CITY OF

FOLSOM

DISTINCTIVE BY NATURE

2016 WATER MASTER PLAN UPDATE

JANUARY 2018

PREPARED BY:

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ENGINEERING . CONSULTING

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DISTINCTIVE BY NATURE

2016 Water Master Plan Update

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EXECUTIVE SUMMARY

This document represents the findings and recommendations of the 2016 update to the City of Folsom's (City) Water Master Plan (WMP). The City has recently expanded its service area to allow for future development projects in the areas south of Highway 50. The *2016 WMP Update* incorporates the City's recent planning efforts for the areas south of Highway 50 into one Master Plan document. This effort was also completed in parallel to and in conjunction with the City's *2015 Urban Water Management Plan* (UWMP) update.

Evaluation of Existing Water System

For the purposes of describing the City's service area, five distinct areas are shown in in Figure ES-1. The American River Canyon and Folsom Prison areas are not served by the City of Folsom.

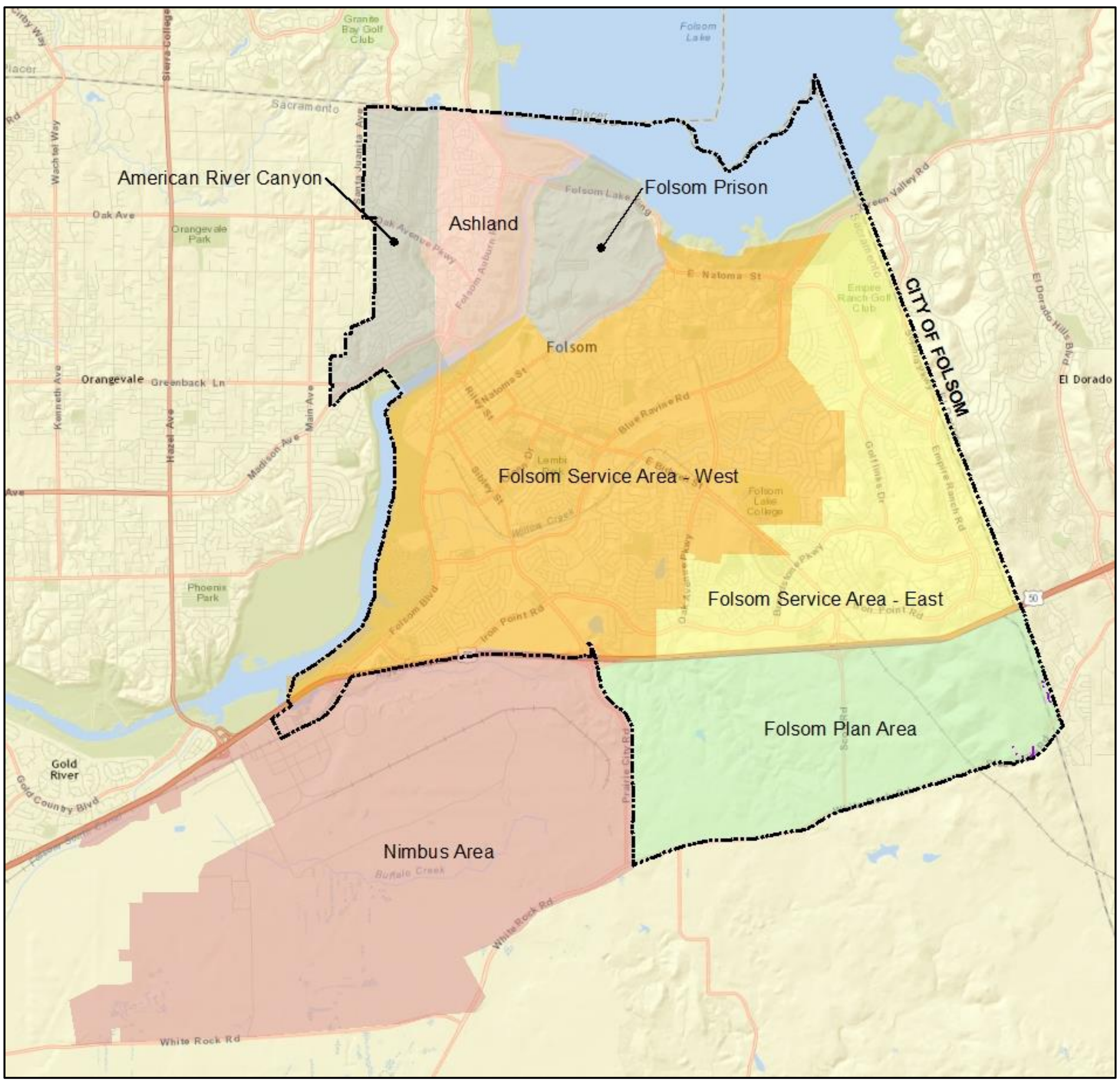


Figure ES-1. City of Folsom water service area

The City depends solely on surface water from the Folsom Reservoir for its water supply. Raw water from the Folsom Reservoir is treated at the City owned and operated conventional WTP with a nominal capacity of 50 mgd. The City utilizes 7 pump stations, 12 storage reservoirs, 18 pressure reducing valves, one flow control station and a network of pipelines in their distribution system.

There are approximately 700 feet of elevation change throughout the City's system. In order to manage that elevation difference, the City has established 7 main pressure zones. In addition, several minor sub-zones have been established to provide water service to customers at a reasonable pressure. Zones 1 to 6 serve the majority of the City south of the American River. Zone 1A (Nimbus) serves an area west of the City limits along Folsom Boulevard.

Water System Demand Projections

The City is preparing for significant growth, particularly in the areas south of Highway 50. The major planned developments south of Highway 50 include the Easton Project and the Folsom Plan Area (FPA).

Water demands used in this *2016 WMP Update* were developed in conjunction with the City's *2015 Urban Water Management Water Management Plan* (Tully & Young, June 2016). The current and projected water use is primarily based on the following:

- Existing & Projected Population
- Existing & Projected Land Use
- Water Demands by Land Use Type
- Distribution System Water Losses

Table ES-1 shows the average day, maximum day and peak hour demands for treated water at various planning horizons.

Table ES-1. Summary of treated water demands

Customer	Existing [MGD]	2025 [MGD]	2035 [MGD]	Build Out [MGD]
Average Day	17.1	22.2	23.6	25.3
Maximum Day*	29.1	37.7	40.1	43.1
Peak Hour*	53.1	68.7	73.1	78.5

Notes: Demands do not include Aerojet raw water or demands from the Ashland service area
*Max Day = 1.7x average day; Peak Hour = 3.1x average day

As a result of increased conservation efforts and system improvements to reduce system water loss, the planned buildout water demands for the existing service area have decreased by approximately 20 percent since the *2008 WMP*.

Table ES-2. Comparison of buildout water demands by zone: *2008 WMP* vs. *2015 UWMP*

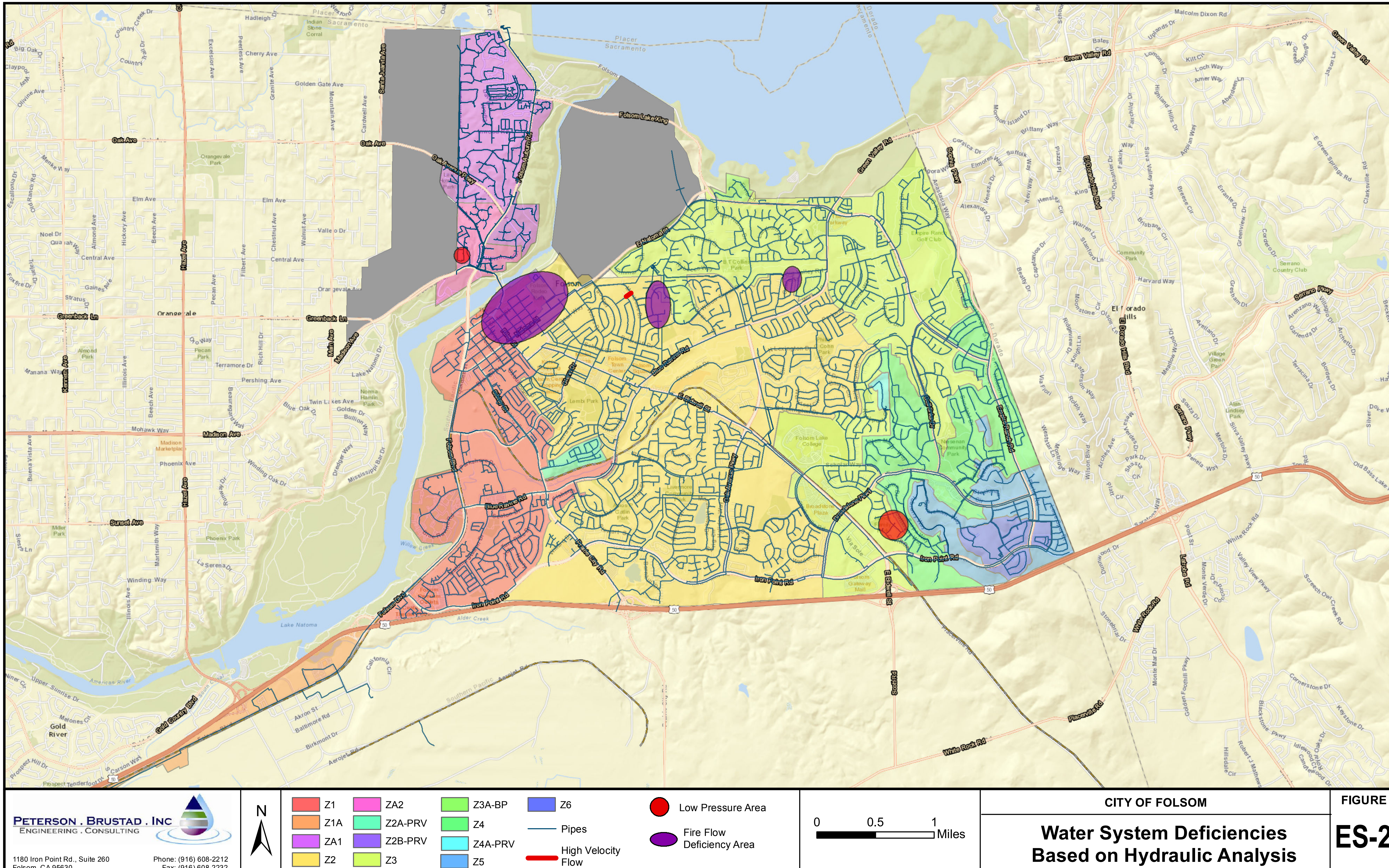
Zone	2008 WMP		2015 UWMP	
	Buildout Average Day Demand (MGD)	Buildout Maximum Day Demand (MGD)	Buildout Average Day Demand (MGD)	Buildout Maximum Day Demand (MGD)
1	4.3	8.1	3.1	5.2
1A			0.5	0.9
Easton 1A			0.4	0.7
Easton 1	-	-	0.7	1.2
2	9.7	18.4	8.1	13.8
Easton 2	-	-	1.0	1.7
3	3.7	7.1	2.6	4.3
3 - Cimamaron	1.7	3.3	1.8	3.0
4	2.0	3.8	1.5	2.5
5	0.9	1.7	0.6	1.1
6	0.3	0.7	0.4	0.6
FPA 2	-	-	1.6	2.8
FPA 3	-	-	1.9	3.3
FPA 4	-	-	0.6	1.0
FPA 5	-	-	0.4	0.7
FPA 6	-	-	0.2	0.4
Total	**22.7**	**43.2**	**25.3**	**43.1**

System Analysis

The updated distribution system hydraulic model was used to run simulations based on the identified system criteria to determine if the existing and proposed infrastructure is adequate. This evaluation included confirmation of the results from the previously developed planning efforts: the *2008 WMP*, Aerojet/Easton, and FPA developments.

Maximum day demand, peak hour demand, and maximum day plus fire flow scenarios were simulated in the model for the analysis. Areas of low domestic pressures, high pipe velocities, and low fire flow capabilities were identified within the existing system and are summarized in Figure ES-2 below.

The *2008 WMP* recommended the addition of approximately 10 MG of storage within the City's existing service area. This recommendation was reevaluated using updated demand data and it was determined that only 1.5 MG of this additional storage is needed only to accommodate future developments which will save the City approximately $10 million in capital improvement costs.



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Water System Deficiencies Based on Hydraulic Analysis

FIGURE

ES-2

Recommended Capital Improvement Plan

Recommended improvement projects to resolve the identified deficiencies were prioritized and divided into three main categories: (a) high priority projects that are correlated to system reliability and safety of water users, (b) infrastructure replacement projects that are aimed to replace old and deteriorating pipes, and (c) annual infrastructure programs.

Estimated costs along with a prioritized implementation schedule are summarized in Table ES-3.

Table ES-3. Recommended implementation schedule and costs

Fiscal Year	Activities		Estimated Cost
2017/18	Design:	Zone 1 Fire Flow Improvements	$120,000
	Annual Leak Detection Program		$200,000
		FY 2017/18 Total:	**$320,000**
2018/19	Design:	Zone 2 Fire Flow Improvements	$90,000
	Construct:	Zone 1 Fire Flow Improvements	$1,081,000
	Annual Leak Detection Program		$200,000
		FY 2018/19 Total:	**$1,371,000**
2019/20	Design:	Infrastructure Replacement Projects - Phase I	$43,000
	Construct:	Zone 2 Fire Flow Improvements	$808,000
	Annual Leak Detection Program		$200,000
		FY 2019/20 Total:	**$1,051,000**
2020/21	Design:	Infrastructure Replacement Projects - Phase II	$61,000
	Construct:	Infrastructure Replacement Projects - Phase I	$387,000
	Annual Leak Detection Program		$200,000
		FY 2020/21 Total:	**$648,000**
2021/22	Design:	Infrastructure Replacement Projects - Phase III	$141,000
	Construct:	Infrastructure Replacement Projects - Phase II	$547,000
	Annual Leak Detection Program		$200,000
		FY 2021/22 Total:	**$888,000**
2022/23	Design:	Infrastructure Replacement Projects - Phase V (Zone 1)	$69,000
	Construct:	Infrastructure Replacement Projects - Phase III	$1,268,000
	Annual Leak Detection Program		$200,000
		FY 2022/23 Total:	**$1,537,000**
2023/24	Design:	Infrastructure Replacement Projects - Phase V (Zone 2)	$172,000
	Construct:	Infrastructure Replacement Projects - Phase V (Zone 1)	$624,000
	Annual Leak Detection Program		$200,000
		FY 2023/24 Total:	**$996,000**
2024/25	Construct:	Infrastructure Replacement Projects - Phase V (Zone 2)	$1,544,000
	Annual Leak Detection Program		$200,000
		FY 2024/25 Total:	**$1,744,000**

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1.0 INTRODUCTION

This document represents the findings and recommendations of the 2016 update to the City of Folsom's (City) Water Master Plan (WMP). The previous update was prepared by West Yost and Associates (WYA) in 2008. Due to the economic downfall that occurred in the years following, the City's existing infrastructure has only seen minor changes since 2008 and build out of the City's General Plan did not occur as anticipated. However, with planned developments approved in the past several years, the City has recently expanded its service area to allow for future development projects in the areas south of Highway 50.

Water master planning efforts for the areas south of Highway 50 were developed and presented in previous reports including a 2014 study for the Aerojet Easton Plan Project (Easton Project) and a 2014 study for the Folsom Plan Area (FPA), both completed by Brown and Caldwell (B&C). The water system recommendations developed in the Easton Project and FPA studies have been incorporated into this *2016 WMP Update* to consolidate the City's recent planning efforts into one Master Plan document. The *2016 WMP Update* effort was also completed in parallel to and in conjunction with the City's *2015 Urban Water Management Plan* (UWMP) update.

As a result, this *2016 WMP Update* provides a comprehensive water outlook that can be used by the City for planning purposes for the foreseeable future.

1.1 Purpose of the Master Plan Update

The purpose of the *2016 WMP Update* is to:

1. Incorporate the latest planning efforts by the City into one comprehensive Water Master Plan.
2. Review current water demands and project future water demands consistent with the City's *2015 UWMP*
3. Analyze the water system infrastructure to determine its ability to meet existing and future water demands
4. Develop a recommended capital improvement program to meet the system needs now and into the future.

The *2016 WMP Update* represents a snapshot of the water system at the time of the data collection. The City should review this WMP annually to compare actual water demands to projected water demands and to track the progress of the implementation of the capital improvement program.

1.2 Background Documents & Data Collection

This WMP Update primarily relies on the following documents for information regarding the City's water use and infrastructure improvements.

- 2008 *Water Master Plan Update* (West Yost Associates, May 2008)
- *Evaluation of City of Folsom Water System Improvements for Initial Easton Development* Technical Memorandum (Brown and Caldwell, March 2011)
- *Existing System Improvements for Ultimate Easton Development* Technical Memorandum (Brown and Caldwell, July 2014)
- *Folsom Plan Area Water System Master Plan* (Brown and Caldwell, October 2014)
- 2015 *Urban Water Management Plan* (Tully & Young, June 2016)

These documents were reviewed in preparation for the analysis of the City's water system. As part of the *2008 WMP*, the City and WYA conducted a thorough investigation of the City's water system, completed an update to and calibration of the City's hydraulic water model, and developed recommendations for a capital improvement program.

There are a number of design assumptions and findings in the *2008 WMP* and in the other listed documents that are still applicable today and appropriate for use in this and in future planning documents prepared by the City. Where appropriate, these findings were incorporated into the *2016 WMP Update*. Additionally, the format of this *2016 WMP Update* intentionally follows the same structure as the *2008 WMP* to provide an opportunity to refer back and forth between the two documents as needed.

1.3 Abbreviations

Abbreviations used in this document are presented below.

af	Acre-Feet
afa	Acre-Feet Annually
ADD	Average Day Demand
BPS	Booster Pump Station
CIP	Capital Improvement Program
City	City of Folsom
DDW	California State Water Resources Control Board, Division of Drinking Water
DU	Dwelling Unit
ENR	Engineering News Report
fps	Feet per Second
ft/kft	Feet per Thousand Feet

gpm	Gallons per Minute
GSWC	Golden State Water Company
HGL	Hydraulic Grade Line (Open to Air, Water Surface Elev.)
Hp	Horse Power
in	Inches
L	Liter
LF	Lineal Feet
MDD	Maximum Day Demand
MG	Million Gallons
mgd	Million Gallons per Day
O&M	Operations and Maintenance
ppm	Parts per Million
PH	Peak Hour
psi	Pounds per Square Inch (Pressure)
PRV	Pressure Reducing Valve
SJWD	San Juan Water District
TDS	Total Dissolved Solids
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
WMP	Water Master Plan
WTP	Water Treatment Plant

1.4 Report Organization

Following this introductory Chapter, the *2016 WMP Update* includes the following chapters:

Chapter 2. Existing Water System – presents the City's existing water service area and provides background information on the City's existing water system including water supply, storage and transmission/distribution facilities.

Chapter 3. Water Demand – presents historical, current and projected water demands which correspond to the growth projections of the City's water service area.

Chapter 4. Hydraulic Model Update – describes the update and expansion of the computer-based hydraulic model from the version that was developed for the *2008 WMP*.

Chapter 5. System Analysis – presents planning and design criteria to be used as the basis for assessing the adequacy of the existing and future water systems, and presents the analysis of the existing water system facilities in comparison to the specified criteria in order to identify needed improvements.

Chapter 6. Recommended Capital Improvement Plan – details the proposed capital improvements needed for all water system elements to meet existing and future demands while complying with drinking water regulations and industry standards for operational criteria.

Appendices – provides supporting documentation for the *2016 WMP Update*.

2.0 WATER SYSTEM

The City of Folsom faces a broad range of management activities related to its water system infrastructure including ongoing infill development and replacing older infrastructure that is nearing the end of its useful life. In addition, the City is about to embark on a major expansion of the water system as new development extends south of Highway 50. This chapter discusses the City's existing water system as well as the planned developments for the area south of Highway 50 and planned water infrastructure to serve these developments.

Understanding of the City's existing and planned water system was gained by collection and review of previous reports, maps, plans, operating records, and other relevant data. The following sections of this chapter describe the components of the City's water system:

- Service Area
- Water Treatment Facilities
- Existing Water Distribution System
- Planned Water Distribution System

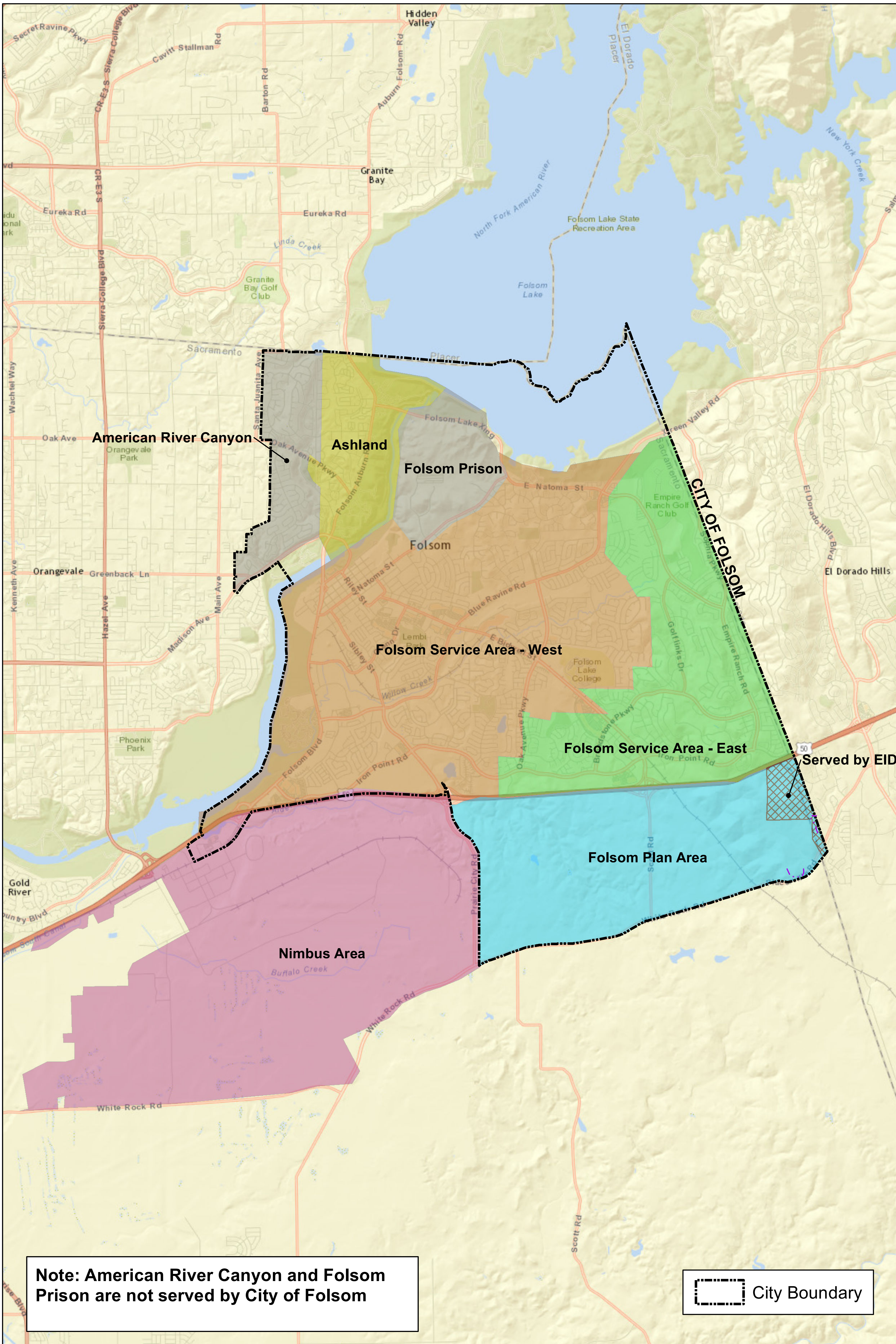
2.1 Service Area

For the purposes of describing the City's service area, five distinct areas are shown in Figure 2-1 and are described in the following subsections:

- Folsom Service Area - West
- Folsom Service Area - East
- Ashland Area
- Nimbus Area
- Folsom Plan Area

As shown in Figure 2-1, the City boundary (outlined in black) does not completely correlate with the City's water service areas. The Nimbus service area is located outside of the City limits whereas the Prison and the San Juan areas are within City limits, but supplied by other sources.

The Folsom State Prison has its own onsite 3.5 million gallons per day (mgd) water treatment plant, but may receive treated water from the City during emergencies through a temporary inter-tie. The City cannot receive water from the Prison through this intertie. The American River Canyon area is located in the San Juan Water District (SJWD) service area and is not supplied by the City of Folsom. Neither the Prison nor the American River Canyon areas were analyzed for this WMP.



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City of Folsom Water Service Areas

FIGURE 2-1

2.1.1 *Folsom Service Area*

The Folsom Service Area (FSA) encompasses approximately 11,000 acres with 7,300 acres in FSA West and 3,700 acres in FSA East. Generally, this main service area is bounded by Lake Natoma and the American River to the west, the Sacramento/El Dorado County line to the East, Folsom Lake, and the Folsom State Prison to the north and Highway 50 to the south.

The FSA was divided into West and East zones because of the elevation differences and other geographic features in the City. Water from Folsom Reservoir is treated at the City's water treatment plant and is delivered to the system by gravity and via pump stations located throughout the system. In addition to the multiple pump stations in the system, the City operates numerous reservoirs along with pressure and flow control valves to safely deliver water to the point of use.

The FSA is comprised of residential, commercial, industrial, municipal, and educational services. The City recently completed their meter installation program and became fully metered in 2013. There are a number of large industrial customers within the FSA including Intel, Aerojet, Kikkoman, and Gekkeikan Sake.

2.1.2 *Ashland Service Area*

The Ashland service area encompasses approximately 1,230 acres in the northwest corner of the City. It is located across Rainbow Bridge on the north side of Lake Natoma. The water distribution system in the Ashland service area is operated and maintained by the City, but is supplied by SJWD. This area is considered to be fully built-out. An analysis of the system was conducted as part of this WMP to determine if any improvements to the distribution system needed to be added to the City's CIP.

2.1.3 *Nimbus Area*

The Nimbus service area encompasses approximately 7,320 acres and consists of Aerojet properties and the proposed developments of Easton Place and Glenborough at Easton. This area is situated south of Highway 50 in an unincorporated area of Sacramento County and outside the City limits, but is within the City's water service area. It is bounded by Prairie City Road to the east and by White Rock Road to the south. The City currently supplies raw water to the Aerojet Campus and is planning to supply potable water to the proposed Easton developments. The planned Easton developments and planned water system to serve these developments is discussed further in Section 2.4.

2.1.4 *Folsom Plan Area*

In 2012, the City annexed the Folsom Plan Area (FPA), which covers approximately 3,660 acres along the southern edge of the City. It is located south of U.S. Highway 50, bounded by the

Sacramento/El Dorado County boundary to the east and Prairie City Road to the west. The FPA was brought into the City's existing water service area, but it is currently undeveloped with no water infrastructure in place. Of the 3,660 acres, approximately 190 acres along the Sacramento/El Dorado County line will be served by the El Dorado Irrigation District (EID) and therefore this portion was not analyzed in this WMP. The planned FPA development and planned water system to serve the development is discussed further in Section 2.4.

2.2 Water Treatment Facilities

The City depends solely on surface water from the Folsom Reservoir for its water supply. Raw water from the Folsom Reservoir is treated at the City owned and operated conventional water treatment plant (WTP) located on East Natoma Street and Randall Drive. The water treatment plant has a nominal capacity of 50 mgd.

Raw water is pumped or fed by gravity, depending on lake levels, from an outlet at the Folsom Dam to the City's WTP through the Natoma Pipeline. The Natoma Pipeline consists of a 42-inch steel pressure pipe through the dam connecting to a 60-inch diameter cement-lined, bar-wrapped concrete cylinder transmission main. A small standpipe and a Bureau of Reclamation (Bureau) controlled valve are located on the 60-inch transmission main. The Bureau valve adjusts to maintain a near constant level in the standpipe. A city-controlled flow control valve located near the treatment plant adjusts the raw water flow to the WTP. As the raw water flow increases, the level in the standpipe drops and the Bureau controlled valve opens to allow more flow through the dam.

Table 2-1 presents the annual WTP production that occurred from 2010 through 2015.

Table 2-1 City of Folsom Water Use, 2010-2015
(Data Source: 2015 UWMP)

Year	Annual Water Use* (AF)
2010	26,425
2011	26,754
2012	25,718
2013	26,577
2014	21,932
2015	17,042
AVERAGE	**23,604**

*Includes Aerojet raw water

Figure 2-2 presents the monthly WTP production since 2010.

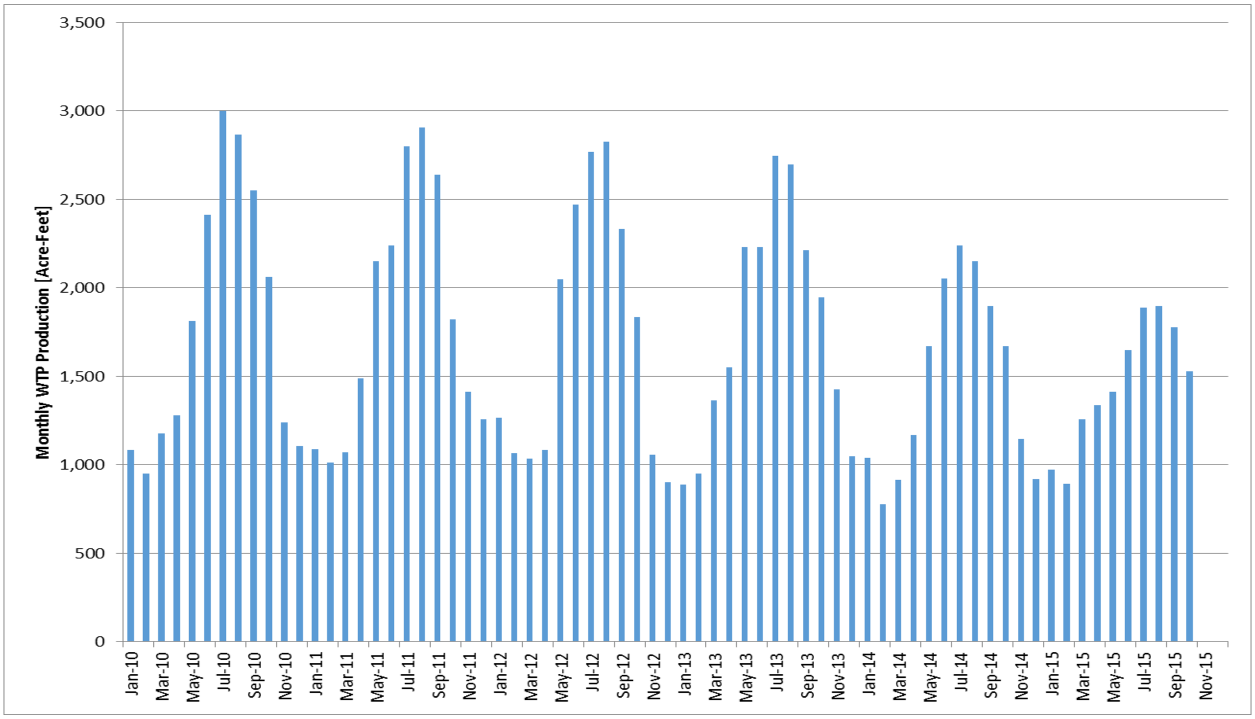

Figure 2-2. Monthly WTP Production, 2010 – 2015
(Data Source: City WTP Production Records)

While there is a clearly identifiable trend in the seasonal variation of the water treatment plant operation over the long term, daily changes in production are less predictable. Operators control the water treatment plant through the SCADA system in the main office and make changes in operation in response to changes in storage tank levels and equipment failures.

The City's water treatment plant typically operates with several flow adjustments made daily, utilizing storage to meet hourly fluctuations in demand. Per City operators, system demands typically peak in the morning and in the evenings.

2.3 Existing Water Distribution System

The City utilizes pump stations, reservoirs, pressure reducing valves, flow control valves and pipelines in their distribution system. Details on the water distribution system features are described in the following sections.

The water distribution system in the Ashland service area is operated and maintained by the City, but is supplied by SJWD. Analysis of the Ashland distribution system is included in this WMP.

2.3.1 *Pressure Zones*

There are approximately 700 feet of elevation change throughout the system as the elevation ranges between approximately 130 feet near Lake Natoma to 830 feet near the east side of the

City on Carpenter Hill. In order to manage that elevation difference, the City has established seven main pressure zones in the system. In addition, several minor sub-zones have been established to provide water service to customers at a reasonable pressure. Zones 1 to 6 serve the majority of the City south of the American River. Zone 1A (Nimbus) serves an area west of the City limits along Folsom Boulevard.

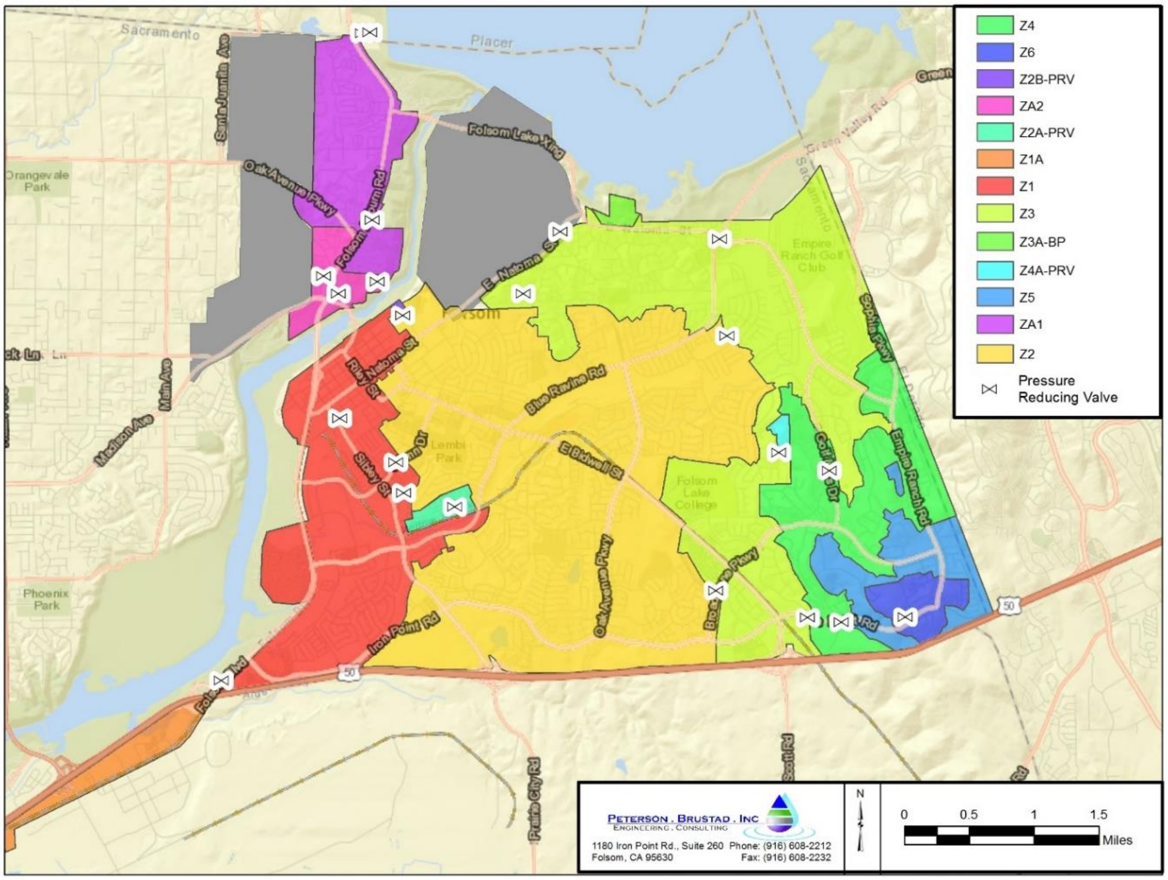

Figure 2-3. Pressure zones within the City's existing water service area.

Table 2-2 presents the operating characteristics for the City's seven main pressure zones.

Table 2-2 Operating characteristics of main pressure zones

Pressure Zone	Approximate Hydraulic Grade Line (ft)	Service Elevation Range (ft)	Static Pressure (psi)[1,2]
1A (Nimbus)	280	Up to 180	43-100+/-
1	370	Up to 280	35 – 95
2	480	230 to 400	39 – 87
3	580	360 to 470	45 – 103
4	730	360 to 540	45 – 114
5	830	410 to 740	45 – 93
6	894	630 to 790	32 – 76

1 Minimum pressure = static pressure at highest zone elevation and tank water surface ten feet below tank overflow elevation.
2 Maximum pressure = static pressure at lowest zone elevation and tank at overflow.

The City currently maintains 18 pressure reducing valve (PRV) stations and one flow control valve station. Table 2-3 summarizes the existing pressure/flow control valve operating characteristics.

Table 2-3 Operating characteristics of control valves

Valve No.	Location	Main Valve Size	Bypass Valve Size	Downstream Pressure Setting	Pressure Zones	Ground El	Status
1	Ashland - Folsom Bluffs	8"	4"	N/A	A1 to A1.5	330	Abandoned
2	Ashland - Folsom Ranch Apartments	3"	8"	60	A1 to A1.5	247	Open
3	Schiedegger and Willow Bend	6"	N/A	35	3 to 2	373	Closed
4	Iron Point Rd and Serpa	12"	N/A	50	5 to 4	520	Closed
5	Iorn Point Rd. and Cavit	10"	N/A	40	4 to 3	470	Closed
6	Broadstone & Clarkesville	6"	N/A	40	3 to 2	365	Closed
7	Levy Rd. and Hunter	10"	4"	60	2 to 2A	280	Open
8	Natoma & Tacana	16"	8"	55	Z3FH to Z3 C	431	Closed
9	Natoma & Blue Ravinde	12"	8"	65	Z3FH to Z3 C	407	Closed
10	Golf Links 300' N. of Arlington	10"	N/A	42	4 to 3	452	Closed
11	Rockport @ East Tanks	6"	2"	73	4 to 3.5	460	Open
12	131 Vierra Cir	10"	4"	38	2 to 1	260	Closed
13	Glen Dr. & Whiting Wy.	10"	4"	N/A	2 to 1	250	Closed
14	Ashland - 9881 Greenback Lane	8"	N/A	80	A1 to A2	208	Removed
14	Ashland - 125 Woodview Drive (New)	6"	2"	60	A1 to A2	261	Open
15	Ashland - 126 Hillswood	6"	2"	60	A1 to A2	277	Open
16	Ashland - 7007 Folsom-Auburn Road	10"	10"	41	A1 to A2	293	Open
17	Rodeo PRV @ Rodeo Grounds	8"	2"	20	2 to 1.5	305	Open
18A	Folsom Blvd. & Iron Point-1	6"	N/A	45	1 to 1A	180	Open
18B	Folsom Blvd. & Iron Point-2	3"	N/A	45	1 to 1A	180	Open
18C	Folsom Blvd. & Iron Point-3	8"	N/A	40	1 to 1A	180	On Demand

2.3.2 *Water Storage Reservoirs*

Storage tanks are located throughout the City's service area to meet operational demands, fire flow requirements, and to meet demands during emergency and power outage conditions. Water levels in the tanks rise and fall with changes in water demand and WTP production.

The City has 10 storage tanks/reservoirs located throughout the distribution system and 2 at the WTP. Table 2-4 presents the characteristics of the 12 potable water storage reservoirs in the City's water system. The total storage capacity is 34.5 million gallons (MG); however, Reservoir No. 1 and Reservoir No. 2 cannot be filled passed 26.5ft without overflowing the chlorine contact basin so total storage capacity in the system is reduced to 33.2 MG.

Table 2-4 Summary of existing potable water storage reservoirs

Storage Reservoir	Capacity (MG)	Zone(s) Served	Overflow Elevation (ft)
Reservoir No. 1	2.4	1 and2	393[1]
Reservoir No. 2	3.3	3, 4, 5, and 6	393[1]
Carpenter Hill Reservoir	3.0	5	830
Broadstone Reservoir	4.0	4	730
Cimmaron Hills Reservoir	2.0	3	580
Foothills Reservoir#1	2.5	3	580
Foothills Reservoir #2	2.5	3	580
East Reservoir #1	3.0	2	480
East Reservoir #2	3.0	2	480
Tower Reservoir	3.0	2	480
South Reservoir	3.0	1	370
Nimbus Reservoir	1.5	1A (Nimbus)	280
Total Storage in Service	**33.2**		
[1]Reservoirs cannot be filled above elevation 387 without overflowing the chlorine contact basin.			

In addition, the concrete chlorine contact basin at the WTP used for disinfection contact time has a volume of 1.2 MG. Since that volume cannot be used for fire or emergency purposes, it is not considered available storage for the purposes of this WMP.

Finished water leaves the chlorine contact basin and flows to the pump station area where Reservoir No. 1 and Reservoir No. 2 are located. The reservoirs are operated in parallel so that Reservoir No. 1 provides water to Zone 1 and Reservoir No. 2 provides water to the two Zone 3 pump stations. The Zone 2 Pump Station receives water prior to Reservoir No. 1. The treated water from the reservoirs is delivered to pressure Zone 1 by gravity and pumped to pressure Zones 2 and 3 by pump stations located near the reservoirs at the plant site.

Figure 2-4 presents an overview of the City's existing potable water storage reservoirs.

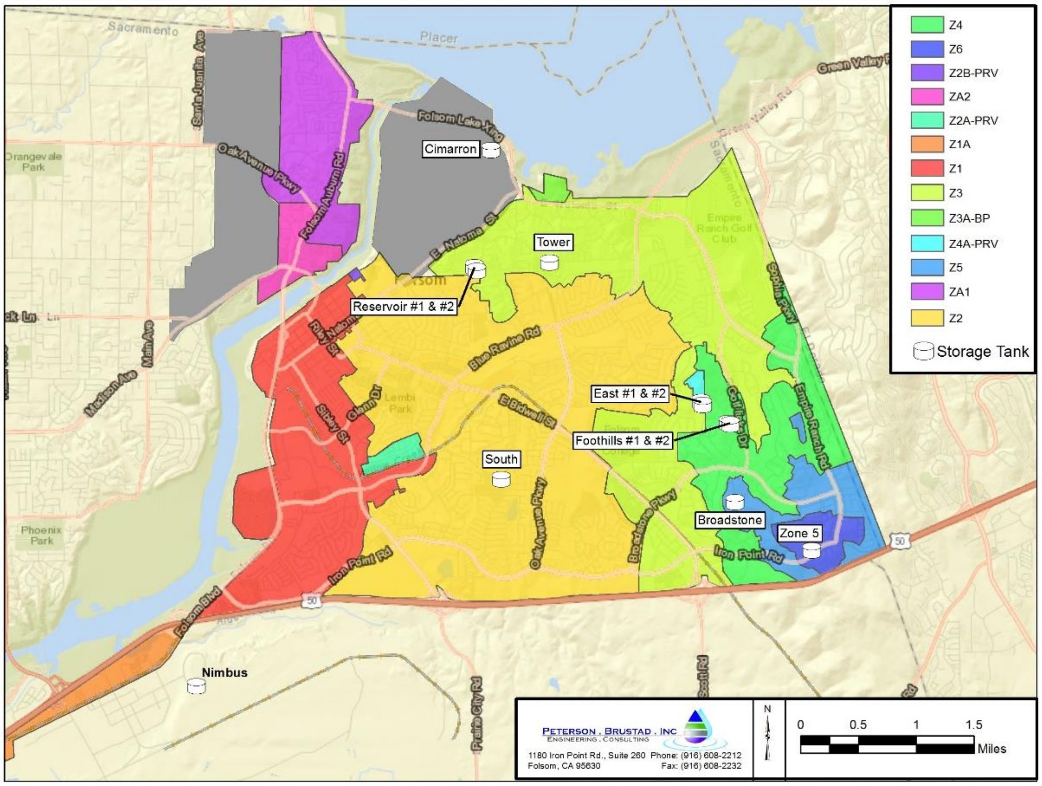

Figure 2-4. Potable water storage tanks within the City's water service area

2.3.3 *Booster Pump Stations*

The City's water distribution system includes 7 booster pump stations that serve Zones 2 through 6. The pump stations have multiple pumps to meet the varying demands in the pressure zones.

Table 2-5 summarizes the pump station capacities and characteristics. Pump station locations are shown in Figure 2-5.

Table 2-5. Pump station characteristics

Location	Pressure Zone	Total Pumping Capacity (gpm)[1]	Firm Pumping Capacity (gpm)[2]
Water Treatment Plant	2	23,850	18,000
Water Treatment Plant	3	3,960	2,760
Water Treatment Plant	3 – East Area (Foothills)	16,420	12,770
East Natoma Street	4	7,200	4,800
La Collina	3A (La Collina dal Lago)	2,310	310
Broadstone Parkway	5	2,200	1,100
Carpenter Hill Reservoir	6	5,600	3,500

1 Total pumping capacity refers to the pumping capacity of all installed pumps
2 Firm pumping capacity refers to the total capacity minus the capacity of the largest

installed pump

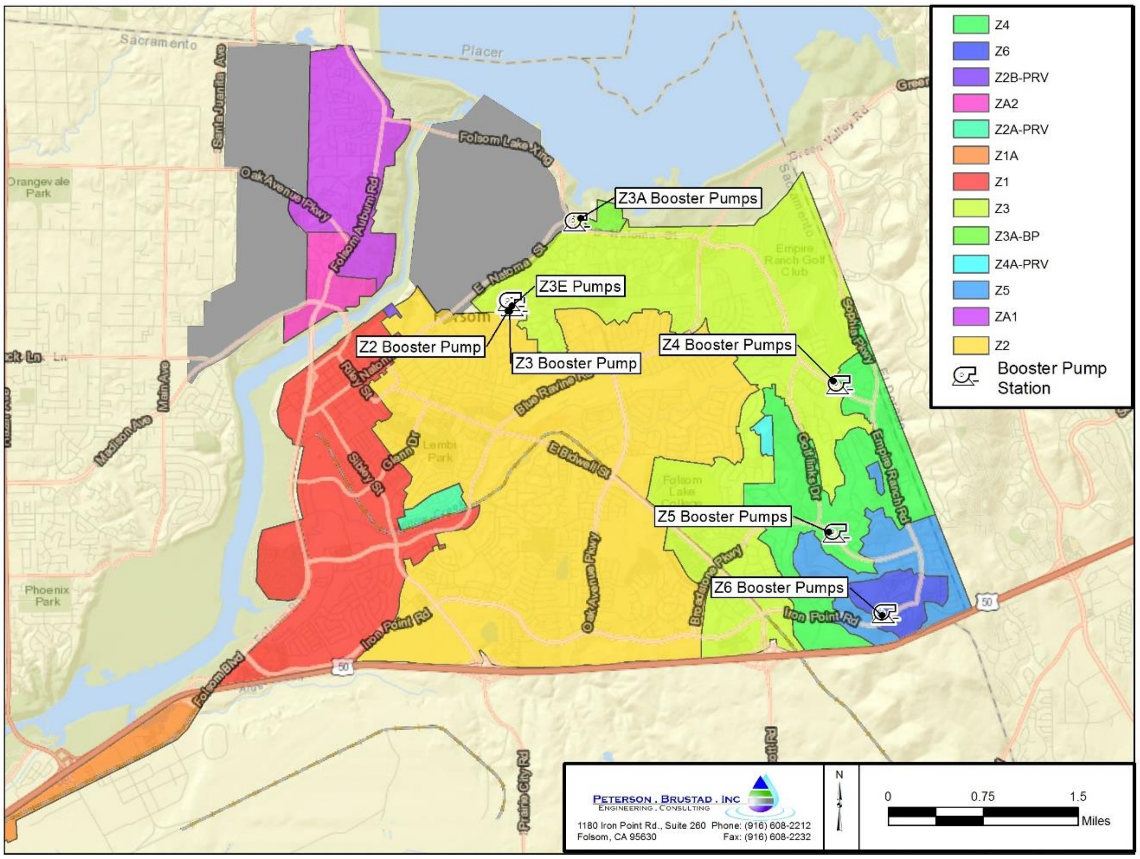

Figure 2-5. Booster pump stations within the City's water service area

2.3.4 *Pipelines and Interconnections*

The existing water distribution system south of the American River includes approximately 280 miles of pipelines that range in size from 4-inches to 30-inches in diameter (not including the raw water pipelines). An additional 28 miles of pipe is included in the Ashland area north of the American River.

In general, pipes are made of cast iron and asbestos cement in the older parts of town and PVC, ductile Iron and steel in the newer developments.

The City has an emergency connection at Rainbow Bridge to serve the Ashland water system. The Golden State Water Company also has an existing emergency intertie to the City's distribution system near Hazel Avenue and Highway 50.

Figure 2-6 presents and overview of the City's existing pipe network. Figure 2-7 presents the hydraulic profile for the water system including the water supply and storage facilities, elevations served, and zone inter-connections for each pressure zone.

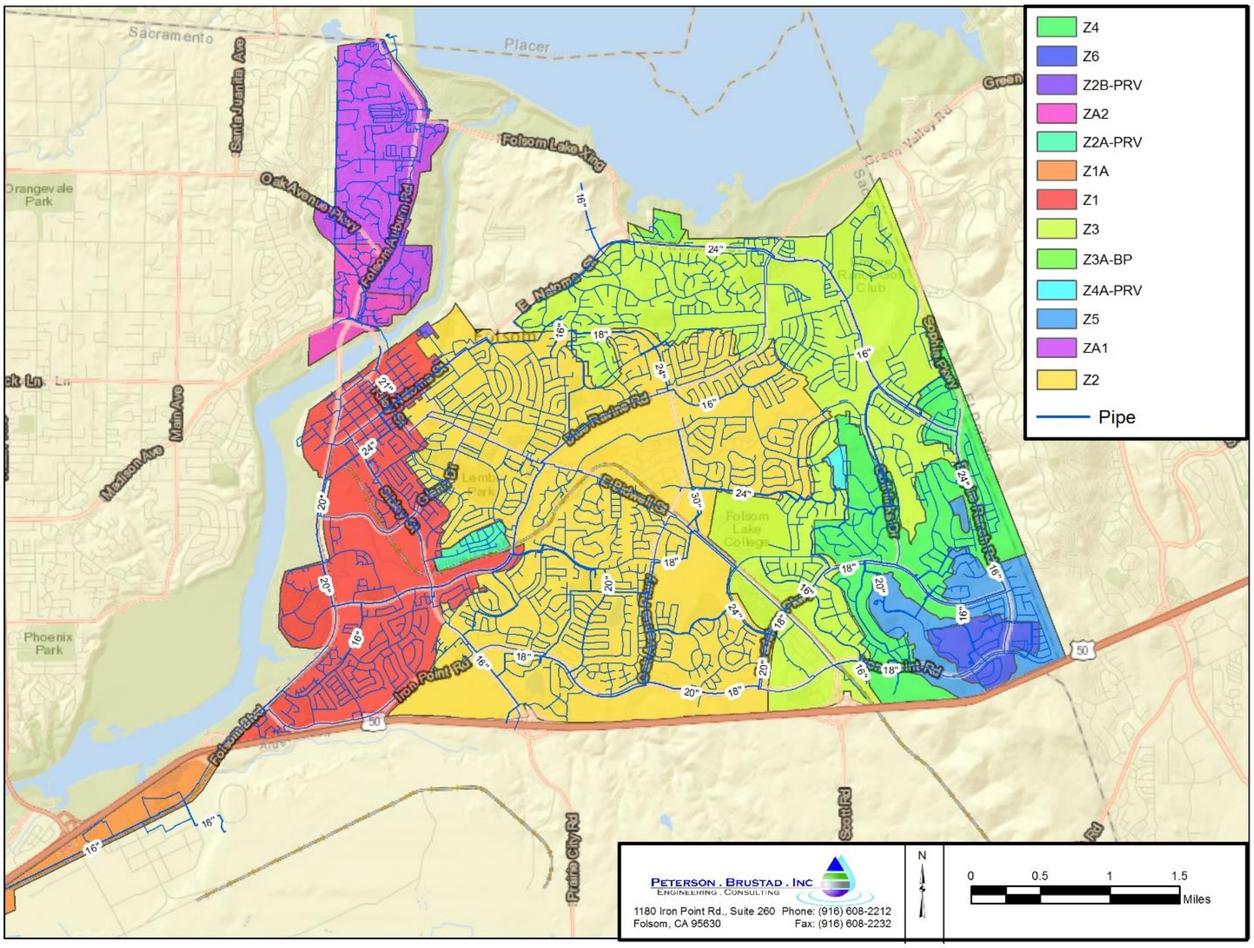

Figure 2-6. Overview of existing pipe network

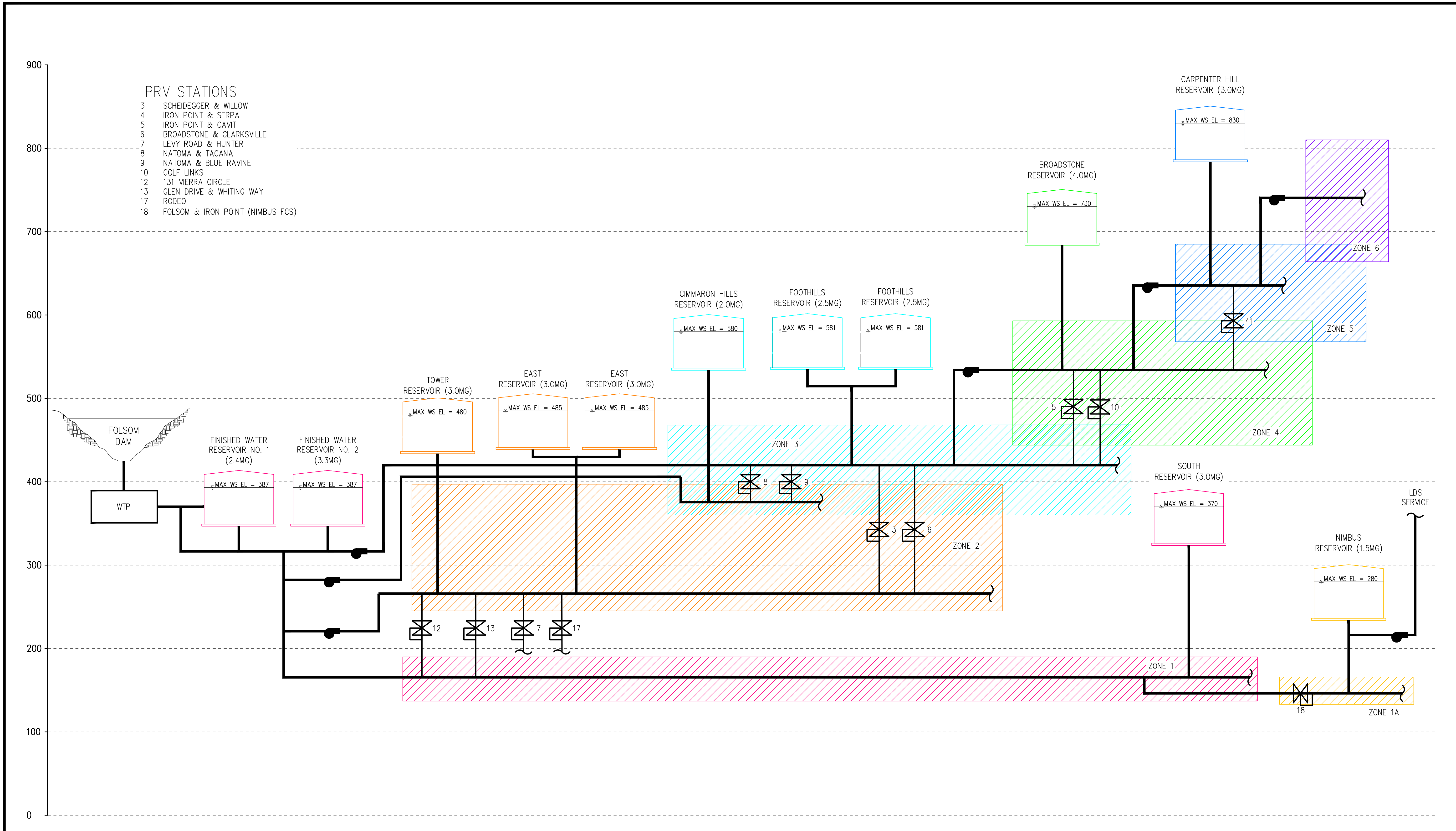

Figure 2-7. Hydraulic Profile of Existing Water System

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2.4 Planned Water Distribution System

The City is preparing for significant growth, particularly in the areas south of Highway 50. The major planned developments south of Highway 50 include the Easton Project and the Folsom Plan Area (FPA).

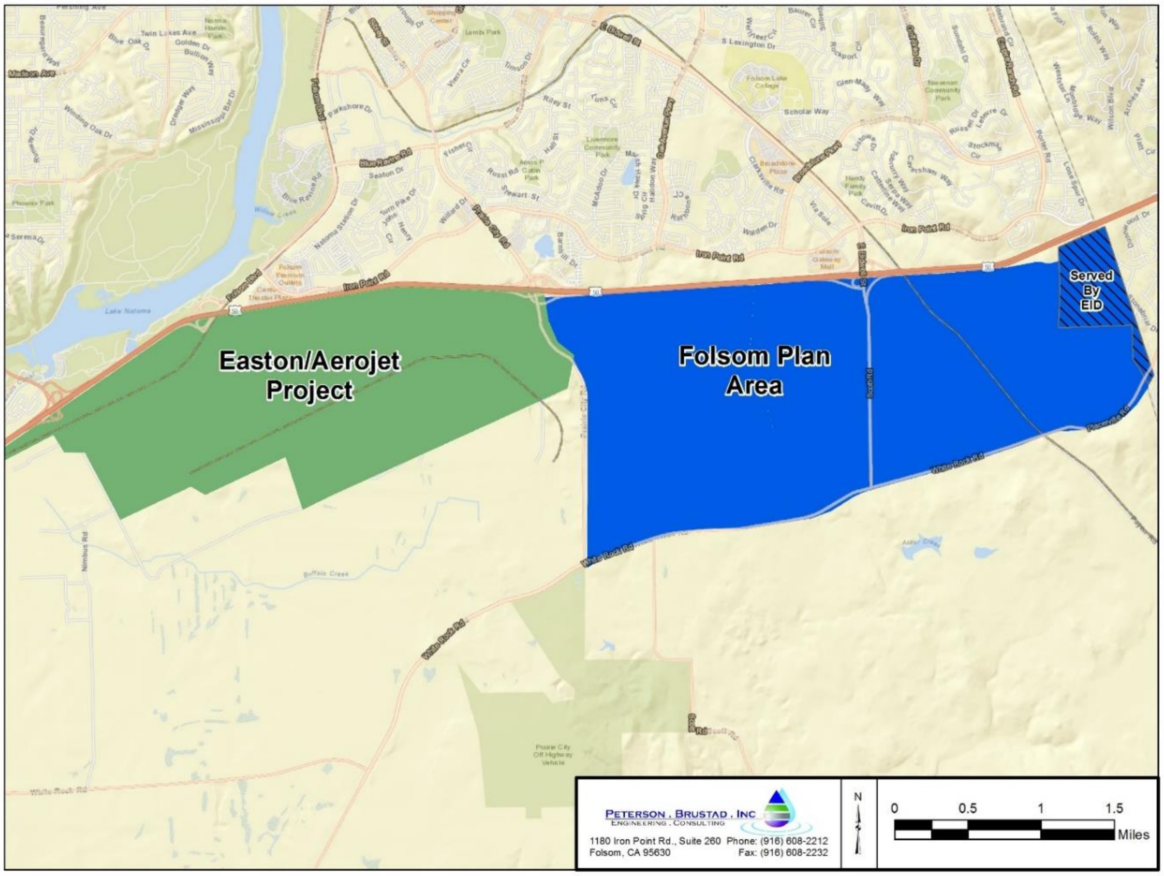
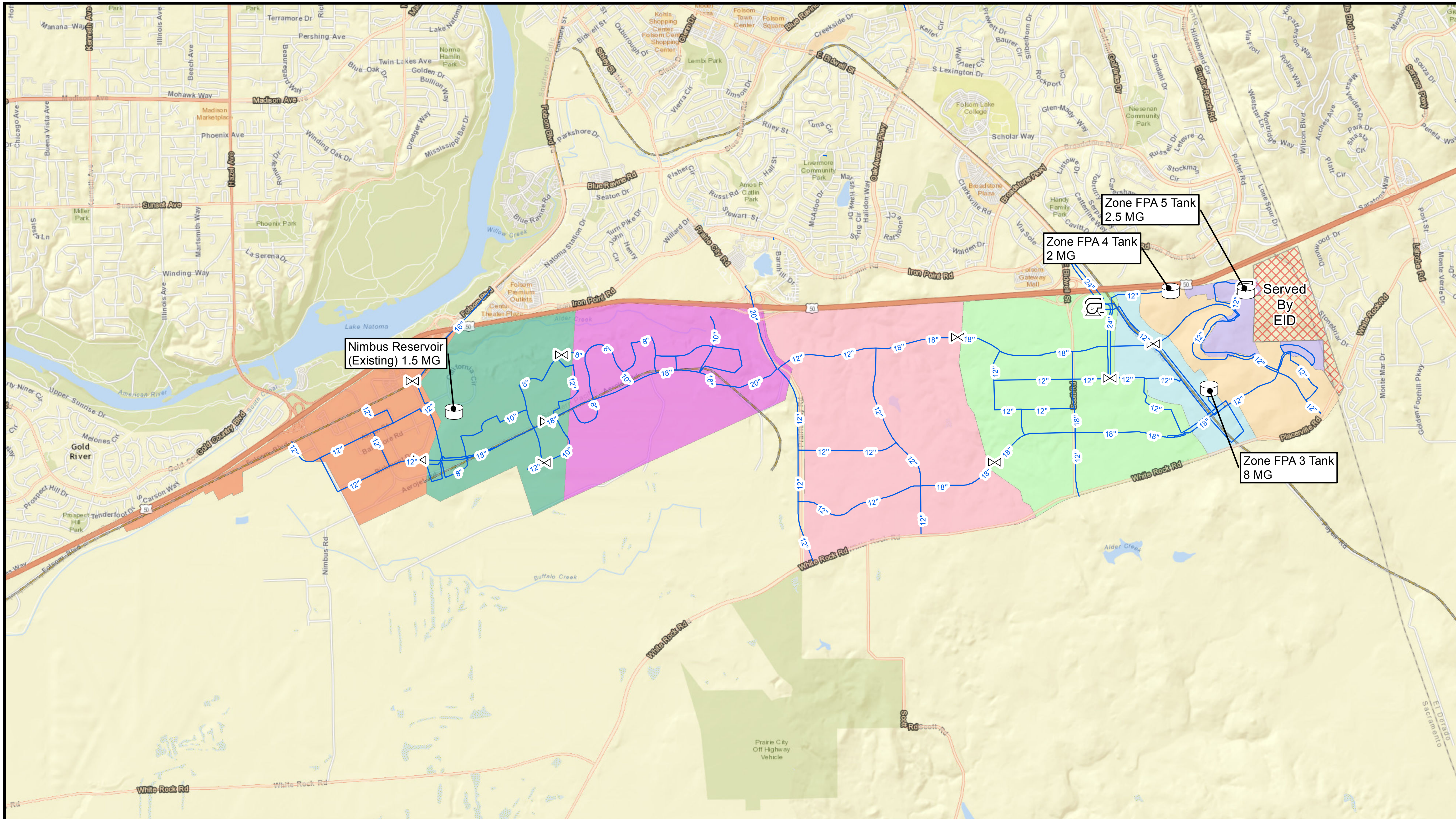


Figure 2-8. Planned developments south of Highway 50.

Water system master planning for these developments are described in detail in the following reports:

- *Evaluation of City of Folsom Water System Improvements for Initial Easton Development* Technical Memorandum (Brown and Caldwell, March 2011)
- *Existing System Improvements for Ultimate Easton Development* Technical Memorandum (Brown and Caldwell, July 2014)
- *Folsom Plan Area Water System Master Plan* (Brown and Caldwell, October 2014)

The following subsections summarize the planned water systems for the Easton and FPA developments. Figure 2-9 gives an overview of the backbone infrastructure that has been planned for these developments based on the previous water master planning studies.



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N

Storage Tank
Pressure Reducing Valve
Pipe
Pump

Easton Zone 1A
Glenborough Zone 1
Glenborough Zone 2
Zone FPA2
Zone FPA3
Zone FPA4
Zone FPA5
Zone FPA6

0 0.5 1 Miles

CITY OF FOLSOM

Planned Infrastructure for Future Developments South of Highway 50

FIGURE

2-9

2.4.1 *Easton Planned Development*

The Easton project consists of an approximately 1,100-acre residential and commercial development and is scheduled to be completed in multiple phases. It is located within the Nimbus water service area just south of Highway 50 and west of Prairie City Road. Previous water master planning studies identified the backbone infrastructure needed to serve the Easton project. The infrastructure shown in Figure 2-9 was incorporated into this *2016 WMP Update* and was evaluated as described in subsequent chapters of this report.

The *Evaluation of City of Folsom Water System Improvements for Initial Easton Development* Technical Memorandum (Brown and Caldwell, March 2011) documented the incorporation of the Initial Easton Project hydraulic model into the City's existing hydraulic model in order to evaluate the impacts of the development's water demands on the City's existing water infrastructure. It concluded that the City's distribution system is at capacity with existing demands and any additional demand required by the Easton project would result in a steady decline of water levels in the South Reservoir over time.

The focus of the 2011 report was on serving the initial Easton development phases in Easton Zone 1A. To provide supply to the initial development, a redundant pipeline was recommended along Folsom Blvd from the City's existing Zone 1 to Zone 1A of the Easton Project.

The *Existing System Improvements for Ultimate Easton Development* Technical Memorandum (Brown and Caldwell, July 2014) documented the incorporation of the Ultimate Easton Project hydraulic model into the City's existing hydraulic model in order to evaluate the impacts of the development's water demands on the City's existing water infrastructure. It concluded that the following improvements to the existing system be made in addition to improvements identified in the 2011 report:

- Zone 1/1A Improvements:
  - Zone 1 booster pump station to increase hydraulic head in Zone 1
  - 7,500 LF of 16 inch transmission main along Folsom Blvd to accommodate peak hour demand in Easton
  - New 4 MG Reservoir in Zone 1/1A next to South Reservoir
  - Easton booster pump station to increase hydraulic head to Easton Zone 1
- Zone 2 Improvements:
  - 10,000 LF of 24 inch pipe dedicated as new Tower supply pipeline
  - Emergency Valve on existing Tower fill pipeline
  - Zone 2 BPS redundant pump at the water treatment plant
  - New 3 MG Reservoir in Zone 2 adjacent to the Lifetime Fitness Facility including 7,300 LF of 24 inch supply pipeline and potential booster pump station
  - 4,900 LF of 18 inch distribution main from Iron Point Road at Grover to Prairie City Road to accommodate velocity concerns

- 3,400 LF of new Zone 2 20 inch transmission main from Zone 2 to Easton 2 at Prairie City Road.

See Section 5 for comparison of current system analysis and recommended improvements compared to previously documented recommended improvements.

2.4.2 *Folsom Plan Area*

The City completed the *Folsom Plan Area Water System Master Plan* (Brown and Caldwell, October 2014) which summarizes the FPA land use, water demands and water supply as well as presents the build out water system infrastructure improvement recommendations. The FPA WMP also provides guidelines for the development of the entire water system in order to meet the new demands.

The conceptual backbone system consists of pipelines that are 12-inch and larger in diameter as well as the other infrastructure improvements such as pressure reducing valves, storage tanks, and booster pump stations (see Figure 2-9). The location of the infrastructure is based on the future backbone of roads and utility easements.

The initial phases of the FPA are planned to be served through a connection with the City's existing Zone 3 using two parallel pipes (one 24-inch pipe and one 18-inch redundant pipe) that run along East Bidwell Street from Iron Point Road to the FPA. Improvements to the existing Zone 3 East booster pump station (up to an additional 1,000 gpm) will also be needed for the FPA initial phases. The ultimate FPA build out will require a new dedicated 30-inch pipe from the WTP to the FPA and a new booster pump station (6,100 gpm firm capacity) at the WTP. Figure 2-10 presents an overview of planned improvements to the City's existing water system needed to serve the FPA.

A water system hydraulic profile of the existing City system with the proposed FPA additions is illustrated in Figure 2-11.

The *2014 FPA WMP* evaluated this backbone infrastructure and concluded that it was adequate to supply water to all developments in the FPA. The planned infrastructure described was incorporated into this *2016 WMP Update* and was evaluated as described in subsequent chapters of this report.

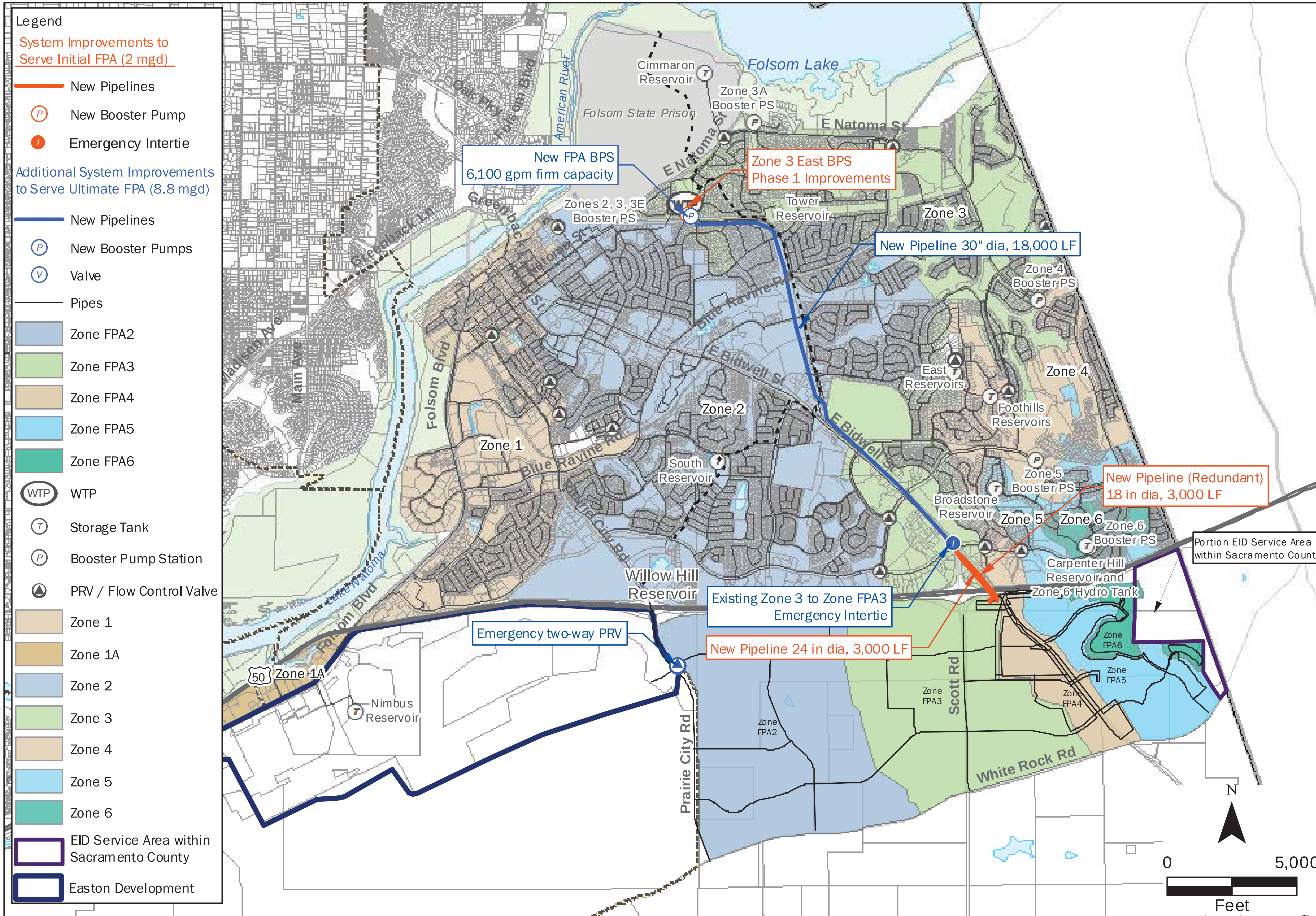


Figure 2-10. Improvement to City's Existing Infrastructure to Serve the FPA.

(Source: *Folsom Plan Area Water System Master Plan*, Brown and Caldwell, October 2014)

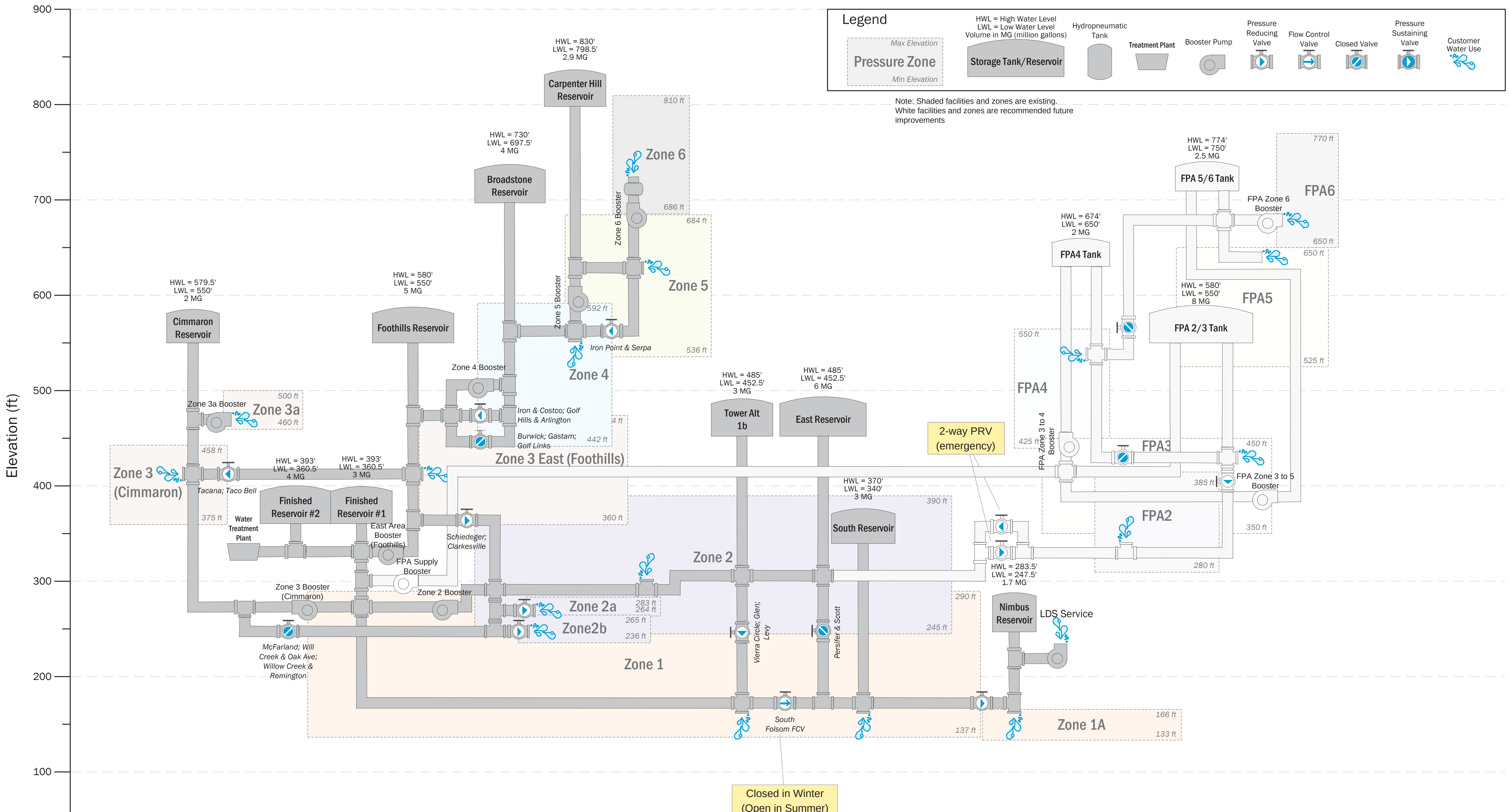


Figure 2-11. Schematic of City's Water System Including Planned FPA System

(Source: *Folsom Plan Area Water System Master Plan*, Brown and Caldwell, October 2014)

3.0 WATER DEMANDS

Current and projected water demands are used as inputs for the hydraulic modeling analysis to (a) identify deficiencies in the existing water system and (b) assist in the assessment of future water system capacity and required improvements based on planned development. Water demands used in this WMP were analyzed as part of the City's *2015 Urban Water Management Water Management Plan (2015 UWMP)* (Tully & Young, June 2016). This chapter includes the following sections related to water demands:

- Existing & Projected Population
- Existing & Projected Land Use
- Diurnal Demand Patterns
- Water Demands by Land Use Type
- Distribution System Water Losses
- Water Demand Peaking Factors
- Summary of Water Demands

3.1 Existing & Projected Population

The City's population within its water service area, which does not include the American River Canyon, was estimated at 63,536 at the end of 2015 according to its *2015 UWMP*. The population within the City's water service area is expected to almost double by the time the City is fully built out.

Table 3-1. City of Folsom water service area historic and projected population (Data Source: City of Folsom 2015 UWMP)

Year	Population
Historic	
2010	61,187
2011	61,351
2012	61,600
2013	62,145
2014	62,756
2015	63,536
2016	65,909
Projected	
2020	69,196
2025	74,855
2030	81,223

2035	88,552
2040	96,787
Build Out	114,507

Planned development projects in the areas south of Highway 50 are primarily responsible for the increase in population at buildout conditions.

3.2 Existing & Projected Land Use

A variety of land uses exist within the City including residential, industrial, retail and commercial customers. Figure 3-1 provides a summary of existing land uses that are within the City's water service area.

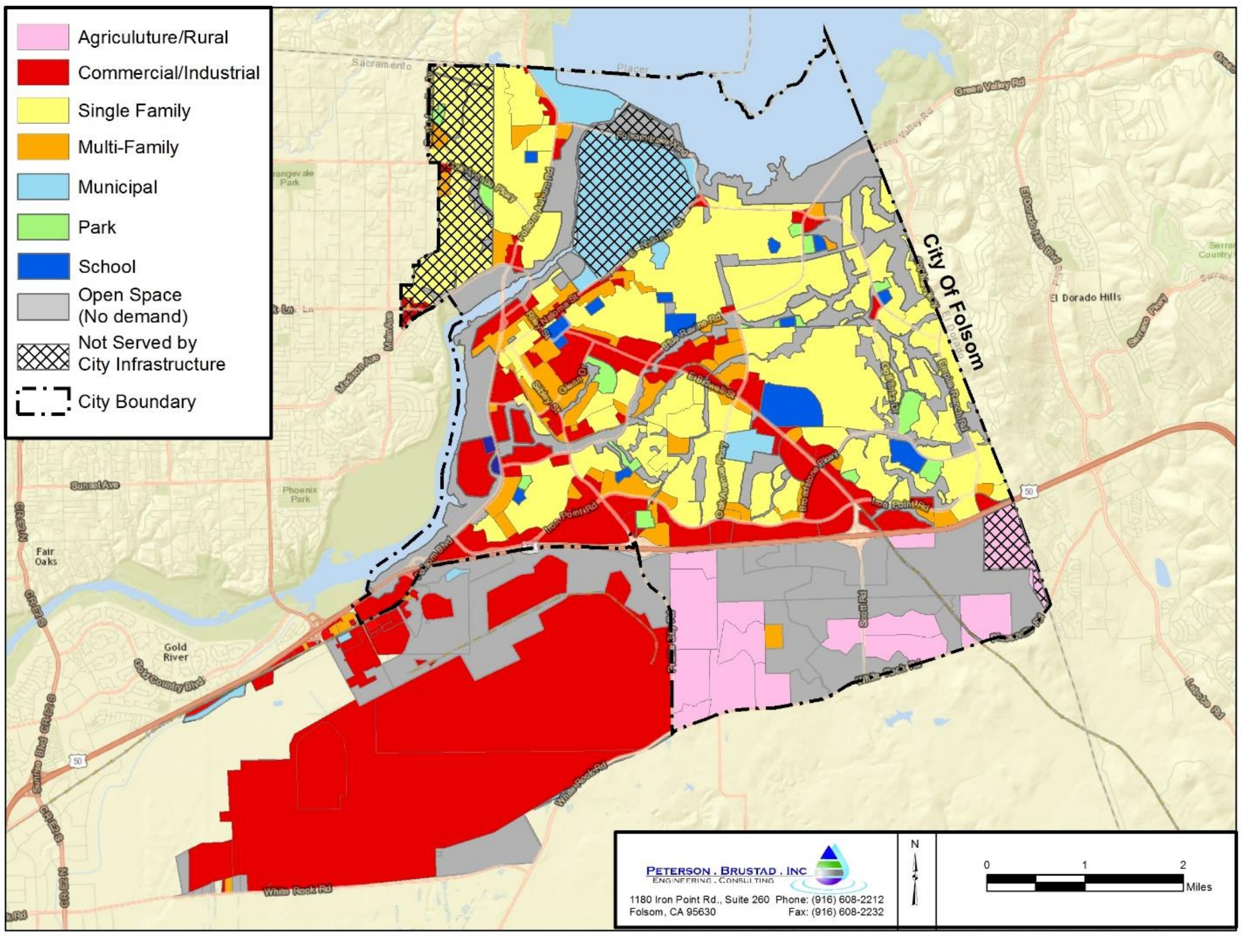


Figure 3-1. Existing land use within the City of Folsom water service area
(Data Sources: City of Folsom & County of Sacramento GIS databases)

Proposed developments south of Highway 50 include the Easton project and the Folsom Plan Area (FPA), as discussed in Chapter 2.0. Figure 3-2 presents the fully built-out land use for the area south of Highway 50.

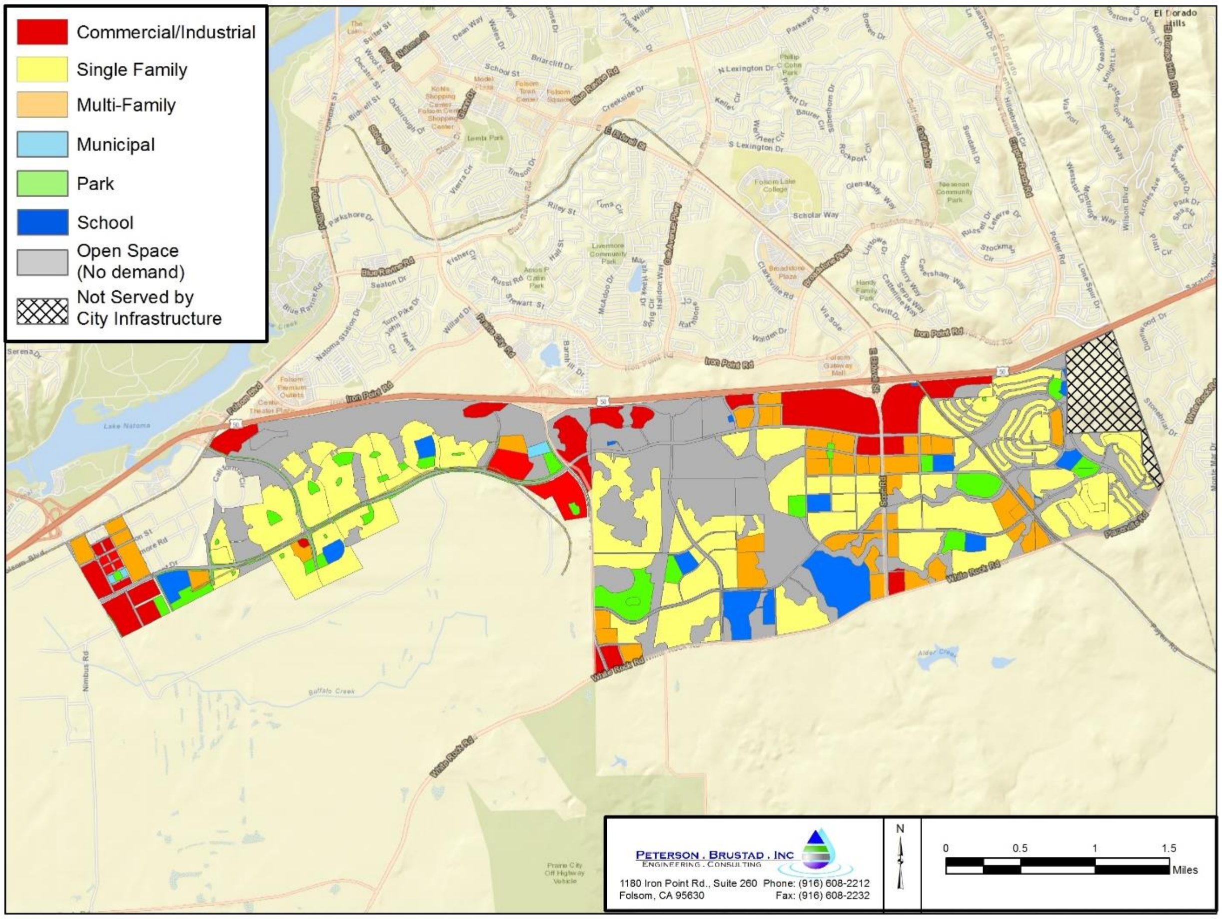


Figure 3-2. Fully built-out land use for the service area south of Highway 50
(Data Source: Tully & Young, Received 17JUN2016)

3.3 Diurnal Demand Patterns

As part of the City's *2008 WMP*, SCADA data was analyzed to develop diurnal demand curves for each pressure zone. The SCADA data included water levels at all storage tanks and readings from pump station flow meters for a three-week period between August 1, 2005 and August 22, 2005. By calculating the flow into each pressure zone and the change in tank levels at one hour intervals, the net system demand in each pressure zone was plotted as a function of time to produce diurnal demand curves.

As noted in the *2008 WMP*, there were some gaps in the data that prevented development of diurnal curves for each pressure zone. These deficiencies included:

- There was no independent flow meter data for the Nimbus Pressure Zone, therefore a diurnal curve could not be calculated.
- The diurnal curves for Zones 3 to 5 were too erratic, possibly due to very short pump cycles. The data could not provide reasonable estimates of the diurnal demand curve for the zones.
- The data for Zone 6 resulted in an unusual shape.
- Undocumented water transfers from Zone 2 to Zone 1 are known to occur.

All zones which diurnal curves could not be calculated were assigned the total system curve. The diurnal curves were updated in the hydraulic model to reflect the curves developed in the 2008 WMP that are represented in Figure 3-3 below. As noted in the FPA WMP, the FPA zones reflect the Zone 3 diurnal curve developed in the 2008 WMP. The zones in the Easton reflect the Zone 1/2 diurnal curve and the zones in the Ashland service area reflect the total system curve which was developed in the 2008 WMP.

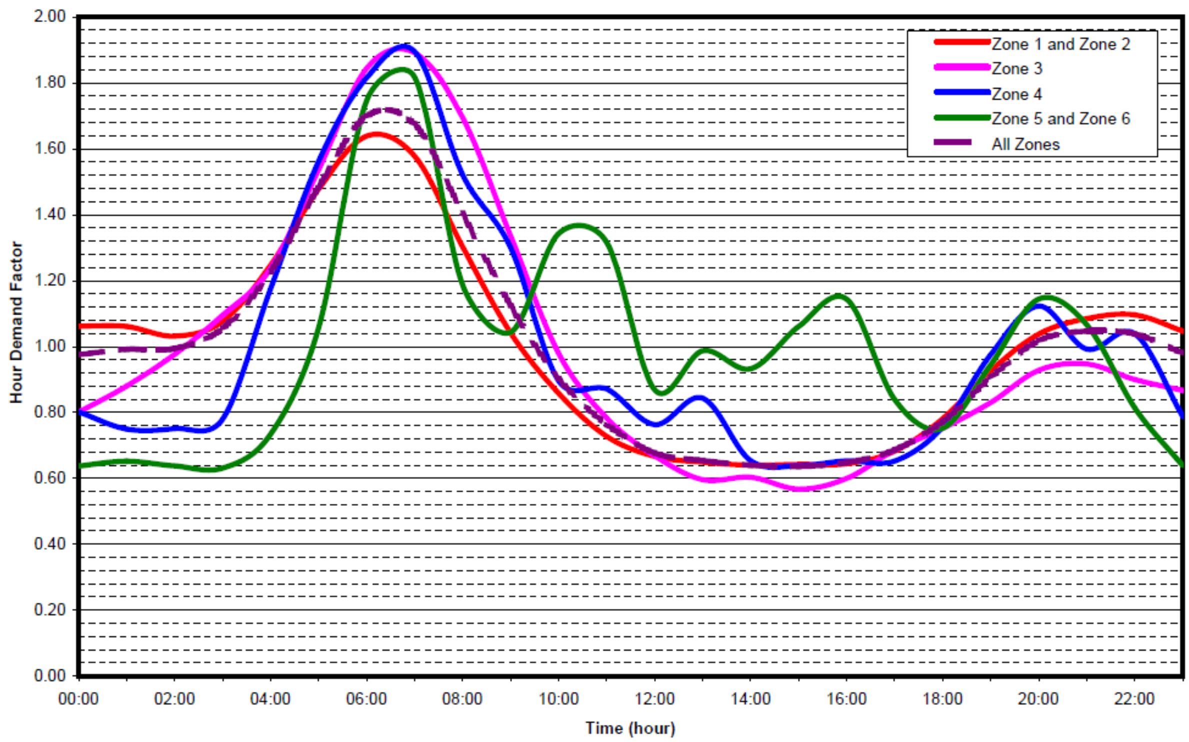


Figure 3-3. Diurnal Curves Applied in the Model
(Source: *Water Master Plan Update*, West Yost Associates, May 2008)

3.4 Water Demands by Land Use Type

The following section summarizes the water demand analysis that was completed as part of the City's *2015 UWMP*. Existing and projected water demands were estimated and categorized by land use type.

Based on available records for water production and water sales/deliveries, the City's water demands for the past five years were assessed as previously presented in Table 2-1. As demonstrated by the presented water use, the City has not experienced much growth since 2010. The City anticipates only limited growth in the existing service areas, but does anticipate significant near-term growth in the planned communities south of Highway 50.

The City's *2015 UWMP* describes several considerations that went into forecasting future demands: assessing the future water use habits of existing customers in light of increased conservation efforts, analyzing the land use plans that indicate locations and types of anticipated growth, and examining the various laws and regulations that determine future water demand factors.

3.4.1 *Existing Customers*

With recent completion of its water meter program, the City has a better understanding of the characteristics of its existing customers' use. The City's database of meter use information is categorized by land use type including: single family residential, multi-family residential, commercial, industrial, schools, parks, and municipal.

Based on 2013 meter data, unit demand factors for existing customers were determined for each land use. 2013 is the best available data to represent average conditions at this time. Using data from the drought years of 2014 and 2015 are less likely to represent average use conditions because of state mandated use reductions.

The City currently serves a mostly built-out area north of Highway 50 including residential and non-residential customers with varying uses. Future demand forecasts for this built-out area predominantly result from the expected changes to existing customers' water use habits. Existing customers' future unit demand factors are assumed to change mostly from drivers such as general homeowner fixture replacements and upgrades, the City's conservation awareness and incentive programs, and other factors affecting a general increased awareness of water conservation.

Table 3-2 summarizes existing and projected average day water demands based on land use type for areas within the City that are currently developed. Water demands were adapted from the City's *2015 UWMP*.

Table 3-2. Existing customer average day water demands

Land Use	Existing		2025		2035		Build Out	
	[AF/acre]	[gpm/acre]	[AF/acre]	[gpm/acre]	[AF/acre]	[gpm/acre]	[AF/acre]	[gpm/acre]
Single Family	2.01	1.27	2.00	1.24	1.95	1.21	1.91	1.18
Multiple Family	1.82	1.13	1.78	1.10	1.75	1.08	1.72	1.07
Commercial/Industrial	2.50	1.55	2.50	1.55	2.50	1.55	2.50	1.55
Schools	1.85	1.15	1.85	1.15	1.85	1.15	1.85	1.15
Parks	3.73	2.31	3.73	2.31	3.73	2.31	3.73	2.31
Municipal	1.35	0.84	1.35	0.84	1.35	0.84	1.35	0.84

Note: Demands presented in this table do not include water loss (see Section 3.4)

3.4.2 *Future Customers*

As discussed previously, the City's service area is substantially built out in the areas north of Highway 50, having little remaining undeveloped land. The expected growth will occur as a result of isolated infill, lot split development projects, and the significant planned communities located south of Highway 50. Based on the *2015 UWMP*, this growth will amount to around 16,000 new dwelling units and will increase the current City population by 80%. Several factors were taken into account for the development of future water demands, which in turn affect the forecasted water demand for future customers. These range from state mandates to changes in the types of housing products being offered.

Table 3-3 summarizes projected average day water demands based on land use type for future developments. Water demands are adapted from the City's *2015 UWMP*.

Table 3-3. Future customer average day water demands

Land Use	2025		2035		Build Out	
	[AF/acre]	[gpm/acre]	[AF/acre]	[gpm/acre]	[AF/acre]	[gpm/acre]
Single Family						
City (North of Hwy 50)	1.89	1.17	1.89	1.17	1.89	1.17
Folsom Plan Area	2.03	1.26	2.03	1.26	2.03	1.26
Easton	1.89	1.17	2.33	1.44	2.33	1.44
Multiple Family						
City (North of Hwy 50)	2.76	1.71	2.76	1.71	2.76	1.71
Folsom Plan Area	3.75	2.32	3.75	2.32	3.75	2.32
Easton	--	--	2.77	1.72	3.89	2.41
Commercial/Industrial	1.97	1.22	1.97	1.22	1.97	1.22
Schools	2.58	1.60	2.58	1.60	2.58	1.60
Parks	3.73	2.31	3.73	2.31	3.73	2.31
Municipal	1.30	0.81	1.30	0.81	1.30	0.81
Mixed Use*	--	--	--	--	5.86	3.63

Note: Demands presented in this table do not include water loss (see Section 3.4) *The Easton development includes areas of mixed use with commercial use on the first level of a building and residential use above.

3.4.3 *Large Water Users*

There are four major industrial/commercial water consumers that have demand allocated individually in the distribution system model. These major consumers are Aerojet, Intel, Kikkoman, and Gekkeikan. The following table summarizes demands of large water users and is based on data presented in the City's *2015 UWMP*.

Table 3-4. Water demands for large water users

Customer	Existing		2025		2035		Build Out	
	[AF/year]	[gpm]	[AF/year]	[gpm]	[AF/year]	[gpm]	[AF/year]	[gpm]
Intel	499	309	383	237	383	237	383	237
Aerojet	530	329	451	280	451	280	451	280
Kikkoman	110	68	158	98	158	98	158	98
Gekkeikan	82	51	67	42	67	42	67	42
TOTAL	1,221	757	1,059	657	1,059	657	1,059	657

Note: Demands presented in this table do not include water loss (see Section 3.4)

3.5 Distribution System Water Losses

The demand factors presented in the above tables represent the water demand at each customer location. To fully represent the demand, distribution system losses must also be included in the distribution system model. System losses often occur due to system leaks, fire protection, construction water, unauthorized connections and inaccurate meters. It is the water that is produced at the City's WTP that does not make it to the customer. In most cases, the source of distribution system losses is from leaks throughout the many miles of pipes and fittings that bring water to the City's customers. The City recently completed a 2-year leak detection and recovery project and, as a result, the measured losses on the potable system have been significantly reduced. Based on analyses included with the City's *2015 UWMP*, a 5% water loss was added to all demands for distribution system modeling.

3.6 Water Demand Peaking Factors

Water demand peaking factors were developed using the City's WTP production data:

- The **average day production** was calculated by adding the historical monthly plant production for the years between 2010 and 2015 and dividing by 365 days per year.
- The **maximum month production** was calculated by dividing the maximum month total production by the number of days in that month.
- The **maximum day production** was determined by evaluating the data to see which day had the highest production rate for each year.

Peaking factors were then determined to convert average day demand data to maximum month and maximum day demands:

- The **maximum month peaking factor** was determined by dividing the maximum month production by the average day production. The average maximum month peaking factor over the years between 2010 and 2015 is 1.6 (drought had no impact).
- The **maximum day peaking factor** was calculated by dividing the maximum day production by the average day production. The average maximum day demand peaking factor over the years between 2010 and 2015 is 1.7 (drought had no impact on this peaking factor).

The average day to maximum month and average day to maximum day peaking factors identified in the City's previous WMP were based on data for the years 1990 to 2005. While the peaking factors have been relatively consistent over time, there does appear to be a decline in the factors over the last decade. This is typical of a system that continues to grow. Peaking factors have a tendency to decrease as the system becomes larger and the peak demand's impact on the system is not as significant as before.

Due to the fact that peak hour demands are met by both WTP and system storage, the peak hour demand must be calculated by averaging all of the peak hour factors for each pressure zone based on the respective zone tank level data and pump station data. This approach requires hourly data for tank levels. The 2008 WMP collected and analyzed this hourly data, but did not report the peak hour factor that was calculated. The *2008 WMP* recommended that the maximum day to peak hour peaking factor from the 1998 and 2003 WMP should be used since their analysis did not vary significantly from the previously recommended value. The City's system has had minor changes since 2008 so it is recommended to use the same peak hour peaking factor as the *2008 WMP*.

Table 3-5 presents a summary of the peaking factors, including those from the City's design standards and the *2008 WMP*, along with those recommended for this plan.

Table 3-5. Water demand peaking factors

Peaking Factor	Peaking Factors from City Design Standards	2008 WMP Peaking Factors	Peaking Factors Based on 2010-2015 System Data	Recommended Peaking Factors
Average Day to Maximum Month Demand	-	1.7	1.6	**1.6**
Average Day to Maximum Day Demand	2.0	1.9	1.7	**1.7**
Maximum Day Demand to Peak Hour	1.7	1.8	-	**1.8**
Average Day to Peak Hour Demand	3.4	3.4	-	**3.1**

The recommended peaking factors were applied to the average day demands to obtain maximum day and peak hour demands for various model simulation scenarios.

3.7 Summary of Water Demands

Table 3-6 presents the current and projected average day, maximum day, and peak hour demands for treated water. Average day demands were estimated as part of the City's *2015 UWMP*.

Table 3-6. Summary of treated water demands

Customer	Existing [MGD]	2025 [MGD]	2035 [MGD]	Build Out [MGD]
Average Day	17.1	22.2	23.6	25.3
Maximum Day*	29.1	37.7	40.1	43.1
Peak Hour*	53.1	68.7	73.1	78.5

Notes: Demands do not include Aerojet raw water
*Max Day = 1.7x average day; Peak Hour = 3.1x average day

As a result of increased conservation efforts and system improvements to reduce system water loss, the planned buildout water demands have decreased significantly since the *2008 WMP*.

Table 3-7. Comparison of buildout water demands by zone: *2008 WMP* vs. *2015 UWMP*

	2008 WMP		2015 UWMP	
Zone	Buildout Average Day Demand (MGD)	Buildout Maximum Day Demand (MGD)	Buildout Average Day Demand (MGD)	Buildout Maximum Day Demand (MGD)
1	4.3	8.1	3.1	5.2
1A			0.5	0.9
Easton 1A			0.4	0.7
Easton 1	-	-	0.7	1.2
2	9.7	18.4	8.1	13.8
Easton 2	-	-	1.0	1.7
3	3.7	7.1	2.6	4.3
3 - Cimamaron	1.7	3.3	1.8	3.0
4	2.0	3.8	1.5	2.5
5	0.9	1.7	0.6	1.1
6	0.3	0.7	0.4	0.6
FPA 2	-	-	1.6	2.8
FPA 3	-	-	1.9	3.3
FPA 4	-	-	0.6	1.0
FPA 5	-	-	0.4	0.7
FPA 6	-	-	0.2	0.4
Total	**22.7**	**43.2**	**25.3**	**43.1**

4.0 Hydraulic Model Update

The purpose of this Chapter is to describe modifications made to the City's existing water distribution system hydraulic model. The hydraulic modeling study area includes the area south of American River as well as future development sites south of Highway 50. The Ashland service area, north of the American River, is operated and maintained by the City and is included in this WMP update. This area is considered to be fully built-out.

4.1 Background

West Yost Associates (WYA) developed the InfoWater® version of the City's hydraulic model in 2005 which is discussed in detail in the 2008 WMP Update. The model used for the *2008 WMP* underwent a verification process as described in Section 4.6 and has been updated several times since the *2008 WMP*. The model development progression is documented in the following studies:

- *Evaluation of City of Folsom Water System Improvements for Aerojet Development* Technical Memorandum (Brown and Caldwell, March 2011): Incorporated the planned Easton development into the hydraulic model. The impacts of the Easton project's initial development were analyzed using City demands for 2009, midway between 2009 and 2018, and 2018.
- *Existing System Improvements for Ultimate Easton Development* (Brown and Caldwell, July 2014): Evaluated the incorporation of the Ultimate Easton Project hydraulic model into the City's existing hydraulic model in order to evaluate the impacts of the development's water demands on the City's existing water infrastructure.
- *Folsom Plan Area Water System Master Plan* (Brown and Caldwell, October 2014): Incorporated the FPA into the hydraulic model. The hydraulic model was evaluated based on 20% reduction of Master Plan 2018 demands to take into account water use reduction measures.

The above studies incorporated pipelines for planned developments and recommended system improvements into the hydraulic model.

4.2 Approach

The approach for updating the hydraulic model includes:

- Adding pipelines for new residential developments
- Updating the distribution network to include replacements/modifications in system

- Incorporating updated demand scenarios for existing and buildout conditions based on the demand analysis presented in the City's *2015 UWMP*,
- Verifying all control settings in the model with City operations staff.

4.3 Data Collection

Updated facility and demand information needed to be collected and verified:

- Updated pipeline GIS shapefiles were provided by the City on January 11, 2016.
- Demand analysis was provided by Tully & Young for average day demand for the existing, intermediate, and buildout scenarios consistent with the *2015 UWMP*.
- Existing operational controls within the model were verified through interviews with City Operations Staff.

4.4 Model Update Methodology

The following methods were used in updating the hydraulic model:

4.4.1 *Model Projection*

The hydraulic model's horizontal datum was originally projected in NAD 1927 California State Plane Zone II. The City's current GIS shapefile of the water distribution system is projected in NAD 1983 California State Plane Zone II. To incorporate new and modified pipelines, the hydraulic model was re-projected into NAD 1983 California State Plane Zone II.

4.4.2 *Topography*

With limited reliable terrain data available for the City's water service area, elevation data for areas in the system that had new pipes was assigned based on an interpolation between the existing nodes in the hydraulic model. Elevation contours were created from existing node elevation data and was then exported to a new GIS raster surface. The Elevation Extractor tool within InfoWater® was used to automatically assign elevations to new nodes based on the created GIS elevation surface. Nodes for new pipes were then cross referenced with Google Earth elevations.

4.4.3 *Naming Convention*

Facilities within the hydraulic model such as pipes, nodes, pumps, tanks, and valves are named logically and sequentially to allow the modeler to identify key elements within the model. The *2008 WMP* developed the current naming convention used in the hydraulic model and the same naming convention was used for this 2016 model update. Newly added facility IDs start at the number 5,000 in order to differentiate between updated facilities and facilities that were already in the model. Table 4-1 below describes the various prefixes used for naming each hydraulic model element.

Table 4-1 Naming convention used in the hydraulic model

Type	Description	Prefix
Junction	Removes (demand) or adds (inflow) water from/to the system	J
Node	Represents transition in pipeline characteristic or point where pressure or water quality is monitored	N
Tank	Represents storage capacity	T
Reservoir	Represents an infinite external source	R
Pump	Raises the hydraulic grade to overcome elevation differences and friction losses	PMP
Control Valves	Controls flow or pressure in the system based on specified criteria	PRV/FCV
Pipelines	Conveys water from one node to another	P

4.4.4 *Updated Facilities*

Updating the city's hydraulic model to reflect the existing conditions of the system required the addition of facilities, primarily pipelines, that have been constructed or modified since the last model update. Control settings of tanks and pumps were also verified with City staff.

As described previously, Brown and Caldwell updated the hydraulic model in 2011 and 2014 to include the backbone infrastructure planned for the Easton development and the FPA, but these model updates left the City's existing system (north of Highway 50) as it was in the *2008 WMP* model. Efforts to update the model to reflect the current (2016) conditions of the City infrastructure are described below.

Pipelines

Modification to pipelines in the hydraulic model included (a) importing new pipeline data from the City's current water distribution shapefile to reflect new development since the *2008 WMP* model, and (b) modifying pipelines to reflect pipe replacements and improvement projects (ie-upsizing of pipes) that have taken place since the *2008 WMP*.

Input data for the new/modified pipelines include length, diameter, material, and installation year which were determined from the water distribution shapefile provided by the City. C-factors were assigned to the new/modified pipes based on their material according to the table below.

Table 4-2 Pipe Materials C-Factors

Pipe Material	C-Factor
Ductile Iron Pipe	140
Cast Iron	130
Polyvinyl Chloride, PVC	150
Asbestos Cement	140
Galvanized	120
Welded Steel	100

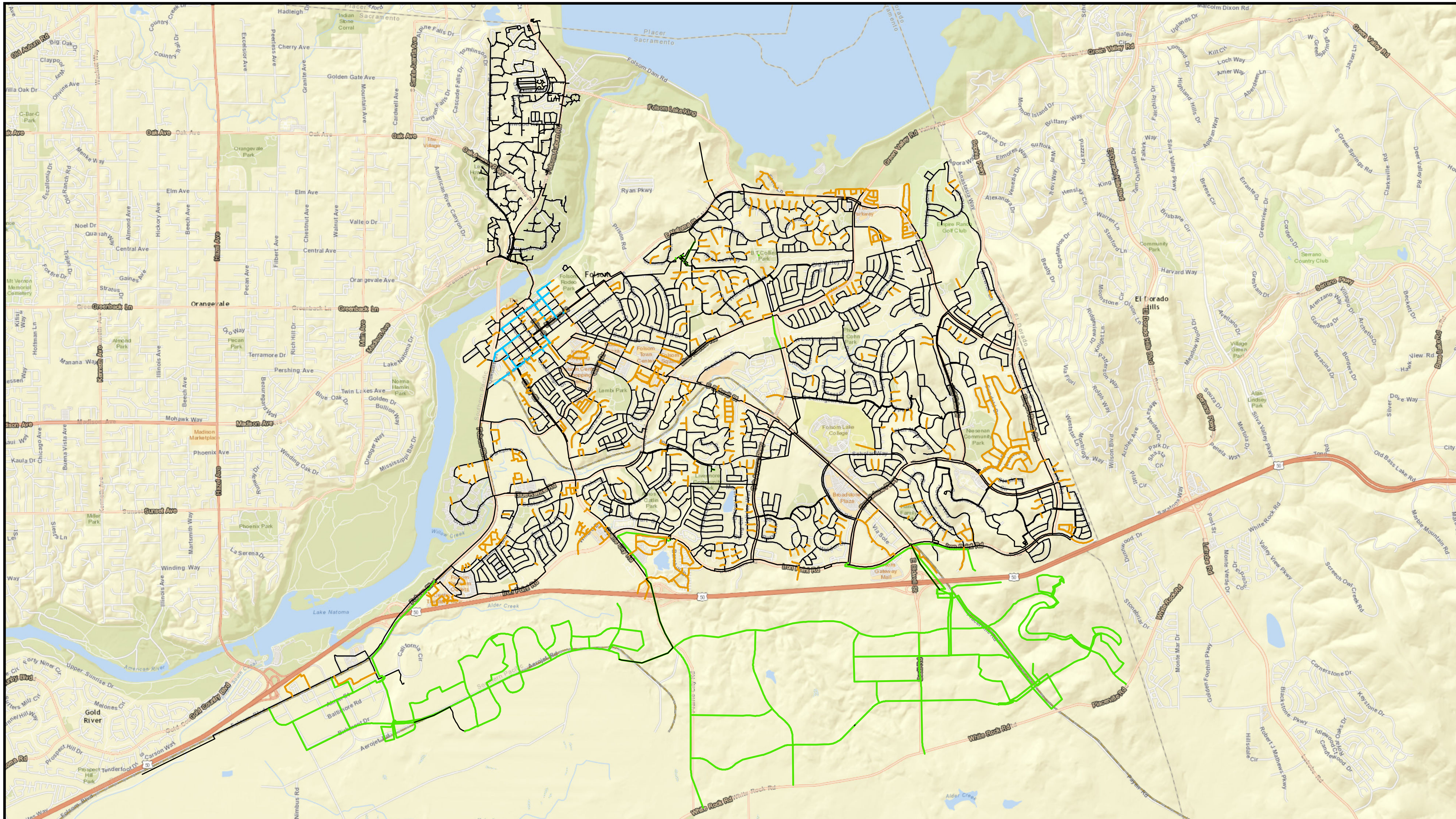
Figure 4-1 below summarizes where pipes were added or modified in the hydraulic model. It also indicates which pipes are planned for future development scenarios and added by Brown & Caldwell in previous updates.

Nodes

Updating nodes in the model included importing new junctions for new pipe intersections. Elevations for the new nodes were assigned based on an interpolation of existing node elevations as discussed in Section 4.4.2.

Control Settings

All system control settings for control valves, storage tanks, and booster pumps were verified with City staff and input into the model as shown in Table 4-3, Table 4-4, and Table 4-5, respectively.



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Existing | Modified | New | Planned

0 0.5 1 Miles

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Hydraulic Model Updates to Pipelines

FIGURE 4-1

Table 4-3 Control Valve Model Settings

Valve No.	Location	Main Valve Size	Bypass Valve Size	Downstream Pressure Setting	Pressure Zones	Ground Elevation	Status
1	Ashland - Folsom Bluffs	8"	4"	N/A	A1 to A1.5	330	Abandoned
2	Ashland - Folsom Ranch Apartments	3"	8"	60	A1 to A1.5	247	Open
3	Schiedegger and Willow Bend	6"	N/A	35	3 to 2	373	Closed
4	Iron Point Rd and Serpa	12"	N/A	50	5 to 4	520	Closed
5	Iorn Point Rd. and Cavit	10"	N/A	40	4 to 3	470	Closed
6	Broadstone & Clarkesville	6"	N/A	40	3 to 2	365	Closed
7	Levy Rd. and Hunter	10"	4"	60	2 to 2A	280	Open
8	Natoma & Tacana	16"	8"	55	Z3FH to Z3 C	431	Closed
9	Natoma & Blue Ravinde	12"	8"	65	Z3FH to Z3 C	407	Closed
10	Golf Links 300' N. of Arlington	10"	N/A	42	4 to 3	452	Closed
11	Rockport @ East Tanks	6"	2"	73	4 to 3.5	460	Open
12	131 Vierra Cir	10"	4"	38	2 to 1	260	Closed
13	Glen Dr. & Whiting Wy.	10"	4"	N/A	2 to 1	250	Closed
14	Ashland - 9881 Greenback Lane	8"	N/A	80	A1 to A2	208	Removed
14	Ashland - 125 Woodview Drive (New)	6"	2"	60	A1 to A2	261	Open
15	Ashland - 126 Hillswood	6"	2"	60	A1 to A2	277	Open
16	Ashland - 7007 Folsom-Auburn Road	10"	10"	41	A1 to A2	293	Open
17	Rodeo PRV @ Rodeo Grounds	8"	2"	20	2 to 1.5	305	Open
18A	Folsom Blvd. & Iron Point-1	6"	N/A	45	1 to 1A	180	Open
18B	Folsom Blvd. & Iron Point-2	3"	N/A	45	1 to 1A	180	Open
18C	Folsom Blvd. & Iron Point-3	8"	N/A	40	1 to 1A	180	On Demand
Future	Easton 1	12"	N/A	40	E1 to E1A	195	N/A
Future	Easton 2	18"	N/A	40	E2 to E1	257	N/A
Future	Easton 3	18"	N/A	40	E2 to E1	259	N/A
Future	Easton 4	8"	N/A	40	E2 to E1	256	N/A
Future	FPA3-2-1	12"	N/A	65	FPA 3-2	379	N/A
Future	FPA3-2-2	12"	N/A	65	FPA 3-2	350	N/A
Future	FPA4-3-1	12"	N/A	25	FPA 4-3	425	N/A
Future	*FPA to Zone 2 (Emergency PRV)*	*20”*	*N/A*	*40*	*FPA 2 to Z2*	*288*	*N/A*
Future	Zone 2 to FPA (Emergency PRV)	20”	N/A	40	Z2 to FPA 2	288	N/A

Table 4-4 Storage tank model settings

Storage Facility	Capacity (MG)	Zone(s) Served	Ground Elevation (ft)	Initial Water Level (ft)	Overflow Elevation (ft)
Reservoir No. 1	3	1 and 2	361	25	393[1]
Reservoir No. 2	4	3, 4, 5, and 6	361	25	393[1]
Carpenter Hill Reservoir	3	5	799	20	830
Broadstone Reservoir	4	4	698	20	730
Cimmaron Hills Reservoir	2	3	550	22	580
Foothills Reservoir#1	2.5	3	550	23	580
Foothills Reservoir #2	2.5	3	550	23	580
East Reservoir #1	3	2	453	23	480
East Reservoir #2	3	2	453	23	480
Tower Reservoir	3	2	453	25	480
South Reservoir	3	1	340	25	370
Nimbus Reservoir	1.5	1A	248	25	280
Total Existing Storage	**33.2**				
FPA3 (Future)	8	2 and 3	550	25	580
FPA4 (Future)	2	4	650	25	680
FPA5 (Future)	2.5	5 and 6	750	25	780
Total Future Storage	**12.5**				

[1]Reservoirs cannot be filled passed elevation 387 without overflowing the chlorine contact basin.

Table 4-5 Booster pump model settings

Zone	Tank	Pump (active)	Initial Status	Control (Elevation)	
Z2	East Reservoirs (Ground El 452.5')	Pump 1	Open	Closed Above	476.5
				Open Below	470.5
		Pump 2	Open	Open Below	470.5
				Closed Above	476.5
		Pump 3	Open	Open Below	470.5
				Closed Above	476.5
		Pump 4	Open	Open Below	470.5
				Closed Above	476.5
		Pump 5	Open	Open Below	470.5
				Closed Above	476.5
		Pump 6	Closed	Open Below	470.5
				Closed Above	476.5
Z3	Cimmaron (Ground El 550')	Pump 1	Open	Closed Above	575
				Open Below	571
		Pump 2	Closed	Open Below	565
				Closed Above	570
		Pump 3	Closed	Open Below	564
				Closed Above	570.5
		Pump 4	Closed	Open Below	563.5
				Closed Above	570

Con't
Table 4-5. **Booster pump model settings**

Zone	Tank	Pump (active)	Initial Status	Control (Elevation)	
Z3E	Foothills (Ground El 550')	Pump 1	Open	Closed Above	579.5
				Open Below	571
		Pump 2	Closed	Closed Above	566
				Open Below	562
		Pump 3	Closed	Open Below	563
				Closed Above	567
		Pump 4	Closed	Open Below	561
				Closed Above	565
Z3A	N/A	Pump 1	Open	Closed below 20 psi	N/A
		Pump 2	Open	Closed below 20 psi	N/A
		Pump 3	Closed	Open below 20 psi	N/A
Z4	Broadstone (Ground El 697.5')	Pump 1	Open	Open Below	712.5
				Closed Above	719.5
		Pump 2	Closed	Open Below	711.5
				Closed Above	718
		Pump 3	Closed	Open Below	710.5
				Closed Above	717.5
Z5	Carpenter (Ground 798.5')	Pump 1	Open	Open Below	818.5
				Closed Above	820.5
		Pump 2	Closed	Open Below	817.5
				Closed Above	819.5
		Pump 3	Closed	Open Below	817
				Closed Above	818.5
Z6	N/A	Pump 1	Closed	Open below 35 psi	N/A
		Pump 2	Closed	Open below 35 psi	N/A
		Pump 3	Open	Closed below 35 psi	N/A
		Pump 4	Open	Closed below 35 psi	N/A

4.5 Demand Allocation

There were two methods used for demand allocation updates in the hydraulic model:

- Demand allocation by land use type
- Demand allocation for large industrial users

This section discusses the procedures followed for assigning water demands within the hydraulic model.

4.5.1 *Demand Allocation by Land Use Type*

The general method of allocating water demand in the model is to identify land use types that surround each of the model nodes and apply unit demand factors (per acre) to each land use type. There are six land use categories defined within the model: (1) commercial/industrial, (2) single family, (3) multi- family, (4) municipal, (5) parks, and (6) schools. GIS shapefiles of existing and future land uses within the study area are uploaded into the hydraulic model. Each model node is assigned an area-weighted demand based on spatial distribution of land use types contained within a corresponding Thiessen polygon (Figure 4-2). Thiessen polygons are created through a GIS function that identifies the area that is closest to each node relative to all other nodes.

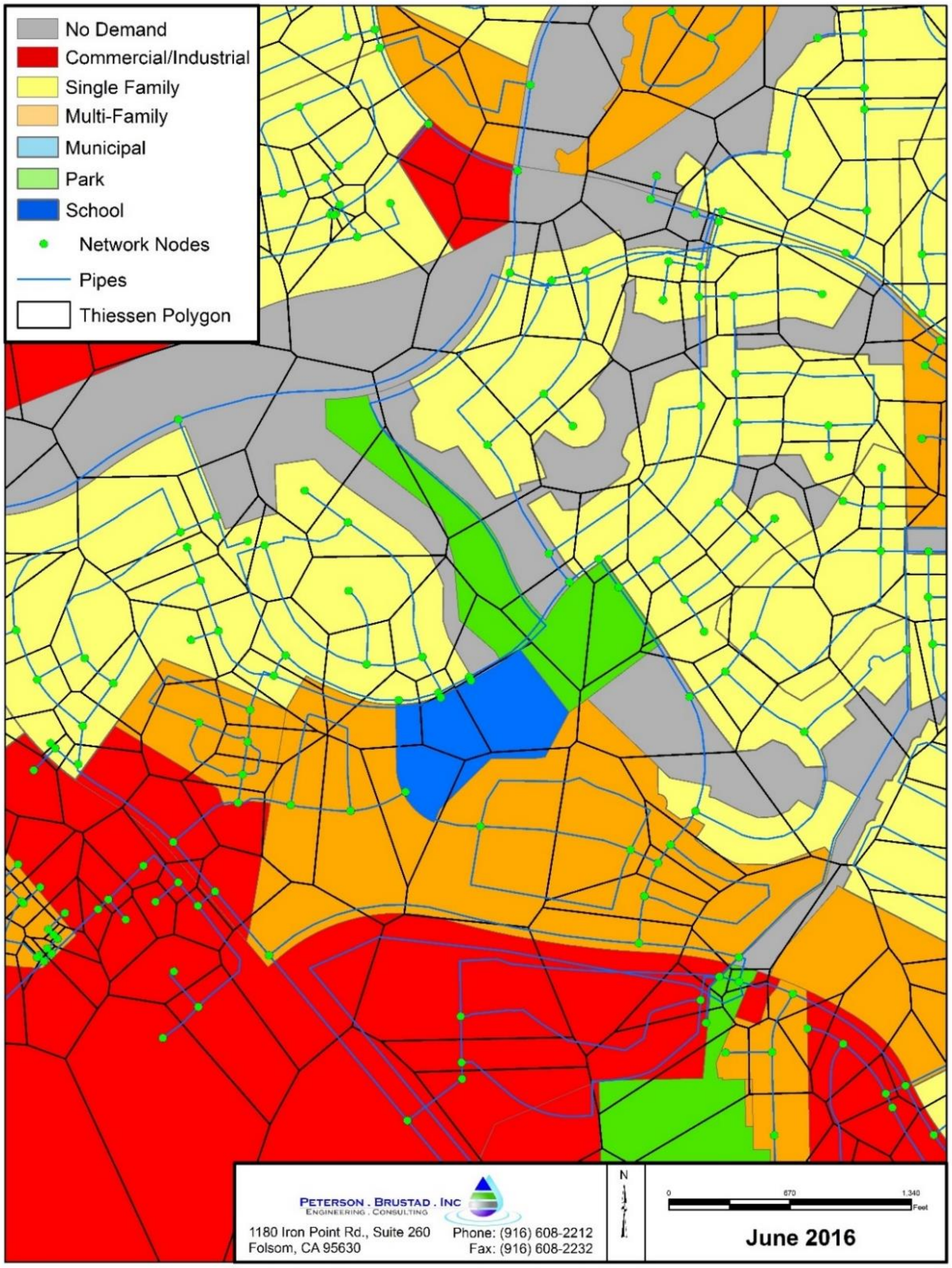


Figure 4-2 Thiessen polygons used for demand allocation in the hydraulic model

Demands associated with each node were then multiplied by the appropriate peaking factor to achieve maximum day and peak hour conditions. Additional detail on demand allocation by land use type is provided in *Chapter 3.0: Water Demand*.

4.5.2 *Demand Allocation for Large Industrial Users*

The City has four large industrial water consumers: Aerojet, Gekkiekan, Kikkoman, and Intel. Demands for these industrial consumers are allocated individually in the model. The City's meter records from 2013 were used in assigning demands in the existing model. Projected demands for these consumers were used for intermediate and built-out model scenarios and are consistent with the City's *2015 Urban Water Management Plan*. Aerojet demands were assigned over two nodes while all other demands were assigned on the single consumer node. Additional detail on demand allocation for large industrial users is provided in *Chapter 3.0: Water Demand*.

4.6 Model Verification

WYA completed a model verification process as part of the *2008 WMP*. In August 2005, a data collection program was implemented to obtain system pressure information at key locations throughout the City's pressure zones. Thirteen (13) Hydrant pressure recorders (HPRs) were used to collect pressure data at 36 locations throughout the distribution system over a 3-week period. The City's water distribution system model was verified by comparing the model results to the time-series data collected in the field.

At the conclusion of the verification process, the hydraulic model appeared to be within +/- 5 p.s.i. of the field-measured pressures and was determined to be acceptable for use in performing a distribution system analysis.

In addition, according to the *2014 FPA Water System Master Plan*, the hydraulic model was updated and operationally calibrated in May 2010 based on 2009 maximum day supervisory control and data acquisition (SCADA) data and operational set points.

Since the development of the *2008 WMP* hydraulic model, only 55 miles out of approximately 280 miles of pipe in the City's existing system were added or modified in the model. The *2008 WMP* hydraulic model verification was therefore considered valid.

The updated hydraulic model setup was then confirmed with historic fireflow field tests provided by the City. The field tests used have been performed within the last five (5) years to accurately represent the current state of the distribution system.

The updated hydraulic model is suitable for informing planning-level recommendations. Any system improvements should be further analyzed and refined through the pre-design process to determine exact improvement locations and required system modifications.

5.0 System Analysis

The purpose of this chapter is to describe the evaluation of the existing and buildout systems and provide recommendations for improvement projects. This evaluation includes evaluation of the results from the previously performed analyses that were presented in the *2008 WMP*. The updated distribution system hydraulic model was used to run simulations based on the identified system criteria to determine if the existing and proposed infrastructure is adequate.

5.1 System Evaluation Criteria

The *2008 WMP* established the system evaluation criteria that are still used by the City. A revised requirement of peak-hour pressure for new development was added to the criteria. The criteria shown below were used to evaluate overall system performance in the hydraulic simulations.

Table 5-1. System Evaluation Criteria

Maximum-Day Demand Plus Fire Flow[1]			
Maximum Pipe Velocity	10.0 fps		
Desirable Pipe Velocity[3]	3.0 to 7.0 fps		
Pressure	20 psi in the pipelines in the vicinity of a fire; 40 psi without a fire[1]		
Peak-Hour Demand			
Maximum Pipe Velocity[1]	7.0 fps		
Pressure[2]	30 psi or greater (existing service area); 40 psi or greater (new development)[1,2]		
Required Fire Flow[2]			
Land Use Type	Required Fire Flow (gpm)	Duration (hrs)	Volume (MG)
Single Family Residential	1,500	2	0.18
Multi-Family Residential	2,500	2	0.30
Commercial/Industrial	3,000	3	0.54
Schools	4,000	4	0.96

[1]Minimum pressure (without fire) requirements must be met when storage levels are at 30 percent of capacity, per City of Folsom.
[2]Per Waterworks standards Section 64602 (b) Each new distribution system that expands the existing system service connections by more than 20 percent or that may otherwise adversely affect the distribution system pressure shall be designed to provide a minimum operating pressure throughout the new distribution system of not less than 40 psi at all times excluding fire flow.
[3]City staff desires maximum pipeline velocities around 3 fps during maximum day conditions.

5.1.1 *Distribution System Analysis Scenarios*

Maximum day demand, peak hour demand, and maximum day plus fire flow scenarios were incorporated into the model for the analysis. As discussed in Chapter 3, peak hour demand produces the largest demand for this system and will govern in sizing infrastructure for buildout conditions. These scenarios assume that all storage facilities were in service and that the water treatment plant is operating.

Maximum Day Demand

The maximum day demand scenario was simulated for existing and buildout systems to evaluate the supply facilities, pump station capacities, and distribution system performance.

Peak Hour Demand

Peak hour demand conditions are met by the combined flows from the system's water production facilities and storage reservoirs. A peak hour flow condition was simulated for both the existing and buildout systems to evaluate the distribution facilities' capabilities and level of service provided.

Maximum Day Plus Fire Flow

To evaluate the system under a maximum day plus fire flow condition, the "Fireflow" analysis option in InfoWater was used which looks at each node in the model individually and assesses how much flow is available during a maximum day demand scenario when the node's pressure is set to 20 psi. The purpose of this simulation was to confirm the recommended fire flow improvements and verify that the fire flow standards are met in the proposed development areas.

5.1.2 *Treated Water Storage and Pump Capacity Criteria*

There are three main purposes for storage facilities in a water system: operational storage; emergency storage; and fire protection storage. Each pressure zone in the system was analyzed individually for required storage to meet the three purposes.

For pressure zones without firm pumping capacity, the following criteria was used for determining adequate system storage:

1. Operational Storage equal to 25 percent of maximum day demand
2. Emergency Storage equal to 75 percent of maximum day demand
3. Fire Flow Storage based on the volume of the largest fire flow requirement in the pressure zone if it were to be maintained for 4 hours

The combined volume of each of these criteria is equal to one maximum day demand plus the required fire flow volume. The largest fire flow requirement is a 4,000 gpm flow for schools (see Table 5-1) that would be needed for a 4-hour period; this equates to just under 1 million gallons.

The criteria in the *2008 WMP* identified that the booster pumping facilities should be able to supply the maximum day demand within all dependent pressure zones over a 24-hour period assuming that there is sufficient treated water storage within the pressure zone to meet operational, emergency, and fire flow criteria. Although the total required storage is equal to one maximum day plus fire flow storage, the storage volume requirement for an individual zone can additionally be supplemented by providing reliable firm pumping capacity. Reliable firm pumping capacity is defined as the booster pump station capacity with the largest pump out of service and with sufficient back-up power to operate the pump station. The criteria for storage within an individual zone that has a booster pump station with a reliable firm capacity equal to or greater than max-day demand is as follows:

1. Operational storage equal to 25 percent of maximum day demand
2. Emergency Storage equal to 25 percent maximum day demand
3. Fire Flow Storage based on the volume of the largest fire flow requirement in the pressure zone if it were to be maintained for 4 hours

The maximum day water demands for each pressure zone are summarized in Table 5-2 for the existing and buildout systems. A comparison is made to the demands that were used in the *2008 WMP.* This table compares the Buildout conditions include demands for the Easton project and for the FPA.

Table 5-2. Existing and Buildout Demands by Pressure Zone

	2008 WMP				2015 UWMP			
Zone	Existing Average Day Demand (MGD)	Existing Maximum Day Demand (MGD)	Buildout Average Day Demand (MGD)	Buildout Maximum Day Demand (MGD)	Existing Average Day Demand (MGD)	Existing Maximum Day Demand (MGD)	Buildout Average Day Demand (MGD)	Buildout Maximum Day Demand (MGD)
1	3.6	6.9	4.3	8.1	3.3	5.5	3.1	5.2
1A					0.7	1.2	0.5	0.9
Easton 1A						-	0.4	0.7
Easton 1	-	-	-	-		-	0.7	1.2
2	8.6	16.4	9.7	18.4	7.8	13.2	8.1	13.8
Easton 2	-	-	-	-		-	1.0	1.7
3	3.3	6.2	3.7	7.1	2.0	3.5	2.6	4.3
3 - Cimamaron	1.6	3.1	1.7	3.3	1.6	2.7	1.8	3.0
4	1.9	3.6	2.0	3.8	1.1	1.9	1.5	2.5
5	0.8	1.5	0.9	1.7	0.5	0.8	0.6	1.1
6	0.3	0.6	0.3	0.7	0.2	0.3	0.4	0.6
FPA 2	-	-	-	-		-	1.6	2.8
FPA 3	-	-	-	-		-	1.9	3.3
FPA 4	-	-	-	-		-	0.6	1.0
FPA 5	-	-	-	-		-	0.4	0.7
FPA 6	-	-	-	-		-	0.2	0.4
Total	**20.2**	**38.3**	**22.7**	**43.2**	**17.1**	**29.1**	**25.3**	**43.1**

5.2 Storage and Pumping Capacity Analysis

The existing pressure zones in the system were analyzed individually while taking into account the available reliable firm pumping capacity. The required storage for each zone along with existing pumping capacities are shown in Table 5-3. All pump stations are assumed to be equipped with a reliable source of backup power by the buildout year. An additional 1.5 MG of storage is required to be located within the current Zone 1 service area in order to accommodate new developments in the Easton area. This additional storage can be accommodated at the existing South Reservoir site. There is also additional storage that is required and incorporated as part of the FPA development that is included in the storage analysis below.

Table 5-3. Minimum Storage and Pumping Requirements by Pressure Zone

			Minimum Zonal Storage Requirements, MG				
Pressure Zone	Required Capacity (GPM)[5]	Existing Firm Capacity (GPM)[2]	Emergency/ Operational Storage[3]	Fire Flow	Total Required	Existing Storage	Storage Needed
Existing							
Z1	**-**	**-**	**5.5**	**0.96**	**6.5**	**5.4**	**1.1**
Z1A	**-**	**-**	**1.2**	**0.54**	**1.7**	**1.5**	**-**
Z2	**9,173**	**18,000**	**6.6**	**0.96**	**7.6**	**9**	**-**
Z3/Z3-Cimm Combined[4]	**6,353**	**15,530**	**3.1**	**0.96**	**4.0**	**8.3**	**-**
Z4[4]	**2,086**	**4,800**	**0.9**	**0.96**	**1.9**	**4**	**-**
Z5[4]	**799**	**1,100**	**0.4**	**0.96**	**1.4**	**3**	**-**
Z6	**227**	**3,500**	**0.2**	**0.54**	**0.7**	*****	**-**
Buildout							
1	-	-	5.2	-	-	-	-
Easton 1	815	850	0.6	-	-	-	-
1A	-	-	0.9	-	-	-	-
Easton 1A	459	-	0.7	-	-	-	-
Z1/1A Combined	**459**	**-**	**7.3**	**0.96**	**8.3**	**6.9**	**1.4**
2	9,585	18,000	6.9	-	-	-	-
Easton 2	1,148	-	0.8	-	-	-	-
Z2 Combined	**9,585**	**18,000**	**7.7**	**0.96**	**8.7**	**9**	**-**
Z3/Z3-Cimm Combined[4]	**7,984**	**15,530**	**3.7**	**0.96**	**4.6**	**8.3**	**-**
Z4[4]	**2,898**	**4,800**	**1.2**	**0.96**	**2.2**	**4**	**-**
Z5[4]	**1,169**	**1,100**	**0.5**	**0.96**	**1.5**	**3**	**-**
Z6	**423**	**3,500**	**0.3**	**0.54**	**0.8**	**3**	**-**
FPA 3[1]	**4,201**	**6,100[6]**	**3.0**	**0.96**	**4.0**	**-**	**4.0**
FPA 4	**745**	**800[6]**	**0.5**	**0.96**	**1.5**	**-**	**1.5**
FPA 5	**807**	**900[6]**	**0.4**	**0.96**	**1.3**	**-**	**1.3**
FPA 6	**295**	**500[6]**	**0.2**	**0.96**	**1.2**	**-**	*****

[1]FPA Zone 2 included with Zone 3; [2]See Table 2-5; [3]Volume = 1.0 maximum day for gravity zones or 0.5 maximum day for pumped zones with reliable capacity; [4]Required capacity includes capacity pumped to higher zones; [5]Required Capacity = maximum day demand; [6]Proposed pumping capacities; *Storage is pumped from adjacent zone

The *2008 WMP* identified that 7 MG of storage should be added at the water treatment plant as well as 3 MG added in Zone 2 to meet the system storage criteria. The 2008 analysis was based on higher unit demand factors resulting in a buildout demand approximately 20 percent greater than identified in the 2015 UWMP.

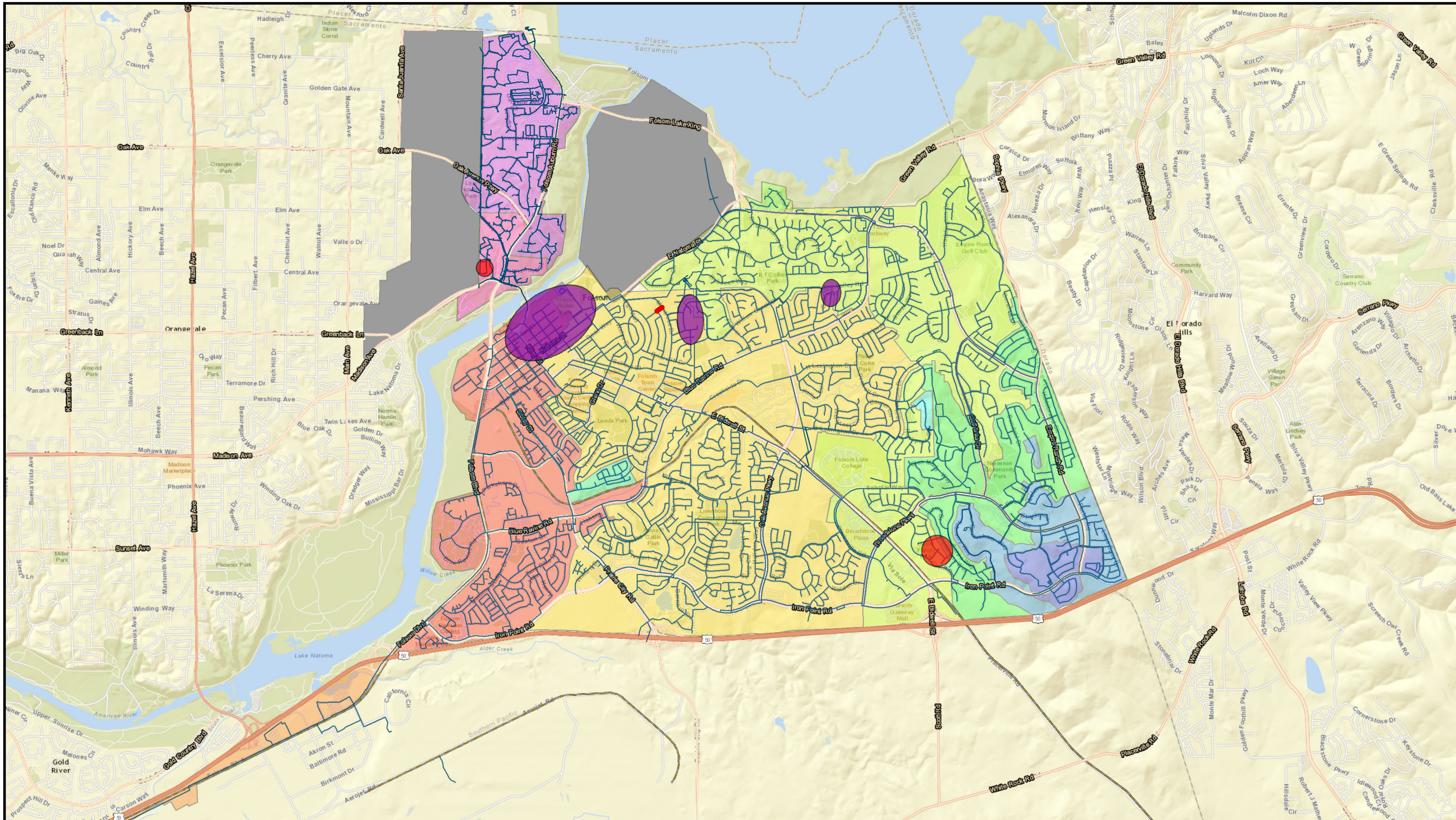
The *July 2014 B&C Report* recommended 4 MG of additional storage in Zone 2 and 3 MG of additional storage in Zone 1 to accommodate the ultimate Easton development. These recommendations were reevaluated using updated demand data and it was determined that only 1.5 MG additional storage is needed in Zone 1 to accommodate the ultimate Easton Development.

To accommodate the interim development of the FPA, the *2014 FPA WMP* recommends a shared capacity in Zone 3 prior to the installation of the new FPA BPS at the WTP. The capacity of the new BPS at the WTP to serve the FPA development has only been analyzed at a planning level and will need to be determined in a pre-design process under a separate contract.

The only additional storage needed will be to serve the FPA and Easton developments therefore the development will be required to provide funding for new storage. Due to the reduction in buildout demand, the additional storage identified in the *2008 WMP* is no longer necessary. This will save the City approximately $10 million in capital improvement costs.

5.3 Distribution System Analysis

An analysis was performed for existing and buildout conditions of the City's distribution system utilizing the hydraulic model. The analysis was performed using the system evaluation criteria described in Section 5.1. Areas of low domestic pressures, high pipe velocities, and low fire flow capabilities were identified within the existing system and are summarized in Figure 5-1 and are discussed in this section.



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Z1	ZA2	Z3A-BP	Z6	Low Pressure Area
Z1A	Z2A-PRV	Z4	Pipes	Fire Flow Deficiency Area
ZA1	Z2B-PRV	Z4A-PRV	High Velocity Flow	
Z2	Z3	Z5		

0 0.5 1 Miles

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Water System Deficiencies Based on Hydraulic Analysis

FIGURE 5-1

5.3.1 *Low Domestic Pressures*

Areas of low domestic pressure were found in the maximum day and peak hour simulations. Low pressures are commonly correlated with relatively high pad elevations for the zone or other head losses in the distribution system. The service elevation range for each pressure zone is presented in Table 5-4 below.

Table 5-4. Pressure zone service elevation range

Zone	Service Elevation Range, NAVD88 FT
Nimbus	Up to 180
1	Up to 280
2	280 to 380
3	341 to 466
4	466 to 616
5	591 to 716
6	716 to 790

Areas of the distributions system experienced low pressures during maximum day and peak hour conditions include Listowe Drive in Zone 3 and is described below.

<u>Zone 3 – Listowe Drive</u>

Listowe Drive is also located in an area of Zone 3 that is in the upper end of the service elevation range system experiences low pressures. The results of the hydraulic model indicate that the pressures are just below the minimum criteria at the upper end of the development and just above the minimum criteria in the rest of Listowe Drive. No improvement projects are recommended at this time as this pressure issue is due to high pad elevation for the zone.

5.3.2 *High Pipe Velocities*

The peak hour demand conditions resulted in one location of velocity exceeding 7 feet per second on Alezan Drive in Zone 2. This is a small segment (275 feet), small diameter (6-inch) pipe that reaches 8.5 feet per second at peak hour demand. There are no recommended improvements at this time as the velocity was not a concern when modeled at buildout conditions which include the recommended improvements in this vicinity as discussed in Section 5.4.

5.3.3 *Low Fire Flow Capabilities*

After running the maximum day demand plus fire flow simulation, there are several areas that were determined could not meet the minimum required fire flow based on land uses as described in Table 5-1. Appendix A provides a detailed fire flow report from this simulation which includes the available fire flow at each junction and the required fire flow for land use at that junction.

For the purposes of identifying the most critical locations with low fire flow capabilities, areas that did not meet the minimum fire flow requirement (1,500 gpm) are identified in Figure 5-1. These critical areas include downtown Folsom, Blanche Sprentz School, and Rambling drive. The recommended improvements for these areas are discussed in Section 5.4.

A few other single-family residential areas were found to be just below the minimum fire flow requirements due to small diameter, dead end pipes. There are no recommended improvements for these areas.

All planned areas were assessed and meet all fire flow required by land use type.

5.3.4 *Deteriorating Infrastructure*

Downtown Folsom includes some of the oldest infrastructure in the distribution system as well as small diameter pipes. The *2008 WMP* recommended replacing infrastructure that is small diameter, cast iron, or was installed in the 1930's and 1940's that are still in service as an asset management procedure which is predominately in Downtown Folsom. Several pipes do not have age or material identified and will need to be addressed as they are exposed in the field. A number of these infrastructure replacements have not yet been completed. These infrastructure replacements are still recommended and are detailed in the Capital Improvement Plan (CIP) presented in Chapter 6.0.

All recommended improvements have been incorporated into the buildout scenario of the hydraulic model.

5.4 Recommended Capital Improvement Projects

The recommended projects are divided into the two following categories:

- High Priority Projects
- Infrastructure Replacement Projects
- Annual Infrastructure Programs

The proposed implementation schedule, based on the project priority, and estimated costs of the projects are presented in Chapter 6.0. Specific infrastructure that will be needed to serve the South of Highway 50 developments are not included in the list of recommended improvements.

5.4.1 *High Priority Improvement Projects*

The high priority improvements are improvements correlated to system reliability and safety of water users. These priorities include:

- Zone 1 Fire Flow Improvements
- Zone 2 Fire Flow Improvements
- Zone 2 Transmission Main

Zone 1 Fire Flow Improvements

The improvement projects as recommended by the *2008 WMP* are presented in Table 5-6 below. Some of the projects have been constructed since 2008 and are in place. The completed projects were incorporated into the updated water distribution system model. The improvements that have not been completed were verified through the system evaluation as still being necessary and remain as recommended improvements.

Table 5-5. Recommended Zone 1 Fire Flow Improvement Projects

Description	Existing Diameter, inches	Recommended Diameter, inches	Length, lineal feet
Downtown			
Construct 8-inch on Leidesdorff Street from end of Leidesdorff pipeline to end of 8-inch near North Granite Way	N/A	8	1,450
Intertie – 24-inch and 8-inch at Scott Street and Natoma Street	N/A	8	N/A
Intertie – 24-inch and 8-inch at Coloma Street and Natoma Street	N/A	8	N/A

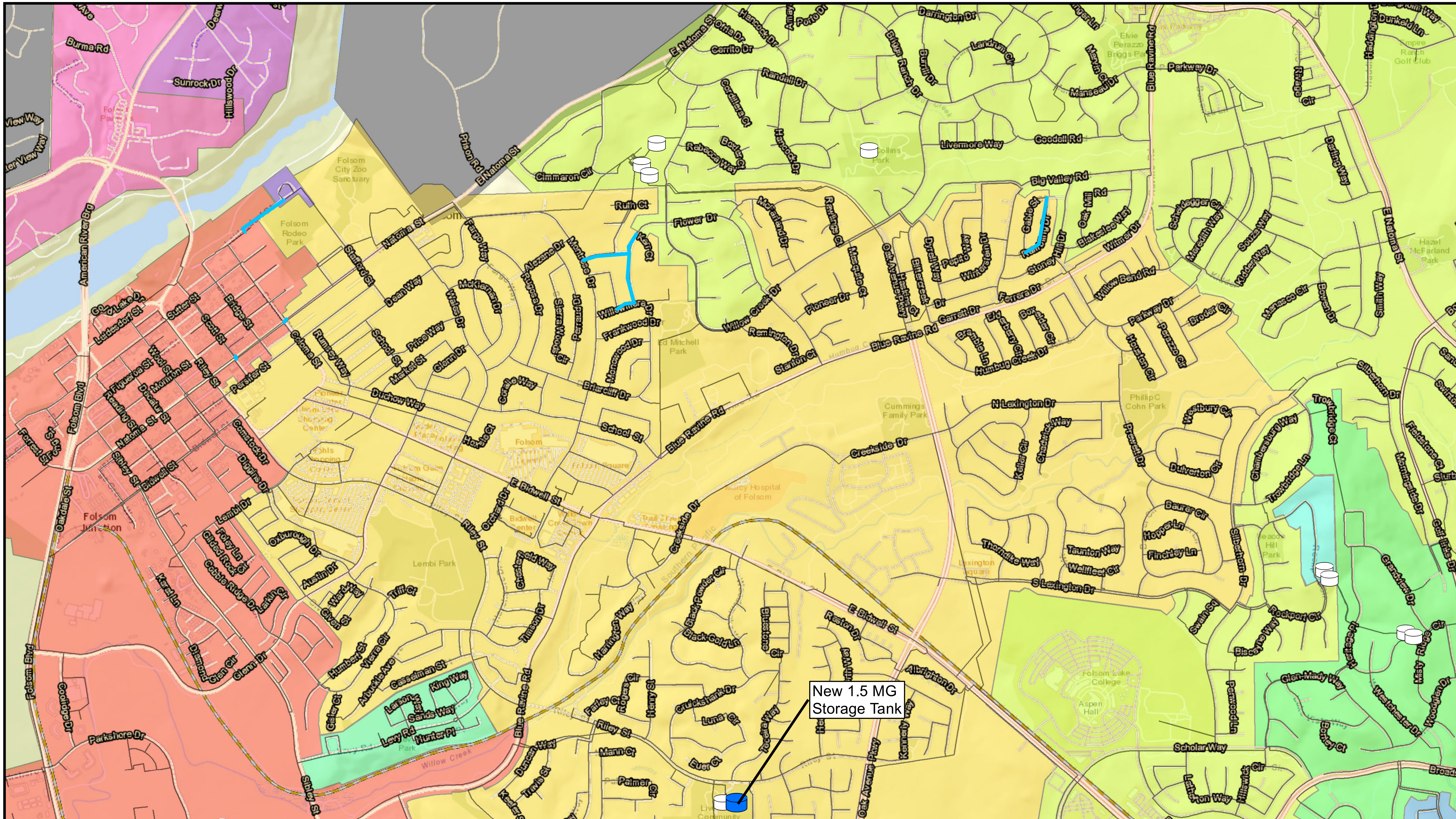
Zone 2 Fire Flow Improvements

The fire flow improvements recommended for Zone 2 by the *2008 WMP* have not yet been completed. These improvements were verified through the system evaluation using the updated water distribution system model and remain as recommended improvements. The recommended improvement for Flower Drive also resolves the nearby velocity issue in the short segment of pipe on Alezane Drive.

Table 5-6. Recommended Zone 2 Fire Flow Improvement Projects

Description	Existing Diameter, inches	Recommended Diameter, inches	Length, lineal feet
Flower Drive/Blanch Sprentz School			
Replace 6-inch with 12-inch on Flower Drive	6	12	1,300
Rambling Drive			
Replace 3-inch with 8-inch on Rambling Drive	3	8	1,300

Figure 5-2 below summarizes the high priority improvement projects.



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Z1	Z2A-PRV	High Priority Improvements
ZA1	Z2B-PRV	Existing Pipes
Z2	Z3	Storage Tank
ZA2	Z4	

0 0.25 0.5 Miles

CITY OF FOLSOM

High Priority Improvement Projects

FIGURE

5-2

5.4.2 *Infrastructure Replacement Projects*

The proposed improvements are broken into several phases based on the pipe type and age. The five phases are:

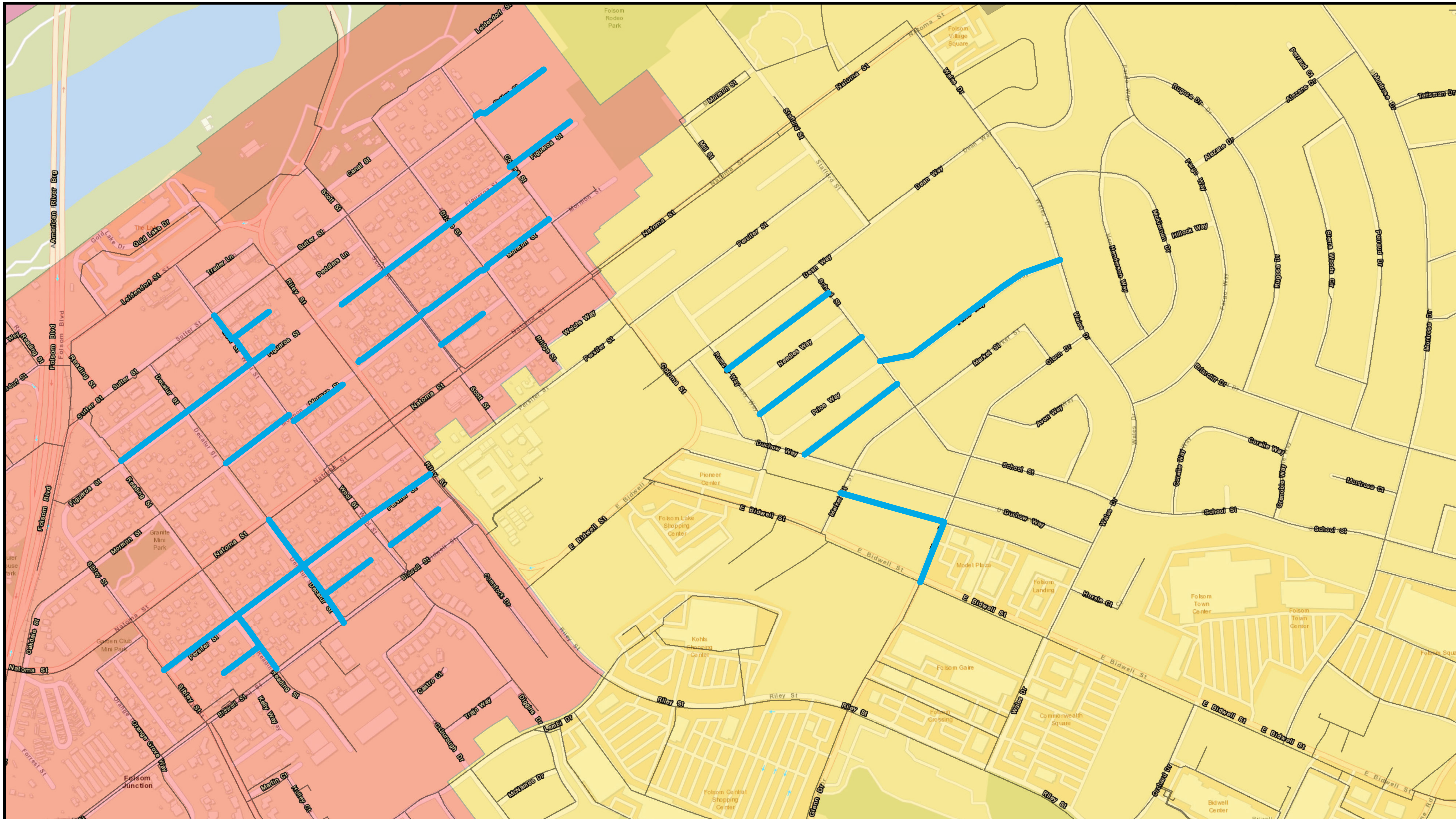
- Phase I – Replace old 4-inch cast iron mains
- Phase II – Replace old 6-inch cast iron mains
- Phase III – Replace old 6-inch mains of unknown pipe type
- Phase IV – Replace remaining 3-inch and 4-inch mains

Table 5-7 and Figure 5-3 present the recommended improvements.

Table 5-7. Infrastructure Replacement Projects

Description	Existing Diameter, inches	Recommended Diameter, inches	Length, lineal feet
Phase I – Total length = 1,550 lineal feet			
Alley between Figueroa St. and Scott St. east of Wool St.	4	8	300
Mormon St. from Wool St. to Riley St.	4	8	450
Reading St. from Bidwell St. to Persifer St.	4	8	400
Wool St. from Bidwell St. to Persifer St.	4	8	400
Phase II – Total Length = 2,200 lineal feet			
Persifer St. from Reading St. to Riley St.	6	8	1,400
Wool St. from Sutter St. to Figueroa St. and Natoma St. to Persifer St.	6	8	800
Phase III – Total Length = 5,100 lineal feet			
Figueroa St. from Oakdale St. to Coloma St.	6	8	3,200
Mormon St. from Decatur St. to Wool St. and Riley St. to Coloma St.	6	8	1,900

Table 5-7 Continued…			
Description	**Existing Diameter, inches**	**Recommended Diameter, inches**	**Length, lineal feet**
Phase V – Total Length = 8,700 lineal feet			
Sutter St. northeast of Coloma St.	3	6 or 8	450
Figueroa St. northeast of Coloma St.	3	6 or 8	400
Alley between Persifer St. and Bidwell St. northeast of Sibley St.	4	6 or 8	300
Alley between Persifer St. and Bidwell St. southwest of Reading St.	2	6 or 8	300
Alley between Persifer St. and Bidwell St. northeast of Decatur St.	3	6 or 8	350
Alley between Persifer St. and Bidwell St. northeast of Wool St.	3	6 or 8	350
Alley between Mormon St. and Natoma St. northeast of Scott St.	4	8	350
Alley between Needles Way and Dean St.	4	6 or 8	700
Alley between Needles Way and Price Way	4	8	700
Price Way from School St. to Wales Dr.	4	8	1,300
Alley between Price Way and Market St. from Duchow Way to School St.	4	8	700
Alley between East Bidwell St. and Duchow Way from Market St. to Glenn Dr.	4	8	600
Glenn Drive southwest of Duchow Way	4	8	200



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N

Z1	Z2A-PRV
ZA1	Z2B-PRV
Z2	Z3
ZA2	Z4

Recommended Improvements

Existing Pipes

0 1,500 Feet

CITY OF FOLSOM

Recommended Infrastructure Replacement Projects

FIGURE 5-3

5.4.3 *Annual Infrastructure Programs*

The City has adopted an annual leak detection program to find and fix identified system leaks. In accordance with the 2015 UWMP, the City plans to diminish system losses due to leaks to 5% by 2020. This program has an annual budget of $200,000 per year.

5.5 Adapted Improvements for Future Developments

As discussed in Section 2, B&C developed three reports which provided recommendations for improvements to the existing system to accommodate future FPA and Easton developments. These recommended improvements were reevaluated as part of this analysis. This section discusses any recommended deviations to existing system improvements from the previous reports as a result of this analysis. All other improvements previously recommended remain the same. The capital improvement program does not include any of these recommended improvements as they will be funded by the future developments.

5.5.1 *Zone 1 and Zone 2 Storage*

As discussed in Section 5.2, the *July 2014 B&C Report* recommended 3 MG of additional storage in Zone 2 and 4 MG of additional storage in Zone 1 to accommodate the ultimate Easton development. The recommendations for the Zone 2 reservoir included a booster pump and supply pipeline from the new reservoir location identified adjacent to the Lifetime Fitness Facility. These recommendations were reevaluated using updated demand data and the same analysis outlined in the *2008 WMP*. It was determined that only 1.5 MG additional storage is needed in Zone 1 to accommodate the ultimate Easton Development. The additional Zone 1 storage can be added adjacent to the existing South Reservoir. It was also determined that no additional storage is required in Zone 2 and that the location identified in the *July 2014 B&C Report* would not be the appropriate HGL for a new reservoir in Zone 2.

5.5.2 *Zone 2 Velocity Improvements*

The *July 2014 B&C Report* recommended 4,900 LF of 18-inch distribution main from Iron Point Road to Prairie City to address velocity concerns with the addition of the Easton Project at peak hour conditions. The updated model did not result in any velocity concerns for peak hour conditions in the area likely due to the reduced demands identified in the City's *2015 UWMP*. No improvements are recommended in this area at this time.

5.5.3 *Zone 2 Tower Reservoir Supply Pipeline*

Analyses in the City's previous master planning efforts showed that the Tower Reservoir has an inability to empty during peak demand periods. The Zone 2 booster pump station is operated based on the East Reservoir's tank levels. Tower Reservoir is located closer to the pump station and due to hydraulic limitations between Tower and East reservoirs, the hydraulic grade line at Tower is significantly greater than that of the East Reservoirs during peak demand periods, which creates an issue for reservoir turn over. The *2008 WMP* recommended a large diameter transmission main to be installed from the existing 24" at Blue Ravine Road to the intersection of Willow Creek Drive and Oak Avenue Parkway. The *July 2014 B&C Report* recommended two alternatives: (A) 10,000 linear feet of 24" transmission main installed from South Lexington to Tower Reservoir or (B) install a 16" transmission main from the 16" transmission main in the west area of Zone 2 to Tower Reservoir. For either alternative, the existing Tower fill pipeline would be replaced so an emergency valve can be installed that would be normally closed.

After modeling this analysis, it was determined that alternative A from the 2014 evaluation with a minor modification would be the recommended approach. A new 24-inch pipeline from the existing Tower Reservoir tied into the existing 24-inch pipeline at the intersection of Willow Creek Drive and Oak Avenue Parkway will mitigate head loss between the Tower Reservoir and the East Reservoirs. An additional 24" tie in is recommended to connect the new transmission main to the existing Tower fill pipeline connection. The reduction in head loss allows the hydraulic grade line at Tower Reservoir to more closely mimic that of the East Reservoirs and allow for acceptable tank turnover.

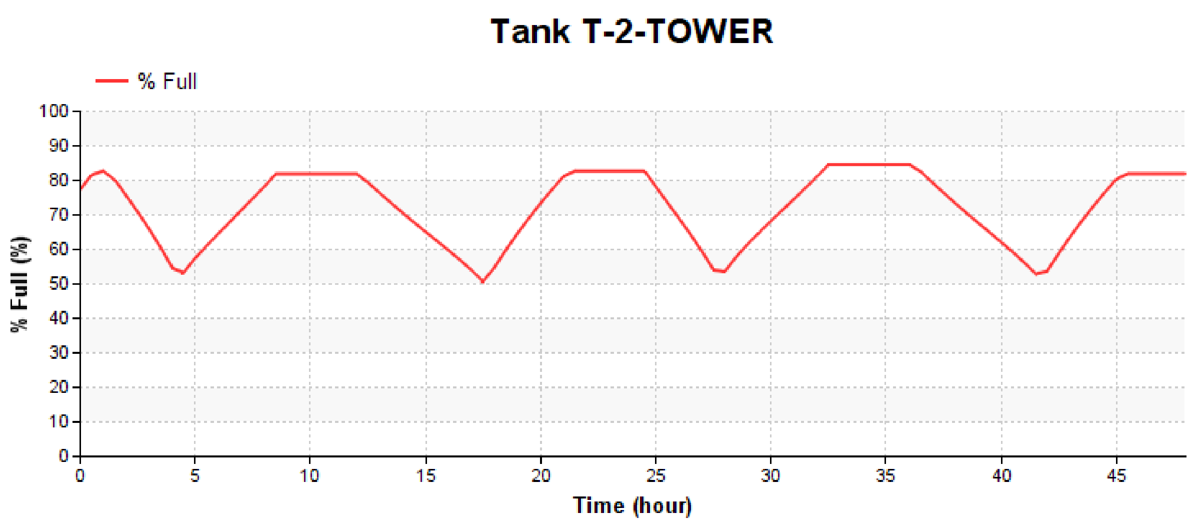

Figure 5-4 Tower Reservoir Existing System

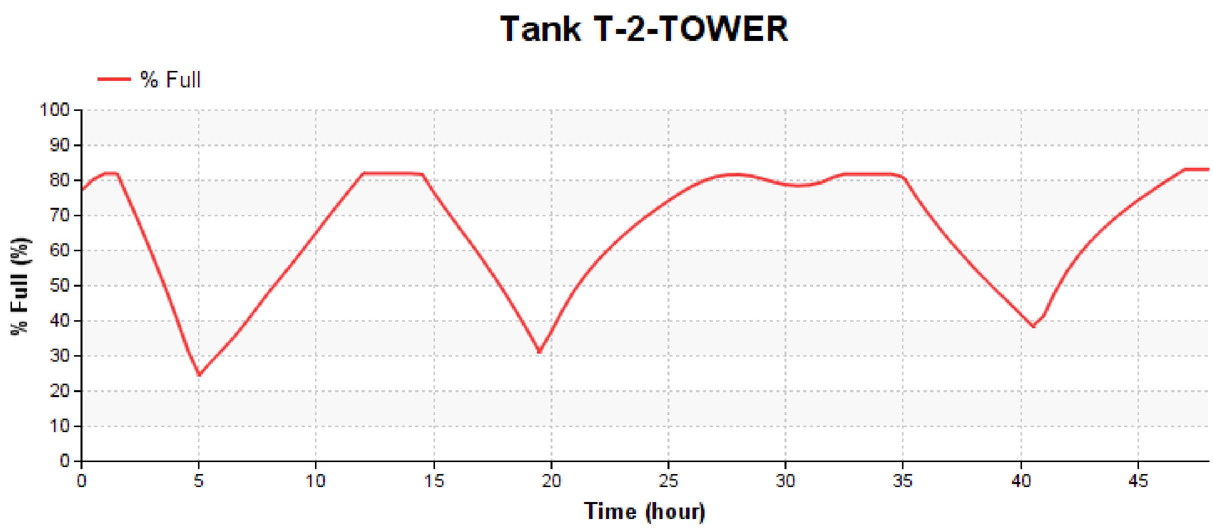

Figure 5-5 Tower Reservoir with Recommended Improvements

5.5.4 *Zone 2 and FPA Zone 2 Emergency PRV*

The *2014 FPA WMP* recommended a two-way emergency PRV between FPA Zone 2 and Glenborough Zone 2 to allow water to move in either direction as necessary during emergencies. The configuration of the PRV station will have two separate PRVs to accommodate flow in each direction. The PRVs will be approximately at elevation 288 both with a setting at 40 psi. This PRV station is intended for emergency only and will be an alternate source for FPA Zone 2 and Glenborough Zone 2.

The primary source for FPA Zone 2 is gravity fed from two PRVs connected to FPA Zone 3 which has a higher HGL from the FPA Zone 3 tank. The primary source for Zone 2 is pumped from the Zone 2 pump station at the WTP. The HGL of this future PRV station is beneath the HGL of the FPA Zone 3 to 2 PRVs in order to maintain the FPA Zone 3 to 2 PRVs as the primary source for FPA Zone 2.

Two emergency scenarios were modeled to confirm the PRV station settings: (1) a fire flow at 20 psi at the far west side of the FPA Zone 2 and (2) a fire flow at 20 psi at the far east side of Glenborough Zone 2. The results from both scenarios confirm that this PRV station will provide an alternate source during an emergency in each zone while maintaining the primary sources for either zone during a normal model simulation.

The *2014 FPA WMP* assumed that the Glenborough piping would be installed prior to the FPA. The Glenborough developed has not yet begun construction. The phasing of this PRV station will be based upon the phasing of the Glenborough development.

6.0 RECOMMENDED CAPITAL IMPROVEMENT PROGRAM

Recommendations for a capital improvement program (CIP) were developed based on the assessment of the City water system that was described in *Chapter 5.0: System Analysis*. The following sections estimate costs and lay out a prioritized implementation schedule for the recommended improvements that were discussed in *Chapter 5.0*.

6.1 Approach

The City's *2008 WMP* included a CIP that has been partially implemented over the past 8 years. Primarily the projects that have been completed since 2008 have included upsizing of pipes in the downtown area to improve fire flows. The improvement projects from the 2008 CIP that have not been implemented were assessed and, if still warranted, included in the CIP for this *2016 WMP Update*. Discussions with City staff and review of the hydraulic model indicate the system deficiencies still exist and the previously identified improvement projects are still applicable, with the exception of the storage improvement projects that were recommended in the *2008 WMP*. The updated system evaluation indicated that there were no storage deficiencies in the existing system and that the only reservoirs that will be needed will come with the South of Highway 50 developments.

The backbone infrastructure that is specific to the south of Highway 50 planned developments is not included in this CIP as it will be the responsibility of the developers to implement.

Planning-level cost estimates are included for each of the recommended capital improvements. The *2008 WMP* estimated costs for pipeline projects at $20 per lineal foot per inch diameter, plus contingencies and allowances. This base cost was indexed up to 2016 dollars and was estimated at $23 per lineal foot per inch diameter for the purposes of this *2016 WMP Update*. The following contingencies and allowances were added to the base cost:

- 20% Estimating Contingency
- 10% Allowance for Engineering/Design Cost
- 10% Allowance for Construction Management
- 10% Allowance for Bonds/Insurance/Mobilization

The recommended projects, estimated costs, and proposed schedule were developed through a planning-level of analysis that was appropriate for this WMP update and should be re-evaluated in further detail prior to implementation.

6.2 Estimated Costs

The table on the following page categorizes the infrastructure improvements for the recommended CIP and gives planning-level costs for each project.

Table 6-1. Estimated costs for capital improvement projects

Description	Existing Diameter, inches	Recommended Diameter, inches	Length, lineal feet	Estimated Cost
ZONE 1 FIRE FLOW IMPROVEMENTS				
Construct 8-inch on Leidesdorff Street from end of 4-inch near Coloma Street to end of 8-inch near North Granite Way	N/A	8	1,450	$401,000
Intertie – 24-inch and 8-inch at Scott Street and Natoma Street[1]	N/A	8	50	$400,000
Intertie – 24-inch and 8-inch at Coloma Street and Natoma Street[1]	N/A	8	50	$400,000
Zone 1 Fire Flow Improvements Total	--	--	***1,550***	***$1,201,000***

[1]Cost of interties estimated at $400,000 each based on estimates from similar projects

Description	Existing Diameter, inches	Recommended Diameter, inches	Length, lineal feet	Estimated Cost
ZONE 2 FIRE FLOW IMPROVEMENTS				
Replace 6-inch with 12-inch on Flower Drive	6	12	1,300	$539,000
Replace 3-inch with 8-inch on Rambling Drive	6	8	1,300	$359,000
Zone 2 Fire Flow Improvements Total	--	--	***2,600***	***$898,000***
INFRASTRUCTURE REPLACEMENT PROJECTS				
Phase I – Total length = 1,550 lineal feet				
Alley between Figueroa St. and Scott St. east of Wool St.	4	8	300	$83,000
Mormon St. from Wool St. to Riley St.	4	8	450	$125,000
Reading St. from Bidwell St. to Persifer St.	4	8	400	$111,000
Wool St. from Bidwell St. to Persifer St.	4	8	400	$111,000
Phase I Total	--	--	***1,550***	***$430,000***
Phase II – Total Length = 2,200 lineal feet				
Persifer St. from Reading St. to Riley St.	6	8	1,400	$387,000
Wool St. from Sutter St. to Figueroa St. and Natoma St. to Persifer St.	6	8	800	$221,000
Phase II Total	--	--	***2,200***	***$608,000***
Phase III – Total Length = 5,100 lineal feet				
Figueroa St. from Oakdale St. to Coloma St.	6	8	3,200	$884,000
Mormon St. from Decatur St. to Wool St. and Riley St. to Coloma St.	6	8	1,900	$525,000
Phase III Total	--	--	***5,100***	***$1,409,000***
Phase IV – COMPLETE				
Phase V – Total Length = 8,700 lineal feet				
Zone 1 Projects				
Alley between Persifer St. and Bidwell St. northeast of Sibley St.	4	6 or 8	300	$83,000
Alley between Persifer St. and Bidwell St. southwest of Reading St.	2	6 or 8	300	$83,000
Alley between Persifer St. and Bidwell St. northeast of Decatur St.	3	6 or 8	350	$97,000
Alley between Persifer St. and Bidwell St. northeast of Wool St.	3	6 or 8	350	$97,000
Sutter St. northeast of Coloma St.	3	6 or 8	450	$125,000
Figueroa St. northeast of Coloma St.	3	6 or 8	400	$111,000
Alley between Mormon St. and Natoma St. northeast of Scott St.	4	8	350	$97,000
Zone 2 Projects				
Alley between Needles Way and Dean St.	4	6 or 8	700	$194,000
Alley between Needles Way and Price Way	4	8	700	$194,000
Price Way from School St. to Wales Dr.	4	8	1,300	$359,000
Alley between Price Way and Market St. from Duchow Way to School St.	4	8	700	$194,000
Duchow Way from Rumsey Way to Market St.	4	8	500	$138,000
Market St. from Duchow Way to Glenn Drive	4	8	1,500	$414,000
Alley between East Bidwell St. and Duchow Way from Market St. to Glenn Dr.	4	8	600	$166,000
Glenn Drive southwest of Duchow Way	4	8	200	$56,000
Phase V Total	--	--	***8,700***	***$2,408,000***
TOTAL COST OF CIP IMPLEMENTATION				**$6,954,000**

6.3 Implementation Schedule

The fire flow improvement projects are considered high priority projects that should be completed as soon as possible to improve fire flow delivery capabilities.

Once these few high priority projects are complete, the City can incrementally resolve the low domestic service pressure issues and replace the aging infrastructure that was identified. The City also plans to continue their annual leak detection program and will replace laterals as part of this effort.

Following these replacement programs, the City will still have an unknown quantity of 6-inch and 8-inch diameter pipes of unknown age and type in service. When these pipes are exposed during maintenance or other construction projects, the City should note the pipe type, assess the remaining useful life, and add it to the replacement program, if deemed necessary.

The following prioritization was used in developing the CIP implementation schedule:

1. Zone 1 Fire Flow Improvements
2. Zone 2 Fire Flow Improvements
3. Infrastructure Replacement Projects
    a. Phase I
    b. Phase II
    c. Phase III
    d. Phase V

A detailed implementation schedule is summarized in Table 6-2.

Table 6-2. Recommended Project Implementation Schedule

Fiscal Year	Activities			Estimated Cost
2017/18	Design:	Zone 1 Fire Flow Improvements		$120,000
	Annual Leak Detection Program			$200,000
			FY 2017/18 Total:	**$320,000**
2018/19	Design:	Zone 2 Fire Flow Improvements		$90,000
	Construct:	Zone 1 Fire Flow Improvements		$1,081,000
	Annual Leak Detection Program			$200,000
			FY 2018/19 Total:	**$1,371,000**
2019/20	Design:	Infrastructure Replacement Projects - Phase I		$43,000
	Construct:	Zone 2 Fire Flow Improvements		$808,000
	Annual Leak Detection Program			$200,000
			FY 2019/20 Total:	**$1,051,000**
2020/21	Design:	Infrastructure Replacement Projects - Phase II		$61,000
	Construct:	Infrastructure Replacement Projects - Phase I		$387,000
	Annual Leak Detection Program			$200,000
			FY 2020/21 Total:	**$648,000**
2021/22	Design:	Infrastructure Replacement Projects - Phase III		$141,000
	Construct:	Infrastructure Replacement Projects - Phase II		$547,000
	Annual Leak Detection Program			$200,000
			FY 2021/22 Total:	**$888,000**
2022/23	Design:	Infrastructure Replacement Projects - Phase V (Zone 1)		$69,000
	Construct:	Infrastructure Replacement Projects - Phase III		$1,268,000
	Annual Leak Detection Program			$200,000
			FY 2022/23 Total:	**$1,537,000**
2023/24	Design:	Infrastructure Replacement Projects - Phase V (Zone 2)		$172,000
	Construct:	Infrastructure Replacement Projects - Phase V (Zone 1)		$624,000
	Annual Leak Detection Program			$200,000
			FY 2023/24 Total:	**$996,000**
2024/25	Construct:	Infrastructure Replacement Projects - Phase V (Zone 2)		$1,544,000
	Annual Leak Detection Program			$200,000
			FY 2024/25 Total:	**$1,744,000**