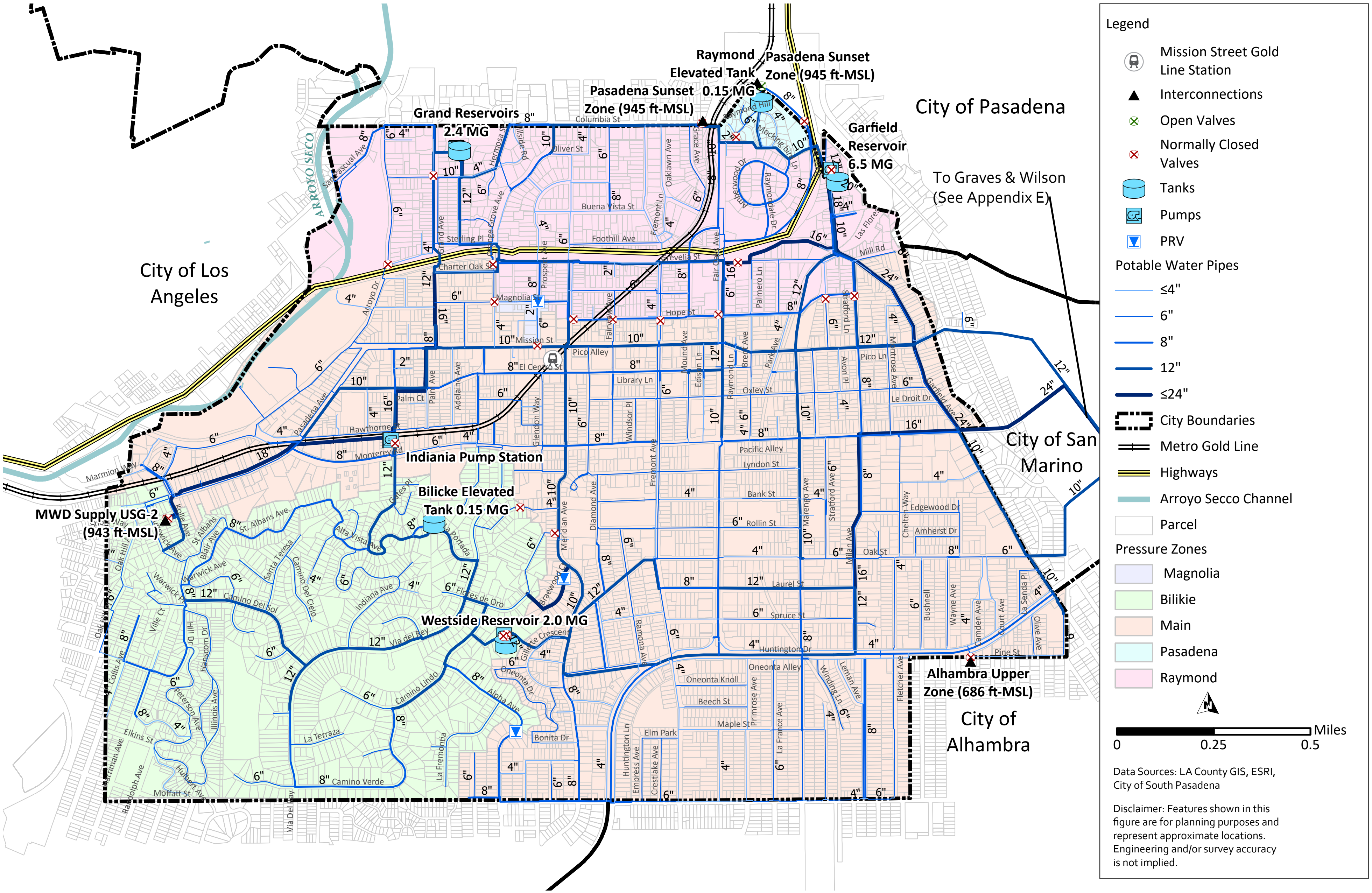

Figure 6.1 Existing Potable Water System as Modeled

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6.1.2.1 Pressure Zones

Potable water systems are typically divided into different hydraulic regions, known as pressure zones, to maintain adequate pressures throughout the distribution system due to varying topography. A hydraulic grade line (HGL) is established for each pressure zone. The high-water levels in reservoirs are set to maintain these HGLs. The City's service area ranges in ground elevation from approximately 540 feet above sea level (ft-msl) to about 905 ft-msl.

The City's distribution system is divided into 5 pressure zones. The HGLs, reservoirs, pump stations, and PRVs of each pressure zone are listed in Table 6.2. The existing water facilities and delineation of the pressure zones are shown on Figure 6.1.

Table 6.2 Existing Pressure Zones

Pressure Zone	HGL (ft msl)	Storage Reservoirs	Pump Stations (Discharges to Zone)	PRV (Discharges to Zone)	Zone ADD (mgd)
Bilicke	963	Bilicke Tank	Indiana PS, Westside PS	N/A	-
Central (Main)	746	Garfield Reservoir, Grand Reservoir, Graves Reservoir, Westside Reservoir, Wilson Reservoir MET USG-02 Connection	Graves PS, Wilson PS	Alpha PRS, Braewood PRV	
Magnolia	820	N/A	N/A	Magnolia PRV	
Pasadena	945	N/A	N/A	N/A	
Raymond	881	Raymond Tank	Garfield PS, Grand PS	N/A	

As shown in Table 6.2, the City's existing storage is in the Bilicke, Central, and Raymond Pressure Zones. The majority of the storage capacity is located in the Central Pressure Zone. The City owns six booster pumping stations (PSs). Five of the six PSs (Garfield, Grand, Graves, Westside, and Wilson) are located at reservoir sites. These pumps boost water from the reservoir to the upstream pressure zones. The Indiana PS pumps water directly from the Central Pressure Zone to the Bilicke Pressure Zone.

The existing water demands within each zone are presented in Table 6.3. As mentioned in Chapter 3, the City experienced low demands since year 2014 due to conservation mandates in response to the state-wide drought. The existing demands in this plan refers to the average demand of year 2014 through year 2019. As shown in Table 6.3, the City's Average Day Demand (ADD) is 3.20 mgd and the Maximum Day Demand (MDD) is 4.81 mgd. The majority (60.1 percent) of the City's existing demand is located in the Central Pressure Zone, which has an existing ADD of 1.92 mgd. The second highest demand (23.2 percent) is in the Raymond Pressure Zone, which has an existing ADD of 0.74 mgd.

Table 6.3 Existing Pressure Zone Demands

Name	HGL (ft msl)	ADD[1] (mgd)	MDD[2] (mgd)	Percent (%)
Bilicke	963	0.49	0.74	15.4%
Central (Main)	746	1.92	2.89	60.1%
Magnolia	820	0.02	0.03	0.7%
Pasadena	945	0.02	0.03	0.7%
Raymond	881	0.74	1.11	23.2%
Total	**N/A**	**3.20**	**4.81**	**100%**

Notes:
(1) Billing data from year 2016 geocoded and scaled up to 2019 production.
(2) Existing ADD multiplied by MDD peaking factor of 1.5.

A hydraulic profile of the City's existing water distribution system is shown on Figure 6.2. This hydraulic profile illustrates the hydraulic connectivity of the distribution system facilities in each pressure zone.

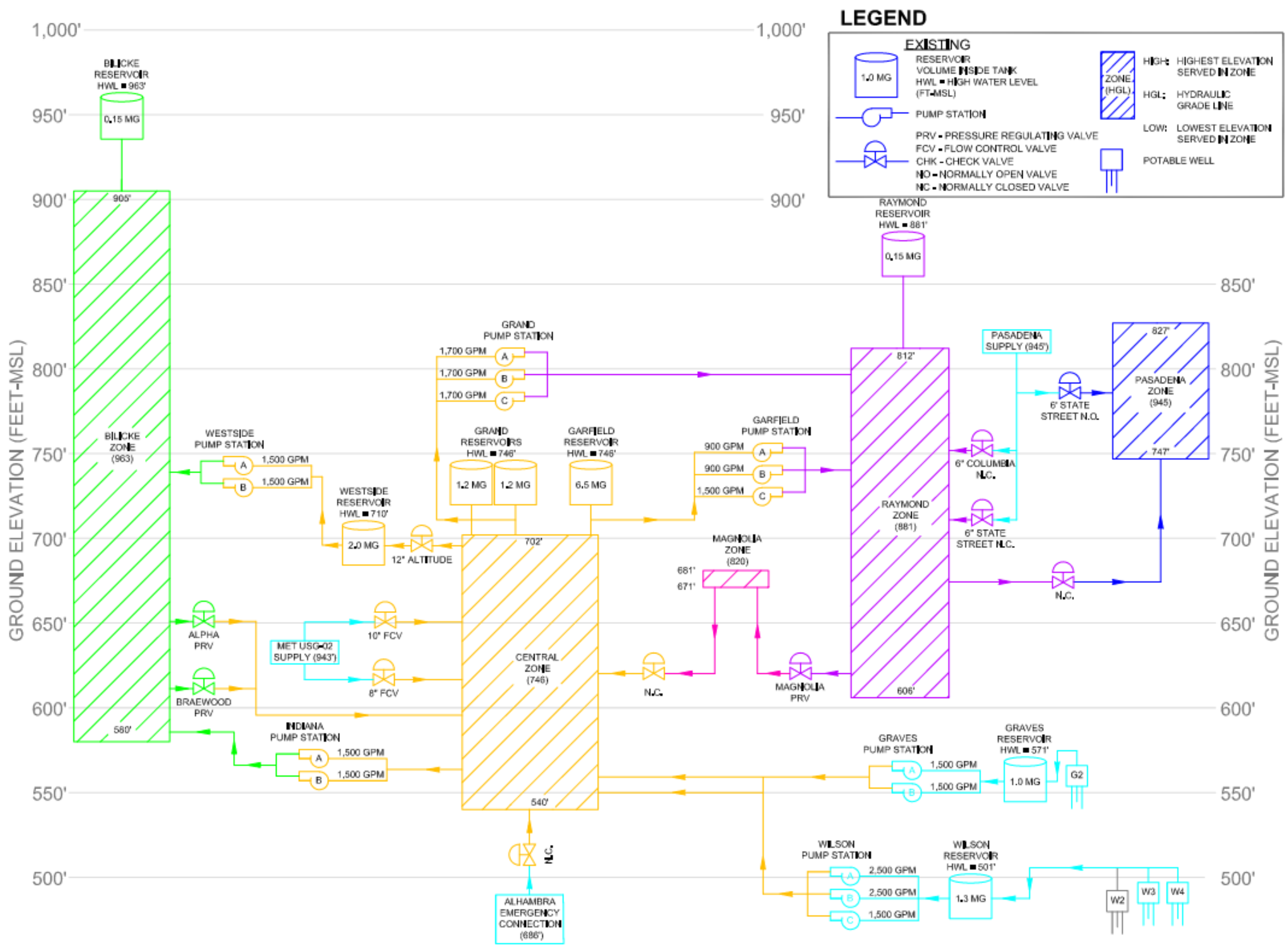

Figure 6.2 Existing Potable Water Hydraulic Profile

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6.1.2.2 Pipelines

The City's distribution system consists of approximately 83 miles of pipeline ranging from 2 inches to 36 inches in diameter. A breakdown of pipelines by diameter and material type is presented in Table 6.4, while this data is graphically depicted on Figure 6.3. South Pasadena doesn't have a GIS layer for their service laterals which supply their approximately 6,200 customers. Therefore, service lateral pipelines are not included in this section of the report.

Table 6.4 Potable Water Distribution System Pipelines

Diam. (in)	Pipeline Length (ft) by Material Class[1]					Total	
	PVC	STL	CI	DI	CC	(ft)	(mi)
2	0	1,090	40	0	0	1,130	0.2
4	0	720	88,400	770	0	89,890	17.0
6	0	460	144,540	10,490	0	155,490	29.4
8	0	10	68,720	3,320	0	72,050	13.6
10	970	40	29,050	0	0	30,060	5.7
12	16,170	150	43,610	0	0	59,930	11.4
14	0	0	70	0	0	70	0.0
16	0	250	8,520	0	0	8,770	1.7
18	850	0	4,030	0	0	4,880	0.9
20	0	360	50	0	0	410	0.1
21	0	0	8,760	0	0	8,760	1.7
24	0	200	4,250	0	3,800	8,250	1.6
36	0	0	90	0	0	90	0.0
Total (ft)	**17,990**	**3,280**	**400,130**	**14,580**	**3,800**	**439,780**	**83**
Total (mi)	**3.4**	**0.6**	**75.8**	**2.8**	**0.7**	**83.3**	**83.3**

Notes:
Abbreviations: Polyvinyl Chloride (PVC), Steel (STL), Cast Iron (CI), Ductile Iron (DI), Concrete Cylindrical Pipe (CC).
(1) Pipeline data retrieved from City's GIS.

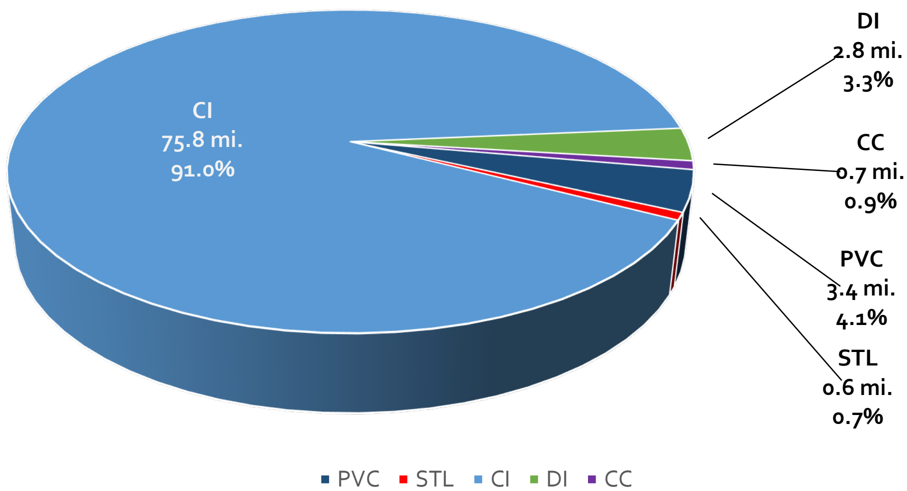

Figure 6.3 Pipelines by Material Type

As shown in Figure 6.3, the majority (76 miles) or 91 percent of the City's transmission and distribution mains consist of Cast Iron Pipe (CI). As shown in Table 6.4, the largest quantity of pipeline diameters in the City are 6-inch diameter, which equates to 29.4 miles or 35 percent. Approximately 17.2 miles or 20 percent of the City's distribution system is 4-inch diameter or smaller.

The pipeline length distribution by material and installation year is summarized in Table 6.5 and graphically depicted on Figure 6.4.

Table 6.5 Pipelines by Installation Year and Material Type

Material	Pipeline Length[(1)] (ft) by Installation Year							Total (mi)
	Prior to 1920	1921 to 1930	1931 to 1940	1941 to 1960	1961 to 1980	1981 to 2000	2001 to 2020	
PVC	0	0	0	0	0	0	17,990	3.4
STL	190	1,040	400	0	530	0	1,110	0.6
CI	29,710	100,650	142,150	53,410	68,870	1,240	4,090	75.8
DI	0	1,000	0	0	30	0	13,550	2.8
CC	0	0	0	3,760	0	0	40	0.7
Total (ft)	**29,900**	**102,690**	**142,560**	**57,170**	**69,430**	**1,240**	**36,780**	**439,770**
Total (mi)	**5.7**	**19.4**	**27.0**	**10.8**	**13.1**	**0.2**	**7.0**	**83.3**

Note:
(1) Pipeline data retrieved from City's GIS data. For pipes without an install date, the approved date was used.

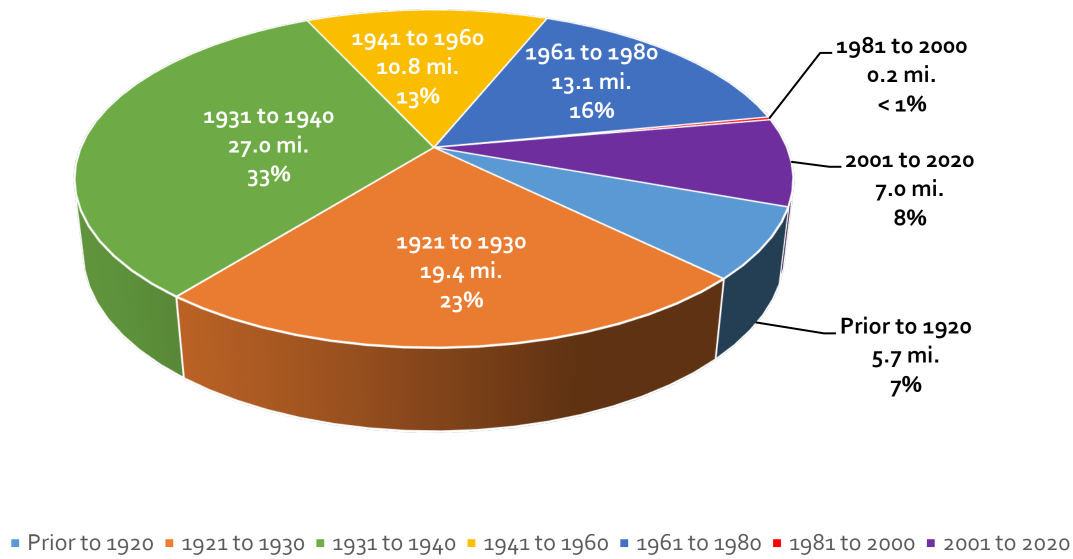

Figure 6.4 Pipelines by Installation Year

Upon initial review of the pipeline data, the City's GIS database was missing less than 5 percent of the install dates. Reasonable assumptions were made to estimate these pipeline installation years based on the approved date to develop a pipeline replacement program, which will be discussed in Section 6.2.8. As shown on Figure 6.4, 75 percent of the City's pipelines were constructed prior to 1960

6.1.2.3 Booster Pump Stations

The City's potable water distribution system uses two pump stations (PSs) to move well water to the Central Pressure Zone (Graves PS and Wilson PS). If needed, MWD water supplies also come into the Central Pressure Zone. From the Central Pressure Zone water supplies are boosted into both the Raymond Pressure Zone via the Garfield PS and/or Grand PS; and into the Bilicke Pressure Zone via the Indiana PS and/or the Westside PS. There are no PSs directly supplying the Pasadena Pressure Zone or Magnolia Pressure Zone. The Magnolia Pressure Zone receives its water from the Raymond PSI zone. Table 6.6 lists some of the key characteristics for each PS, while their operational functionality is described below.

Table 6.6 Existing Pumping Stations

Pump Station Name	From Zone	To Zone	Design Capacity (gpm)(1)	Firm Capacity (gpm)(1)
Garfield PS A B C	Central	Raymond	900 900 1,500	1,800
Grand PS A B C	Central	Raymond	1,700 1,700 1,700	3,000
Graves PS A B	Graves Reservoir Well Supply	Central	1,500 1,500	1,500
Indiana PS A B	Central	Bilicke	1,500 1,500	1,500
Westside PS A B	Central	Bilicke	1,500 1,500	1,500
Wilson PS A B C	Wilson Reservoir Well Supply	Central	2,500 2,500 1,500	4,000

Note:
(1) Capacities provided by City staff.

- **Garfield PS** pumps water from the Central Pressure Zone into the Raymond Pressure Zone. The PS consists of three pump units. Two of the pumps have smaller motors and are sized at 900 gpm. The third, larger pump, is sized at 1,500 gpm. This PS can pump directly from the Central Pressure Zone or from the Garfield Reservoir.
- **Grand PS** pumps water from the Central Pressure Zone into the Raymond Pressure Zone. The PS consists of three pump units. All three pumps are the same size with a design capacity of (1,700 gpm). This PS can pump directly from the Central Pressure Zone or from the Garfield Reservoir.
- **Graves PS** pumps water from the Graves Reservoir into the Central Pressure Zone. Both pumps are the same size with a design capacity of 1,500 gpm. This PS pumps directly from Graves Reservoir.
- **Indiana PS** pumps water from the Central Pressure Zone into the Bilicke Pressure Zone. Both pumps are the same size with a design capacity of 1,500 gpm. This is the only PS in the distribution system that doesn't have a reservoir on site.
- **Westside PS** pumps water from the Central Pressure Zone into the Bilicke Pressure Zone. Both pumps are the same size with a design capacity of 1,500 gpm. This PS can pump directly from the Central Pressure Zone or from the Westside Reservoir.
- **Wilson PS** pumps water from the Wilson Reservoir into the Central Pressure Zone. The PS has two larger pumps, each with a capacity of approximately 2,500 gpm and one smaller pump with a capacity of 1,500 gpm. This PS can pump directly from the clear well or from Wilson Reservoir.

6.1.2.4 Storage Reservoirs

Water distribution systems rely on stored water to help equalize fluctuations between supply and demand. The storage criteria discussed in Chapter 4 determines the storage required within each pressure zone to provide adequate water supply for firefighting, emergency, or unplanned outages of a major source of supply, and to meet demands. Currently, the City's potable water system has seven reservoirs that provide storage for the distribution system.

Since most the City's water supplies are boosted into the Central Pressure Zone, the majority (three) of the reservoirs are located in the Central Pressure Zone. Two of these reservoirs are boosted into Central Pressure Zone, the other three serve as pressure sustaining to the Central Pressure Zone. The remaining two reservoirs are elevated tanks and are floating on the Bilicke Pressure Zone and the Raymond Pressure Zone. There is no storage in either the Pasadena Pressure Zone or the Magnolia Pressure Zone. Detailed information for each reservoir is summarized in Table 6.7.

Table 6.7 Existing Potable Water Reservoirs

Storage Tank Name	Pressure Zone	HGL (ft)	Max Depth (ft)	Diameter or Length x Width (ft)	Capacity (MG)
Bilicke Tank(1)	Bilicke	963	22	34(5)	0.15
Garfield Reservoir(2)	Central	746	21.5	314 x 136	6.50
Grand Reservoir 1(3)	Central	740	25	96	1.20
Grand Reservoir 2(3)	Central	740	25	96	1.20
Graves Reservoir	Supply/Central(4)	571	12	122 x 122	1.2
Raymond Tank(1)	Raymond	881	22	34(5)	0.15
Westside Reservoir	Central	710	31	105	2.00
Wilson Reservoir	Supply/Central(4)	501	18.5	140 x 90	1.30
Total Storage Capacity	**N/A**	**N/A**	**N/A**	**N/A**	**13.70**

Notes:
(1) Elevated tank.
(2) Garfield Reservoir consists of two 3.25 MG cells.
(3) Grand Reservoir 1 and 2 are each a separate tank but are considered to be one reservoir by the City.
(4) These Reservoirs are pumped into the Central Pressure Zone and do not float on the zone. They cannot be backfilled by the zone.
(5) Equivalent diameter. The elevated tanks are not cylindrical. Garfield reservoir consists of two rectangular cells.

As shown in Table 6.7, the City has 13.7 million gallons (MG) of storage capacity. Most of the storage supplies water to the Central Pressure Zone, with 10.9 MG of storage (80 percent of the total storage). 2.3 MG of storage is used to store the groundwater well supply, this accounts for 17 percent of the City's storage. The remaining 0.3 MG (2 percent) of storage are comprised of two 0.15 MG elevated tanks; one is in the Bilicke Pressure Zone and the other is located in the Raymond Pressure Zone.

6.1.2.5 Pressure Reducing Valves

PRVs allow distribution systems to transfer water from higher-pressure zones to lower-pressure zones without exceeding the allowable pressures in the lower zones or completely draining the pressure out of the higher zone. Water is transferred through a valve that reduces the pressure to a specified pressure setting (pressure-reducing feature), while maintaining the pressure in the upper pressure zones (pressure-sustaining feature).

The pressure-sustaining feature prevents transfer of water into the lower pressure zone if the pressure in the upper zone drops below a certain level. This helps prevent a problem or emergency in the upper pressure zone draining too much water into the lower pressure zone.

The City utilizes three major PRVs that transfer water between pressure zones. The characteristics of these major PRVs are summarized in Table 6.8.

Table 6.8 Existing Pressure Reducing Valves

PRV Name	From Zone	To Zone	No. of Valves	Valve Sizes (inches)	Pressure Setpoint (psi)
Alpha PRS	Bilicke	Central	1	4	45
Braewood PRS	Bilicke	Central	1	8	50
Magnolia PRS	Raymond	Magnolia	1	6	60

6.2 Potable Water Model Development

This section discusses the review and updates for the City's existing potable water hydraulic model. A potable water system hydraulic model is a simplified representation of the real potable water distribution system. Potable system models can assess the capacity of a distribution system. In addition, potable water models can perform "what if" scenarios to assess the impacts of future developments and land use changes. The City's potable water system hydraulic model was constructed using a multi-step process utilizing data from a variety of sources. This chapter summarizes the hydraulic model development process, including a summary of the modeling software selection, a description of the modeled distribution system, the hydraulic model elements, and the model creation process.

6.2.1 Potable Water Hydraulic Modeling Software

There are several software applications for network analysis with a variety of capabilities and features. The selection of a particular model is generally dependent upon user preference, the requirements of the distribution system, and the cost associated with the software.

Carollo developed and calibrated the City's potable water model in Innovyze's H_2OMAP® Water in 2012. The model was developed using as-built drawings. In order to more accurately input updates into the model and provide the City with better spatial approximations of potable water alignments and facilities.

As part of this One Water 2050 Plan the hydraulic model was converted to InfoWater Pro during the model update and conversion process. The current hydraulic model uses Innovyze's InfoWater Pro® Suite 3.5 Update No. 1. The hydraulic modeling engine for the InfoWater Pro® software package uses the Environmental Protection Agency (EPA)'s EPANET model, which is widely used throughout the world for planning, analysis, and design related to potable water distribution systems. InfoWater Pro® consists of multiple products that work together to bring a graphical approach to the analysis and design of potable water collection systems. The program includes seamless integration with GIS data using ArcGIS Pro.

6.2.2 Data Collection and Validation

The primary source for the development of the hydraulic model was the City's converted H_2OMAP® Water model. The City has not added many facilities since the model was developed and calibrated in 2012 so there were little changes that needed to be updated into the model. The City's currently doesn't have GIS data for their potable water distribution system so as-built data was digitized and input into the hydraulic model for new pipelines and facilities that have been added since 2012. Additionally, City staff provided details on the City's facilities including operation set points and capacities.

6.2.3 Elements of the Hydraulic Model

The following provides a brief overview of the major elements of the hydraulic model and the required input parameters associated with each:

- **Junctions:** Locations where pipe sizes change or where pipelines intersect are represented by junctions in the hydraulic model. The only required inputs for junctions are the invert elevations, as well as demand and demand pattern, if any.
- **Pipes:** Transmission mains and distribution system piping are represented as pipes in the hydraulic model. Input parameters for pipes include length (which was auto calculated based on the To/From Node), friction factor (e.g., Hazen Williams C), To/From Node, diameter, and the spatial alignment.
- **Storage Tanks:** Storage tanks are used to represent reservoirs. Input parameters for storage tanks include base elevation, maximum/minimum water levels, tank diameter, and initial water level.
- **Pumps:** Pumps are included in the hydraulic model as points. Pumps can represent either booster pumps or well heads. Input parameters for pumps include pump curves and operational controls.
- **Reservoirs:** Reservoirs represent areas where flow enters the system. For potable modeling, a reservoir typically represents a water source. In South Pasadena's model the sources of water include groundwater wells, the MWD connections, and the interconnect to Pasadena Water and Power (PWP). Every source of water is represented by a reservoir model element.
- **Valves:** Special valves, such as pressure-reducing, or flow-control valves are included in the hydraulic model. The input parameters include diameter and valve type (e.g., Pressure Reducing). Gate valves are typically not included in hydraulic models. Check valves are modeled as pipe elements with the check valve component of the pipe set to "yes".

The City's hydraulic model consists of the following components:

- 1,424 junctions.
- 1,781 pipelines, with a total length of 83 miles (ranging from 2-inch diameter to 36-inch diameter).
- 18 pumps.

- 9 tanks.
- 36 Valves.

6.2.4 Hydraulic Model Update

The City's hydraulic model combines information on the physical and operational characteristics of the potable water distribution system and performs calculations to solve a series of mathematical equations to simulate flows in pipes.

The model update process consisted of seven steps, as described below:

- **Step 1:** The City's old H_2OMAP® Water model was converted to InfoWater Pro®.
- **Step 2:** The as-built data for pipelines and facilities built since 2012 were reviewed, and geocoded (digitally laid in the correct location) in ArcGIS Pro®.
- **Step 3:** The distribution system pipeline data was traced over the geocoded as-builts and digitized into the modeling software and verified.
- **Step 4:** Junctions were generated at the intersection of pipe segments. Junction elevations were imported from the old H_2OMAP® model where applicable. New junctions were assigned elevation data using United States Geological Survey (USGS) contours data.
- **Step 5:** All the facility control data from the old H_2OMAP® model was reviewed by the City and updated as necessary. New control data for the facilities constructed since 2012 were also provided by the City. This type of data consists of pump on/off set points, pump capacities, pumping head, valve types, valve set points, and reservoir dimensions.
- **Step 6:** Potable water demands were then allocated to the appropriate model junctions, using the methods described in Section 6.2.5.
- **Step 7:** The hydraulic model contains certain run parameters that need to be set by the user at the beginning of the project. These include time steps, reporting parameters, output units, and headloss equations. Once the run parameters were established, the model was debugged to ensure that it ran without errors or warnings.

6.2.5 Potable Water Demand Allocation

Determining the quantity of water demanded by City customers and how they are distributed throughout the distribution system is a critical component of the hydraulic modeling process.

Various techniques can be used to allocate water demands within the system. The preferred method is driven by the type of available information. Two common methodologies are the geocoded billing data method and the land used method. The geocoded billing data method uses the City's meters addresses from the billing database to spatially allocate the average annual water demand of each customer in the billing meter shapefile. In the land use method, the land use acreages are multiplied by a water duty factor (WDF) to obtain a spatial distribution of approximate water demands. The geocoded billing data method was used to allocate the existing demands for this One Water 2050 Plan. Through the use of the City's 2019 billing records, the roughly 6,200 water meters were geocoded using the water meter address. Once the meter addresses were represented spatially throughout the water service area, demands were distributed to the model nodes. The demands were then scaled up to the average of the 2012 through 2019 supply of 3.2 mgd or 2,226 gpm as presented in Table 3.4. This average was determined to be representative of present day demands under normal, non-drought conditions, as discussed in Chapter 3. Scaling the demands to match the supply is normal practice in hydraulic modeling, to account for system losses that are not captured in the billing data.

Since the hydraulic model was not developed to represent each individual customer's service lateral, there was not a specific model node for each billing meter. In order to allocate the demands from the GIS billing meters onto the model nodes, the Thiessen polygon demand distribution method was used. The Thiessen polygon method involves using a GIS formula that generates a polygon around each of the model demand nodes. The demands from any billing meter that overlays a Thiessen polygon was applied to that demand node.

The existing annual supply is 3.2 million gallons per day (mgd), or 2,226 gallons per minute (gpm) which represents the ADD of South Pasadena. Applying a maximum day demand (MDD) peaking factor of 1.5 (see Table 3.9), the MDD was estimated to be 3,338 gpm, or 4.8 mgd.

The hydraulic modeling software has the option of assigning 10 different demand types for each demand node. As part of the potable water demand update, 3 of the 10 different demand types were used to help identify the source of the demands in the hydraulic model. The description and demand allocated to the model for each demand type are as follows:

- **Demand Type 1:** This demand type was used to update demands for the existing system consumption (2,226 gpm).
- **Demand Type 2:** This demand type was used to represent the build out (2050) known developments. This demand type varies based on future scenario analyzed see Section 6.4.
- **Demand Type 3:** This demand type was used to distribute the build out (2050) infill. This demand type varies based on future scenario analyzed see Section 6.4.

Each of the three demand types used were input as average day demand (ADD). The demands were entered into the hydraulic model as ADD in order to create a baseline demand set and thus reduced the need for excess demand sets, which reduces the overall time it takes to modify and update demands. Also, a demand set this represents the ADD condition can easily be manipulated by the model global multiplier and/or diurnals patterns, depending on the analysis to be performed. The global multiplier run parameter in the hydraulic modeling software is used to scale up the demand sets by a given number for example: the MDD peaking factor in Table 3.9 is defined as 1.5. By changing the global multiplier to 1.5, the hydraulic model can simulate a MDD model run.

In addition to adjusting the global demand multiplier for seasonal or daily variations, the hydraulic model was set up with the capability of adjusting the hourly variation through diurnal patterns. Different classes of water users require supply from the distribution system at different times of the day. A diurnal curve, or demand pattern, simplifies the typical variation of hourly demands for the City’s customers over the course of a day. In general, typical diurnal curves vary for residential, commercial, and landscape irrigation water users, and will vary for individual users.

As discussed in Chapter 3, diurnal curves are typically calculated based on data gathered as a part of model calibration. The City's available data allowed for calculation of diurnal curves for the system as a whole. Due to the lack of hourly flow data from the City’s Wells, pump stations (PSs) and pressure reducing stations (PRSs), it was not possible to develop diurnal curves for individual pressure zones. Instead, the City's existing diurnal patterns from the City's old H_2OMAP® hydraulic model were used and are presented in Appendix C.

6.2.6 Hydraulic Model Calibration

The purpose of a water system hydraulic model is to predict how a water distribution system will respond under a given set of conditions. One way to test the accuracy of the hydraulic model is to create a set of known conditions in the water system and then compare the results observed in the field against the results of the hydraulic model simulation using the same conditions. Fire flow tests conducted in the field on the water system can yield a profound tool in verifying data used in the hydraulic model and a greater understanding of how the water system operates.

Field testing can indicate errors in the data used to develop the hydraulic model or show that a condition might exist in the field not otherwise known. Valves, which are reported as being open, might be closed (or vice versa), an obstruction could exist in a pipeline, or pressure settings for a PRS may be slightly different than noted. Field testing can also correct erroneous model data such as incorrect pipeline diameters or connections. Data obtained from the field tests can be used to determine appropriate roughness coefficients for each pipeline, as roughness coefficient can vary with age and pipe material. Other parameters can also be adjusted to generate a calibrated model.

The City's old H_2OMAP® hydraulic model was calibrated in 2012, since then only minor changes to the facilities and distribution system have been constructed. Therefore, the existing controls and roughness factors from the 2012 model were used in the updated InfoWater Pro® model. A new model calibration for the new InfoWater Pro® model was not performed.

6.3 Existing System Analysis

The goal of the existing system analysis is to evaluate the existing distribution system under various operating conditions utilizing the evaluation criteria described in Chapter 5 and the existing system demands listed in Table 6.3. The following analyses are described in this section:

- Existing Water Supply Analysis.
- Existing Storage Analysis.
- Existing Pump Station Analysis.
- Existing System Pressure Analysis.
- Existing Pipeline Velocity Analysis.
- Rezoning Analysis of the Magnolia Pressure Zone:
  - Revised Minimum Pressure Analysis.
  - Revised Storage Analysis.
  - Revised Pump Station Analysis.
- Fire Flow Analysis:
  - Existing Distribution System Configuration (before rezoning).
  - Existing Distribution System with Rezoning Modifications.
- Water System Facilities Field Condition Assessment.

6.3.1 Existing Water Supply Analysis

Currently, the City's potable water system is supplied by both groundwater from the wells listed in Table 6.1 as well as a MWD connection. A supply analysis was performed for two different scenarios: largest well out of service and the MWD connection out of service. This evaluation is important due to the decreased availability of water supply due to ongoing and worsening drought conditions in Southern California. The evaluation is performed with water supply sources that can be used on a regular basis; emergency water supply connections are not included in this evaluation.

The first scenario was conducted to determine potential supply sources in the event the largest well was out of service. Wilson Well 3 is the largest well in the system. It supplies an average of approximately 1,900 gpm to Central Pressure Zone. In addition, a second scenario was conducted in the event of an MWD outage, based on recent experience during extreme drought conditions. A summary of the analyses is presented in Table 6.9 and Table 6.10, while details are presented in Appendix F.

As shown in Table 6.9 and Table 6.10, the City has enough capacity to supply existing MDD conditions. In Table 6.9, the MWD supply was increased to account for the lack of Wilson Well 3 supply. When using the MWD connection there is an excess capacity of 4,092 gpm. The second outage scenario in Table 6.10 shows an excess supply of 491 gpm with MWD out of service. This is the typical supply scenario for the City of South Pasadena. Therefore, the City can maintain existing MDD supplies without using the MWD connection as long as all of their wells are in service. It is recommended that the City install a pump on Wilson Well 2 to avoid having to use MWD water in the case of a well outage (CIP Project ID WCW-1).

Table 6.9 Existing Water Supply Analysis With Largest Well Out of Service

Existing Supply	Total Supply Capacity(1) (gpm)	Supply Capacity w/Largest Supply Out of Service (gpm)	Existing MDD(2) (gpm)	Existing Capacity Balance (gpm)
Sunset (Pasadena Connection)(3)	600(4)	30(5)		
Graves Well 2	800	800		
Wilson Well 3	1,900	0		
Wilson Well 4	1,100	1,100		
MWD USG-02	5,500(4)	5,500		
Total	**9,900**	**7,430**	**3,339**	**4,092**

Notes:
(1) Supply capacities retrieved from City staff.
(2) MDD peaking factor assumed to be 1.5.
(3) City of Pasadena Source (Villa/Copelin Wells combined with MWD)
(4) Capacities based on a maximum velocity of 7 fps in pipelines at their respective locations.
(5) Sunset connection only supplies the Pasadena Pressure Zone demand.
(6) Detailed calculations are found in Appendix F.1.

Table 6.10 Existing Water Supply Analysis With MWD Supply Out of Service

Existing Supply	Total Supply Capacity(1) (gpm)	Supply Capacity w/MWD Supply Out of Service (gpm)	Existing MDD(2) (gpm)	Existing Capacity Balance (gpm)
Sunset (Pasadena Connection)(3)	600(4)	30(5)		
Graves Well 2	800	800		
Wilson Well 3	1,900	1,900		
Wilson Well 4	1,100	1,100		
MWD USG-02 (8")	5,500(4)	0		
Total	**9,900**	**3,830**	**3,338**	**492**

Notes:
(1) Supply capacities retrieved from City staff.
(2) MDD peaking factor assumed to be 1.5.
(3) City of Pasadena Source (Villa/Copelin Wells combined with MWD).
(4) Capacities based on a maximum velocity of 7 fps in pipelines at their respective locations.
(5) Sunset connection only supplies the Pasadena Pressure Zone demand.
(6) Detailed calculations are found in Appendix F.2.

6.3.2 Existing Storage Analysis

The storage analysis evaluates the existing storage capacity based on the evaluation criteria listed in Chapter 5. These storage criteria include 3 components, namely operational, fire flow, and emergency storage. Based on the criteria listed, a storage analysis was completed under existing MDD conditions. The results of this analysis are summarized in Table 6.11, while details of this analysis are presented in Appendix F. An example of the calculation is presented below:

Existing Zone Storage Capacity	13.7 MG
Required Storage Capacity (Existing Conditions)	9.9 MG
Existing Storage Excess (13.7 MG – 9.9 MG)	3.8 MG

As shown in Table 6.11, most of South Pasadena's gravity reservoirs are located in the Central Pressure Zone with the exception of the two small, elevated tanks which are in the Raymond and Bilicke Pressure Zones. The existing potable water system has a total storage capacity of 13.70 MG and an overall surplus of 3.79 MG. The storage surplus is in the Central Pressure Zone. All the other pressure zones have storage deficiencies. In lieu of building new storage in the storage deficient pressure zones; the excess storage capacity can be moved from the Central Pressure Zone via PRVs or Pump Stations to the deficient pressure zones. The proposed remedies to the storage deficiencies are as follows:

- **Bilicke Pressure Zone:** The Bilicke Pressure Zone is located adjacent to the Central Pressure Zone and has a storage deficit of 1.65 MG. There are two existing pump stations (Westside and Indiana) that supply water from the Central Pressure Zone to the Bilicke Pressure Zone. Any of the four pumps at either of two pump stations can be used to pump the 1.65 MG storage deficit. Since pumping is required to mitigate the storage deficit, it is recommended that a backup power hookup transfer switch is provided at Indiana Pump Stations (CIP Project ID **BP-1**). Westside Pump Station already has a backup power generator. Additionally, the MWD connection at 1217 Kolle Avenue has the ability to supply the Bilicke Pressure Zone at a reduced HGL in emergency conditions.

- **Pasadena Pressure Zone:** The Pasadena Pressure Zone is located adjacent to the Raymond Pressure Zone and has a storage deficit of 0.34 MG. Typically, the Pasadena Pressure Zone is supplied through an interconnection between Pasadena and South Pasadena. Since there is no storage in this zone and there is no alternate supply for the City of South Pasadena, it is recommended that a low pressure 12-inch diameter check valve be installed between Pasadena Pressure Zone and Raymond Pressure Zone (CIP Project ID **FFCV-1**). The location of FFCV-1 is described in Table 6.17. In the case of a supply outage from the City of Pasadena, the check valve can supply emergency storage from the Raymond Pressure Zone to the Pasadena Pressure Zone when the HGL in the Pasadena Pressure Zone drops below the HGL in the Raymond Pressure Zone.
- **Raymond Pressure Zone:** The Raymond Pressure Zone is above the Central Pressure Zone and has a storage deficit of 2.17 MG. The Raymond Reservoir is only 0.15 MG and has a minor impact on the storage capacity of the zone. Pumping from either the Garfield or Grand Booster PS is required to mitigate the storage deficiency.
- **Magnolia Pressure Zone:** The Magnolia Pressure Zone is below the Raymond Pressure Zone and has a storage deficit of 0.89 MG. Since the zone does not have any gravity storage, it is recommended to mitigate the deficiency by conveying water through the PRV from the Raymond Pressure Zone. No storage improvements are recommended in this zone.
- **Central Pressure Zone:** The Central Pressure Zone has an excess storage capacity of 8.64 MG. The excess capacity from the Central Pressure Zone can be pumped to all the other pressure zones to mitigate their storage deficiencies, via the 6 pumps at the Garfield and Grand Pump Stations. After pumping the other zones, Central Pressure Zone has an excess storage capacity of 3.59 MG. Since pumping out of the Central Pressure Zone is required to mitigate the storage deficiencies, it is recommended that backup power is provided at Grand and Garfield Pump Stations, as well as Wilson and Graves Sites. (CIP Project ID **BP-2, BP-3, BP-4,** and **BP-5**, respectively). All four of these sites currently have hookup for the power, however there is no generator on site.

Table 6.11 Existing Storage Analysis

Zone	Existing Storage Facility	Existing MDD(1) (mgd)	Required Storage (MG)	Available Storage (MG)	Zone Balance (MG)	Proposed Facilities	Proposed Capacity (MG)	Balance with New Storage (MG)
Bilicke	Bilicke Tank	0.74	1.80	0.15	(1.65)	Pump from Central Pressure Zone.	1.65	0.00
Pasadena	None	0.03	0.34	0.0	(0.34)	Install low pressure 12-inch diameter check valve from Raymond Pressure Zone. (FFCV-1).	0.34	0.00
Raymond	Raymond Tank	1.14	2.32	0.15	(2.17)	PRV to Magnolia Pressure Zone. Install low pressure 12-inch diameter check valve from Raymond Pressure Zone. (FFCV-1). Pump from Central Pressure Zone.	(0.89) (0.34) 3.40 [Total: 2.17]	0.00
Central	Westside Reservoir Grand Reservoir Garfield Reservoir Wilson Reservoir Graves Reservoir	2.86	4.56	13.4	8.84	Pump to Bilicke Pressure Zone. Pump to Raymond Pressure Zone.	(1.65) (3.40) [Total: (5.05)]	3.79
Magnolia	None	0.04	0.89	0.0	(0.89)	PRV from Raymond Pressure Zone.	0.89	0.00
Total		**4.81**	**9.91**	**13.7**	**3.59**	**N/A**	**0.00**	**3.79**

Notes:
(1) MDD peaking factor assumed to be 1.5.
(2) Proposed Facilities in bold are not existing.
(3) Detailed calculations are found in Appendix F.3.

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6.3.3 Existing Pump Station Analysis

The pump station analysis evaluates the existing pump station capacities based on the evaluation criteria listed in Table 4.1. These pump station evaluation criteria define that in zones with gravity storage, the firm capacity of the booster pump station shall be able to supply MDD of the zone it feeds into (including upstream zones), this only applies to the Central Pressure Zone. In zones without gravity storage, the firm capacity of the pump station shall be able to supply MDD of the zone it feeds into (including upstream zones), as well as the maximum fire-flow demand in that zone.

The results of the pump station analysis are summarized in Table 6.12, while the details are presented in Appendix F.

The City currently has four pump stations within the City of South Pasadena, and two booster pump stations at the well sites. These six pump stations have a total pumping supply of 28,625 gpm. The City's firm pumping capacity is 13,539 gpm. The firm capacity excludes the largest pumps at each pump station. As listed in Table 6.12, the pump station evaluation demonstrated a pumping deficiency of 602 gpm under existing demand conditions. The deficiencies and recommended improvements are as follows:

- **Bilicke Pressure Zone:** The Indiana Booster PS and the Westside Booster PS pump from the Central Pressure Zone to the Bilicke Pressure Zone and have a pumping capacity deficit of 1,250 gpm. The existing pump stations have enough capacity to supply the existing MDD and fire flow. However, under firm capacity at both pump stations there is a deficit. It is recommended that the city add a third pump to the Westside Booster Pump Station to increase the firm pumping capacity into the Bilicke Pressure Zone. Also, both Indiana and Westside Booster PSs are in poor condition. It is recommended that all pumps at Westside and Indiana Booster PS be replaced (CIP Project IDs **WRPS-1**, and **WRPS-2**). Indiana Booster PS doesn't have a backup power source or backup power hookups. It is recommended that a backup power hookup transfer switch is added to Indiana Booster PS (CIP Project ID **BP-1**). Additionally, backup power will provide supply redundancy and mitigate pumping deficiencies in the case that Westside Booster PS is out of service.
- **Pasadena Pressure Zone:** There are no booster pumps supplying the Pasadena Pressure Zone. Under normal operation conditions the Pasadena Pressure Zone is supplied from the City of Pasadena, which may have the capacity to supply the 2,500 gpm fire flow demand. However, it is not recommended to solely rely on Pasadena during emergency conditions. Therefore, it is recommended to install a low pressure 12-inch diameter check valve (CIP Project ID **FFCV-1**) from the Raymond Pressure Zone into the Pasadena Pressure Zone. This check valve would allow flows to enter the Pasadena Pressure Zone during fire conditions but not during normal operating conditions.
- **Raymond Pressure Zone:** The Garfield Booster PS and Grand Booster PS pump from the Central Pressure Zone into the Raymond Pressure Zone and have an excess capacity of 875 gpm. These existing pump stations have enough capacity to supply the existing MDD and fire flow under firm capacity conditions.

- **Central Pressure Zone:** The Graves Booster PS and Wilson Booster PS pump from their respective Reservoirs to the Central Pressure Zone has and have an excess pumping capacity of 2,296 gpm. The existing pump stations have enough capacity to supply the existing MDD of the entire City. There are no pump recommendations for this pressure zone.
- **Magnolia Pressure Zone:** The Magnolia Pressure Zone is fed by a PRV from the Raymond Pressure Zone, and the Magnolia Pressure Zone demands are included in the analysis for the Raymond Pressure Zone, thus there are no pumping recommendations for this pressure zone.

Table 6.12 Existing Pump Station Analysis

Discharge Pressure Zone	Existing MDD(1) (gpm)	Required Max Fire Flow (gpm)	Total Required Capacity(2) (gpm)	Existing Firm Capacity(3) (gpm)	Existing Capacity Balance (gpm)	Proposed Facilities (Recommendations)	Capacity Balance w/Recommendations (gpm)
Bilicke	515	3,500	4,015	3,000	(1,015)	Replace old pumps at Indiana. (WRPS-2) Add transfer switch for backup power at Indiana. (BP-1). Replace pumps at Westside/Add 3rd Pump (WRPS-1).	485
Pasadena	24	2,500	2,524	0	(2,524)	Install low pressure 12-inch diameter check valve from Raymond Pressure Zone. (FFCV-1)	1,376
Raymond	788	3,500	4,313(5)	5,200	887	None.	887
Central	1,987	0(4)	3,290(6)	5,500	2,210	None.	2,210
Magnolia	25	0(6)	0	0	0	None.	0
Total	**3,338**		**14,141**	**13,700**	**(441)**		**4,959**

Notes:
(1) MDD assumed to be ADD x 1.5.
(2) Required Capacity includes upstream zones and flow requirements.
(3) PS capacities provided by City staff.
(4) Central Pressure Zone has gravity storage so there is no fire flow required
(5) Raymond Pressure Zone's required capacity includes MDD of Raymond Pressure Zone, Magnolia Pressure Zone, and 3,500 gpm fire flow in Raymond Pressure Zone.
(6) Central Pressure Zone's required capacity includes MDD of Central, Raymond, Magnolia, and Bilicke Pressure Zones.
(7) Magnolia has no fire hydrants in zone.
(8) Detailed calculations in Appendix F.4.

6.3.4 Existing System Pressure Analysis

Based on the evaluation criteria listed in Chapter 4, the system pressures are evaluated for the distribution system under existing demand conditions. The hydraulic model is used to identify areas with pressures above 120 psi under minimum demand (MinDD) conditions, while peak hour demand (PHD) conditions were used to identify areas with pressures below 40 psi. The results from this pressure analysis are based on hydraulic model results.

6.3.4.1 Low Pressures

Instances of low pressures (less than 40 psi) in the existing system are presented on Figure 6.5. A large area of lower pressure is seen at the northern portion of the Central Pressure Zone. The low pressures are a result of a low static head in the Central Pressure Zone. It is recommended that the City of South Pasadena rezone this area into a pressure zone with a higher HGL. Section 6.2.6 describes the rezoning analysis and resulting CIP project recommendations which will resolve the low-pressure deficiency show in the upper part of the Central Pressure Zone. As a conclusion of the analysis this area should be rezoned into the Magnolia Pressure Zone.

A second area of low pressures exist near the higher elevation lot in the Bilicke Pressure Zone. Since the low pressures only affect a small number of homes at the higher elevations in the Bilicke Pressure Zone, and these customers are already used to the low pressures, recommendations are not made.

6.3.4.2 High Pressures

When conducting the analysis of the existing system using the hydraulic model, several areas with pressures greater than 120 psi are identified, which are presented on Figure 6.6. Most of the high pressures are located at the bottom of hills in the Bilicke Pressure Zone. The high pressures have been confirmed by the City's operations staff and customers in this area are already equipped with individual pressure regulating valves. No recommendations are made regarding the high-pressure analysis.

6.3.5 Existing Pipeline Velocity Analysis

The hydraulic model is used to evaluate pipeline velocities in the existing system with existing system demands under MDD conditions. Under MDD conditions pipelines convey the highest demands and thus reveal the maximum operating velocity of the pipelines. The City's pipelines are all within the established velocity criteria presented in Section 4 of this report. Thus, no improvements are needed to mitigate high velocities.

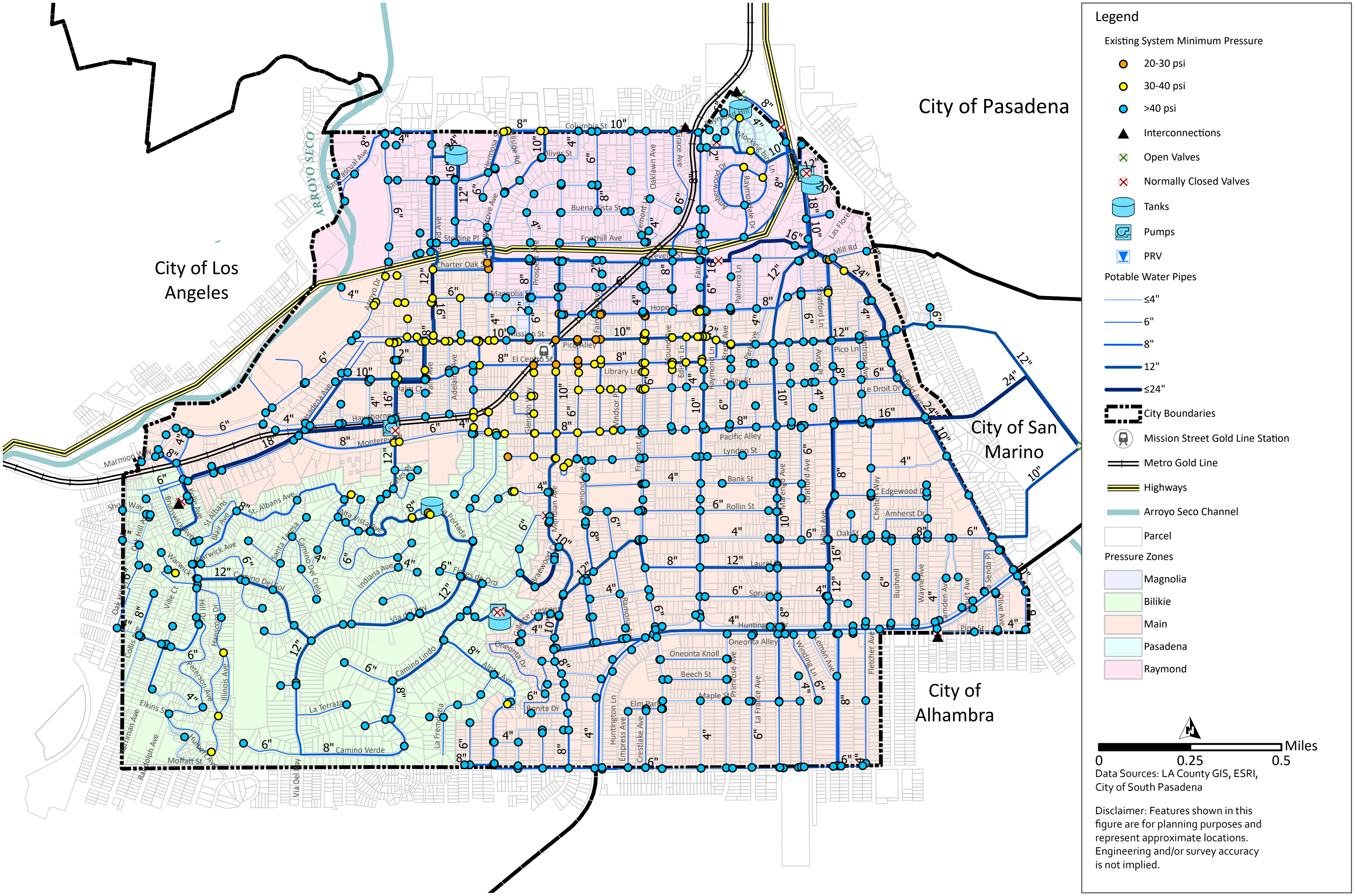

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Figure 6.5 Existing System Minimum Pressures

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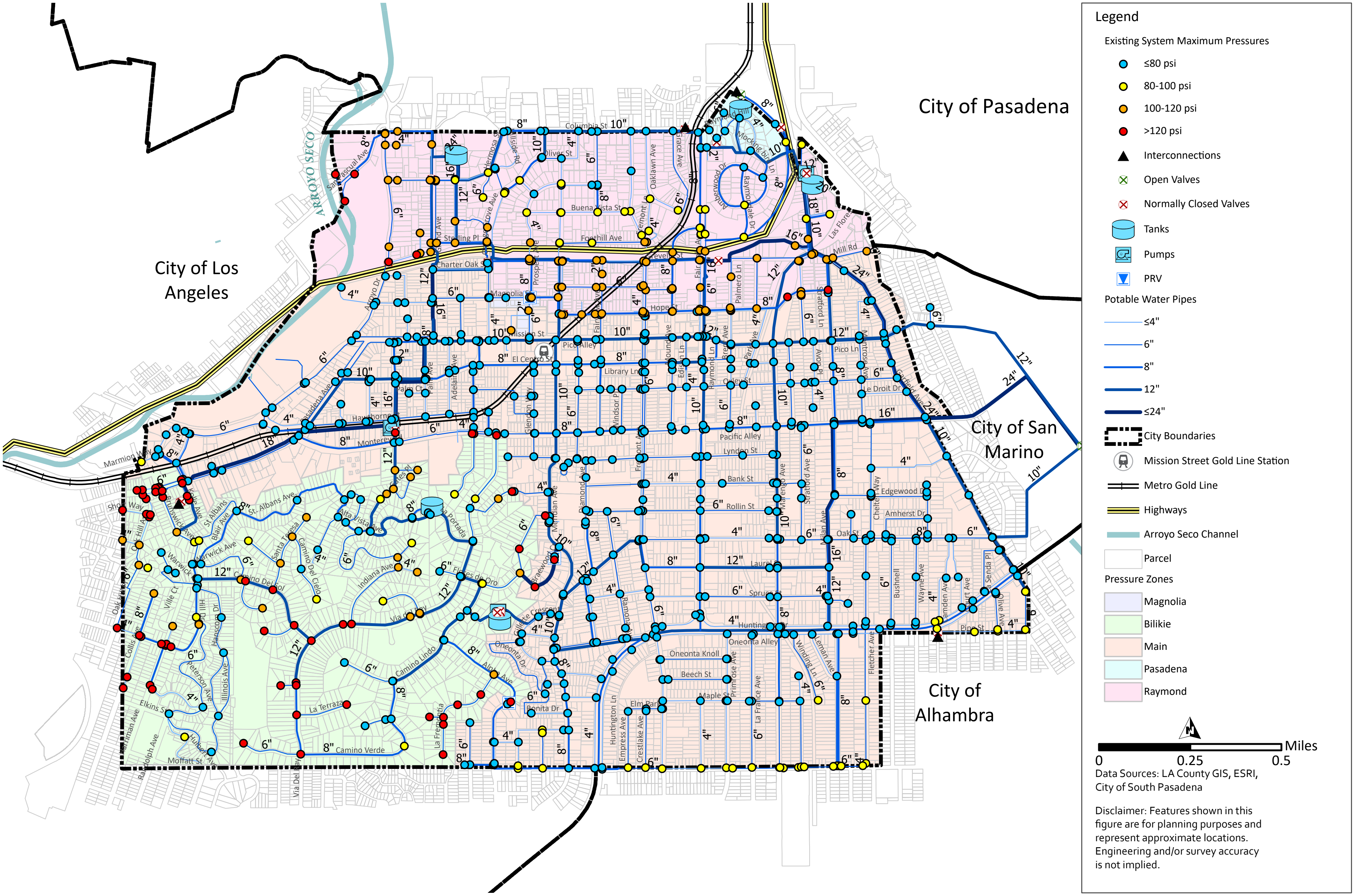

Figure 6.6 Existing System Maximum Pressures

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6.3.6 Rezoning Analysis of the Magnolia Pressure Zone

Low pressures are identified in the Central Pressure Zone between Mission Street, Indiana Avenue, Monterey Road, and Fair Oaks Avenue as shown on Figure 6.6. These low pressures are a result of a low static head. The low pressure in this area is not only concerning for the existing customers but also because there is major growth planned in this area. To remedy the low pressures, it is not practical to raise the static head in the Central Pressure Zone as this would require re-configuring all the booster pump stations and reservoirs in the Central Pressure Zone. Therefore, the solution to mitigate the low pressures is to incorporate the areas of low pressures into a pressure zone with a higher HGL. This process is called rezoning.

All other pressure zones in South Pasadena (Bilicke, Raymond, Pasadena, and Magnolia) have a higher HGL than the Central Pressure Zone. The HGL in the Pasadena, Raymond, and Bilicke Pressure Zones would be adequate to raise the static head in the low-pressure area, however this would result in pressures being too high. The Magnolia Pressure Zone is at the correct HGL and proximal location within the City and is the zone that is recommended to be expanded into the low-pressure area. The City created the Magnolia Pressure Zone within the past 17 years to accommodate new developments in this area that had low static pressures in the Central Pressure Zone, but high pressures in the Raymond Pressure Zone. Therefore, it is recommended that the Magnolia Pressure Zone be expanded to the south to encompass the low-pressure area.

The proposed revised boundary of the Magnolia Pressure Zone is presented in Figure 6.7 and demonstrates the expansion of the Magnolia Pressure Zone into the Central Pressure Zone. Several modifications will need to be made to the potable water system to achieve this rezoning. Thirty Six (36) valves at the boundary of the expanded Magnolia Pressure Zone will have to be closed; two (2) valves will have to be opened, three (3) additional pressure reducing stations (PRS) will need to be constructed, and seven (7) new segments of pipeline with a combined length of 2.1 miles/11,000 linear feet will need to be installed.

The following improvements are needed to implement the Magnolia rezoning:

6.3.6.1 Pressure Reducing Stations

There is one existing PRV between the Raymond Pressure Zone and Magnolia Pressure Zone. In order to expand the Magnolia Pressure Zone, two additional pressures reducing stations are needed to reduce the hydraulic grade line from the Raymond Pressure Zone to the Magnolia Pressure Zone.

1. A PRS is needed near the intersection of Hope Street and Brent Avenue. This PRS has been preliminarily located in the sidewalk in the southwest corner of the intersection (CIP Project ID **WCV-1**). The PRS should consist of two PRVs: one larger 10-inch diameter and one smaller 4-inch diameter valve. The larger valve is used for fire protection and should have a 5 psi to 10 psi lower setting than the smaller valve which is used for normal daily operation. The setting on the smaller PRV should maintain a head of 820 feet in the Magnolia Pressure Zone. An accompanying pipeline project WC-1 is also needed and described in the following pipeline section.
2. A PRS is needed in the southwest corner of the intersection of Meridian Avenue and Hope Street (CIP Project ID **WCV-2**). The PRS should consist of two PRVs: one larger 8-inch diameter and one smaller 4-inch diameter valve. The larger valve is used for fire protection and should have a 5 psi to 10 psi lower setting than the smaller valve which is

used for normal daily operation. The setting on the smaller PRV should maintain a head of 820 feet in the Magnolia Pressure Zone. An accompanying pipeline project WC-2 is also needed and described in the following pipeline section.

One additional PRS is needed to serve as a backup supply to the Magnolia Pressure Zone from the Bilicke Pressure Zone. This project is needed for supply reliability to the Magnolia Pressure Zone in the emergency situation where the supply from the Raymond Pressure Zone is cut off. This PRS will reduce the hydraulic grade line from the Bilicke Pressure Zone to the Magnolia Pressure Zone. The PRS is needed southeast of the intersection of Indiana Avenue and Monterey Road. This PRS has been preliminarily located in the sidewalk. (CIP Project ID WCV-3). The PRS should consist of two PRVs: one larger 12-inch diameter and one smaller 6-inch diameter valve. The larger valve is used for fire protection and should have a 5 psi to 10 psi lower setting than the smaller valve which is used for normal daily operation. The setting on the smaller PRV should maintain a head of 820 feet in the Magnolia Pressure Zone. An accompanying pipeline project WC-3 is also needed and described in the following pipeline section.

The preliminary sizing of the PRVs in the proposed PRSs were approximated for costing purposes. Final sizes should be determined when developing detailed design drawings.

6.3.6.2 Pipelines

1. Approximately 650 feet of 12-inch diameter pipeline is needed to connect the proposed PRS project WCV-1 from the Raymond Pressure Zone to the Magnolia Pressure Zone. This pipeline will connect the existing 8-inch diameter pipeline in the Raymond Pressure Zone at the intersection of Hope Street and Brent Avenue. The pipeline will continue south to the PRS. From the PRS the pipeline will head directly east across Fair Oaks Avenue and connect to the existing 4-inch diameter pipeline which is previously in the Central Pressure Zone. This 4-inch diameter pipeline will need to be replaced with a 12-inch diameter pipeline between Hope Street and Mission Street (CIP Project ID **WC-1**). The piping in the PRS supplying the smaller valve will need to be an 8-inch diameter pipe.
2. Approximately 100 feet of 10-inch diameter pipeline is needed to connect the proposed PRS project WCV-2 from the Raymond Pressure Zone to the Magnolia Pressure Zone. This pipeline will connect to the existing 8 by 8 by 4-inch diameter tee in the Raymond Pressure Zone east of the intersection of Meridian Avenue and Hope Street. The pipeline will continue south to the sidewalk southeast of the intersection where the PRS vault has been preliminary located. From the PRS vault the pipeline will head directly west across Meridian Avenue and connect to the existing 10-inch diameter pipeline which was previously in the Central Pressure Zone. An isolation valve (Map ID 1 in Table 6.13) will need to be added north of this connection to separate the Central Pressure Zone from the proposed Magnolia Pressure Zone (CIP Project ID **WC-2**). The piping in the PRS supplying the smaller valve will need to be an 8-inch diameter pipe.

3. Approximately 200 feet of 12-inch diameter pipeline is needed to connect the proposed PRS project WCV-3 from the Bilicke Pressure Zone to the Magnolia Pressure Zone. This pipeline will tee off of the existing 12-inch diameter pipe in the Bilicke Pressure Zone south of the intersection of Indiana Avenue and Monterey Road. The pipeline will continue east to the sidewalk southeast of the intersection where the PRS vault has been preliminary located. From the PRS vault, the pipeline will head directly west across Indiana Avenue and connect to the 12 by 8 by 6 tee at the intersection of Indiana Avenue and Monterey Road which was previously in the Central Pressure Zone (CIP Project ID **WC-3**). The piping in the PRS supplying the smaller valve will need to be an 8-inch diameter pipe.
4. The Magnolia rezoning splits the Central Pressure Zone into a portion on the east side and a portion on the west side. A 7,050 foot pipeline project; consisting of 6,800 feet of 12-inch diameter pipeline and 250 feet of 18-inch diameter is needed to convey the water from the west side of Central Pressure Zone to the east side of Central Pressure Zone. This project will increase the water quality and provides reliability in the case that the 18-inch diameter pipeline between the MWD connection and the Grand Reservoir is out of service. The proposed 12-inch diameter section of this pipeline connects to the existing 8-inch diameter pipeline at the intersection of Monterey Road and Hawthorne Street. The 12-inch diameter pipeline heads east on Monterey Road and terminates at the intersection of Fair Oaks Avenue and Monterey Road. The second leg of the proposed pipeline is 18-inch diameter section that connects to the existing 18-inch diameter pipe at the intersection of Hawthorne Street and Indiana Avenue. The proposed 18-inch diameter pipeline heads south and terminates into the proposed 12-inch diameter running along Monterey Road. Another 12-inch diameter section of pipe will connect to the proposed 12-inch diameter pipe running east-west at the intersection of Monterey Road and Meridian Avenue. This section of pipe will continue south down Meridian Avenue and terminate 150 feet north of the intersection of Meridian Avenue and Bank Street just south of proposed isolation valve with Map ID 21 in Table 6.13 (CIP Project ID **WC-4**).
5. Approximately 300 feet of a 12-inch diameter section of pipeline is needed to convey water to the west side of the Central Pressure Zone from the existing 18-inch diameter pipeline between the MWD connection and the Grand Reservoir. The proposed 12-inch diameter pipeline connects to the 18-inch diameter pipeline at the intersection of El Centro Street and Indiana Avenue. It continues west and connects into the existing 10-inch diameter pipeline, halfway between Cawston Avenue and Indiana Avenue just west of the proposed isolation valve with Map ID 27 in Table 6.13 (CIP Project ID **WC-5**).
6. The existing 18-inch diameter pipeline between the MWD connection and the Grand Reservoir will remain in the Central Pressure Zone. There is a section of pipeline on Grand Avenue between Mission Street and Charter Oak Street that is connected to the existing 18-inch diameter pipeline. A new section of 12-inch diameter pipeline needs to be paralleled in this area in order to transfer the pipelines running on Magnolia and Charter Oak Street from the Central Pressure Zone to the proposed Magnolia Pressure Zone. The proposed 12-inch diameter pipeline will connect to the existing 10-inch diameter pipeline at the intersection of Grand Avenue and Charter Oak Street. It will continue south down Grand Street and terminate into the existing 10-inch diameter pipeline on Grand Street halfway between Magnolia Street and Mission Street. A second

section of 12-inch diameter pipeline is prosed to connect to the existing 8-inch diameter pipeline at the intersection of Magnolia Street and Grand Avenue. This proposed section of pipeline will head east across Grand Avenue and connect into the first section of the proposed 12-inch diameter pipeline. The total length of 12-inch diameter pipeline needed is 850 feet (CIP Project ID **WC-6**).

7. The eastern portion of the Magnolia rezoning isolates a portion of the east side of the Central Pressure Zone from the conveyance piping from Grand Reservoir. An 1,850 foot section of 12-inch diameter pipeline is proposed to replace the conveyance piping that is proposed to be incorporated into the Magnolia Pressure Zone. The proposed 12-inch diameter pipeline will connect into the existing 12-inch diameter pipeline at the intersection of Grevilia Street and Mound Avenue. The pipeline will head south down Mound Avenue and terminate at the intersection of Oxley Street and Mound Avenue just south of the proposed isolation valve with Map ID 4 in Table 6.13 (CIP Project ID **WC-7**).

6.3.6.3 Magnolia Pressure Zone Boundary Isolation Valve Modifications

Twenty (20) isolation valves will need to be shut, nine (9) existing isolation valves will need to remain closed, seven (7) new isolation valves will need to be added (CIP Project ID **WCV-4**), and two (2) isolation valves will need to be opened. This totals to 38 valve modifications needed in order to separate the prosed Magnolia Pressure Zone from the Central Pressure Zone. This analysis has identified described the modifications needed to be made as well as the location of each valve in Table 6.13. The locations of each of the 38 valves are shown on Figure 6.7. The City should add red blocks in the valve riser box, consistent with the City's indicator of a pressure zone break.

Table 6.13 Proposed Modifications to Isolation Valves for Magnolia Rezone

Map ID(1)	Location Description	City's Valve ID (Valve Diameter)
1	Add and close a valve in the 10-inch diameter pipe north of the intersection of Hope Street and Meridian Avenue. The closed valve should be located north of the proposed pipeline project WC-2.	New (10")
2	Keep the existing 10-inch diameter valve at the intersection of Hope Street and Meridian Avenue closed.	3-126(2) (10")
3	Keep the existing valve in the 6-inch diameter pipeline south of the intersection of Hope Street and Fairview Avenue closed.	3-134 (6")
4	Keep the two existing valves in the 6-inch diameter pipeline south of the intersection of Hope Street and Fremont Avenue closed.	3-141/3-142 (6"/6")
5	Keep the existing valve in the 6-inch diameter pipe north of the intersection of Mission Street and Mound Avenue closed.	3-153 (6")
6	Keep the existing valve in the 2-inch diameter pipe east of the intersection of Mound Avenue and Central Alley closed. Alley is located between Hope Street and Mission Street.	3-152 (2")
7	Keep the existing valve in the 4-inch diameter pipe northwest of the intersection of Hope Street and Fair Oaks Avenue closed.	4-80 (4")

Map ID(1)	Location Description	City's Valve ID (Valve Diameter)
8	Add and close a valve in the 12-inch diameter pipe north of the intersection of Hope Street and Fair Oaks Avenue. The closed valve should be located in the central zone pipe between Grevilia Street and Hope Street.	4-77 (12")
9	Close the valve in the 4-inch diameter pipeline north of the intersection of Mission Street and Park Avenue.	4-153 (4")
10	Close the valve in the 12-inch diameter pipeline west of the intersection of Mission Street and Park Avenue.	4-153*W (12")
11	Close the valve in the 8-inch diameter pipeline north of the intersection of Brent Avenue and Brent Avenue.	4-195 (6")
12	Close the valve in the 10-inch diameter pipeline north of the intersection of Oxley Street and Fair Oaks Avenue.	4-196*N (10")
13	Close the valve at the zone break in the 8-inch diameter pipeline north of the intersection of Oxley Street and Edison Avenue.	3-218 (4")
14	Close the valve in the 6-inch diameter pipeline north of the intersection of Mound Avenue and Oxley Street. North of Project WC-7.	3-222 (6")
15	Close the valve in the 6-inch diameter pipeline west of the intersection of Mound Avenue and Oxley Street.	3-222*W (6")
16	Close the valve in the 6-inch diameter pipeline south of the intersection of Oxley Street and Fremont Avenue. This pipeline is on the west side of Fremont Avenue.	3-226*S (6")
17	Close the valve in the 6-inch diameter pipeline north of the intersection of Oxley Street and Fremont Avenue. This pipeline is on the east side of Fremont Avenue.	3-227 (6")
18	Close the valve in the 4-inch diameter pipeline southwest of the intersection of Oxley Street and Fremont Avenue.	3-229 4
19	Close the valve at the zone break in the 8-inch diameter pipeline east of the intersection of Windsor Place and Monterey Road and west of the intersection of Fremont Avenue and Monterey Road.	3-268 (6")
20	Close the valve at the zone break in the 6-inch diameter pipeline east of the intersection of El Cerrito Circle and Lyndon Street.	8-11* (6")
21	Add and close a new 10-inch diameter isolation valve in the in the 10-inch diameter pipeline north of the intersection of Bank Street and Meridian Avenue. Approximately near 1325 Meridian Avenue.	New (10")
22	Close a valve on the 8-inch diameter pipeline west of the intersection of Indiana Avenue and Monterey Road. The closed valve should be located between the 8-inch diameter pipeline and proposed pipeline project WC-4.	2-36 (8")
23	Keep the existing valve in the 4-inch diameter pipe that bypasses the pumps in Indiana pump station closed.	2-40(2) (12")
24	Add and close a 12-inch diameter valve that allows the existing 12-inch diameter pipeline in the Central Pressure Zone to bypass the Indiana Booster PS, located south of the intersection of Indiana Avenue and Hawthorne Street. Project WC-4 should be in between this new valve and the existing closed valve labeled as Map ID 23 in this table.	New (12")

Map ID(1)	Location Description	City's Valve ID (Valve Diameter)
25	Add and close a 12-inch diameter valve between the 12-inch diameter connection from the MWD supply line and the proposed project WC-4, located south of the intersection of Indiana Avenue and Hawthorne Street.	New (12")
26	Add and close a new 6-inch diameter isolation valve in the 6-inch diameter pipeline west of the intersection of Indiana Avenue and Hawthorne Street and east of the intersection of Cawston Avenue and Hawthorne Street. FF-1 will be connected to the west of this closed valve.	New (6")
27	Add and close a new 10-inch diameter isolation valve in the 10-inch diameter pipe in El Centro Street. The new valve should be located near 418 El Centro Street and on the west side of the proposed pipeline project WC-5	New (10")
28	Close the valve on the 6-inch diameter pipeline between the Central Pressure Zone and the Magnolia Pressure Zone boundary east of the intersection of Mission Street and Indiana Avenue.	2-129 (6")
29	Close the valve in the 10-inch diameter pipe between the 10-inch diameter pipe and the 16-inch diameter pipe in the intersection of Mission Street and Palm Avenue.	2-127 (10")
30	Close the valve at the zone break in the 6-inch diameter pipeline north of the intersection of Mission Street and Arroyo Drive.	2-20 (6")
31	Keep the existing valve in the 6-inch diameter pipe south of the intersection of Sterling Place and Arroyo Drive closed.	2-10 (6")
32	Close the valve between the location where the proposed project WC-6 connects to the existing 4-inch diameter pipeline and the 10-inch diameter pipeline to the north, located at the intersection of Grand Avenue and Charter Oak Street.	2-155 (10")
33	Close the valve on the 6-inch diameter pipeline between the 16-inch diameter pipe on the west and 6-inch diameter pipeline on the east at the intersection of Magnolia Avenue and Grand Avenue.	2-138 (6")
34	Close the valve between the location where the proposed project WC-6 connects to the existing 8-inch diameter pipeline and the 16-inch diameter pipeline at the intersection of Magnolia Avenue and Grand Avenue.	2-137 (4")
35	Close the valve between the 10-inch diameter and 16-inch diameter pipeline north of the intersection of Mission Street and Grand Avenue.	2-119 (10")
36	Keep the existing valve in the 6-inch diameter pipe south of the intersection of Orange Grove Avenue and Grevilia Street closed.	2-147 (6")
37	OPEN the existing closed valve in the 6-inch diameter pipe at the intersection of Magnolia Street and Orange Grove Avenue.	2-143 (6")
38	OPEN the existing closed valve in the 6-inch diameter pipe at the intersection of Mission Street and Prospect Avenue.	3-182 (6")

Notes:
(1) MAP ID corresponds with the closed valve IDs on Figure 6.7. and Appendix E.
(2) Valve is already closed in the distribution system.
* Valve is in the system, however there is no valve number in the City's Valve Book. N, S, E, W indicate the location relative to an existing valve.

The location of the Magnolia rezoning as well as the pipelines, PRVs, and closed valves are shown on Figure 6.7. Figure 6.15, which is located near the end of this chapter, shows the revised hydraulic profile with Magnolia rezoned.

The Magnolia Rezoning will transfer many customers from the Central Pressure Zone to the Magnolia Pressure Zone and thus adjust the pressure zone demand distribution of demands. Approximately 250 gpm or 0.35 mgd of ADD will be transferred from the Central Pressure Zone to the Magnolia Pressure Zone. A revised breakdown of demands by pressure zone is presented in Table 6.14.

Table 6.14 Pressure Zone Demands After Magnolia Rezone

Name	HGL (ft msl)	ADD(1) (mgd)	MDD(2) (mgd)	Percent (%)
Bilicke	963	0.49	0.74	15.4%
Central (Main)	746	1.55	2.32	48.2%
Magnolia	820	0.39	0.58	12.0%
Pasadena	945	0.02	0.03	0.7%
Raymond	881	0.76	1.14	23.6%
Total	**N/A**	**3.20**	**4.81**	**100%**

Notes:
(1) Billing data from year 2016 geocoded and scaled up to 2019 production.
(2) Existing ADD multiplied by MDD peaking factor of 1.5.

As shown in Table 6.14 the Magnolia Pressure Zone will have and ADD of 0.39 mgd which is an increase of 0.37 mgd from the existing demand of 0.02 mgd seen in Table 6.3. The Central Pressure Zone is also reduced by 0.37 mgd from 1.92 mgd in Table 6.3 to 1.55 mgd in Table 6.14. The 0.37 mgd demand has been transferred from the Central Pressure Zone to the Magnolia Pressure Zone. In order to supply the Magnolia Pressure Zone, water is pumped from the Central Pressure Zone into the Raymond Pressure Zone; from the Raymond Pressure Zone water is conveyed through PRVs into the Magnolia Pressure Zone. There is a minor increase in pump cost associated with rezoning and supplying the additional ADD of 0.37 mgd in the Magnolia Pressure Zone. The benefits of rezoning include increased fire protection, as well as a pressure increase to a majority the customer locations in the City that were deficient.

6.3.6.4 Revised Minimum Pressure Analysis

With the Magnolia Rezoning CIP projects implemented, the previously low pressures seen in the north part of the Central Pressure Zone, have been increased above the criteria presented in Table 4.1. Figure 6.8 shows the revised minimum pressures with the Magnolia Pressure Zone expanded. The only remaining area with pressure below 40 psi is in the Bilicke Pressure Zone which has no recommended projects, as stated before.

6.3.6.5 Revised Storage Analysis

The storage analysis from Section 6.3.2 was re-evaluated with Magnolia rezoned and is presented on Table 6.15. As seen on Table 6.15, the demand transferred between pressure zones as part of the Magnolia rezoning, has a minor impact on the storage analysis and thus the recommendations from Section 6.3.2 remain. There is an increased flow that needs to be transferred via PRV from the Raymond Pressure Zone to the Magnolia Pressure Zone. This increase in flow has already been addressed with the three proposed PRVs, WCV-1 WCV-2, and WCV-3.

6.3.6.6 Revised Pump Station Analysis

Similar to the storage analysis, the pumping analysis from Section 6.3.3 was re-evaluated with Magnolia rezoned and is presented on Table 6.16. As seen on Table 6.16, now that Magnolia Pressure Zone has fire hydrants within its boundary, a fire flow of 3,500 gpm is required. Since there are no booster PS feeding Magnolia Pressure Zone, that flow will be fed through the two PRVs from the Raymond Pressure Zone as well as through the backup PRS from the Bilicke Pressure Zone. Three PRVs have been recommended as part of the rezoning analysis (WCV-1, WCV-2, and WCV-3).

Table 6.15 Existing Storage Analysis After Magnolia Rezoning

Zone	Existing Storage Facility	Existing MDD(1) (mgd)	Required Storage (MG)	Available Storage (MG)	Zone Balance (MG)	Proposed Facilities	Proposed Capacity (MG)	Balance with New Storage (MG)
Bilicke	Bilicke Tank	0.74	1.80	0.15	(1.65)	Pump from Central Pressure Zone	1.65	0.00
Pasadena	None	0.03	0.34	0.0	(0.34)	Install Check Valve from Raymond Pressure Zone	0.34	0.00
Raymond	Raymond Tank	1.14	2.32	0.15	(2.17)	PRV to Magnolia Pressure Zone Install Check Valve to Pasadena Zone Pump from Central Pressure Zone	(1.59) (0.34) 4.10 [Total: 2.17]	0.00
Central	Westside Reservoir Grand Reservoir Garfield Reservoir Wilson Reservoir Graves Reservoir	2.32	3.85	13.4	9.55	Pump to Bilicke Pressure Zone Pump to Raymond Pressure Zone	(1.65) (4.10) [Total: (5.75)]	3.79
Magnolia	None	0.58	1.59	0.0	(1.59)	PRV from Raymond Pressure Zone	1.59	0.00
Total		**4.81**	**9.91**	**13.5**	**3.79**	**N/A**	**0.00**	**3.79**

Notes:
(1) MDD peaking factor assumed to be 1.5.
(2) Proposed Facilities in bold are not existing.
(3) Detailed calculations are found in Appendix F.5.

Table 6.16 Existing Pump Station Analysis After Magnolia Rezoning

Discharge Pressure Zone	Existing MDD(1) (gpm)	Required Max Fire Flow (gpm)	Total Required Capacity(2) (gpm)	Existing Firm Capacity(3) (gpm)	Existing Capacity Balance (gpm)	Proposed Facilities (Recommendations)	Capacity Balance w/Recommendations (gpm)
Bilicke	515	3,500	4,015	3,000	(1, 015)	Replace old pumps at Indiana. (WRPS-2) Add transfer switch for backup power at Indiana. (BP-1) Replace pumps at Westside/Add 3rd Pump (WRPS-1)	485
Pasadena	24	2,500	2,524	0	(2,524)	Install Check Valve from Raymond Pressure Zone.	1,376
Raymond	788	3,500	4,690(5)	5,200	510	Install Check Valve to Pasadena Pressure Zone	510
Central	1,610	0(4)	2,913(6)	5,500	2,587	Add backup power.	2,587
Magnolia	401	3,500	3,901	0	(3,901)	PRV flows from Raymond Pressure Zone	0
Total	**3,338**		**18,042**	**13,700**	**(4,342)**		**4, 959**

Notes:
(1) MDD assumed to be ADD x 1.5.
(2) Required Capacity includes upstream zones and flow requirements.
(3) PS capacities provided by City staff.
(4) Central Pressure Zone has gravity storage so there is no fire flow required
(5) Raymond Pressure Zone's required capacity includes MDD of Raymond Pressure Zone, Magnolia Pressure Zone, and 3,500 gpm fire flow in Raymond Pressure Zone.
(6) Central Pressure Zone's required capacity includes MDD of Raymond, and Magnolia.
(7) Detailed calculations in Appendix F.6.

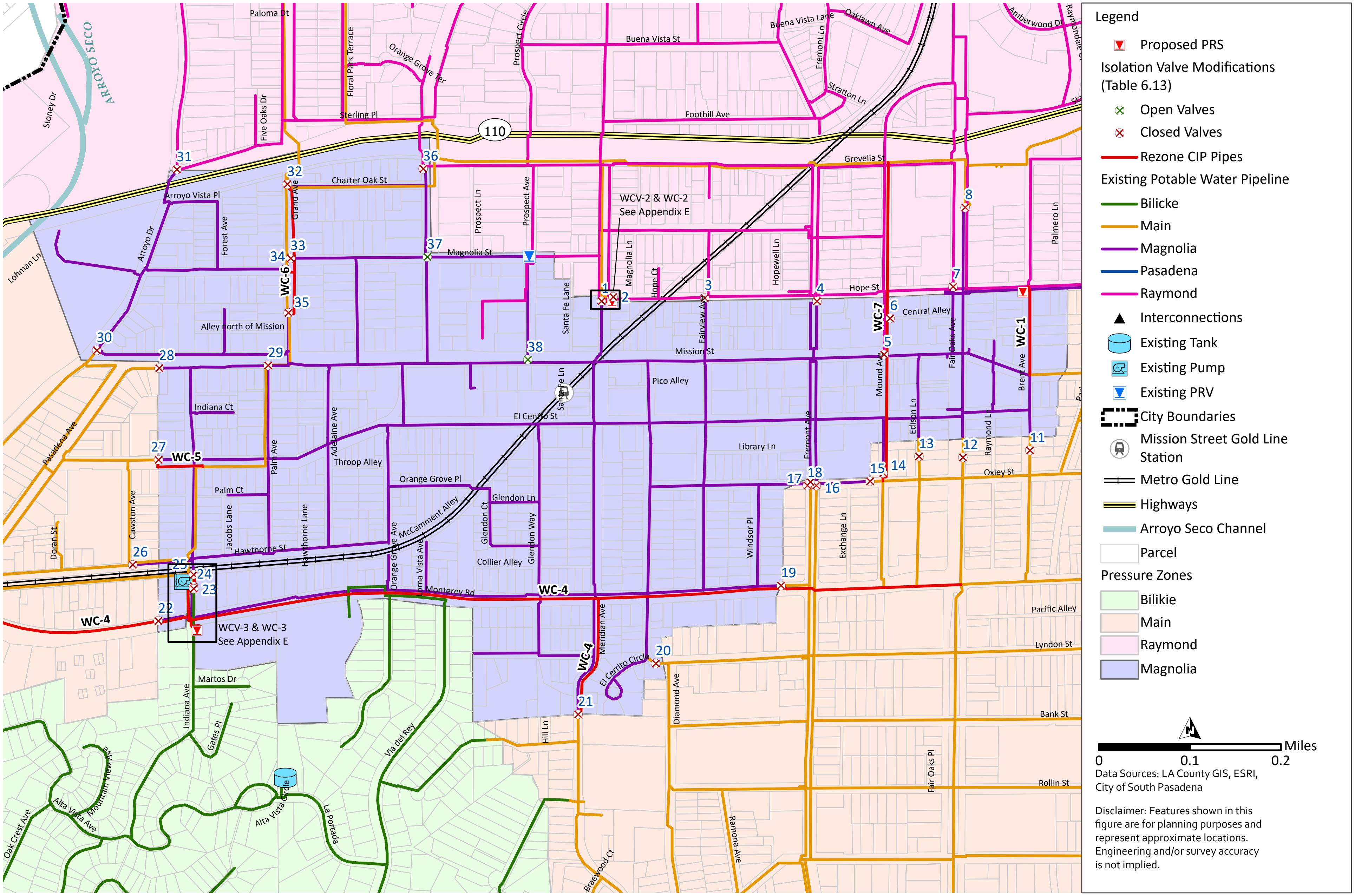

Figure 6.7 Revised Pressure Zone Boundary

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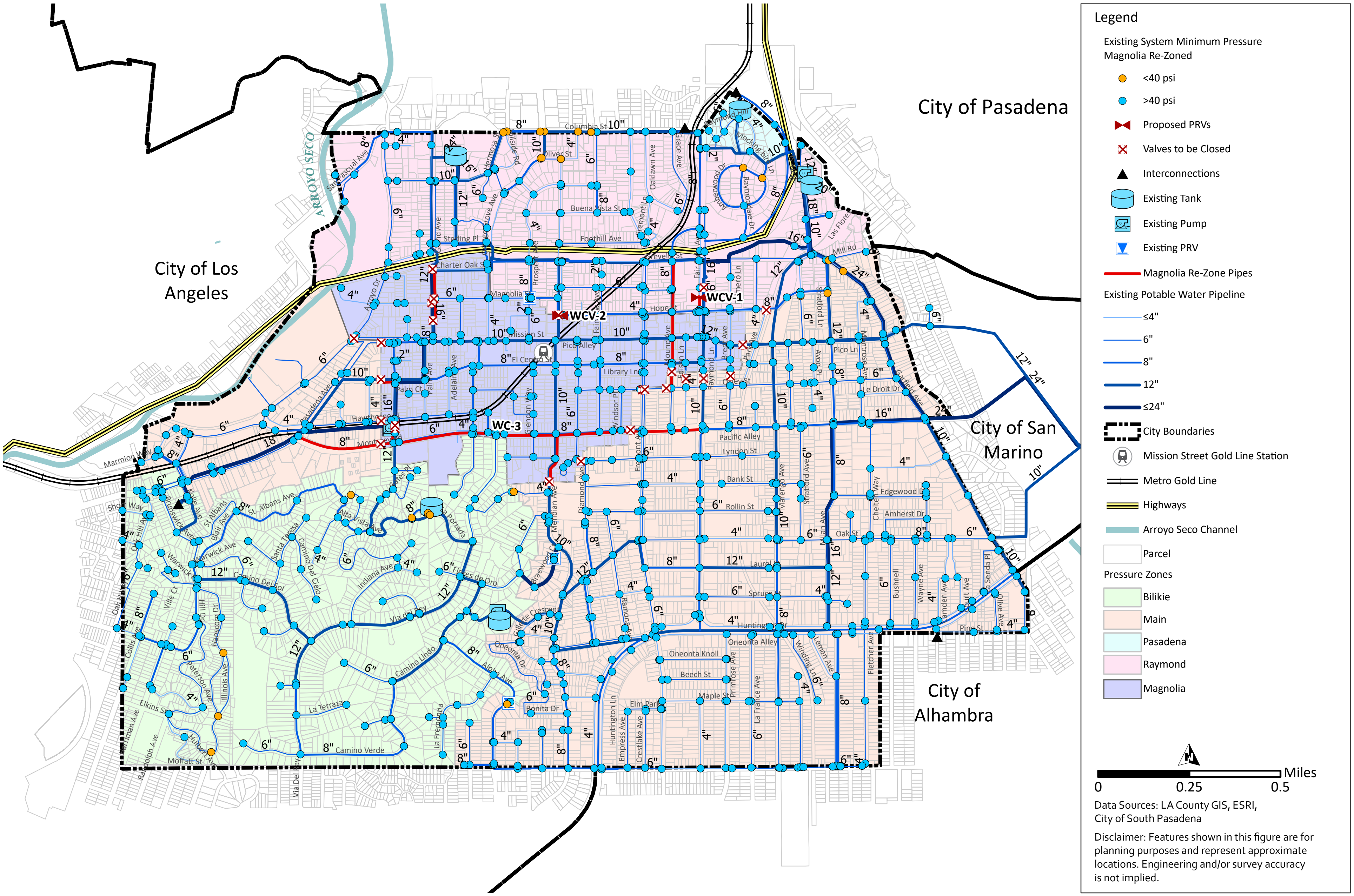

Figure 6.8 Existing System Minimum Pressure Magnolia Rezoned

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6.3.7 Fire Flow Analysis

A fire-flow analysis was completed using the evaluation criteria listed in Chapter 4. Based on these criteria, the existing distribution system was evaluated to verify that a minimum residual pressure of 20 psi was met under MDD conditions, while maintaining a fire flow ranging from 1,500 gpm to 4,000 gpm within the corresponding land-use category. The City's 492 hydrants were evaluated and 195 (40 percent) of the fire hydrants were able to provide sufficient fire flow. The results of the existing fire hydrant analysis are presented on Figure 6.9.

A second fire-flow analysis was conducted to determine the impacts that the Magnolia Rezoning will have on the system. This fire-flow analysis resulted in 177 (36 percent) deficient hydrants. The results of this analysis are presented on Figure 6.10. Although the static pressure in the Magnolia Pressure Zone was increased as part of the rezoning, many hydrants in the expanded pressure zone are still deficient which implies that the deficiency is caused from head loss during the fire flow. Additionally, many of the deficient hydrants are being served from pipelines less than 8-inches in diameter, with some diameters as small as 4-inches.

These small diameter pipelines are not capable of conveying the large flows of water required for modern fire suppression code. Therefore, it is recommended that the City upsize all of their pipelines which are 4-inches in diameter or less to 8-inch diameter pipelines if the pipeline is a part of a loop or connects to a hydrant. Pipelines that are on dead end streets are not included in this recommendation. This project is included in the CIP as improvement project "SDR-4" (CIP Project ID **SDR-4**), where there are 14.6 miles of pipeline that will need to be replaced with 8-inch diameter pipelines.

It should be noted that at the time when the existing facilities were constructed, less stringent fire-flow criteria were in place. Hence, this analysis identifies insufficient pipeline conveyance capacity at certain locations. As it is beyond the scope of this plan to verify the historic fire-flow criteria, it is recommended that City staff verify the actual fire-flow to evaluate alternatives to improve fire protection while minimizing the need to upsize existing pipelines. In addition, the fire flow criteria may be reduced in select locations that have indoor fire sprinkler systems. These locations will be reviewed by the City to determine if some of the fire flow projects can be eliminated with a reduced flow rate requirement, as allowed by the California Fire Code.

The fire flow analysis was re-run with the 4-inch diameter or smaller improvements implemented. The resulting model run predicted that 80 hydrants of the City's 492 hydrants (16 percent) were deficient. This resulted in an improvement to 80 percent of the original 200 deficient hydrants. Figure 6.11 shows the remaining fire flow deficiencies following the SDR-4 improvements. Additionally, several groups of deficient hydrants are identified on Figure 6.11.

An additional 23 fire flow improvement projects were identified to address the remaining fire flow deficiencies shown on Figure 6.11. These 23 fire flow projects are shown along with the 4-inch diameter and smaller replacement project on Figure 6.12 and are summarized in Table 6.17. Since pipeline replacement projects may overlap some of these fire flow improvement projects, they were only counted as fire flow projects and removed from the pipeline replacement program. Also, four of the fire flow projects are located near schools and considered critical projects. These 23 projects are identified in Table 6.17 and will be prioritized in the CIP.

As shown in Table 6.17, a total of 23 improvements have been proposed involving upsizing existing pipelines and/or completing pipeline loops with a combined length of approximately 33,060 feet or 6.3 miles (CIP Project ID FF-1 to FF-23). In addition to pipelines, one fire flow project (FF-1) includes an additional check valve (CIP Project ID FFCV-1).

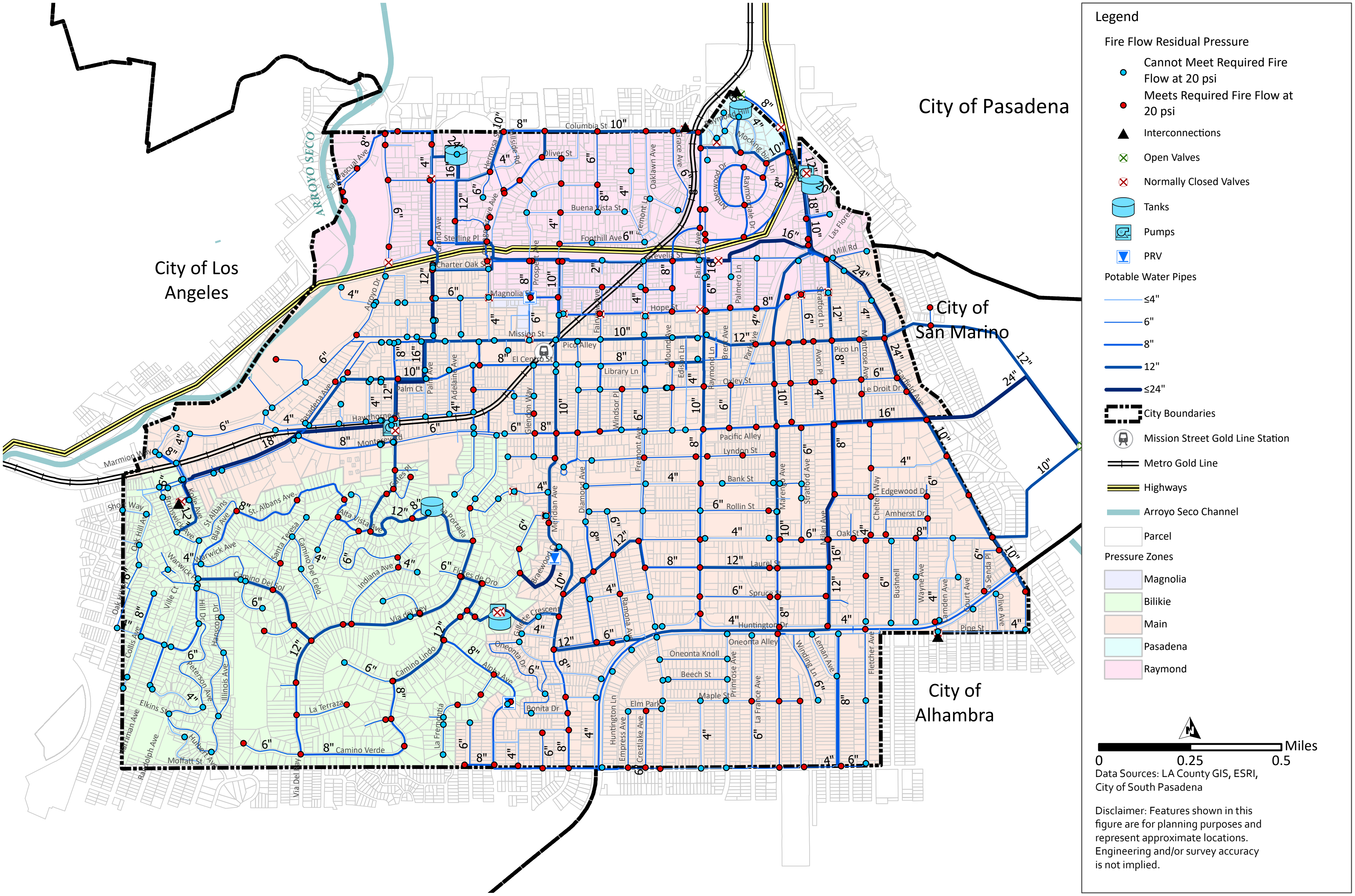

Figure 6.9 Existing Fire Flow Analysis

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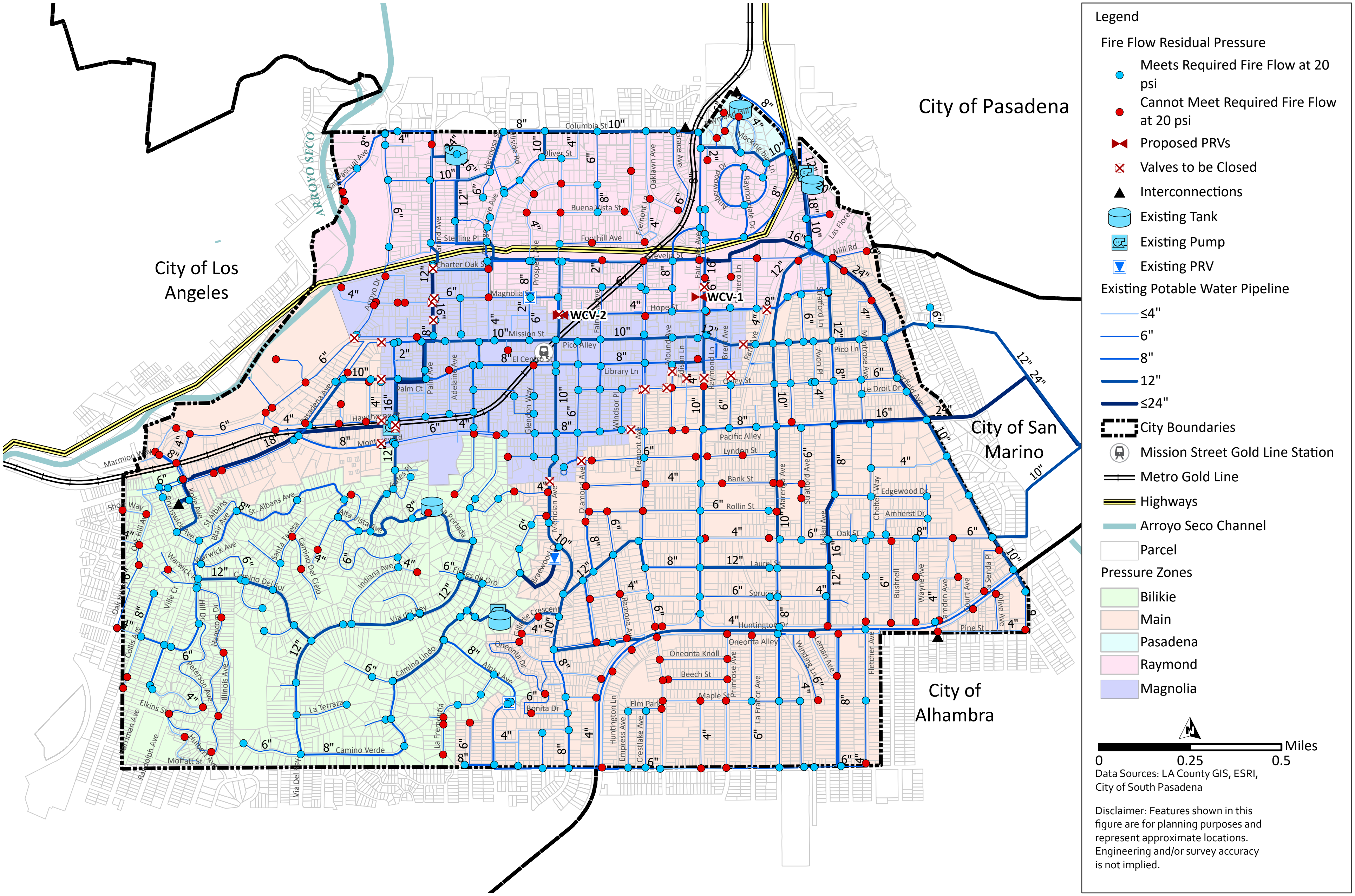

Figure 6.10 Existing Fire Flow Analysis With Magnolia Rezoned

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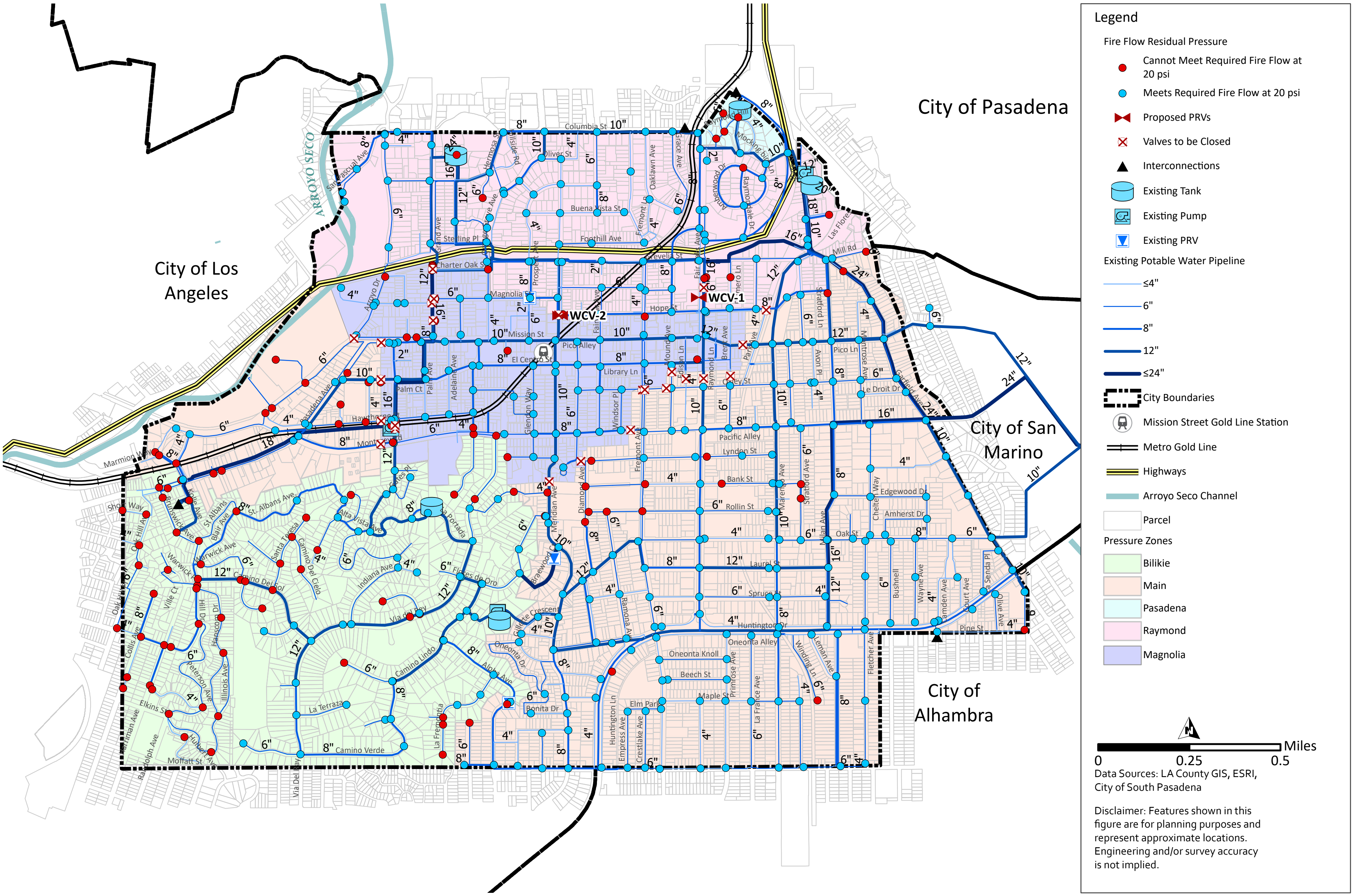

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Figure 6.11 Remaining Fire Flow Deficiencies After After Small Diameter Replacement (SDR-4)

Last Revised: August 26, 2021 pw:\\IO-PW-INT.Carollo.local:Carollo\Documents\Client\CA\South Pasadena\11822A00\GIS\SouthPasadena11822A00\PW_SouthPasadena118A00.arpx\High Priority Fire Flow Deficiencies

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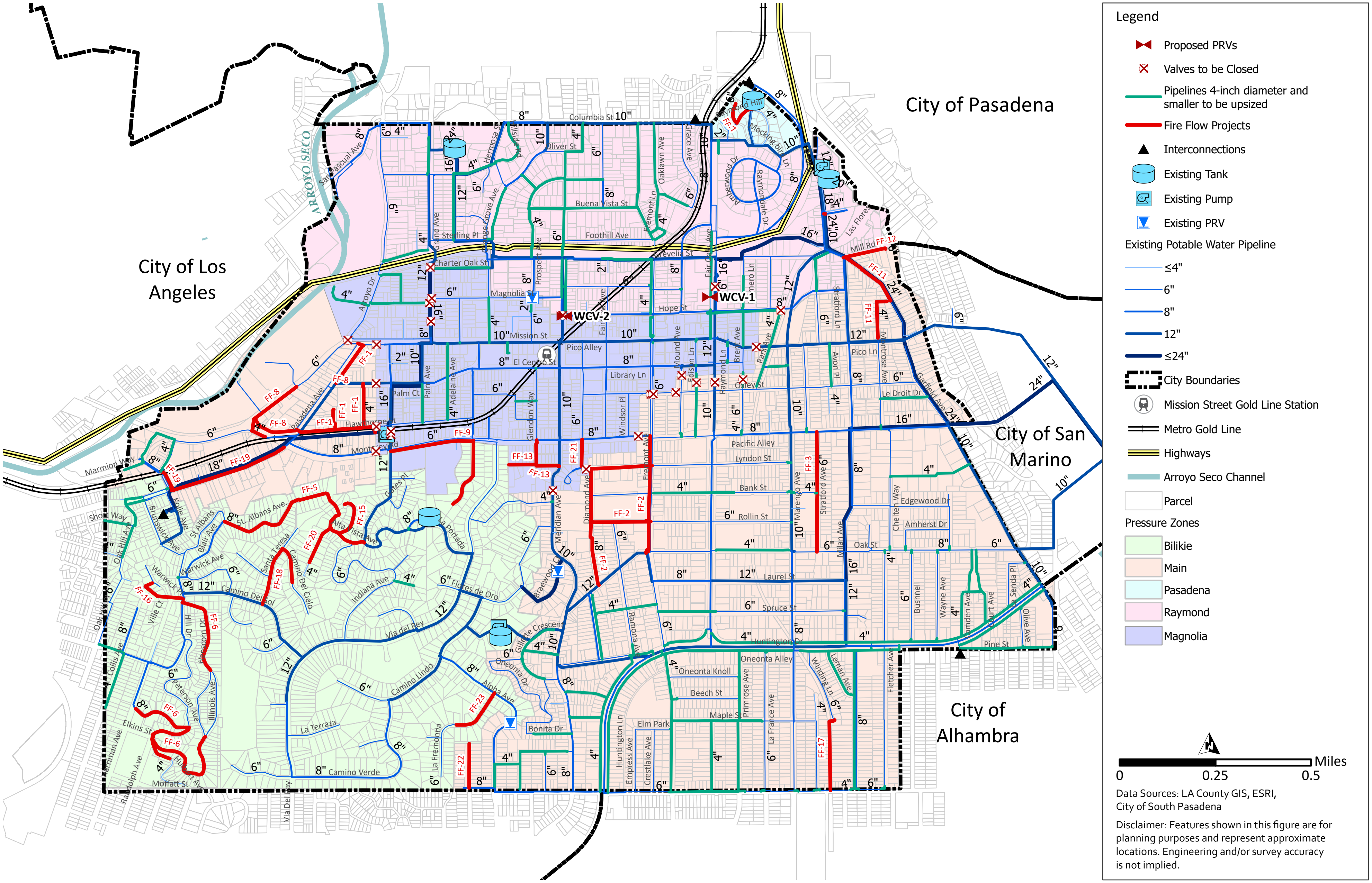

Figure 6.12 Recommended Fire Flow Improvements

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Table 6.17 Proposed Fire Flow Improvements

CIP ID	High Priority	Project Location	Length of Replacement (ft)			Total Replacement Length (ft)[3]	Deficiency Resolved (gpm)
			6-inch	8-inch	12-inch		
FF-1	Yes	• Install new 8-inch diameter pipeline from the existing 6-inch diameter pipeline southwest of the intersection of Mission St. and Pasadena Ave, across Pasadena Ave. to the existing 6-inch dimeter pipeline southwest of the intersection of Mission St. and Pasadena Ave. From there upsize the existing 6-inch diameter pipeline to an 8-inch diameter pipeline, south to El Centro St. • Upsize the existing 6-inch diameter pipeline with an 8-inch diameter pipeline across the intersection of Hawthorne St. and Pasadena Ave. From there continue upsizing the pipeline with a 12-inch diameter pipe, east down Hawthorne St to the proposed Magnolia rezone break approximately 200 feet west of the intersection of Indiana Ave. At this location install a new 12-inch diameter pipeline to the south to connect the north and south pipelines on Hawthorne St. upsize existing Hawthorne St, Doran St, Cawston Ave, Pasadena Ave • Replace the existing 4-inch diameter pipe on Doran St with an 8-inch diameter pipe. • Replace the existing 4-inch diameter pipe on Cawston Ave. with an 8-inch diameter pipe.	0	1,580	1,230	2,810	9,750
FF-2	Yes	• Upsize the existing 4-inch diameter pipe with an 8-inch diameter pipe from the intersection of Oak St. and Fremont Ave. to the intersection of Monterey Rd. and Fremont Ave. • Upsize/Replace the existing 6-inch/8-inch diameter pipe with an 8-inch diameter pipe from the intersection of Lyndon St. and Diamond Ave. to the intersection of Oak St. and Diamond Ave. • Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Diamond Ave. and Rollin St. to the intersection of Rollin St. and Fremont Ave. • Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Diamond Ave. and Lydon St. to the intersection of Lyndon St. and Fremont Ave.	0	5,070	0	5,070	7,056
FF-3	Yes	• Upsize/Replace the existing 6-inch/8-inch diameter pipe to an 8-inch diameter pipe on Stratford Ave. from the intersection of Stratford Ave. and Monterey Rd. to the intersection of Strafford Ave. and Oak St.	0	1,660	0	1,660	822
FF-4	Yes	• Install a new 8-inch diameter pipe to connect the existing 10-inch diameter pipe in the Raymond Pressure Zone at the intersection of Garfield Ave. and Hardison Pl. to the existing 10-inch diameter pipe on Hardison Pl.	0	20	0	20	834
FF-5[1]		• Upsize the existing 8-inch diameter pipe to a 12-inch diameter pipe from the intersection of Alta Vista Ave. and Indiana Ave. to the intersection of Blair Ave. and St. Albans Ave.	0	0	2,810	2,810	0
FF-6		• Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Illinois Ave. and Hanscom Dr. to the intersection of Hanscom Dr. and Hulbert Ave. • Upsize the existing 4-inch diameter pipe with an 8-inch diameter pipe from the intersection of Hanscom Dr. and Hulbert Ave. 800 feet to the southeast. • Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Hanscom Dr. and Hulbert Ave. to the intersection of Hanscom Dr. and Peterson Ave. • Upsize the existing 4-inch diameter pipe with an 8-inch diameter pipe from the intersection of Hanscom Dr. and Peterson Ave. to the intersection of Peterson Ave. and Harriman Ave. • Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Illinois Ave. and Hanscom Dr. to the intersection of Hanscom Dr. and Warwick Pl.	0	4,720	0	4,720	4,193
FF-7[2]		• Upsize the existing 6-inch diameter pipe with a 12-inch diameter pipe from the intersection of Raymond Hill and Cedarcrest Ave. to the intersection of Raymond Hill and Mockingbird Ln. • Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Raymond Hill and Mockingbird Ln. to the end of Mockingbird Ln. • Install an 8-inch diameter check valve between the Raymond Pressure Zone and the Pasadena Pressure Zone at the intersection of Raymond Hill and Cedarcrest Ave.	0	290	290	580	3,810

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Table 6.17 Proposed Fire Flow Improvements *(continued)*

CIP ID	High Priority	Project Location	Length of Replacement (ft)			Total Replacement Length (ft)(3)	Deficiency Resolved (gpm)
FF-8		• Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the existing 6-inch diameter tee 840 northeast of the intersection of Arroyo Dr. and Hawthorne St. south to the intersection of Arroyo Dr. and Hawthorne St. From there continue the upsize, but with an 8-inch diameter pipe east to the intersection of Pasadena Ave. and Hawthorne St. • Upsize the existing 6-inch diameter pipe to a 12-inch diameter pipe from the intersection of Arroyo Dr. and Hawthorne St south across Hawthorne St. From that location Upsize the existing 8-inch diameter pipe to a 12-inch diameter pipe an additional 230 feet to the southeast.	0	1,020	880	1,900	2,036
FF-9		• Install a new 8-inch diameter pipe in the existing 12-inch diameter pipe in the Bilicke Pressure Zone from the intersection of Indiana Ave. and Monterey Rd. to the intersection of Orange Grove Ave. and Monterey Rd. Terminate the new 8-inch pipe into the existing 6-inch diameter pipe in the Bilicke Pressure Zone. • Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Orange Grove Ave. and Monterey Rd. south to the end of Orange Grove Ave.	0	2,140	0	2,140	1,640
FF-10		• Install new 8-inch diameter pipe from the intersection of Milan Ave. and Hope St. from the existing 8-inch diameter pipe in the Raymond Pressure Zone to the hydrant on the southwest corner of the intersection of Milan Ave. and Hope St.	0	100	0	100	1,182
FF-11		• Upsize the existing 6-inch diameter pipe to an 8-inch diameter pipe from the Intersection of Garfield Ave. and Mill Rd. to the intersection of Garfield Ave. and Montrose Ave. • Upsize the existing 4-inch diameter pipe to an 8-inch diameter pipe from the intersection of Garfield Ave. and Montrose Ave. to the intersection of Mission St. and Montrose Ave.	0	1,510	0	1,510	1,080
FF-12		• Upsize the existing 6-inch and 8-inch diameter pipes with an 8-inch diameter pipeline on Mill Rd. from the Intersection of Garfield Ave. and Mill Rd.	0	600	0	600	1,076
FF-13		• Upsize the existing 6-inch diameter pipe to an 8-inch diameter pipe from the intersection of Lyndon St. and Meridian Ave. to the intersection of Lyndon St. and Glendon Way. • Replace the existing 6-inch diameter pipe from the intersection of Lyndon St. and Glendon Way. West to the end of Lyndon St. • Upsize the existing 6-inch diameter pipe to an 8-inch diameter pipe from the intersection of Lyndon St. and Glendon Way north to the intersection of Glendon Way and Monterey Rd.	380	680	0	1,060	1,040
FF-14		• Install new 8-inch diameter pipe from the existing 6-inch diameter pipe on Bank St. in the Bilicke Pressure Zone to the hydrant east of the Bilicke Pressure Zone.	0	100	0	100	909
FF-15		• Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Alta Vista Ave. and Mountain View Ave. north to the end of Mountain View Ave.	0	620	0	620	745
FF-16		• Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Hanscom Dr. and Warwick Pl. to the existing 6-inch pipeline near the hydrant on Warwick Pl.	0	680	0	680	719
FF-17		• Install a new 8-inch diameter pipe from the existing 6-inch diameter pipe at the south end of Winding Ln. through the easement to the southwest to the existing 6-inch diameter pipe in Alabama Rd.	1,030	0	0	1,030	656
FF-18		• Upsize the existing 6-inch diameter pipe to an 8-inch diameter pipe from the intersection of Santa Teresa and Camino Del Cielo to the intersection of Santa Teresa and Camino Del Sol • Upsize the existing 6-inch diameter pipe to an 8-inch diameter pipe from the intersection of Santa Teresa and Camino Del Cielo to the hydrant on Camino Del Cielo.	0	1,340	0	1,340	553
FF-19		• Upsize the existing 4-inch diameter pipe in Arroyo Verde to an 8-inch diameter pipe from the intersection of Arroyo Verde and Sycamore Ave. to the intersection of Arroyo Verde and Monterey Rd. • From the intersection of Arroyo Verde and Monterey Rd. upsize the 6-inch diameter pipe on the south side of Monterey Rd. to an 8-inch diameter pipe up to the intersection of Monterey Rd. and Pasadena Ave.	0	2,010	0	2,010	424
FF-20		• Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Alta Vista Ave. and Oak Crest Ave. south to the hydrant on Oak Crest Ave.	0	570	0	570	379
FF-21		• Replace the existing 6-inch diameter pipe from the intersection of Monterey Rd. and Diamond Ave. to the intersection of Diamond Ave. and El Cerrito Circle.	380	0	0	380	354

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Table 6.17 Proposed Fire Flow Improvements *(continued)*

CIP ID	High Priority	Project Location	Length of Replacement (ft)			Total Replacement Length (ft)(3)	Deficiency Resolved (gpm)
FF-22		• Upsize the existing 4-inch diameter pipe with an 8-inch diameter pipe from the intersection of Maycrest Ave. and Moffatt St. to the end of Maycrest Ave.	0	610	0	610	342
FF-23		• Upsize the existing 6-inch diameter pipe with an 8-inch diameter pipe from the intersection of Alpha Ave. and La Fremontia 740 feet south down La Fremonita.	0	740	0	740	337
Total Fire Flow Replacement (feet)			**1,790**	**26,060**	**5,3210**	**33,060**	
Total Fire Flow Replacement (miles)			**0.3**	**4.9**	**1.0**	**6.3**	

Notes:
(1) This project is required for FF-6, FF-15, FF-16, FF-18, and FF-20
(2) This project also requires an 8-inch diameter check valve in the proposed 12-inch diameter pipe (FF-7) between Pasadena Pressure Zone and Raymond Pressure Zone located at the intersection of Raymond Hill and Cedarcrest Avenue (CIP Project ID **FFCV-1**).
(3) 5.8 miles of the 6.3 miles of fire flow project length include upsizing and/or replacing existing pipelines. Only 0.3 miles of new pipeline alignments.

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6.3.8 Water System Facilities Field Condition Assessment

A condition assessment was performed on July 9, 2020 by Carollo Engineers' assessment team for all of the City's potable water distribution system facilities. The following facilities were assessed:

- Well Sites:
  - Wilson Well 2.
  - Wilson Well 3.
  - Wilson Well 4.
- Reservoir Sites:
  - Garfield Reservoir.
  - Raymond Elevated Tank.
  - Westside Reservoir.
  - Grand Reservoirs.
  - Bilicke Elevated Tank.
  - Wilson Reservoir.
- Pump Stations:
  - Garfield Pump Station.
  - Grand Pump Station.
  - Westside Pump Station.
  - Indiana Pump Station.
  - Wilson Pump Station.
- MWD Connection:
  - Kolle Pump House (MWD G-05).
- Lift Station:
  - Stoney Lift Station.

The Graves Reservoir Site was not evaluated because it was under construction on the date of the condition assessment.

Improvement projects were identified and grouped into three phases; Near-Term Phase (by year 2025), Mid-Term Phase (year 2026-2030), and the Long-Term phase (year 2031-2050). A summary of the recommended capital improvement projects is summarized by phase in Table 6.18. The detailed Condition Assessment Report with field photos and field notes organized by engineering discipline is provided in Appendix G.

It should be noted that many of the smaller improvement projects will likely be funded from the City's water systems operations budget and are therefore not included in the Capital Improvement Plan (CIP) presented in the Chapter 10 of this One Water 2050 Plan.

Table 6.18 Water System Condition Assessment Recommendations

Facility (Install Year)	Recommended Improvements[1, 2]
Garfield Reservoir & Pump Station (2018)	**Near-Term:** • Add CCTV monitoring and SCADA linked security systems. • Install LED-type fixtures. • Provide containments system around chemical storage tank. **Long-Term:** • Install replacement electrical equipment having NEMA 4 (minimum) enclosures, or relocate electrical equipment outside of pump room. • Repair concrete cracks on walls and roof or reservoir; Install solar array on top of reservoir.
Raymond Elevated Tank (1936)	**Near-Term:** • Add CCTV monitoring and SCADA linked security systems, as well as automatic security lighting to alert neighbors of unwanted personnel at site. • Replace/Remove elevated tank, or seismic rehabilitation. • Install retaining wall and driveway to site entrance. • Build concrete stairs to access site from above. • Modernize brick retaining wall. • Pave areas around footings of elevated tank. • Remove corrosion in telemetry cabinet, then seal up unwanted enclosure openings to prevent future water penetrations • Implement a maintenance program to check the operational capabilities of the batteries. **Mid-Term:** • Refinish the miscellaneous cabinets to restore their protective coating. **Long-Term:** • Replace alarm system with SCADA. • Refinish the cabinet to restore its protective coating.
Grand Reservoir & Pump Station (2007)	**Near-Term:** • Add CCTV monitoring and SCADA linked security systems. • Install a permeant disinfection system to replace the temporary setup. • Check/replace either the fluorescent lamps or ballast in the pump room. • Replace lights in pump room and chemical room with LED-type fixture. **Mid-Term:** • Spot recoating on both reservoirs. • Add automation and SCADA control to CLA valves. • Retrofit to a MicOclor System to be consistent with the rest of the facilities. • Perform regular electrical maintenance to extend functionality before considering replacement of electrical equipment. **Long-Term:** • Replace sealant along bottom of pump pads. • Regrade area near storage room to nearest drainage system. • Check weep holes in retaining walls to ensure proper drainage. • Install replacement electrical equipment having a NEMA 4 (minimum) enclosures, or relocate electrical equipment outside of pump room for electrical equipment. • Replace radio alarms with SCADA.

Facility (Install Year)	Recommended Improvements[1, 2]
Kolle Pump House MWD Connection USG-2 (1965)	**Near-Term:** • Add CCTV monitoring and SCADA linked security systems. • Remove and replace foundation and block wall. • Provide a drainage channel or trench across the driveway to reduce stormflow into the pump station site. • Install a permeant breakpoint chlorine system. • Install a flow switch on the eye wash water feed line and monitor eyewash operating remotely via SCADA • Replace lighting with new energy efficient LED light fixture. • Install replacement electrical equipment having NEMA 4 (minimum) enclosures, or relocate electrical equipment outside with NEMA 3R enclosures for electrical equipment. • Replace the valve building duplex wall receptacle with a ground fault type receptacle with new enclosure. • Re-grade and add sump pump/storm drain inlet. **Mid-Term:** • Re-pave and add wall at south property line. • Replace antenna and locate on a new area light pole near Kolle Street entrance.
Westside Reservoir & Pump Station (1963)	**Near-Term:** • Add CCTV monitoring and SCADA linked security systems. • Conduct a study to analyze options for repair, replacement of roof, or replacement of entire reservoir. • Conduct a study to analyze options for localized crack repairs and patching or replacement of entire reservoir. • Install existing replacement check valve; Replace pump station and outdoor lighting with LED-type fixtures. • Mount Antenna on taller stand, or mount stand higher up on the hillside. • Provide new disconnect switch and relocated at an accessible location. • Install replacement electrical equipment having NEMA 4 (minimum) enclosures, or relocate electrical equipment outside of pump room. • Replace pump room receptacle with ground fault type receptacle • Perform maintenance on irrigation system. **Mid-Term:** • Provide permanent backup generator and move temporary generator to a different location. • Replace all pumps with reservoir retrofit.

Facility (Install Year)	Recommended Improvements[1, 2]
Bilicke Elevated Tank (1940)	**Near-Term:** • Add CCTV monitoring and SCADA linked security systems. • Remove or Replace Tank. • Remove wooden electrical box with NEMA 3R enclosure, replace/move wiring as needed. • Replace conduit cover near reservoir ladder. • Install a new gate to eliminate gap at site entrance along La Portada Street. **Mid-Term:** • Provide slope repair and retaining walls along access road and sidewalk along La Portada street. • Develop drainage analysis based on new site layout. • Install new antenna to replace existing system.
Indiana Pump Station (1940)	**Near-Term:** • Add CCTV monitoring and SCADA linked security systems. • Commission a ventilation system study and upgrade. • Add oxygen sensor for confined space entry. • Install new pumps and motors. • Install replacement electrical equipment having NEMA 4 (minimum) enclosures, or relocate electrical equipment outside with NEMA 3R enclosures. • Replace receptacle with ground-fault type. **Mid-Term:** • Change entrance door to steel. • Install a flow meter on discharge of pump station.
Wilson Reservoir & Pump Station (2015)	**Near-Term:** • Add CCTV monitoring and SCADA linked security systems. • Maintain/replace leaking valve on GAC system. • Provide separate generator termination cabinet and eliminate the need to make internal generator connections to the ATS. • Install a flow switch on the eye wash water feed line, and monitor eyewash operating remotely via SCADA. **Mid-Term:** • Perform a drainage analysis and regrade to reduce ponding. • Add camlock hookup for auto transfer switch. • Long-Term: • Spot recoating of walls on buildings.
Wilson Wells (years of installation vary)	**Near-Term:** • Install new well pump and motor on Well 3. • Replace lights with LED-type fixture. **Long-Term:** • Evaluate to activate or abandon well and sell property. • Install pump and motor on Well 2.

Note:
(1) See Appendix G for condition assessment technical memorandum.

As seen in Table 6.18, each facility has recommendations for near-term, mid-term, and/or long-term. Each of the sites near-term, mid-term, and long-term projects have been grouped into a single line item in the CIP IDs containing WRSI-NT-, WRSI-MT, and WRSI-LT-, respectively. Additionally, larger projects such as booster PS replacement and reservoir removal/replacements have their own Project CIP IDs which are not grouped into the general site improvement Project CIP IDs. Appendix H show the CIP Project IDs and costs for each item listed in Table 6.18. Some recommendations were categorized as maintenance or O&M. The larger projects recommendations coming from the condition assessment are as follows:

- Removal of Raymond Elevated Tank (CIP Project ID WRS-1). The removal of the tank should be proceeded with a predesign report to assess the location and sizing of any surge tanks or VFDs need to accommodate pumping into a closed pressure zone. This predesign report should include a hydraulic surge study. The pumps at Grand booster pumps will need to be equipped with VFDs (CIP Project ID WRPS-3). Similarly, Garfield booster pumps will need to be equipped with VFDs (CIP Project ID WRPS-4).
- Decommissioning the Bilicke Elevated Tank as a water storage vessel and retrofitting it for other use such as structure for antenna array (CIP Project ID WRS-2). The decommissioning of the tank should be proceeded with a predesign report to assess the location and sizing of any surge tanks or VFDs need to accommodate pumping into a closed pressure zone. This predesign report should include a hydraulic surge study. This study should be performed in coordination with the replacement of the Indiana Booster PS (WRPS-2) and Westside Booster PS (WRPS-1).
- Replace the Westside Reservoir (CIP Project ID **WRS-3**).
- Replace the Westside Booster PS (CIP Project ID **WRPS-1**).
- Replace the Indiana Booster PS (CIP Project ID **WRPS-2**).
- Install a new well pump and motor on Wilson Well 2 (CIP Project ID **WCW-1**).
- Replace motor on Wilson Well 3 (CIP Project ID **WRW-1**).

With the removal of Raymond Tank (0.15 MG), and the decommissioning of Bilicke Tank (0.15 MG) there is a reduction of storage of 0.30 MG in South Pasadena's Storage. As shown in

Table 6.11 there is an excess storage capacity 3.59 MG. This excess storage will be reduced to a systemwide excess of 3.29 MG with the reduction in storage from Raymond and Bilicke Tanks. This will not affect the storage recommendations. However now both the Raymond Pressure Zone and the Bilicke Pressure Zone will be supplied mainly by booster pumps and thus the need for backup power at all booster pump stations (BP-1 through BP-5) is reaffirmed.

6.3.9 Pipeline Replacement Analysis

As presented in Section 6.1.2.2, the City's water system GIS currently has approximately 83 miles of potable water pipelines. As a full asset-management analysis is beyond the scope of this plan, a cursory level pipeline replacement analysis was conducted along with planning level cost estimates using a number of general planning assumptions.

Based on the hydraulic modeling analysis:

- 14.6 miles of pipeline 4-inch diameter and smaller need to be upsized for fire protection.
- Of the twenty-three fire flow projects, 5.8 miles have been identified as pipeline replacement.
- Project WC-3 and WC-4 includes replacing nearly 0.5 miles of pipeline as part of the Magnolia rezoning.

These pipeline replacement projects total 20.8 miles and should be the first pipelines in the system to be replaced. The remaining 62.5 miles (83.3 – 20.8) of pipeline are evaluated based on their remaining useful life and pipeline leak history. It was assumed that the average useful life for all pipeline materials is 80 years. Figure 6.13 shows the length and percentage of pipelines that need to be replaced organized by decade.

As seen in Figure 6.13, approximately 91 percent or 56.6 miles of pipeline need to be replaced by 2050. Of the 56.6 miles, 27.9 miles are overdue for replacement and are past their useful life in 2021 at the writing of this plan. Another 13.1 miles of pipeline should be replaced this decade (2020s).

The 20.8 miles of replacements from the hydraulic analysis in addition to the 27.9 miles of overdue replacement pipeline and the 13.1 miles to be replaced this decade, totals 61.8 miles of pipeline to be replaced by 2030. This would be the ideal replacement date; however, the City may not have enough funds in their budget and thus the pipeline replacement will be spread out throughout the near-term mid-term and long-term planning years. In addition, the pipeline leak history will be considered when prioritizing the replacement of these pipes. The CIP (Chapter 10) breaks down the phasing of this pipeline replacement.

It is recommended to first replace the 20.8 miles of pipeline identified in the hydraulic analysis and thus these projects are noted as near-term projects. The second set of pipeline replacements include 56.6 miles of pipeline that are due for replacement before 2050. The 56.6 miles of pipeline are evenly broken into two replacement periods (mid-term and long-term) in the CIP. A budget for 28.3 miles of pipeline replacement should be included for mid-term (CIP Project ID **RR-1**), and a budget for 28.3 miles of pipeline replacement should be included for long-term (CIP Project ID **RR-2**). Additionally, another pipeline condition analysis study should be performed in 2030 and again in 2040 to identify which specific pipes need replacement during that decade (CIP Project ID **WS-1**).

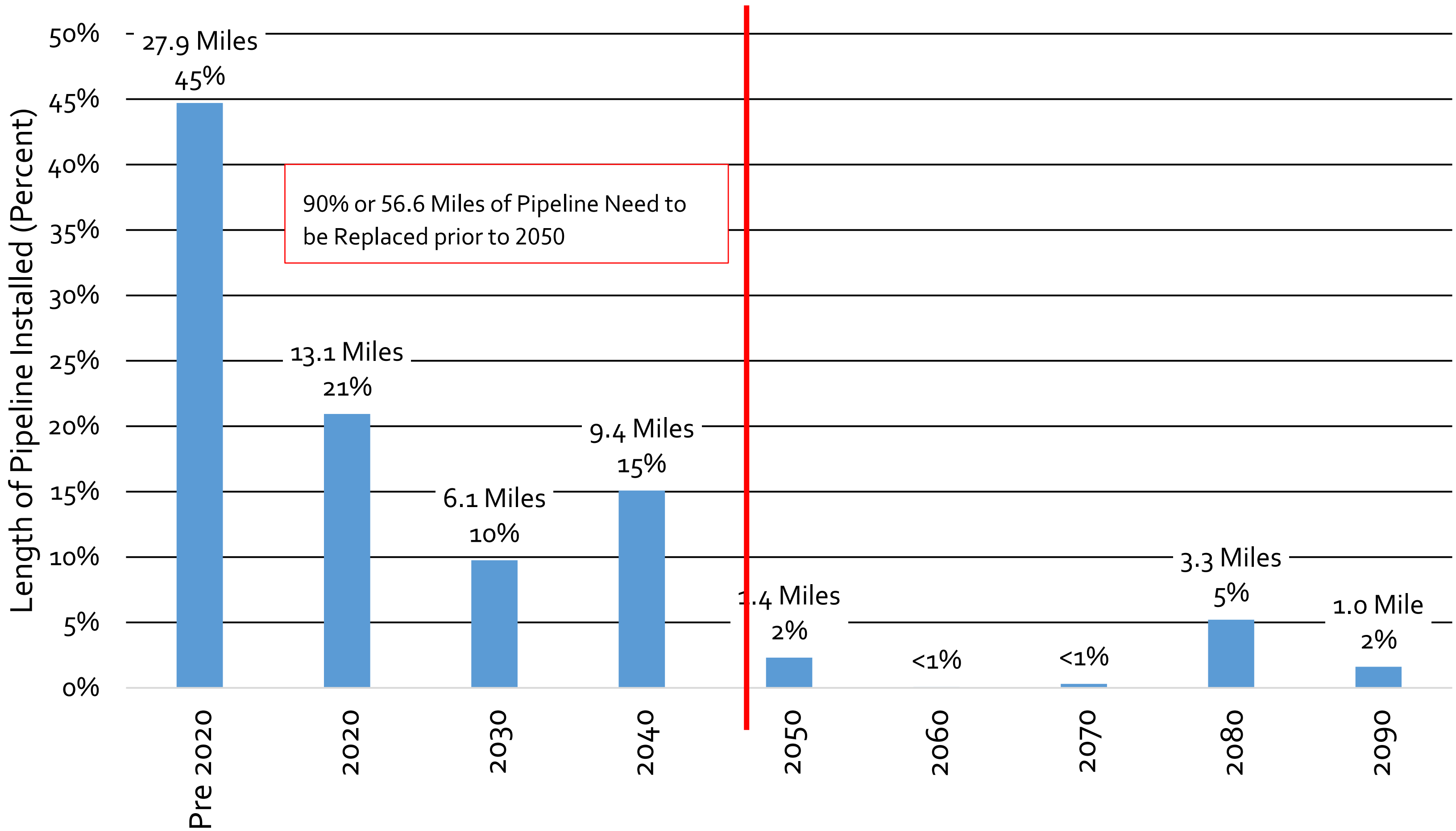

Figure 6.13 Length of Pipeline Replacement Needed by Decade

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6.4 Future System Analysis

The goal of the future system analysis is to evaluate the water distribution system under various operating conditions utilizing the evaluation criteria summarized in Chapter 4 and the future demand projections described in Chapter 3. As part of the future system analysis, a preliminary analysis was performed to identify improvements under build-out demand conditions. Since the timing and amount of growth under build-out conditions is unknown, the future analysis was performed under two different growth conditions:

1. 2020 General Plan demands for 2040 projected to 2050.
2. Regional Housing Needs Assessment (RHNA) growth demands projected to 2050.

Additionally, the analysis presented in this chapter will need to be updated in the following master planning update cycle (every 5-10 years) or earlier if critical new information becomes available (CIP Project ID **WS-2**).

Similar to the existing system analysis, the following analyses were conducted and are described in this section:

- Future Water Supply Analysis.
- Future Storage Analysis.
- Future Pump Station Analysis.
- Future System Pressure Analysis.
- Future Pipeline Velocity Analysis.
- Future Fire Flow Analysis.

Each future system analysis was conducted with both growth conditions for year 2050 (General Plan projections, and RHNA projections). Table 6.19 presents both of the future demand projections split by pressure zone.

Table 6.19 Future Projected Demands by Pressure Zone

Pressure Zone	2050 General Plan Demand Projections			2050 RHNA Demand Projections		
	ADD (gpm)	MDD(1) (gpm)	Percent of Total Demands in Pressure Zone	ADD (gpm)	MDD(1) (gpm)	Percent of Total Demands in Pressure Zone
Bilicke	315	472	14%	323	484.335	13%
Central	1,116	1674	49%	1,236	1853.985	48%
Raymond	521	781	23%	572	858.12	22%
Magnolia	318	477	14%	435	652.68	17%
Pasadena	15	22	1%	15	22.635	1%
Total (gpm)	**2,285**	**3,427**	**100%**	**2,581**	**3,872**	**100%**
Total (mgd)	**3.3**	**4.9**		**3.7**	**5.6**	

Note:
(1) MDD peaking factor assumed to be 1.5.

As listed in Table 6.19, the ADD projected from the General Plan for year 2050 is 2,285 gpm or 3.3 mgd. The ADD projected from the RHNA for year 2050 is 2,581 gpm or 3.7 mgd. The ADD projected from the General Plan for year 2050 and the ADD projected from the RHNA for year 2050 are an increase to the existing ADD (2,226 gpm) by 59 gpm and 355 gpm respectively. The 2050 General Plan demand projections are only an increase of roughly 3 percent, however the increased demands are concentrated in specific planning areas and could result in localized pressure decreases or velocity increases. The 2050 RHNA demand projections are an increase of approximately 15 percent and are also concentrated in specific planning areas. Therefore, both future demand conditions were analyzed.

The locations of the planning areas are described in Chapter 3. These planning areas were translated to locations in the hydraulic model as shown on Figure 6.14. The demand growth from the 2050 General Plan projections and the 2050 GPLU projections were allocated to the growth areas, with conservation (demand decrease) allocated to existing customers. The growth in these areas is quantified in Table 6.20.

Table 6.20 Future Model ADD Adjustments

Planning Areas	2050 General Plan Projections Model Demand Adjustment (gpm)	2050 RHNA Projections Model Demand Adjustment (gpm)
Mixed Use – Downtown	111	262
Mixed Use – Ostrich Farm District	39	77
Mixed Use – Huntington Drive and Garfield Avenue	30	67
Mixed Use – Huntington Drive and Fletcher Avenue	1	1
Mixed Use – Huntington Drive and Fremont Avenue	19	44
Neighborhood Very Low	-32	-30
Neighborhood Low	-55	-25
Neighborhood Medium	-26	-23
Neighborhood High	-27	-18
Total	**59**	**355**

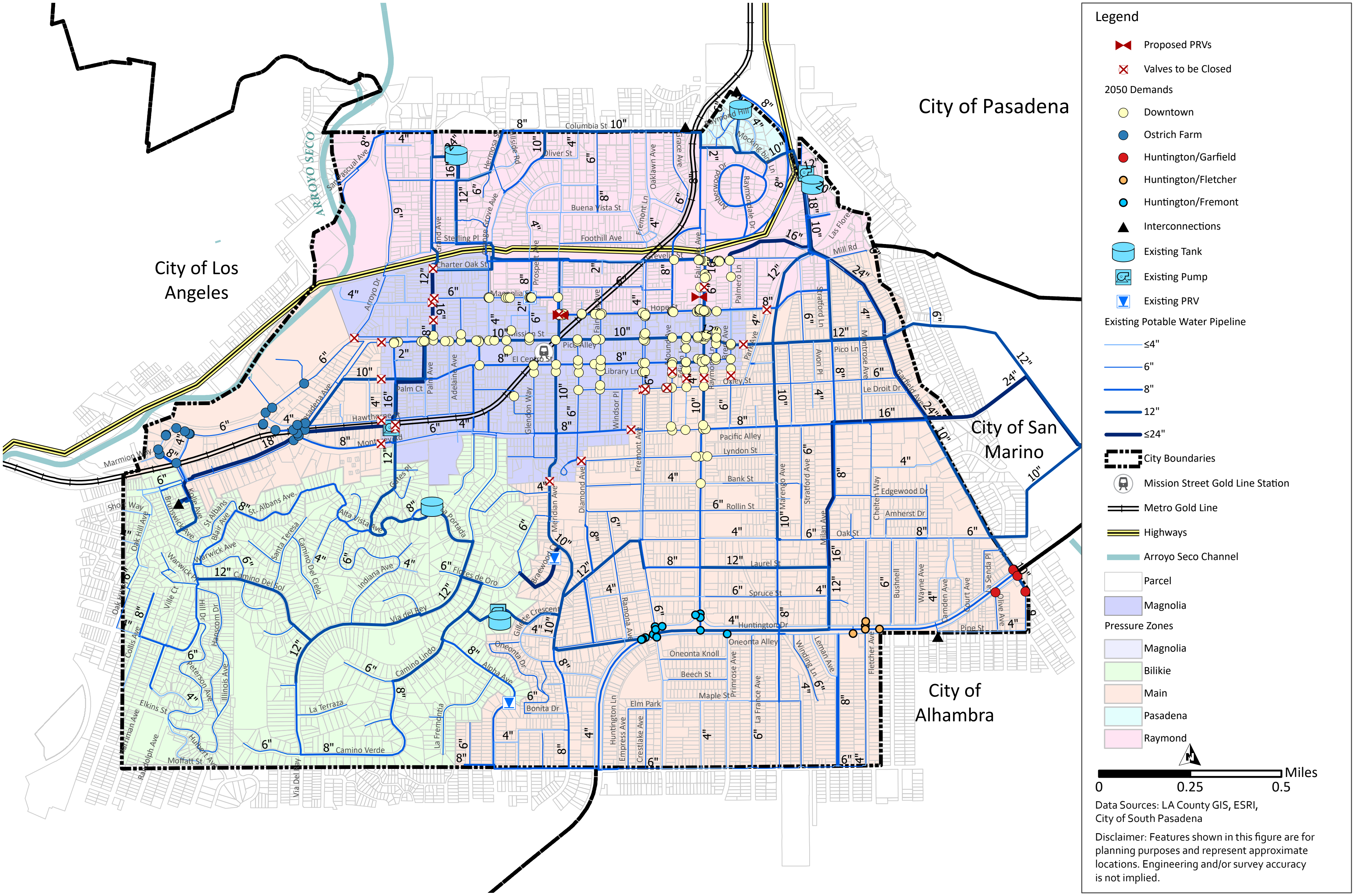

Figure 6.14 Future (2050) Demand Projection Locations

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As shown in Table 6.20 demand adjustments were negative in the residential areas. This is due to conservation throughout the city, the only growth was anticipated to be within specific planning areas (Downtown, Ostrich Farm, and Huntington Drive). The demands adjustments shown in Table 6.20 were added to future system hydraulic model for both the 2050 General Plan Scenario and the 2050 RHNA Scenario, respectively. Additionally, it was assumed that all existing system improvements identified in Section 6.2 were implemented for the future system analyses. It was also assumed that the Magnolia pressure zone modifications discussed in Section 6.3.6.3. will be included as part of the future analysis.

Due to anticipated conservation the increase in total demand between existing conditions and the future ADD conditions are only 59 gpm and 335 gpm for the 2050 GP demand projections, and the 2050 RHNA demand projections, respectively.

6.4.1 Water Supply Analysis

As previously described in Chapter 5, the City's potable water system is supplied by groundwater wells and a MWD connection. Similar to the existing system water-supply, the City's local supply was evaluated under future demand conditions assuming the same two scenarios: largest well out of service and MWD out of service. A recommendation from the existing supply analysis was to bring Wilson Well 2 back online and thus it will be included as a supply in the future supply analysis.

Similar to Section 6.1.1, the first scenario was conducted assuming the largest well was out of service. The second scenario was conducted in the event that MWD is out of service. Both scenarios were evaluated for the 2050 GP demand projections and the 2050 RHNA demand projections. Details of this analysis are provided in Appendix F. A summary of the analyses is presented in Table 6.21 through Table 6.24.

Table 6.21 Future Water Supply Analysis With Largest Well O.O.S. (2050 GP Projections)

Existing Supply	Total Supply Capacity(1) (gpm)	Supply Capacity w/Largest Well out of service (gpm)	Existing MDD(2) (gpm)	Existing Capacity Balance (gpm)
Sunset (Pasadena Connection)	600(2)	30(3)		
Graves Well 2	800	800		
Wilson Well 2	800	800		
Wilson Well 3	1,900	0		
Wilson Well 4	1,100	1,100		
MWD USG-02	5,500(2)	5,500		
Total	**10,700**	**8,230**	**3,428**	**4,803**

Notes:
(1) Supply capacities retrieved from City staff.
(2) Capacities are based on a maximum velocity of 7 fps in pipelines at their respective locations.
(3) Sunset connection only supplies the Pasadena Pressure Zone demand.
(4) MDD peaking factor assumed to be 1.5.
(5) Detailed calculations are found in Appendix F.7.

Table 6.22 Future Water Supply Analysis With MWD Supply O.O.S. (2050 GP Projections)

Existing Supply	Total Supply Capacity(1) (gpm)	Supply Capacity w/MWD Supply out of service (gpm)	Existing MDD(2) (gpm)	Existing Capacity Balance (gpm)
Sunset (Pasadena Connection)	600(2)	30(3)		
Graves Well 2	800	800		
Wilson Well 2	800	800		
Wilson Well 3	1,900	1,900		
Wilson Well 4	1,100	1,100		
MWD USG-02	5,500(2)	0		
Total	**10,700**	**4,630**	**3,428**	**1,203**

Notes:
(1) Supply capacities retrieved from City staff.
(2) Capacities are based on a maximum velocity of 7 fps in pipelines at their respective locations.
(3) Sunset connection only supplies the Pasadena Pressure Zone demand.
(4) MDD peaking factor assumed to be 1.5.
(5) Detailed calculations are found in Appendix F.8.

Table 6.23 Future Water Supply Analysis With Largest Well O.O.S. (2050 RHNA Projections)

Existing Supply	Total Supply Capacity(1) (gpm)	Supply Capacity w/Largest Well out of service (gpm)	Existing MDD(2) (gpm)	Existing Capacity Balance (gpm)
Sunset (Pasadena Connection)	600(2)	30(3)		
Graves Well 2	800	800		
Wilson Well 2	800	800		
Wilson Well 3	1,900	0		
Wilson Well 4	1,100	1,100		
MWD USG-02	5,500(2)	5,500		
Total	**10,700**	**8,230**	**3,872**	**4,358**

Notes:
(1) Supply capacities retrieved from City staff.
(2) Capacities are based on a maximum velocity of 7 fps in pipelines at their respective locations.
(3) Sunset connection only supplies the Pasadena Pressure Zone demand.
(4) MDD peaking factor assumed to be 1.5.
(5) Detailed calculations are found in Appendix F.9.

Table 6.24 Future Water Supply Analysis With MWD Supply O.O.S. (2050 RHNA Projections)

Existing Supply	Total Supply Capacity[1] (gpm)	Supply Capacity w/MWD Supply out of service (gpm)	Existing MDD[2] (gpm)	Existing Capacity Balance (gpm)
Sunset (Pasadena Connection)	600[2]	30[3]		
Graves Well 2	800	800		
Wilson Well 2	800	800		
Wilson Well 3	1,900	1,900		
Wilson Well 4	1,100	1,100		
MWD USG-02	5,500[2]	0		
Total	**10,700**	**4,630**	**3,872**	**758**

Notes:
(1) Supply capacities retrieved from City staff.
(2) Capacities are based on a maximum velocity of 7 fps in pipelines at their respective locations.
(3) Sunset connection only supplies the Pasadena Pressure Zone demand.
(4) MDD peaking factor assumed to be 1.5.
(5) Detailed calculations are found in Appendix F.10.

As listed in Table 6.21, Table 6.22, Table 6.23, and Table 6.24, there are no supply deficits in the City of South Pasadena under the either of the 2050 demand projections. The worst case supply situation is shown in Table 6.24. There is a supply surplus of 758 gpm under the 2050 RHNA demand conditions when MWD is out of service. This is excess is roughly the supply of one of the smaller wells (Graves Well 2 or Wilson Well 2). This excess will allow the City to supply to the system with MWD O.O.S. and one out of service for a short amount of time. This reaffirms the need to bring Wilson Well 2 back online.

For the purposes of planning the supply capacities in Table 6.21 through Table 6.24 were assumed to be the same as the existing supply capacities. However, over time the capacity of the wells will inevitably decrease. Therefore, it is recommended that regular maintenance be performed on the wells.

Well pumps and motors typically need to be replaced every 15 to 25 years. Therefore, it is recommended to repair and replace the well motors and pumps approximately every 20 years, including well casing inspection and relining as needed. A replacements project for Wilson Well 2 has already been recommended (WCW-1) as part of the existing supply analysis and is currently in the City's existing CIP. The motor replacement for Wilson Well 3 has already been recommended as part of the facilities condition assessment (WRW-1), however the replacement of the well pump will need to occur sometime before 2050 (CIP Project ID **WRW-2**). Additionally, the pumps and motors for Graves Well 2 and Wilson Well 4 should be replaced sometime before 2050 to maintain their pumping capacities and head (CIP Project ID **WRW-3, and WRW-4**).

6.4.2 Storage Analysis

A future storage analysis was completed using the 2050 General Plan demand projections, and the 2050 RHNA demand projections. Both storage analyses were evaluation using the criteria listed in Chapter 4. Additionally, it was assumed that all recommendations from Section 6.3 as well as the Magnolia Rezoning were implemented. The results of this analysis are summarized in Table 6.25 and Table 6.26. Details of this analysis are presented in Appendix F.

As shown in Table 6.25 and Table 6.26, the City will have an excess storage capacity of 3.12 MG and 2.29 MG, respectively. There are no additional recommendations from this evaluation.

6.4.3 Pump Station Analysis

The pump station analysis evaluates the future pump station capacities based on the evaluation criteria listed in Chapter 4 for both future demand projections. The results of the pump station analysis for the 2050 GPLU demand projections, and 2050 RHNA demand projections are summarized in Table 6.27 and Table 6.28, respectively. The details are presented in Appendix F. It was assumed that all existing system improvements identified in Section 6.2 including the rezoning modifications would have been implemented.

As shown in Table 6.27 and Table 6.28, the pump station evaluation demonstrated that the future system is anticipated to have a surplus pumping capacity. If the 2050 General Plan demand projections are used, it is calculated that there will be a surplus future pumping capacity of 4,750 gpm. If the 2050 RHNA demand projections are used, it is calculated that there will be a surplus future pumping capacity of 4,220 gpm. No recommendations are made for the future pumping analysis.

Table 6.25 Future (2050 General Plan) Storage Analysis

Zone	2050 Storage Facilities	2050 MDD(1) (mgd)	Required Storage (MG)	Available Storage (MG)	Zone Balance (MG)	Proposed Facilities	Proposed Capacity (MG)	Balance with New Storage (MG)
Bilicke	None	0.68	1.72	0.00	(1.72)	Pump from Central Pressure Zone	1.72	0.00
Pasadena	None	0.03	0.34	0.00	(0.34)	Check Valve from Raymond Pressure Zone	0.34	0.00
Raymond	None	1.13	2.30	0.00	(2.30)	PRV to Magnolia Pressure Zone Check Valve to Pasadena Pump from Central Pressure Zone	(1.73) (0.34) 4.38 [2.30]	0.00
Central	Westside Reservoir Grand Reservoir Garfield Reservoir Wilson Reservoir Graves Reservoir	2.41	3.97	13.40	9.43	Pump to Bilicke Pressure Zone Pump to Raymond Pressure Zone	(1.72) (4.38) [(6.10)]	3.32
Magnolia	None	0.69	1.73	0.00	(1.73)	PRV from Raymond Pressure Zone	1.73	0.00
Total		**4.94**	**10.08**	**13.40**	**3.32**	**N/A**	**0.00**	**3.32**

Notes:
(1) MDD peaking factor assumed to be 1.5.
(2) Detailed calculations are found in Appendix F.11.

Table 6.26 Future (2050 RHNA) Storage Analysis

Zone	2050 Storage Facilities	2050 MDD(1) (mgd)	Required Storage (MG)	Available Storage (MG)	Zone Balance (MG)	Proposed Facilities	Proposed Capacity (MG)	Balance with New Storage (MG)
Bilicke	None	0.70	1.75	0.00	(1.75)	Pump from Central Pressure Zone	1.75	0.00
Pasadena	None	0.03	0.34	0.00	(0.34)	Check Valve from Raymond Pressure Zone	0.34	0.00
Raymond	None	1.24	2.45	0.00	(2.45)	PRV to Magnolia Pressure Zone Check Valve to Pasadena Pump from Central Pressure Zone	(2.06) (0.34) 4.85 [2.45]	0.00
Central	Westside Reservoir Grand Reservoir Garfield Reservoir Wilson Reservoir Graves Reservoir	2.67	4.31	13.40	9.09	Pump to Bilicke Pressure Zone Pump to Raymond Pressure Zone	(1.75) (4.85) [(6.60)]	2.49
Magnolia	None	0.94	2.06	0.00	(2.06)	PRV from Raymond Pressure Zone	2.06	0.00
Total		**5.58**	**10.91**	**13.40**	**2.49**	**N/A**	**0.00**	**2.49**

Notes:
(1) MDD peaking factor assumed to be 1.5.
(2) Detailed calculations are found in Appendix F.12.

Table 6.27 Future (2050 GP) Pump Station Analysis

Discharge Pressure Zone	2050 MDD(1) (gpm)	Required Max Fire Flow (gpm)	Total Required Capacity(2) (gpm)	2050 Firm Capacity(3) (gpm)	2050 Capacity Balance (gpm)
Bilicke	473	3,500	3,973	4,500	528
Pasadena	23	2,500	2,523	3,900	1,378
Raymond	782	3,500	4,759(5)	5,200	4342
Central	1,674	0(4)	2,658(6)	5,500	2,572
Magnolia	477	3,500	3,977	3,977	0
Total	**3,428**		**18,159**	**23,077**	**4,919**

Notes:
(1) MDD assumed to be ADD x 1.5.
(2) Required Capacity includes upstream zones and flow requirements.
(3) PS capacities provided by City staff.
(4) Central Pressure Zone has gravity storage so there is no fire flow required
(5) Raymond Pressure Zone's required capacity includes MDD of Raymond Pressure Zone, Magnolia Pressure Zone, and 3,500 gpm of fire flow in Raymond Pressure Zone.
(6) Central Pressure Zone's required capacity includes MDD of Central, Raymond, Magnolia, and Bilicke Pressure Zones.
(7) Detailed calculations in Appendix F.13.

Table 6.28 Future (2050 RHNA) Pump Station Analysis

Discharge Pressure Zone	2050 MDD(1) (gpm)	Required Max Fire Flow (gpm)	Total Required Capacity(2) (gpm)	2050 Firm Capacity(3) (gpm)	2050 Capacity Balance (gpm)
Bilicke	484	3,500	3,984	4,200	516
Pasadena	23	2,500	2,523	3,900	1,377
Raymond	858	3,500	5,011(5)	5,200	189
Central	1,854	0(4)	3,196(6)	5,500	2,304
Magnolia	653	3,500	4,153	4,153	0
Total	**3,872**		**18,867**	**23,253**	**4,386**

Notes:
(1) MDD assumed to be ADD x 1.5.
(2) Required Capacity includes upstream zones and flow requirements.
(3) PS capacities provided by City staff.
(4) Central Pressure Zone has gravity storage so there is no fire flow required
(5) Raymond Pressure Zone's required capacity includes MDD of Raymond and Magnolia Pressure Zones.
(6) Central Pressure Zone's required capacity includes MDD of Central, Raymond, Magnolia, and Bilicke Pressure Zones.
(7) Detailed calculations in Appendix F.14.

6.4.4 System Pressure Analysis

As part of the system-pressure evaluation, the future distribution system was analyzed under both demand conditions with the hydraulic model: (1 to identify areas with pressures above 150 psi under MinDD conditions, and (2) to identify areas with pressures below 40 psi under MDD conditions. It was assumed that recommendations from Section 6.3 had been implemented as well as the Magnolia Rezoning.

6.4.4.1 High Pressures

Based on the modeling analysis under 2050 MinDD conditions, no new high-pressure areas were identified. No additional recommendations are made for the high-pressure analysis.

6.4.4.2 Low Pressures

Based on the modeling analysis under year 2050 MDD conditions, no new low-pressure areas with pressures below 40 psi were identified. No additional recommendations are made for the low-pressure analysis.

6.4.5 Pipeline Velocity Analysis

The hydraulic model was used to evaluate pipeline velocities with both future system demand conditions. It was concluded that velocities throughout the distribution system were within an acceptable range below 7 fps. It was assumed that new supply sources, storage reservoirs, and pump stations recommended in Section 6.3 had been implemented as well as the Magnolia Rezoning.

6.4.6 Fire Flow Analysis

The hydraulic model was used to evaluate the conveyance capacity of the future distribution system to meet the fire flow requirements listed in Chapter 4 with a minimum residual pressure of 20 psi. It was assumed that all of the recommended projects from Section 6.3 had been implemented as well as the Magnolia Rezoning. Based on the hydraulic model results there are no new fire flow projects required, and thus there are no additional recommended projects for the future fire flow analysis.

6.5 Proposed Improvements

The recommendations for existing and future conditions identified in this chapter are summarized in this section. Detailed cost estimates for each of these recommendations are included in the CIP of this One Water 2050 Plan (see Chapter 10). Based on the analysis of the existing water system under existing and future demand conditions, the following improvements are proposed:

- Supply Improvements:
  - Existing System:
    - Add Pump to Wilson Well 2 (CIP Project ID **WCW-1**).
    - Evaluation of Wilson Well 3 & 4
    - Replace Motor on Wilson Well 3 (CIP Project ID **WRW-1**).
  - Future System: None.
    - Replace pump on Wilson Well 3 (CIP Project ID **WRW-2**).
    - Replace pump and motor on Graves Well 2 (CIP Project ID **WRW-3**).
    - Replace pump and motor on Wilson Well 4 (CIP Project ID **WRW-4**).
- Storage Improvements:
  - Existing System:
    - Install backup power at Indiana, Grand, Garfield, Wilson, and Graves Sites (CIP Project ID **BP-1 to BP-5**).
    - Install a check valve from Raymond Pressure Zone to Pasadena Pressure Zone (CIP Project ID **FFCV-1**).
  - Future System: None.
    - Removal or Raymond Elevated Tank along with a Surge and VFD Study (CIP Project IDs **WRS-1**).
    - Removal of Bilicke Elevated Tank along with a Surge and VFD Study (CIP Project IDs **WRS-2**).
    - Replacement of Westside Reservoir (CIP Project ID **WRS-3)**.
- Pump Station Improvements:
  - Existing System:
    - Add backup power to Indiana, Grand, Garfield, Wilson, and Graves Sites (CIP Project ID **BP-1 to BP-5**).
  - Future System:
    - Replace Westside PS (CIP Project ID **WRPS-1**).
    - Replace Indiana PS (CIP Project ID **WRPS-2**).
    - Pump station modifications at Grand and Garfield due to removal of Raymond Tank (CIP Project IDs **WRPS-3, and WRPS-4**).
- Pressure Improvements:
  - Existing System:
    - Rezoning part of Central Pressure Zone to the Magnolia Pressure Zone. Add 6 segments of new pipelines (CIP Project ID **WC-1 to WC-7**). Add three pressure reducing stations (CIP Project ID **WCV-1, WCV-2, and WCV-3**). Add 7 new isolation valves (CIP Project ID **WCV-4**).
  - Future System: None.

- Fire Flow Improvements:
  - Existing System:
    - Upsize pipelines 4-inch diameter and less to 8-inch diameter pipelines. Nearly 76,900 feet or 14.6 miles (CIP Project ID **SDR-4**).
    - Twenty-three (23) fire flow pipeline projects ranging from 6-inches- to 12-inches in diameter and a total length of 32,950 feet or 6.2 miles (CIP Project ID **FF-1 to FF-23**). One of the projects includes a check valve (CIP Project ID FFC**V-1**).
  - Future System: None.
- Repair and Rehabilitation Improvements:
  - A total of approximately 56.5 miles of pipeline replacement due to estimated useful life (CIP Project ID **RR-1 and RR-2**).
- Site Improvements:
  - Near-term, mid-term, and/or long-term projects for each site:
    - Garfield Site (Project CIP IDs **WRSI-NT-1, and WRSI-LT-1**).
    - Raymond Site (Project CIP IDs **WRSI-NT-2, and WRSI-LT-2**).
    - Grand Site (Project CIP IDs WRSI-NT-3, WRSI-MT-3, and WRSI-LT-3).
    - Kolle Site (Project CIP IDs **WRSI-NT-4, and WRSI-MT-4**).
    - Westside Site (Project CIP IDs **WRSI-NT-5, and WRSI-MT-5**).
    - Bilicke Site (Project CIP IDs WRSI-NT-6, WRSI-MT-6, and WRSI-LT-6).
    - Indiana Site (Project CIP IDs **WRSI-NT-7, and WRSI-MT-7**).
    - Wilson Site (Project CIP IDs **WRSI-NT-8, and WRSI-MT-8**).
- Studies:
  - Pipeline condition assessment for years 2030 and 2040 (Project CIP ID **WS-1**).
  - One Water 2050 Plan update for years 2030 and 2040 (Project CIP ID **WS-2**).

The proposed improvements from the existing system and future system will result in a change the City's hydraulic profile and thus a revised hydraulic profile was developed and is presented on Figure 6.15.

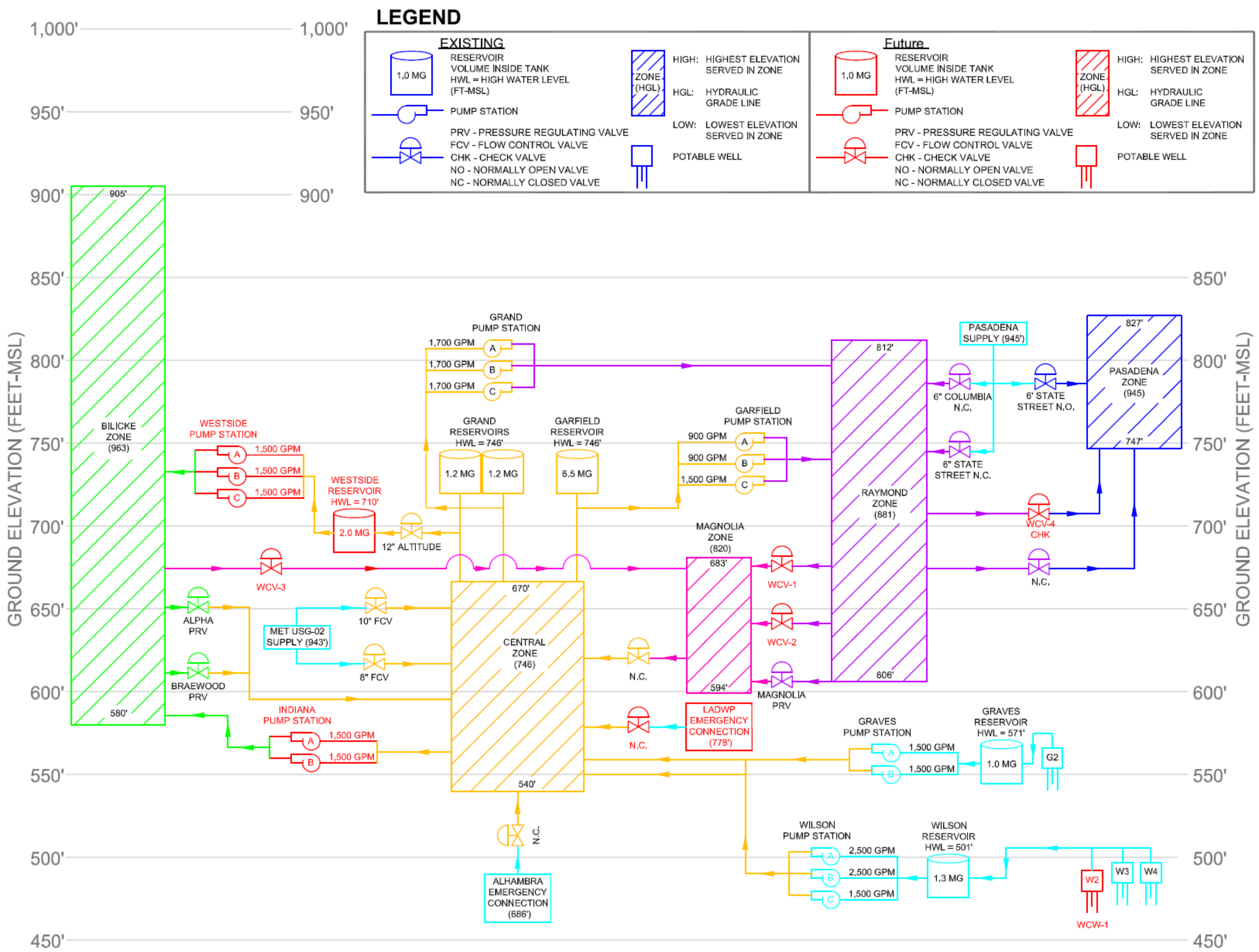

Figure 6.15 Future (2050) Potable System Schematic