Final Draft

2018 CONDITION BASED ASSESSMENT & WATER MASTER PLAN

for
Casitas Municipal Water District

Municipal Water District

WSC
Water Systems Consulting, Inc.

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Prepared Under the Responsible Charge of:

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Table of Contents

List of Tables

List of Figures

Glossary of Terms

AC	Asbestos Cement
ADD	Average Day Demand
AFY	Acre- feet per Year
ASCE	American Society of Civil Engineers
ATS	Advantage Technical Service, Inc.
AWWA	American Water Works Association
BPS	Booster Pump Station
CBA	Condition Based Assessment
CI	Cast Iron
CIP	Capital Improvement Plan
CMWD	Casitas Municipal Water District
DBP	Disinfection Byproduct
DI	Ductile Iron
EPA	Environmental Protection Agency
EPS	Extended Period Simulation
°F	Fahrenheit
FF	Fire Flow
Filter Plant	San Antonio Pressure Filter Plant
ft	Feet
GIS	Geographic Information Systems
gpm	Gallons per Minute
grains/gal	Grains per Gallons
GSWC	Golden State Water Company
HP	Horsepower
in	Inch
MCL	Maximum Contaminant Limit
MDD	Maximum Day Demand
MG	Million Gallons
mg/L	Milligram per Liter

MGD	Million Gallons per Day
MSL	Mean Sea Level
NRW	Non-Revenue Water
NSF	National Sanitation Foundations
NTU	Nephelometric Turbidity Unit
OBGMA	Ojai Basin Groundwater Management Agency
pCi/L	PicoCuries per Liter
PHD	Peak Hour Demand
PRV	Pressure Reducing Valve
psi	Pounds per Square Inch
PVC	Polyvinyl chloride
RTP/SCS	Regional Transportation Plan/ Sustainable Communities Strategy
SCADA	Supervisory Control and Data Acquisition
SCAG	Southern California Association of Governments
STL	Steel
SWRCB	State Water Resources Control Board
TAZ	Transportation Analysis Zone
TM	Technical Memorandum
TO	Turnout
TT	Treatment Technique
µS/cm	MicroSiemens per centimeter
USA	Utility Services Associated
VFD	Variable Frequency Drive
WMP	Water Master Plan
WSC	Water Systems Consulting, Inc.

Section 1

EXECUTIVE SUMMARY

SECTION 1

Executive Summary

Casitas Municipal Water District (CMWD) operates the Ojai potable water system (system) that serves approximately 2,940 residences and businesses within the City of Ojai through a network of 45 miles of pipe, 6 storage reservoirs, 5 booster pump stations, and 6 groundwater wells. This Condition Based Assessment (CBA) and Water Master Plan (WMP) assesses the ability of the system to meet the needs of current and future customers and evaluates the system condition and asset remaining useful life. The CBA & WMP identifies a prioritized list of improvements to the water distribution system necessary to meet existing and projected demands and provide continued reliable water service. This CBA & WMP is intended to assist CMWD in long-term planning and budgeting for water system projects.

1.1 Water Supply

The Ojai potable water system receives water from 2 sources: Groundwater from the Ojai Valley Basin and surface water from Lake Casitas. Under current and future demands, all supply scenarios can be met reliably with the Ojai system's existing supply sources. However, the 6 groundwater wells are aging and have experienced a significant decrease in production since they were constructed. To improve supply reliability, it is recommended to construct an additional interconnection between the Ojai water system and the main Casitas water distribution system.

IN THIS SECTION

An inventory and assessment of the Ojai system wellfield determined the production loss in all wells is due to the encrustive nature of the groundwater clogging the well casings. To improve well performance, it is recommended the 2 newest wells are fully rehabilitated, including chemical and mechanical well rehabilitation, to increase production capacity. Based on the age of the existing wells, it is also recommended to drill and equip a new groundwater well to replace 1 of the aging wells and increase total groundwater production.

1.2 Booster Pump Stations

CMWD maintains and operates 5 booster pump stations within the Ojai water system, which pump water from the lower distribution zones to higher zones, and fill storage reservoirs. All pump stations are adequality sized to meet the system's demands except for the Heidelberger Pump Station. Because this pump station serves a zone without gravity storage, its pumping capacity must meet maximum day demand plus fire flow. It is recommended to install a fire pump at the Heidelberger Pump Station to meet this criterion.

The condition of the pump stations was evaluated based on documentation of maintenance, recent pump tests, and knowledge from CMWD operations staff. Their condition ranges from poor to fair. Projects regarding the specific condition of the pump stations are included in the Capital Improvement Plan (CIP), and it is expected all pump stations will require some minor rehabilitation or major replacements over the next 10 years.

1.3 Storage

There are 6 storage reservoirs that provided a total of 1.99 million gallons of operational, emergency, and fire flow storage for the Ojai potable water distribution system. The existing storage deficit in the Ojai system is 387,000 gallons, and it is expected to increase to about 450,000 gallons by 2027 without additional storage volume.

The 6 storage tanks were dived and inspected to determine the existing condition and recommendations for rehabilitation. The 2 Running Ridge Tanks are in poor condition and are recommended for replacement. The Signal Tank is also in poor condition and due to its age and excess storage, is also recommended for replacement. The remaining 3 reservoirs are in fair condition and recommended for minor rehabilitation.

A total of 6 alternatives are proposed to improve the system storage deficit that also consider the existing condition of the reservoirs. The first 3 storage alternatives include improvements in the Running Ridge and Heidelberger Zones (Upper Zones) and last 3 alternatives include improvements in the Signal, Main, and Saddle Lane Zones (Lower Zones). The solutions include the abandonment of the Running Ridge Tanks and the Signal Tank and replacement of the reservoirs or improvements in reliable pumping capacity and zone connections to reduce storage in all zones. It is recommended that CMWD perform a more detailed analysis of the 6 alternatives to determine the ideal solution to improve system storage.

1.4 Distribution and Transmission Pipelines

The Ojai potable water system consists of approximately 45 miles of distribution and transmission pipelines. The hydraulic model was used to evaluate system pressures and pipeline capacity. Most areas in the distribution system were found to have adequate pressures across a range of demand scenarios. There are 4 locations identified as having low or high pressure due to elevation in relation to the gravity reservoir in each zone, but it only affects a few services. There are many undersized water mains recommended for upgrade to improve system fire flow and pipeline velocities. These projects represent about 4.5 miles of pipeline upgrades and include a significant portion of the projects included in the CIP.

Pipeline condition was also evaluated using pipe age, material, historic leak reports, and CMWD operations staff knowledge. About 4 miles of pipelines are recommended for replacement or abandonment based on condition and are included in the CIP. A pipeline replacement curve was generated based on when pipelines and assets are expected to reach the end of their useful lives. Findings indicate over 3 miles of pipeline are close to exceeding their useful life, not including the pipes identified in a capacity or condition project. It is recommended CMWD budget $0.72 million for pipeline replacements annually to replace aging infrastructure and maintain reliable service to existing customers.

1.5 Operational Analysis

The Ojai system operations were also evaluated and included a water quality analysis and pumping controls analysis. Currently, the Ojai system delivers high quality potable water that meets all Federal and State drinking water standards. The hydraulic model was used to evaluate the water age throughout the distribution system. There is not a recognized standard for water age, but it is generally accepted as an indirect measurement of water quality with shorter detention times corresponding to lower water age and better water quality. The analysis predicts that most locations in the Ojai system have a low water age corresponding to high water quality. The small Upper Zones were modeled having the oldest water. It is recommended that CMWD continues pipe flushing as needed, or implement a pipe flushing program, to improve water quality and lower water age. The analysis also predicts occasional bleeding of water between the Heidelberger Tank and Running Ridge Zones and lowering the Signal Tank operating range will improve water quality.

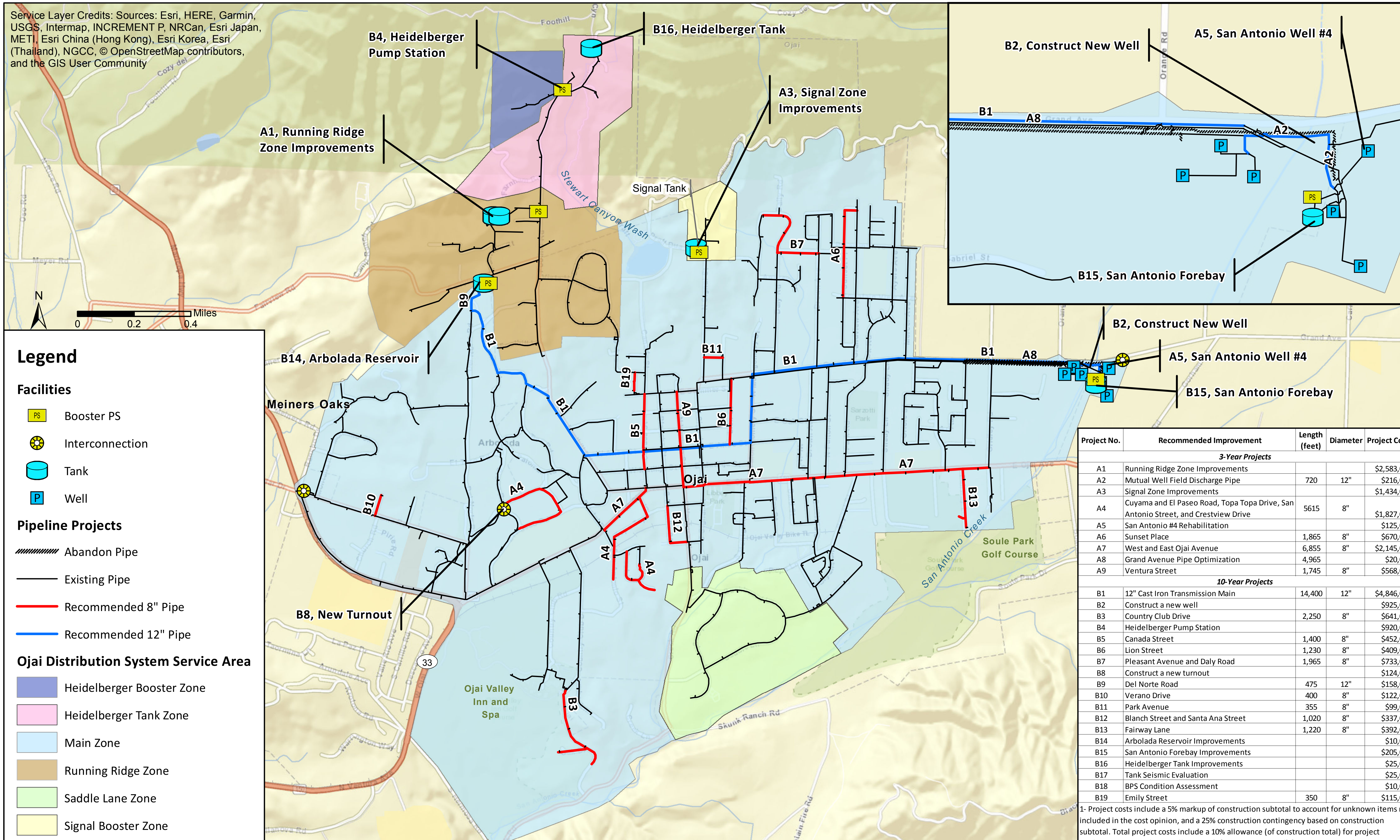
The pump station controls and operations were also evaluated. CMWD staff typically cannot run 2 pumps simultaneously at the Arbolada, Valley View, and San Antonio Pump Stations due to high discharge pressures. It is recommended to maintain the controls at the Arbolada Pump Station although 2 pumps may occasionally operate simultaneously in order to maintain the water level in the Running Ridge Tanks. The high discharge pressures at the Valley View Pump Station is due to its elevation compared to the Heidelberger Tank. To resolve pressures here, it is recommended to relocate the Valley View Pump Station to a higher elevation. The high discharge pressures at the San Antonio Pump Station are due to high head losses within the distribution system. It is recommended to replace aging cast iron and steel mains within the system to reduce the system head loss, flatten the San Antonio Pump Station system curve, and lower discharge pressures.

1.6 Recommended Improvements

The total recommended projects to correct existing and anticipated future deficiencies is approximately $20 million. The projects are grouped into 2 categories, Priority A and Priority B. Priority A projects are higher priority and are generally forecast to occur in 0 to 3 years. Priority B projects are a lower priority and address longer-term needs in the 4 to 10-year time frame. Table 1-1 summarizes the recommended capital improvement projects in this Condition Based Assessment and Water Master Plan and project costs. Project costs presented in this table are planning level, classified as Class 4 Conceptual Report Classification of Opinion of Probable Construction Costs as developed by the Association for the Advancement of Cost Engineering, and include markups for construction contingency, project implementation, and construction phase support. Figure 1-1 includes a map of the Ojai System with the recommended capital improvement projects. Plate 1, enclosed with this study, shows a large-scale map of the distribution system recommended improvements.

Table 1-1. Recommended Capital Improvement Projects

Project No.	Recommended Improvement	Length (feet)	Diameter (inches)	Project Cost
3-Year Projects				
A1	Running Ridge Zone Improvements	N/A	N/A	$2,583,000
A2	Mutual Wellfield Discharge Pipe	720	12	$216,000
A3	Signal Zone Improvements	N/A	N/A	$1,434,000
A4	Cuyama and El Paseo Road, Topa Topa Drive, San Antonio Street, and Crestview Drive	5,615	8	$1,827,000
A5	San Antonio Well #4 Rehabilitation	N/A	N/A	$125,000
A6	Sunset Place	1,865	8	$670,000
A7	West and East Ojai Ave	6,855 feet	8	$2,145,000
A8	Grand Avenue Pipe Optimization	4,965 feet	N/A	$20,000
A9	Ventura Street	1,745 feet	8	$568,000
			Total 3-Year Budget:	**$9,588,000**
10-Year Projects				
B1	12-inch Cast Iron Transmission Main	14,400	12	$4,846,000
B2	Construct a new well	N/A	N/A	$925,000
B3	Country Club Drive	2,250	8	$641,000
B4	Heidelberger Pump Station Reconstruction	N/A	N/A	$920,000
B5	Canada Street	1,400	8	$452,000
B6	Lion Street	1,230 feet	8	$409,000
B7	Pleasant Avenue and Daly Road	1,965 feet	8	$733,000
B8	Construct a new turnout	N/A	N/A	$124,000
B9	Del Norte Road (below the Arbolada Reservoir)	475 feet	12	$158,000
B10	Verano Drive	400 feet	8	$122,000
B11	Park Avenue	355 feet	8	$99,000
B12	Blanch Street and Santa Ana Street	1,020 feet	8	$337,000
B13	Fairway Lane	1,220 feet	8	$392,000
B14	Arbolada Reservoir Improvements	N/A	N/A	$10,000
B15	San Antonio Forebay Improvements	N/A	N/A	$205,000
B16	Heidelberger Tank Improvements	N/A	N/A	$25,000
B17	Tank Seismic Evaluation	N/A	N/A	$25,000
B18	BPS Condition Assessment	N/A	N/A	$10,000
B19	Emily Street	350 feet	8	$115,000
			Total 10-Year Budget:	**$10,548,000**
			Grand Total:	**$20,136,000**



Project No.	Recommended Improvement	Length (feet)	Diameter	Project Cost[1]
	3-Year Projects			
A1	Running Ridge Zone Improvements			$2,583,000
A2	Mutual Well Field Discharge Pipe	720	12"	$216,000
A3	Signal Zone Improvements			$1,434,000
A4	Cuyama and El Paseo Road, Topa Topa Drive, San Antonio Street, and Crestview Drive	5615	8"	$1,827,000
A5	San Antonio #4 Rehabilitation			$125,000
A6	Sunset Place	1,865	8"	$670,000
A7	West and East Ojai Avenue	6,855	8"	$2,145,000
A8	Grand Avenue Pipe Optimization	4,965		$20,000
A9	Ventura Street	1,745	8"	$568,000
	10-Year Projects			
B1	12" Cast Iron Transmission Main	14,400	12"	$4,846,000
B2	Construct a new well			$925,000
B3	Country Club Drive	2,250	8"	$641,000
B4	Heidelberger Pump Station			$920,000
B5	Canada Street	1,400	8"	$452,000
B6	Lion Street	1,230	8"	$409,000
B7	Pleasant Avenue and Daly Road	1,965	8"	$733,000
B8	Construct a new turnout			$124,000
B9	Del Norte Road	475	12"	$158,000
B10	Verano Drive	400	8"	$122,000
B11	Park Avenue	355	8"	$99,000
B12	Blanch Street and Santa Ana Street	1,020	8"	$337,000
B13	Fairway Lane	1,220	8"	$392,000
B14	Arbolada Reservoir Improvements			$10,000
B15	San Antonio Forebay Improvements			$205,000
B16	Heidelberger Tank Improvements			$25,000
B17	Tank Seismic Evaluation			$25,000
B18	BPS Condition Assessment			$10,000
B19	Emily Street	350	8"	$115,000

1- Project costs include a 5% markup of construction subtotal to account for unknown items not included in the cost opinion, and a 25% construction contingency based on construction subtotal. Total project costs include a 10% allowance (of construction total) for project implementation and a 10% allowance (of construction total) for construction phase support.

Figure 1-1. Recommended Capital Improvement Projects

Section 2

INTRODUCTION

SECTION 2

Introduction

Casitas Municipal Water District has a 137.5 square mile service area and provides water to more than 65,000 customers in Western Ventura County. Previously, CMWD only served a portion of the City of Ojai and the water distribution system was owned by Golden State Water. In June 2017, CMWD took over the City of Ojai's water distribution system.

2.1 Overview and Purpose

IN THIS SECTION

Overview & Purpose

Background Information

CMWD provides water to over 65,000 people in Western Ventura County and to hundreds of agricultural customers over a 137.5 square mile service area. The City of Ojai is encompassed in CMWD's service area, but CMWD previously provided only a portion of the water for the City of Ojai. The Ojai water distribution system was formerly owned by Golden State Water Company (GSWC), a private water purveyor. In June 2017, CMWD negotiated a $34.4 million deal with GSWC to take over the Ojai distribution system (Ojai system). The Ojai system is different from the CMWD system in many ways, including:

- The Ojai system contains primarily residential and commercial customers, so water demands year to year are relatively steady, while CMWD's demands vary drastically year to year based on rainfall due to many agricultural customers.
- The Ojai system's primary supply source is from groundwater, while CMWD primarily supplies its service area with surface water from Lake Casitas.

CMWD selected Water Systems Consulting, Inc. (WSC) to perform a Condition Based Assessment and update the Water Master Plan for the Ojai water distribution system. The goal is to guide CMWD's planned capital project expenditures and asset management in an efficient and cost-effective manner. The primary purposes of this CBA and WMP are to evaluate the condition and capacity of the existing water system, identify improvements necessary to continue providing reliable service to the customers and meet demands (including fire flow) for the current and future population, and develop a plan for water system improvements, as further described on the following page:

- Plan for growth expected within the Ojai distribution system.
- Develop an accurate hydraulic model of the distribution system.
- Identify the existing condition and expected useful lifetime of the distribution facilities and assets.
- Identify existing and future system capacity deficiencies.
- Develop a 3-year and 10-year prioritized improvement projects list, including anticipated costs, to address the condition and deficiencies to assure system reliability and adequate capacity of the distribution system.

2.2 Background Information

2.2.1 Location

CMWD is located in Western Ventura County and the distribution system includes the City of Ojai, Upper Ojai, the Ventura River Valley area, the City of Ventura to Mills Road, and the Rincon and beach area to the ocean and Santa Barbara County line. The distribution system focused in this CBA and WMP serves the City of Ojai and a small portion of the Meiners Oaks Community west of Ojai. Ojai is located about 15 miles inland from Ventura, CA and is bounded generally by the San Antonio Creek to the east and south, Highway 33 to the west, and Topatopa Mountains to the north. Figure 2-1 shows a location map of the CMWD service area and the Ojai water distribution system service area.

2.2.2 Climate

The climate in Ojai can be classified as Mediterranean with warm, dry summers and cool, wet winters. The average annual temperature is 67.2 degrees Fahrenheit (°F) and an average annual rainfall of 21.3 inches, but can range between 6.9 inches to 49.2 inches.

2.2.3 Population

The population for Ojai is estimated to be 7,585 people. Ojai's population has remained relatively steady since 2010 and is expected to have a slow 0.5 percent annual increase in population between 2020-2040, according to data from the Southern California Associations of Governments (SCAG). The City of Ojai has also seen an increase in accessory dwelling units (ADUs) on existing single-family residential parcels in recent years. To promote the development of ADUs, changes to California law were implemented in 2018, including:

- Allowing ADUs to be built concurrently with a single-family home;
- Opening areas where ADUs can be built to all zoning districts that allow single-family uses;
- Modifying fees from utilities;
- And reducing parking requirements.

As a result of these changes, the number of ADUs in Ojai is also expected to increase (1). ADUs have a significantly lower impact on water use compared to other residences such as single-family homes.

2.2.4 Distribution System

The Ojai water distribution system is comprised of 6 groundwater wells, 3 water supply interconnections (turnouts) to the CMWD main distribution and transmission system, 5 booster pump stations, and 6 storage reservoirs that can store approximately 1.99 million gallons (MG). The system contains 6 distribution zones, including the Main Zone that includes a small Raw Water Pressure Zone, the Signal Booster Zone, the Saddle Lane Reduced Zone, the Running Ridge Zone, the Heidelberger Tank Zone, and the Heidelberger Booster Zone. The system ranges in elevations of 675 feet above mean sea level (MSL) to 1,427 feet MSL from the southern to the northern portion of the distribution system.

2.2.5 Water Sources

The Ojai distribution system receives water from 2 sources: local groundwater from the Ojai Valley Basin and local surface water from Lake Casitas. The Ojai Valley Basin has an operational safe yield of 5,026 acre-feet per year (AFY) and has approximately 149 privately and publicly owned wells that supply tree crops, residents, and businesses in the City of Ojai and the surrounding areas (2). Lake Casitas has an average safe yield value of 20,840 AFY and is managed by CMWD.


View overlooking Lake Casitas

Figure 2-1. Casitas MWD and Ojai System Service Area and Location Map

Section 3

EXISTING SYSTEM

SECTION 3

Existing System

The Ojai water distribution system is comprised of 6 distribution zones and contains a total of 6 groundwater wells, 3 interconnections to the CMWD main distribution and transmission main, 5 booster pump stations, and 6 storage reservoirs.

3.1 Overview

According to Ojai's 2018 GIS data, the distribution system contains approximately 45 miles of distribution and transmission mains, 6 wells, 3 interconnections (turnouts), 5 booster pump stations, and 6 storage reservoirs within 6 distribution zones. Included in the Main Distribution Zone are two additional sub-zones: the Raw Water Sub-Zone and the County Club Drive Sub-Zone, as described below. Table 3-1 summarizes the distribution system's zones, supply sources, and storage reservoirs. Figure 3-1 includes a map of the distribution system.

The Ojai distribution system supplies water over a large range of elevations from 675 feet to 1,425 feet above MSL, and uses BPS and PRVs to increase and reduce water pressure as needed. A hydraulic profile of the distribution system is shown in Table 3-1.

IN THIS SECTION

Table 3-1. Ojai System Distribution System Summary

Pressure Zone (or Sub-Zone)	Hydraulic Grade (ft)	Supply		Storage	
		From	Booster Station or PRV	Reservoir Name	Size (MG)
Main	1,029	Sierra-Cuyama Turnout Montana-Cuyama Turnout	San Antonio BPS Signal Booster A	Arbolada	1
Raw Water[1]	828	San Antonio Well #3 San Antonio Well #4 Gorham Well Mutual Well #4 Mutual Well #5 Mutual Well #6 San Antonio- Grand Turnout	---	San Antonio Forebay	0.5
Country Club Drive[1]	910	Main Distribution	County Club Drive PRV	---	---
Running Ridge	1,150	Main Distribution	Arbolada BPS	Running Ridge 1 Running Ridge 2	0.05 0.044
Heidelberger Tank	1,440	Running Ridge Distribution	Valley View BPS	Heidelberger	0.1
Heidelberger Boosted	1,500	Heidelberger Distribution	Heidelberger BPS and Pressure Tank	---	---
Signal	1,112	Main Distribution	Signal Booster B	Signal Tank	0.3
Saddle Lane	957	Main Distribution	Saddle Lane PRV Ventura Street PRV	---	---

1. The Raw Water Pressure Zone and Country Club Drive Pressure Zone are sub-zones of the Main Zone due to their small size and limited number of services.

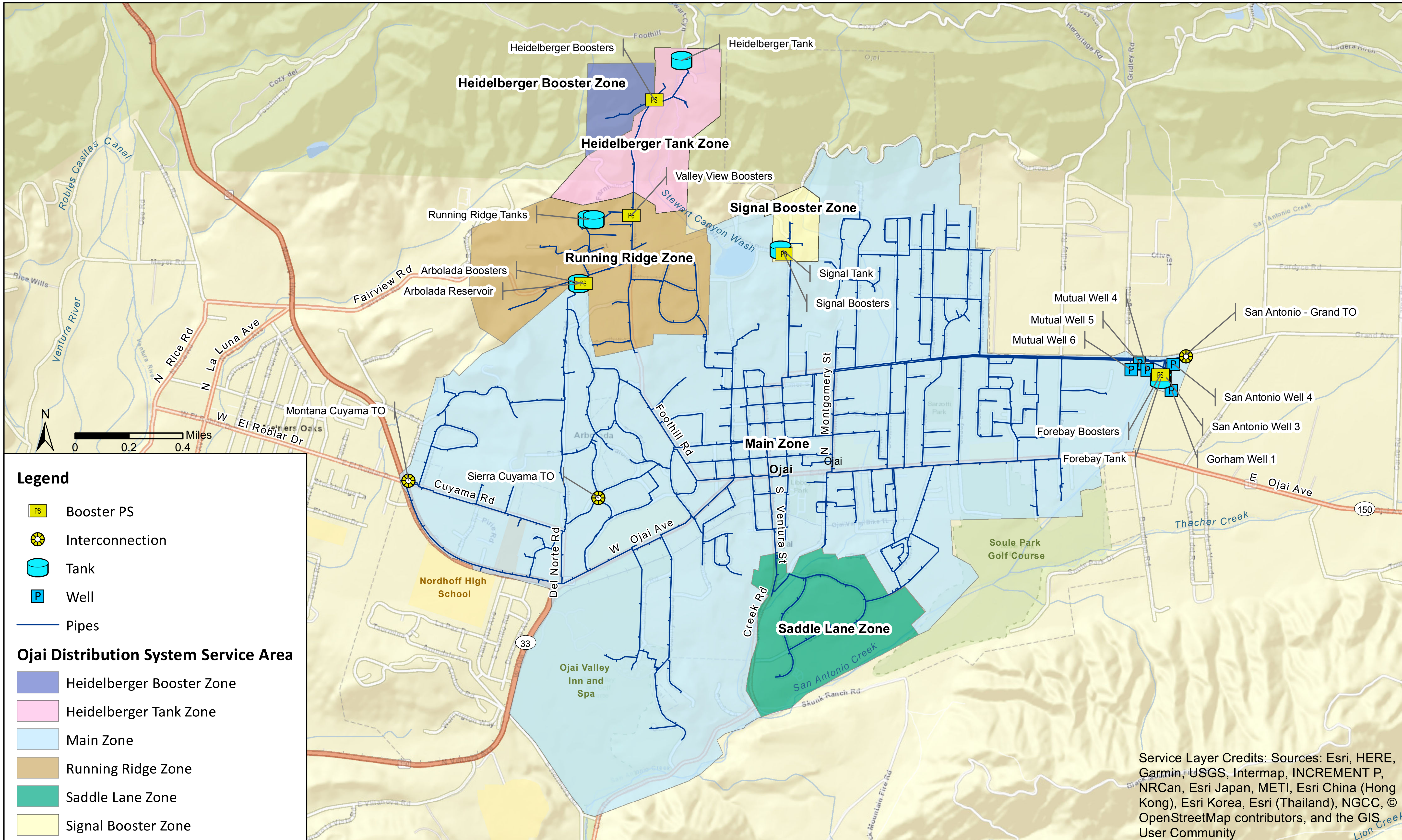


Figure 3-1. Ojai Water Distribution System

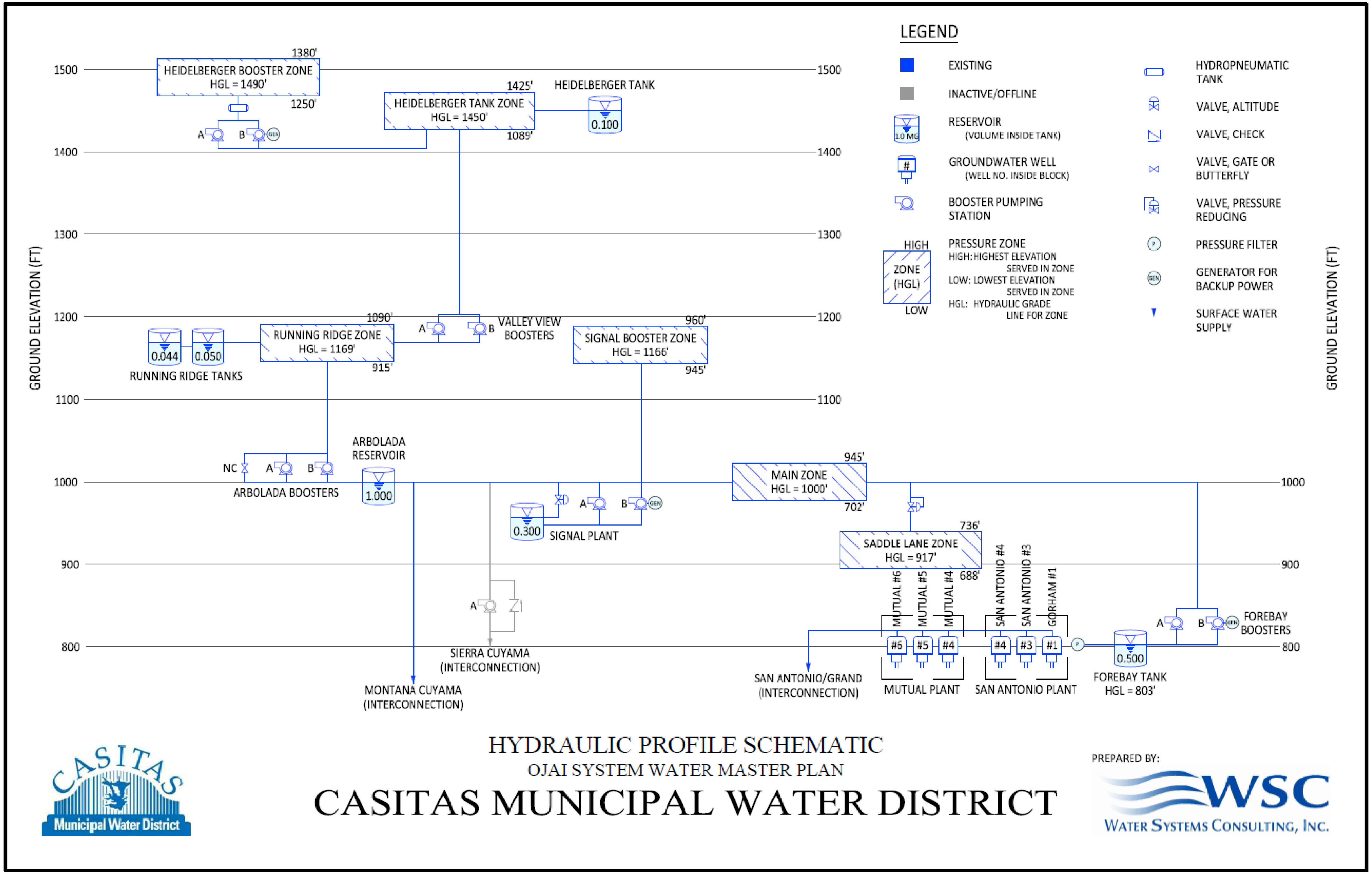


Figure 3-2. Ojai System Hydraulic Profile

Each distribution zone's supply sources and associated facilities are described below.

Main Zone: The Main Zone is the largest pressure zone in the distribution system, contains all the supply sources, and feeds all the other smaller zones in the system. Supply sources include 6 groundwater wells and 3 surface water turnouts. All the groundwater wells and 1 turnout are fed into the Raw-Water Sub-Zone of the Main Zone, described below, and pumped into the Main Zone via the San Antonio Booster Pump Station (BPS). Of the other 2 surface water turnouts, only 1 is operational and directly supplies the Main Zone. The Main Zone contains 3 storage reservoirs: The San Antonio Forebay, the Arbolada Reservoir (formerly known as the Fairview Reservoir), and the Signal Reservoir. The Arbolada Reservoir is the only tank that provides gravity storage for the Main Zone. The San Antonio Forebay stores water from the supply sources in the Raw-Water Sub-Zone and provides suction pressure for the San Antonio BPS. The Signal Reservoir is filled from the Main Zone, which is sitting at a lower hydraulic grade line (HGL) than the Main Zone, and does not overfill because of an altitude valve located on the fill line. There is a small booster pump, Signal Booster A, that is designed to pump water out of the Signal Tank back into the Main Zone but is currently not operational. Within the Main Zone, there are two smaller sub-zones that operate at a lower HGL, but are grouped within the Main Zone for the system analysis throughout this Water Master Plan, described below:

> ***Raw Water Sub-Zone:*** As mentioned, the Raw Water Sub-zone contains the 6 active wells and the San-Antonio Grand surface water turnout for blending. The blended raw water is conveyed to the San Antonio Filter Plant for chlorination and iron and manganese treatment and stored into the San Antonio Forebay Tank. The Raw-Water Sub-Zone contains less than 1 mile of pipeline.
>
> ***Country Club Road Sub-Zone:*** The Country Club Road Sub-Zone is a small reduced sub-zone along the southern end of Country Club Road Zone. There is an 8-inch pressure reducing valve (PRV) located at the end of Country Club Drive near the parking lot for the Ojai Valley Inn and Spa that reduces pressures from the Main Zone and feeds the 0.45 miles of main line in the pressure gradient.

Running Ridge Zone: The Running Ridge Zone is north of the Main Zone and is supplied by the Arbolada BPS (formerly known as the Fairview BPS) and 2 gravity storage reservoirs, Running Ridge Reservoir 1 and Running Ridge Reservoir 2. Together these reservoirs provide 94,000 gallons of storage. There is a closed PRV located at the northern end of Libby Avenue that separates the Running Ridge Zone and the Main Zone. The PRV is set to open when low pressures occur in the Main Zone, like during a fire flow event.

Heidelberger Tank Zone: The Heidelberger Tank Zone is supplied from the Running Ridge Zone via the Valley View BPS located along Foothill Boulevard just north of Layton Street. The Heidelberger Tank Zone contains the Heidelberger Reservoir which provides 100,000 gallons of gravity storage.

Heidelberger Boosted Zone: The Heidelberger Boosted Zone is a small boosted zone that serves 5 residences and contains less than 0.5 miles of pipeline. The Heidelberger BPS pumps from the Heidelberger Tank Zone to the Heidelberger hydropneumatic tank. The hydropneumatic tank is not used as storage but maintains the water pressure in the small zone and saves energy by allowing the pumps to cycle less often compared to if there was no hydropneumatic tank.

Signal Zone: The Signal Zone is a small boosted zone north of the Main Zone and serves approximately 8 homes on the most northern end of North Signal Street. This zone contains the Signal Tank that is gravity filled from the Main Zone. This tank is at a lower HGL than the Main and Signal Zones, so it is equipped with an altitude valve to prevent overflowing. Signal Booster B pumps water from the Signal Tank into the Signal Zone. Because the pump is not operated on a variable frequency drive (VFD), during low demands the pressure in the Signal Zone can increase greatly. To relieve the high pressures, a valve opens and allows flow to feed back into the Main Zone. Signal Booster B is currently the only available pump to supply the Signal Zone, so it is always running and is equipped with an onsite backup generator in case of power failure.

Saddle Lane Zone: The Saddle Lane Zone is located in the southern portion of the distribution system, south of the Main Zone. The Saddle Lane Zone is at a low elevation and is supplied from the Main Zone through 2 PRVs located on Saddle Lane and Ventura Street.

View looking west along Ojai Avenue located within the Main Zone

3.2 Existing Supplies

The Ojai distribution system receives water from 2 sources: groundwater in the Ojai Valley Basin and surface water from Lake Casitas.

3.2.1 Ojai Valley Basin

The Ojai system contains 6 active wells that draw water from the Ojai Valley Basin. The Ojai Valley Basin covers a 6,830 acre area and is bounded by the tertiary rocks on the west and east end, by the Santa Ana Fault and Sulphur Mountain Range on the south, and by the Black Mountain and Topatopa Mountains on the north (3). The Ojai Valley Basin is generally unconfined and recharges from precipitation and percolation from surface water. Water levels in wells respond to seasonal variation and fluctuate during dry and wet periods.

The Ojai Basin Groundwater Management Agency (OBGMA) was formed in 1991 when the California Legislature adopted the Ojai Groundwater Basin Management Act (Senate Bill 534). OBGMA monitors and manages the groundwater use in the Ojai Basin for the protection and common benefit of agricultural, municipal, and industrial water users of the basin (2). The safe annual yield of the Ojai Valley Basin is approximately 5,026 acre-feet per year (AFY) based on the OBGMA 2018 Draft Groundwater Management Plan (4).

Table 3-2 describes the system's existing well supply capacity. The observed production capacities are much less than the design capacity for most pumps due to aging infrastructure and low pump efficiencies. The Ojai distribution system does not have an allocated amount of water it is allowed to pump from the Ojai Basin, but CMWD does coordinate with the OBGMA and surrounding groundwater users to actively manage their shared water source.


View overlooking the Ojai Valley

Table 3-2. Supply Well Summary[1]

Well	Location	Year Constructed	Well Depth (ft)	Pump Setting Depth (ft)	Water Level Depth [2] (ft)	Motor Size (HP)	Casing Diameter (in)	Design Production Capacity (gpm)	Observed Production Capacity [2] (gpm)
San Antonio #3	San Antonio Plant	1956	600	460	202	40	16	551	197
San Antonio #4	San Antonio Plant	2005	610	440	193.9	60	20	500	174
Gorham	San Antonio Plant	1996	650	590	190	40	16	1000	239
Mutual #4	Mutual Plant	1947	580	450	186.8	10	14	275	131
Mutual #5	Mutual Plant	1951	610	380	190	50	12	670	140
Mutual #6	Mutual Plant	2012	510	490	187.7	50	14	471	280
							Total	**3,467**	**1,161**

1. Information is based on the best available data, including the Ojai System 2009 Water Master Plan, construction as-builts, recent pump tests, and other design documents.
2. Observed water level depth and production capacity based on well pump tests on 9/19/2016.

3.2.2 Lake Casitas

There are 3 interconnections between the main Casitas distribution system and the Ojai distribution system, also referred to as turnouts: the San Antonio-Grand turnout, the Sierra-Cuyama turnout, and the Montana-Cuyama turnout. These turnouts are used to supply surface water from Lake Casitas to Ojai. Currently only 2 of the turnouts are active. Surface water is more expensive than the local groundwater supplies, so the turnouts are only used to meet demand after all groundwater sources are in use. Table 3-3 describes the existing turnouts.

Table 3-3. Existing Turnouts[1]

Turnout Name and Location	Supply Zone	Control	Maximum Capacity	Current Capacity
San Antonio-Grand	Raw Water/ Main	Controlled by San Antonio Forebay Tank Level	800	800
Sierra-Cuyama	Main	Manual. Pumped into the Main zone	900	0
Montana-Cuyama	Main	Controlled by a valve to maintain the Arbolada Reservoir level	800	800
		Total	**2,500**	**1,100**

1. Information is based on the best available data, including the Ojai System 2009 Water Master Plan, 2010 Urban Water Management Plan, construction as-builts, and other design and planning documents.

The Ojai distribution system also has an additional turnout located at the Ojai Valley Inn that is only used for fire service. This turnout is not included in the supply analysis because it is not used for regular supply purposes.

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3.3 Booster Pump Stations

The Ojai distribution system contains 5 BPSs. These BPSs pump water into the Main Zone and from the Main Zone to the smaller zones operating at a higher HGL. BPSs typically operate based on gravity storage tank levels or pressure settings to maintain adequate supply in the system. Table 3-4 provides a summary of the booster station information, pump specifications, and respective associated infrastructure

Table 3-4. Booster Pump Station Summary[1]

Booster Pump Station	Pumps	Design Capacity (gpm)	Design Total Dynamic Head (ft)	Observed Capacity (gpm)	Observed Total Dynamic Head (ft)	Pump Test Date	Pump Make and Model	Motor Size (HP)	Zone Pumping From/To	Associated Infrastructure
San Antonio	San Antonio Booster A San Antonio Booster B	1,500 1,500	280 280	1,529 1,469	284 284	9/19/2016 9/19/2016	2 x Goulds Turbine, Model 14RJLC, 4 stages	2 x 150	Raw Water / Main	San Antonio Forebay
Signal A	Signal Booster A	600	50	181	76	9/20/2016	Paco, Model 4ma-LRu	10	Main / Main	Signal Tank
Signal B	Signal Booster B	100	150	56	148	9/20/2016	Goulds Turbine, G+L Series SSH, 1x 2-8	7.5	Main / Signal	Signal Tank
Arbolada	Arbolada A Arbolada B	250 250	195 195	283 263	198 196	9/19/2016 9/19/2016	2 x Flowserve Model O8ELL, 2 stages	2 x 20	Main / Running Ridge	Arbolada Reservoir
Valley View	Valley View A Valley View B	250 250	350 350	198 288	333 340	9/20/2016 9/20/2016	2 x Paco Model 1595-7	2 x 40	Running Ridge / Heidelberger Tank	Running Ridge 1 and 2 Tanks
Heidelberger	Heidelberger A Heidelberger B	11 42	149 89	6 38	72 88	9/20/2016 9/20/2016	Grundfos CR2-40 Grundfos CRB-20U	1 1.5	Heidelberger Tank / Heidelberger Boosted	Heidelberger Tank Heidelberger Pressure Tank

1. Information is based on the best available data, including the Ojai System 2009 Water Master Plan, construction as-builts, recent pump tests, and other design documents.

3.4 Storage

The Ojai distribution system has 6 storage reservoirs or tanks that provide operational, emergency, and fire flow storage for the distribution system. The total storage capacity is 1.9 MG. Of the 6 tanks, 4 provide water via gravity, while the San Antonio Forebay and Signal Tank are adjacent to pump stations that supply their respective zones. Table 3-5 summarizes the storage tank characteristics.

Table 3-5. Storage Summary[1]

Reservoir or Tank Name	Zone Served by Gravity	Zone Served by BPS	Type	Estimated Year Constructed	Ground Elevation (ft)	Diameter (ft)	Height (ft)	Capacity (gallons)
Arbolada Reservoir	Main	Running Ridge	Circular Partially Buried Concrete	Unknown; Before 1966	972	100	17	1,000,000
Signal Tank	Main[2]	Signal Booster	Circular Ground Supported Welded Steel	1948	948	36	41	300,000
San Antonio Forebay	None	Main	Circular Ground Supported Welded Steel	2011	801	64	27	500,000
Running Ridge 1	Running Ridge	Heidelberger Tank	Circular Ground Supported Bolted Steel	1956	1,161	22	16	44,000
Running Ridge 2	Running Ridge	Heidelberger Tank	Rectangular Partially Buried Concrete	1914	1,170	N/A	9	50,000
Heidelberger Tank	Heidelberger Tank	Heidelberger Boosted	Circular Ground Supported Bolted Steel	2010	1,435	27.9	24.5	100,000
							Total	1,994,00

1. Information is based on the best available data, including the Ojai System 2009 Water Master Plan, Construction As-builts, and other design documents.
2. Signal Tank can serve Main Zone by gravity if the HGL drops in the Main Zone such as during a fire or emergency.

3.5 Distribution and Transmission Mains

The Ojai distribution system consist of about 45 miles of distribution and transmission mains. The most current atlas map of the Ojai distribution system is from 2014, and includes information on pipe material, diameter, and installation year. There are some small laterals and pipes within the well plants and booster pump stations where the material and installation year are not indicated and are noted as unknown. Table 3-6 and Table 3-7 describe the physical characteristics and age of the water mains based on the best available data.

Table 3-6. Distribution System Main Materials and Diameter Summary

Material/ Diameter	2-inch	3-inch	4-inch	6-inch	8-inch	10-inch	12-inch	16-inch	Total (ft)	Total (miles)
Asbestos Cement (AC)	0	0	2,988	40,125	47,315	0	87	0	90,515	17.1
Cast Iron (CI)	216	0	22,466	28,473	7,499	2,020	12,310	0	72,984	13.8
Ductile Iron (DI)	0	0	0	2,425	22,540	0	4,115	2,869	31,949	6.1
Polyvinyl Chloride (PVC)	350	0	190	3,256	20,519	0	43	514	24,872	4.7
Steel (STL)	2,359	577	853	1,131	5,581	8,602	0	0	19,104	3.6
Unknown	0	0	0	73	242	0	0	0	315	0.1
Total (ft)	**2,926**	**577**	**26,496**	**75,482**	**103,696**	**10,622**	**16,556**	**3,383**	**239,737**	**-**
Total (miles)	**0.6**	**0.1**	**5.0**	**14.3**	**19.6**	**2.0**	**3.1**	**0.6**	**-**	**45.4**

Table 3-7. Distribution System Installation Year Summary

Material/ Year	Unknown Year	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2017	Total (ft)	Total (miles)
Asbestos Cement (AC)	4,295	0	0	0	3,342	26,024	27,850	27,465	1,538	0	0	90,515	17.1
Cast Iron (CI)	398	581	21,899	4,956	25,763	16,661	652	1,423	0	650	0	72,984	13.8
Ductile Iron (DI)	1,819	218	0	65	0	0	0	1,603	1,376	10,994	15,874	31,949	6.05
PVC	1,651	0	0	0	322	0	0	13,217	8,683	607	392	24,872	4.71
Steel (STL)	3,775	3,539	132	1,299	6,552	1,926	817	1,064	0	0	0	19,104	3.62
Unknown	315	-	-	-	-	-	-	-	-	-	-	315	0.06
Total (ft)	**12,253**	**4,338**	**22,031**	**6,320**	**35,980**	**44,611**	**29,319**	**44,773**	**11,596**	**12,251**	**16,266**	**239,737**	**-**
Total (miles)	**2.3**	**0.8**	**4.2**	**1.2**	**6.8**	**8.4**	**5.6**	**8.5**	**2.2**	**2.3**	**3.1**	**-**	**45.4**

3.6 Water Quality

The water quality in the Ojai water distribution system can be described as generally good water quality. In 2016, all Federal and State water quality requirements were met.

Table 3-8 contains the 2016 average distribution system water quality and Table 3-9 contains the 2016 average source water quality. There is 1 treatment plant located adjacent to the San Antonio Forebay reservoir known as the San Antonio Pressure Filter Plant (filter plant). The filter plant was constructed in the late 1990s to reduce high iron and manganese concentrations in the groundwater. Iron and manganese naturally occur in soils, rocks, and minerals and although they do not pose a risk to health, dissolved iron and manganese have secondary maximum contaminant limits (MCL) for drinking water because they can cause taste and odor issues. The filter plant consists of chlorination to oxidize iron and manganese and form insoluble compounds and then filtration to remove the formed compounds. All 6 of the system wells are pumped through the San Antonio Pressure Filter before filling the San Antonio Forebay and pumping into the Main Zone.

CMWD currently uses chloramines as a residual disinfectant in their main distribution system, while the Ojai system uses free chlorine (sodium hypochlorite) as their disinfectant residual. Chloramines are an effective disinfectant that prevent the formation of disinfectant byproducts normally formed when chlorine comes in contact with organic matter. When mixing chloramines and free chlorine, excess sodium hypochlorite must be added to pass the breakpoint chlorination to maintain a chlorine residual. To limit operating costs and reduce sodium hypochlorite use, the surface water turnouts are only used as needed to meet demands with groundwater as the preferred supply source.

Table 3-8. 2016 Distribution System Water Quality

Constituents	Units	MCL (Action Level)	Average Detection Limit	Exceeds Limit
Total Coliform Bacteria <40 Samples/month	Present/ Absent	No more than 1 positive monthly sample	Highest number of monthly samples positive was 1	No
Chlorine (as Cl_2)	mg/L	4.0	0.8	No
HAA5 (Total of 5 Haloacetic Acids)	µg/L	60	18	No
TTHMs (Total of 4 Trihalomethanes)	µg/L	80	56	No
Copper	mg/L	(1.3)	0.78 (90th Percentile Level)	No

Table 3-9. 2016 Source Water Quality

Constituent	Units	Maximum Contaminant Limit (MCL)	Average Detection Level	Exceeds Limit?
Primary Standards[1]				
Highest Single Turbidity Measurement of the Treated Surface Water	NTU	TT=1.0	0.11	No
Lowest Percentage of all Monthly Readings Less than 0.3 NTU	%	TT=95%	100%	No
Barium	mg/L	1	ND	No
Fluoride	mg/L	2	0.41	No
Nitrate (as N)	mg/L	10	3.6	No
Gross Alpha Activity	pCi/L	15	ND	No
Uranium	pCi/L	20	1.6	No
Secondary Standards[2]				
Color	units	15	ND	No
Chloride	mg/L	500	59	No
Specific Conductance	µS/cm	1600	920	No
Sulfate	mg/L	500	160	No
Turbidity	NTU	5	0.16	No
Total Dissolved Solids	mg/L	1000	610	No
Zinc	mg/L	5	ND	No
Other Parameters[3]				
Alkalinity	mg/L	N/A	195	No
Calcium	mg/L	N/A	95	No
Hardness (as $CaCO_3$)	grains/gal	N/A	20	No
Magnesium	mg/L	N/A	24	No
pH	pH units	N/A	7.3	No
Potassium	mg/L	N/A	1.3	No
Sodium	mg/L	N/A	60	No

1. Primary Standards for contaminants are set because they can have diverse effects on human health. Primary MCLs are the highest level of a contaminant that is allowed in drinking water and are set as close the public health goals as is economically and technologically feasible.
2. Secondary Standards and MCLs are set to protect the odor, taste, and appearance of drinking water.
3. Other parameters are monitored and reported, but do not have any set MCLs.

Section 4

SYSTEM EVALUATION CRITERIA

SECTION 4

System Evaluation Criteria

The Ojai distribution system evaluation criteria was determined by current regulations and engineering standards and practices, as well as the review of the Ojai water distribution system's previous Water Master Plan. The evaluation criteria are: Customer and Demand Projections; Supply Reliability; Distribution; Storage; and Booster Pumps.

IN THIS SECTION

Water System Planning and Evaluation Criteria

To develop evaluation criteria for the water system, WSC reviewed criteria used in the Ojai distribution system's previous Water Master Plan as well as current regulations and accepted engineering standards and practices. The evaluation criteria for the water system have been organized into 5 categories: Customer and Demand Projections (Table 4-1), Supply Reliability (Table 4-2), Distribution (Table 4-3), Storage (Table 4-4), and Booster Pumps (Table 4-5). The specific criteria included in each of the categories are shown in the following tables.

Table 4-1. Water System Planning and Evaluation Criteria: Customer and Demand Projections

Purpose	Regulation or Reference	Engineering and Planning Criteria
Future System Demand	Based on District staff input and Professional Judgment	3-year (2020) and 10-year (2027) demands calculated from: (1) Existing (2017) water use (2) Application of Southern California Association of Governments (SCAG) 2016-2040 RTP/SCS Final Growth Forecast (5) population and employment growth rates to existing residential and non-residential customers' water use
MDD Factor	Based on historical water demands	2.10[1] x ADD
PHD Factor	California Waterworks Standards	1.5 x MDD
1. MDD peaking factor based on maximum production day compared to the average daily production as reported in the Ojai system 2016 Annual Report to the Drinking Water Program		

Table 4-2. Water System Planning and Evaluation Criteria: Supply Reliability

Purpose	Regulation or Reference	Engineering and Planning Criteria
Reliable Supply	California Waterworks Standards	Calculate reliable supply by determining system capacity with the Ojai distribution system's largest source out of service
Source Capacity	California Waterworks Standards and CMWD Preference	• System must be able to meet average day demand (ADD) with total source capacity only • System must be able to meet maximum daily demand (MDD) with reliable source capacity only • System must be able to meet 4 hours of Peak Hour Demand (PHD) with reliable source capacity and operational storage capacity • System must be able to meet 7 days of ADD during a planned turnout outage with production capacity and emergency and half of operational storage capacity • System must be able to meet 1 day of MDD and 6 days of ADD during an unplanned turnout outage with production capacity and emergency and half of operational storage capacity
Water Quality	Current and pending drinking water regulations	Analyze existing water quality and compare against current and pending maximum contaminant levels (MCLs)
Water Disinfection	California Waterworks Standards	Disinfection systems must meet regulations for chloramine residuals and disinfection by-products (DBP); Chemical storage must be enough for at least 2 weeks

Table 4-3. Water System Planning and Evaluation Criteria: Distribution

Purpose	Regulation or Reference	Engineering and Planning Criteria
System Pressure	California Waterworks Standards and CMWD Preference	• 40 psi minimum and 125 psi maximum at ADD, MDD, and PHD • 20 psi minimum residual at MDD plus FF
Fire Flows	California Fire Code (Appendix B) and CMWD Preference	• Residential – 1,000 gpm for 2 hours • Public Facilities, Commercial, Business, Schools – 2,000 gpm for 3 hours • Hospital – 2,000 gpm for 3 hours • Parks, Recreational Facilities – 1,750 for 3 hours • The distribution system analysis assumes only 1 fire will occur within the Ojai system at a time.
Pipeline Velocities	Engineer's Judgment and CMWD Preference	• Less than 5 feet per second (fps) at ADD • Less than 5 fps at MDD • Less than 10 fps at PHD • Less than 10 fps at FF plus MDD condition (less than 15 fps near the source of fire)
New Distribution Mains	Engineer's Judgement and CMWD Preference	All new water mains must be 8-inch or greater
Fire Hydrant spacing	Ventura County Fire Department Standards and Engineer's Judgement	At intervals not more than 250 feet in commercial zones, and not more than 500 feet spacing in Single Family Dwelling areas

Table 4-4. Water System Planning and Evaluation Criteria: Storage

Purpose	Regulation or Reference	Engineering and Planning Criteria
Operational Storage	AWWA Manual of Standard Practices M32 and CMWD Preference	25% of MDD for 24 hours
Fire Flow Storage	California Fire Code (Appendix B)	Sufficient storage is required to provide the fire flows for each zone listed in Table 4-3)
Emergency Storage	The Ojai distribution system's Historic Emergency Storage Criteria	ADD for 12 hours

Table 4-5. Water System Planning and Evaluation Criteria: Booster Pumps

Purpose	Regulation or Reference	Engineering and Planning Criteria
Zone Reliability	California Waterworks Standards; Accepted Engineering Practices	Must be able to meet MDD within the zone with the largest pump out of service for zones with gravity storage. Must be able to meet MDD plus fire flow or PHD, whichever is larger, for zones without gravity storage
Emergency Power	Recommended Standards for Water Works[1]	Emergency power must be sufficient to meet system average day demands and preparedness for other emergencies
1. Recommended Standards for Water Works (Ten State Standards). Water Supply Committee of the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. Albany: Health Research, Inc., 2007.		

Section 5

EXISTING & PROJECTED WATER DEMAND

SECTION 5

Existing and Projected Water Demand

Since 2013, there has been a significant reduction in water demand within the Ojai water distribution system. The 2017 demands represent a "new normal" for the Ojai area and the decrease in water demand is expected to continue. WSC utilized spatially allocated demands to associate with various cross-sectional data to understand demand patterns and determine water demand factors.

IN THIS SECTION

This section presents the historic, current, and projected system demands. For the purposes of this section, the following defined terms are used:

- **Consumption:** The amount of billed metered water consumed by customers. CMWD provided monthly consumption data for November and December 2017 with water meter coordinates.
- **Production:** The amount of water produced from supply sources and put into the Ojai distribution system based on metered flows at each source. CMWD provided monthly and annual production data for 2009 through 2017 but advised that production data in 2016 and 2017 is the most accurate period, therefore these years of production data were used to develop existing and projected water demands.
- **Non-revenue Water (NRW):** The amount of water losses making up the difference between production and consumption. The average NRW in November and December 2017 was 12.7%.
- **Demand:** The amount of water distributed through the water system calculated based on consumption and production. Demand takes into account non-revenue water.

5.1 Historical Water Demand

Historical production records were available for 2013, 2016, and 2017 from CMWD, Golden State Water Company, and the State Water Resource Control Board's (SWRCB) records. The historic demand graphed in Figure 5-1 show there has been a significant reduction in annual demand since 2013. Water use reduction has been the trend throughout California due to the drought from 2014-2017. As shown in Figure 5-1, the City of Ojai's water use reduction is even greater than the water use reduction for the Central Coast region as reported by the SWRCB. Due to data availability and assuming that 2017 demands represent a "new normal" demand pattern expected to continue into the future, 2017 data was assumed to represent a good existing baseline to use for spatial allocation and modeling.

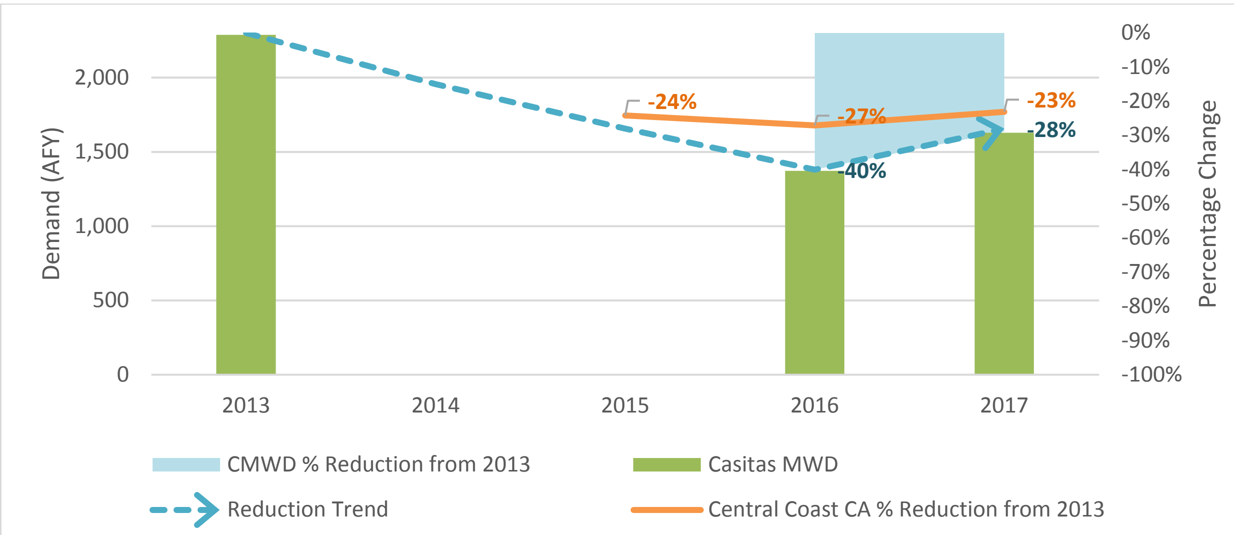


Figure 5-1. District Historical Demand Compared to Central Coast Demand

Spatially allocated demands were established based on historical annual water customer consumption for November and December 2017 and 2017 production data from CMWD's records. CMWD provided November and December 2017 consumption data with meter coordinates, which were scaled to their respective month's production and used to estimate January to October demands assuming an average non-revenue water percentage of 12.7% from November and December data. Estimated 2017 consumption is shown in Figure 5-2.

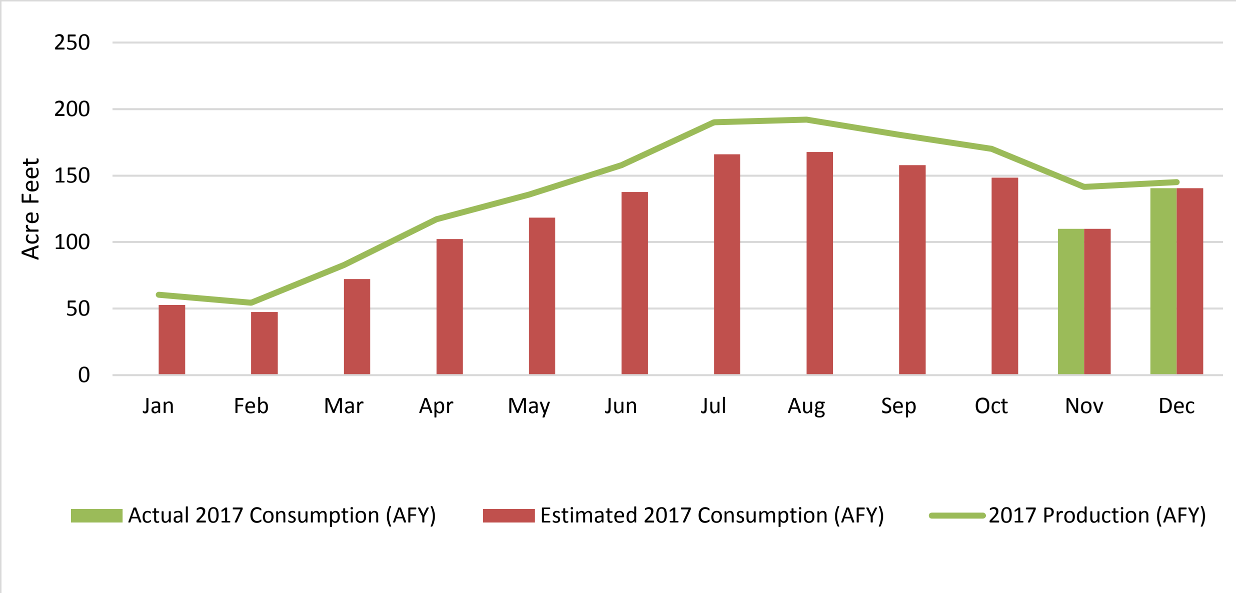


Figure 5-2. 2017 Monthly Consumption & Demand

The 2017 demand was assigned to each customer based on each customer's percentage of total water demand in November and December. These demands by customers were spatially allocated in Geographical Information Systems (GIS) software based on each customer's percentage of total demand in November and December. The location of high demand customers varied when comparing November and December consumption data. In an effort to account for the monthly spatial variation in customer specific demands and their impact to different parts of the water distribution system, each customer's demands were averaged between November and December. Then, 2017 demands were assigned to each customer based on their average percentage of the total average November and December 2017 demand. This methodology was used due to the lack of better available data and may reflect spatial and temporal demand patterns that are not reflective of annual average demands. It is recommended that loading be updated in the future when a full year's worth of consumption and demand is available.

In addition to evaluating annual demands, daily and hourly peak demand factors were also evaluated. As noted in Table 4-1, the maximum day demand (MDD) was determined by evaluating historic daily production data. Because annual production data is limited, the identified maximum daily production rate in 2016 reported in the Ojai water distribution system's Large Water System 2016 Annual Report to the Drinking Water Program was used as the MDD peaking factor. Based on the reported maximum production in 2016, the MDD peaking factor is 2.1 times the ADD. Hourly production data is not recorded, so 1.5 times the MDD was used as the peak hourly demand (PHD) peaking factor per California Waterworks Standards.

5.2 Future Demand Projections

Spatially allocated demands can be associated with various cross-sectional data to help understand existing water demand patterns to determine water demands per unit, or water demand factors. Water demand factors can be applied to future growth unit forecasts to project future water demands. The SCAG forecast provides existing and projected units of population and employees within transportation analysis zones (TAZs), which can be intersected with CMWD's service area in GIS to calculate CMWD-specific growth rates, as shown in Table 5-1 (5). It is assumed that the SCAG growth rates account for increased development of ADUs on existing single-family use parcels. Recent changes in California law promote the development of ADUs, and with such the number of ADUs in Ojai are expected to increase (1). Because of ADUs small footprint and low use of resources, their continued development is not expected to have a significant impact on the water supply in Ojai.

Table 5-1. SCAG Growth Rates for Ojai, CA

	2017-2020	2021-2027
Population Annual Growth Rate	0.42%	0.42%
Employment Annual Growth Rate	0.03%	0.04%

Future demands in 2020 and 2027 were projected by applying SCAG TAZ population growth rates to existing residential demands and employee growth rates to non-residential customers. While this does not directly allocate new development or redevelopment, it is assumed that existing customer demands and customer use types' spatial distribution will not change significantly by 2027 (Figure 5-3). The spatial distribution of existing demands scaled to expected growth rates is assumed to be sufficient for modeling purposes, but could be improved with additional planning data from the City of Ojai.

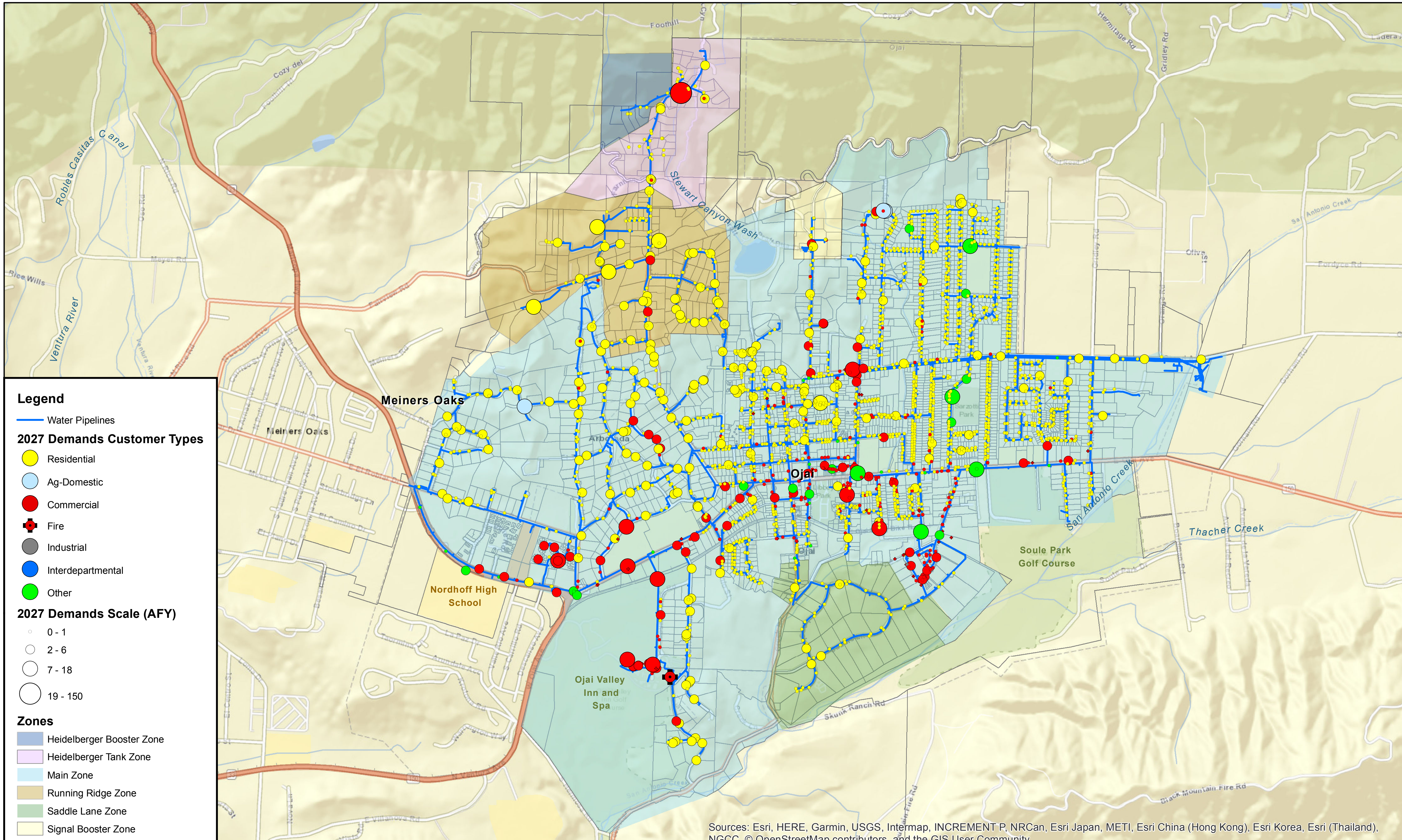


Figure 5-3. Spatially Allocated Demands

Section 6

MODEL DEVELOPMENT

SECTION 6

Model Development

The objective of the hydraulic model is to create a calibrated, representative model of the Ojai distribution system to simulate and predict the performance of the distribution system under a variety of demand and operational scenarios. The hydraulic model is also extremely useful for reevaluating alternative configurations and capital project recommendations in order to provide the most valuable configuration to meet the system's needs. For more detailed information on the model development and calibration, see Appendix A, Hydraulic Model Development Technical Memorandum.

6.1 Model Structure and Demands

Because there are currently no GIS shapefiles of the Ojai water distribution system, the model structure was manually digitized using the most recent atlas maps of the system within InfoWater, Innovyze's® GIS-based hydraulic modeling software. InfoWater's Digitize Network tool was used to quickly digitized pipes, junctions, and hydrants based on the distribution system map. Major facilities such as tanks, pump stations, and wells were also manually added to the model. Because the system was manually digitized, the system's connectivity was maintained throughout the model building process.

Physical and operational data used in the model was extracted from multiple sources including the atlas map, planning reports including the 2009 Water Master Plan and 2010 Urban Water Management Plan, as-builts, pump tests, and input from CMWD. GSWC did not submit a 2015 UWMP.

Spatially allocated demands were established based on metered customer consumption in November through December 2017 and production data from CMWD and GSWC's historic records. The 2017 water consumption data included meter coordinates to determine each customer's location. Future demands, including 2020 and 2027 demands, were projected using the current consumption per capita and expected population forecasts provided by SCAG. Peaking factors were determined from historical daily production data. A summary of the modeled demands in provided in Table 6-1.

Table 6-1. Summary of Modeled Demands.

System Demand	2017		2020		2027		Peaking Factor from ADD
	MGD	gpm	MGD	gpm	MGD	gpm	
Average Daily Demand (ADD)	1.45	1,008	1.47	1,018	1.51	1,050	N/A
Maximum Daily Demand (MDD)	3.05	2,117	3.08	2,138	3.18	2,206	2.1
Peak Hourly Demand (PHD)	4.57	3,175	4.62	3,206	4.76	3,308	3.15

6.2 Model Calibration

The model was calibrated based on 5 hydrant tests throughout the distribution system. After calibration, the hydrant testing results matched what the model predicted. The model was refined during calibration by adjusting pipe C-factors based on material to better reflect the hydrant testing results.

CMWD provided detailed Supervisory Control and Data Acquisition (SCADA) records from August 2017 that included tank levels and pump and well status, flow rate, and pressure. The model was calibrated for a 24-hour extended period simulation (EPS) scenario until modeled tank levels and fill and empty pattern matched the observed levels. The calibration included adjusting controls and diurnal demand factors until calibration was deemed adequate.

Section 7

SUPPLY & STORAGE ANALYSIS

SECTION 7

Supply and Storage Analysis

Ojai's primary water supply comes from 6 wells that extract groundwater and 3 turnouts that provide surface water from the main CMWD transmission main. The Ojai water distribution system contains 6 distribution zones that contain 7 pressure zones. The storage requirements for each reservoir / tank are based on the zone(s) it serves. The storage requirements include volume for operational storage, fire flow storage, and emergency storage.

7.1 Supply Analysis

IN THIS SECTION

As previously described, the Ojai water distribution system depends on both groundwater from 6 wells and surface water from 3 turnouts connected to the main CMWD water transmission system for their supply sources. Groundwater is the primary source of water, while surface water is used secondarily during high demand periods. All groundwater sources and 1 of the 3 turnouts, the San Antonio-Grand turnout, are fed into the Raw Water Zone that is treated through a pressure filter and conveyed to the San Antonio Forebay Tank before being pumped into the Main Zone through the San Antonio pump station. The Montana-Cuyama surface water turnout feeds directly into the Main Zone and the Sierra-Cuyama turnout is designed to also feed directly into the Main Zone, but is currently inoperable. Table 7-1 lists each supply source, their design and observed capacity, and the reliable supply capacity as defined by California Waterworks Standards.

Table 7-1. Design, Observed, and Reliable Supply

Supply Sources	Pressure Gradient Supplied	Design Supply (gpm)	Observed Supply (gpm)[2]	Reliable Supply (gpm)[3]
San Antonio Well #3	Raw Water	551	152	0
San Antonio Well #4	Raw Water	500	174	0
Gorham Well	Raw Water	1000	239	0
Mutual Well #4	Raw Water	275	76	0
Mutual Well #5	Raw Water	670	140	0
Mutual Well #6	Raw Water	471	280	0
San Antonio-Grand TO	Raw Water	800	800	0
Sierra-Cuyama TO[4]	Main Zone	900	0	0
Montana-Cuyama TO	Main Zone	800	800	800
San Antonio Booster A	Main Zone	1,500	1,529	1,500
San Antonio Booster B	Main Zone	1,500	1,469	0
Total Supply[1]		**3,800**	**3,798**	**2,300**

1. The total supply capacity includes the capacity of all the supply sources that directly supply the Main Zone. The total supply capacity does not include any wells or the San Antonio-Grand turnout because their ability to supply the distribution system is limited by the San Antonio Pump Station capacity.
2. The observed capacities are based on pump tests in September 2016. The turnout observed capacities are based on typical operating flow rates.
3. The reliable supply capacity is the total capacity with the largest source of supply offline based on California Waterworks Standards. Sources that supply the Raw Water Zone are not considered reliable because they are dependent on the San Antonio BPS to supply the system.
4. The Sierra-Cuyama turnout is not operational and its condition is unknown. It is assumed to be out of service now and through the future.

The historic supply reliability criteria used to analyze the Ojai distribution system includes 6 demand scenarios with different supply capacities and available storage. These 6 supply scenarios were used to evaluate the current system, and are described below:

1. The system must meet ADD for 24 hours with the design supply capacity and no storage volume. This scenario is assumed to be the normal day supply scenario and is used as a supply baseline.
2. The system must meet MDD for 24 hours with the reliable supply capacity and no storage volume.
3. The system must meet PHD for 4 hours with the reliable supply and operational storage volume.
4. The system must meet MDD plus the most stringent fire flow conditions (2,000 gpm for 3 hours) with design supply capacity and fire flow storage volume.

5. During a planned turnout outage, the system must be able to meet ADD for 7 days with the design capacity minus the turnouts, all the emergency storage volume, and half the operational storage volume.
6. During an unplanned turnout outage, the system must be able to meet MDD for 1 day and ADD for 6 days with design capacity minus the turnouts, all the emergency storage volume, and half the operational storage volume.

Table 7-2, Table 7-3, and Table 7-4 show the results of each supply reliability scenario under 2017, 2020, and 2027 demands, respectively.

Table 7-2. Reliable Supply Evaluation Under 2017 Demands

Description	Units	Average Day	Max Day	Peak Hour	MDD +FF	Planned TO Outage	Unplanned TO Outage
Duration	Hours	24	24	4	3	168	168
System Demand	gpm	1,008	2,117	3,175	4,117	1,008	1,166
Total Demand Volume	**MG**	**1.45**	**3.05**	**0.76**	**0.74**	**10.16**	**11.76**
Available Supply	gpm	3,800	2,300	2,300	3,800	3,000	3,000
Available Storage	MG	0	0	0.76	0.67	0.80	0.80
Total Available Supply	**MG**	**5.47**	**3.31**	**1.31**	**1.36**	**31.04**	**31.04**
Supply minus Demand	MG	4.02	0.26	0.55	0.62	20.88	19.28
Adequate Supply	---	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Table 7-3. Reliable Supply Evaluation Under 2020 Demands

Description	Units	Average Day	Max Day	Peak Hour	MDD +FF	Planned TO Outage	Unplanned TO Outage
Duration	Hours	24	24	4	3	168	168
System Demand	gpm	1,018	2,138	3,206	4,138	1,018	1,178
Total Demand Volume	**MG**	**1.47**	**3.08**	**0.77**	**0.74**	**10.26**	**11.87**
Available Supply	gpm	3,800	2,300	2,300	3,800	3,000	3,000
Available Storage	MG	0	0	0.76	0.67	0.80	0.80
Total Available Supply	**MG**	**5.47**	**3.31**	**1.31**	**1.35**	**31.04**	**31.04**
Supply minus Demand	MG	4.01	0.23	0.54	0.61	20.78	19.17
Adequate Supply	---	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Table 7-4. Reliable Supply Evaluation Under 2027 Demands

Description	Units	Average Day	Max Day	Peak Hour	MDD +FF	Planned TO Outage	Unplanned TO Outage
Duration	Hours	24	24	4	3	168	168
System Demand	gpm	1,050	2,206	3,308	4,206	1,050	1,215
Total Demand Volume	**MG**	**1.51**	**3.18**	**0.79**	**0.76**	**10.59**	**12.25**
Available Supply	gpm	3,800	2,300	2,300	3,800	3,000	3,000
Available Storage	MG	0	0	0.76	0.67	0.80	0.80
Total Available Supply	**MG**	**5.47**	**3.31**	**1.31**	**1.35**	**31.04**	**31.04**
Supply minus Demand	MG	3.96	0.14	0.52	0.60	20.45	18.79
Adequate Supply	---	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Based on current and projected demands, the Ojai water distribution system is expected to meet all supply reliability scenarios over the next 10 years. Based on the above analysis the MDD scenario shows the demand is close to exceeding the available supply. The groundwater well production capacities are also much less than their original production capacities, and the capacities are expected to slowly decline as the wells age. It is recommended to improve supply redundancy within the system even though all supply requirements are met based on the above analysis. Based on conversations with CMWD, it is recommended that a new interconnection be evaluated from the main CMWD water distribution system to the Ojai water distribution system and constructed to improve supply reliability and fire protection.

7.1.1 Booster Pump Supply Analysis

In addition to providing reliable supply to the whole system, the BPSs were evaluated on their ability to supply pressure zones. BPSs must be able to provide the MDD of the zone they serve with the largest pump out of service if gravity storage is available. If gravity storage is not available, the BPS must be able to meet MDD plus fire flow requirements or PHD, whichever is larger, with the largest pump out of service. This criterion only incudes the Heidelberger Boosted Zone. The Signal Zone is not usually supplied via gravity storage, but there is a check valve that opens under low pressure to allow the Signal Reservoir to provide fire flow via gravity.

Table 7-5, Table 7-6, and Table 7-7 summarize the BPS evaluation for 2017, 2020, and 2027 demands, respectively. The Signal Booster A was also not included in this analysis because it is not often used to supply the Main Zone, nor is it considered a reliable supply source. Overall, most of the BPSs can meet the MDD supply criteria except the San Antonio BPS and Heidelberger BPS which require additional capacity to meet this requirement.

The San Antonio BPS has an empty can for an additional pump, and adding a third pump of similar capacity will increase this pump station capacity to above requirement based on California Waterworks Standards. This is not recommended, though, because operating multiple pumps at the San Antonio BPS can cause extremely high pressures in the Main Zone and increase the risk for main breaks. Because there is backup power equipped at the San Antonio BPS and turnouts that directly supply the Main Zone in case the San Antonio BPS cannot keep up with the MDD, there are no recommended capacity improvements for the San Antonio BPS.

The Heidelberger BPS can reliably meet the MDD criteria, but should also contain a fire pump to provide fire protection for the zone. It is recommended to add a fire pump with a minimum 1,000 gpm capacity with backup power to provide reliable fire protection.

Recommended Standards for Waterworks also stipulate that emergency power must be sufficient to meet system average day demands and preparedness for other emergencies. Currently, 1 pump at the San Antonio BPS, Signal Booster B, and the Heidelberger BPS are equipped with backup power. The total pump capacity equipped with backup power is 1,653 gpm, which exceeds the ADD through 2027, as required for BPSs. The Arbolada BPS and Valley View BPS are not equipped with backup power, but their zones contain gravity storage that can be used during an emergency. System reliability can be increased by providing emergency power at these pump stations but is not required because the zones are also supplied by gravity storage.

Table 7-5. Pump Station Supply Analysis under 2017 Demands

Pump Station	Supply Zone	ADD (gpm)	MDD (gpm)	Required Fire Flow (gpm)	PHD (gpm)	Required Flow (gpm)	Total Design Capacity (gpm)	Firm Capacity (gpm)	Pump Station Capacity Deficiency (gpm)	Meets Supply Requirements
San Antonio	Main / Saddle Lane	958.0	2,011.8	N/A	N/A	2,011.8	3,000	1,500	511.8	No
Signal B	Signal	4.4	9.2	N/A	N/A	9.2	100	100	N/A	Yes
Arbolada	Running Ridge	29.3	61.5	N/A	N/A	61.5	500	250	N/A	Yes
Valley View	Heidelberger Tank	16.3	34.2	N/A	N/A	34.2	500	250	N/A	Yes
Heidelberger	Heidelberger Boosted	0.4	0.8	1,250	1.13	1,250.8	150	75	1,175.8	No

Table 7-6. Pump Station Supply Analysis under 2020 Demands

Pump Station	Supply Zone	ADD (gpm)	MDD (gpm)	Required Fire Flow (gpm)	PHD (gpm)	Required Flow (gpm)	Total Design Capacity (gpm)	Firm Capacity (gpm)	Pump Station Capacity Deficiency (gpm)	Meets Supply Requirements
San Antonio	Main / Saddle Lane	967.1	2,031.0	N/A	N/A	2,031.0	3,000	1,500	531.0	No
Signal B	Signal	967.1	2,031.0	N/A	N/A	2,031.0	100	100	N/A	Yes
Arbolada	Running Ridge	4.4	9.3	N/A	N/A	9.3	500	250	N/A	Yes
Valley View	Heidelberger Tank	29.5	62.0	N/A	N/A	62.0	500	250	N/A	Yes
Heidelberger	Heidelberger Boosted	16.4	34.5	1,250	1.15	34.5	150	75	1,175.7	No

Table 7-7. Pump Station Supply Analysis under 2020 Demands

Pump Station	Supply Zone	ADD (gpm)	MDD (gpm)	Required Fire Flow (gpm)	PHD (gpm)	Required Flow (gpm)	Total Design Capacity (gpm)	Firm Capacity (gpm)	Pump Station Capacity Deficiency (gpm)	Meets Supply Requirements
San Antonio	Main/ Saddle Lane	997.9	2,095.6	N/A	N/A	2,095.6	3,000	1,500	595.6	No
Signal B	Signal	997.9	2,095.6	N/A	N/A	2,095.6	100	100	N/A	Yes
Arbolada	Running Ridge	4.6	9.6	N/A	N/A	9.6	500	250	N/A	Yes
Valley View	Heidelberger Tank	30.5	64.0	N/A	N/A	64.0	500	250	N/A	Yes
Heidelberger	Heidelberger Boosted	17.0	35.6	1,250	1.19	35.6	150	75	1,175.8	No

7.2 Storage Analysis

The storage requirements are calculated for each reservoir / tank based on the zone or zones it serves. The storage requirements include volume for operational storage, fire flow storage, and emergency storage. The criteria for each type of storage is listed in Section 5 and described in more detail in the following subsections.

It is important to note that this storage analysis includes different storage requirements than presented in the 2009 Water Master Plan because the former assumptions of how the different pressure zones are connected are no longer true. Some assumptions made in this storage analysis that differ from the 2009 Water Master Plan are listed below:

- The fire flow storage requirements cannot be shared between the Running Ridge Zone and the Heidelberger Tank Zone. The only connection between these zones is at the Valley View BPS that pumps water from the Running Ridge Zone to the Heidelberger Zone. The Valley View BPS has a total capacity of 500 gpm and a firm pumping capacity of 250 gpm. The firm pumping capacity (250 gpm) may be counted as an available supply to reduce fire storage volume in the Heidelberger Tank and the volume included within the Running Ridge Tanks, but this analysis assumed the fire flow is supplied via gravity and the fire flow volume should be contained in each zone's storage tanks for conservative estimates. Also, there is no connection for the Heidelberger Tank Zone to supply the Running Ridge Zone during a fire emergency, so these zones were analyzed separately.
- The San Antonio Forebay Tank does provide storage for the distribution system. In the previous master plan, the San Antonio Forebay Tank had a volume of 0.05 MG and was used to provide suction pressure for the San Antonio BPS, but did not contain enough storage to be counted in the analysis. Since the completion on the 2009 Water Master Plan, the 0.05 MG San Antonio Forebay has been replaced with a 0.5 MG Forebay Tank. Because the San Antonio Forebay has significantly more storage, it was included in this storage analysis.

7.2.1 Operational Storage

Operational storage is the volume of water needed to equalize the daily supply and demand. Without operational storage, water supply facilities would need to be sized to meet the instantaneous peak demands throughout the day. Operational storage is also available during average day demands to allow pumps and wells to cycle off during the day and fill reservoirs during the night. California Waterworks standards state a distribution system with 1,000 or more service connections shall be able to meet 4 hours of PHD with source capacity, storage capacity, and/or emergency source connections. The Ojai system has historically used 25% of MDD for 24 hours as their operational storage requirement, which is equal to the operational storage calculated using California Waterworks Standards due to a peaking factor of 1.5 from MDD and PHD. Table 7-8 includes the calculated required operational storage for 2017, 2020, and 2027 system demands based on California Waterworks Standards.

Table 7-8. Operational Storage Requirements

Zone	2017 Operational Storage (gallons)	2020 Operational Storage (gallons)	2027 Operational Storage (gallons)
Main	714,000	722,600	750,800
Saddle Lane	10,200	10,300	10,700
Signal	3,300	3,400	3,500
Running Ridge	22,100	22,400	23,300
Heidelberger Tank	12,300	12,500	12,900
Heidelberger Boosted	300	300	300
Total	**762,200**	**771,500**	**801,500**

7.2.2 Fire Flow Storage

The fire flow requirements are set by the local fire officials and are determined by the California Building Code construction type and square footage of the fire area. The City of Ojai's fire flow requirements were set by The Ventura County Fire Department based on land use category and are outlined in Table 7-9.

Table 7-9. Fire Flow Requirements Based on Land Use

Land Use Category	Minimum Required Fire Flow (gpm)	Duration (hour)
Public Facilities, Commercial, Business, Schools	2,000	3
Hospitals	2,000	3
Parks, Recreational Facilities	1,750	3
Residential	1,000	2

The fire flow storage requirements assume only 1 fire will occur within the distribution system at a time. Because the Main Zone and the Saddle Lane Zone share the storage within the Arbolada Reservoir and San Antonio Forebay Tank, the fire flow storage calculated for these zones were combined. Zones that do not contain gravity storage, but are supplied via pump stations, assume that their fire flow storage is contained in the zone that supplies their pump station. For example, the Heidelberger Boosted Zone's fire flow is stored in the Heidelberger Tank. Table 7-10 lists the required fire flow storage requirements for the system's reservoirs and the assumed zones they supply. It is assumed the current fire flow storage requirements are applicable for future demands as well.

Table 7-10. Fire Flow Storage Requirements

Reservoir(s)	Zone(s) the Tank / Reservoir Supplies for Fire Protection	Most Stringent Fire Flow Requirement based on Land Use (gpm)	Duration (hour)	Required Fire Flow Volume (gal)
San Antonio Forebay Tank, Arbolada Reservoir	Main Zone, Saddle Lane Zone	2,000	3	360,000
Signal Tank	Signal Zone	1,000	2	120,000
Running Ridge 1 Tank, Running Ridge 2 Tank	Running Ridge Zone	1,000	2	120,000
Heidelberger Tank	Heidelberger Tank Zone, Heidelberger Boosted Zone	1,000	2	120,000

7.2.3 Emergency Storage

According to the American Water Works Association (AWWA) Manual M19 Emergency Planning for Water Utilities, emergency storage is water that is available for use by water system customers in the event of a longer-term disruption of water supply. “Emergency storage provides water during events, such as pipeline failures, equipment failures, power outages, pumping system failures, water treatment plant failures, raw water contamination, or natural disasters” (6). The quantity of emergency storage is determined by the agency based on the required water system dependability, risk acceptance, and water quality in storage reservoirs. Oversized reservoirs can potentially have a negative impact on stored water quality because of increased difficultly in maintaining the chlorine residual and a higher risk of exceeding disinfection byproduct limits.

The Ojai water distribution system has historically used 12 hours of ADD as acceptable emergency storage. This criterion was also used to evaluate the required emergency storage under current demands and through the next 10 years. Table 7-11 includes the emergency storage requirements based 12 hours of ADD storage.

Table 7-11. Emergency Storage Requirements

Zone	2017 Emergency Storage (gal)	2020 Emergency Storage (gal)	2027 Emergency Storage (gal)
Main	680,000	686,500	708,400
Saddle Lane	9,700	9,800	10,100
Signal	3,200	3,200	3,300
Running Ridge	21,100	21,300	21,900
Heidelberger Tank	11,700	11,800	12,200
Heidelberger Boosted	300	300	300
Total	**726,000**	**732,900**	**756,200**

7.2.4 Total Storage Requirements

The total storage requirement is the summation of the operational, fire flow, and emergency storage. Table 7-12, Table 7-13, and Table 7-14 summarize the storage requirements per zone for years 2017, 2020, and 2027, respectively. Under this analysis, the Ojai water distribution system is predicted to have a storage deficiency of just under 450,000 gallons by 2027 if storage volume is not increased. The storage requirements evaluated between each year does not vary greatly because demands are not expected to increase substantially over the next 10 years. It is recommended that storage projects use 2027 storage requirements to determine the required volume.

The San Antonio Forebay Tank was constructed in 2011 and has a nominal 500,000-gallon storage volume

Table 7-12. Total Storage Surplus and Deficit under 2017 Demands

Zone(s)	Reservoir/ Tank	Operational Volume (gal)	FF Volume (gal)	Emergency Volume (gal)	Total Required (gal)	Available Volume (gal)	Surplus / Deficit
Main & Saddle Lane	San Antonio & Arbolada	724,200	360,000	689,700	1,773,900	1,500,000	-273,900
Signal	Signal	3,300	120,000	3,200	126,500	300,000	173,500
Running Ridge	Running Ridge	22,100	120,000	21,100	163,200	94,000	-69,200
Heidelberger Tank & Heidelberger Boosted	Heidelberger	12,600	120,000	12,000	144,600	100,000	-74,600
Total		**762,200**	**720,000**	**726,000**	**2,208,200**	**1,994,000**	**-387,700**

Table 7-13. Total Storage Surplus and Deficit under 2020 Demands

Zone(s)	Reservoir/ Tank	Operational Volume (gal)	FF Volume (gal)	Emergency Volume (gal)	Total Required (gal)	Available Volume (gal)	Surplus / Deficit
Main & Saddle Lane	San Antonio & Arbolada	731,100	360,000	696,300	1,787,400	1,500,000	-287,400
Signal	Signal	3,400	120,000	3,200	126,600	300,000	173,400
Running Ridge	Running Ridge	22,300	120,000	21,300	163,600	94,000	-69,600
Heidelberger Tank & Heidelberger Boosted	Heidelberger	12,700	120,000	12,100	144,800	100,000	-44,800
Total		**769,500**	**720,000**	**732,900**	**2,222,400**	**1,994,000**	**-401,800**

Table 7-14. Total Storage Surplus and Deficit under 2027 Demands

Zone(s)	Reservoir/ Tank	Operational Volume (gal)	FF Volume (gal)	Emergency Volume (gal)	Total Required (gal)	Available Volume (gal)	Surplus / Deficit
Main & Saddle Lane	San Antonio & Arbolada	754,400	360,000	718,500	1,832,900	1,500,000	-332,900
Signal	Signal	3,500	120,000	3,300	126,800	300,000	173,200
Running Ridge	Running Ridge	23,000	120,000	21,900	164,900	94,000	-70,900
Heidelberger Tank & Heidelberger Boosted	Heidelberger	13,100	120,000	12,500	145,600	100,000	-45,600
Total		**794,000**	**720,000**	**756,200**	**2,270,200**	**1,994,000**	**-449,400**

Because the analysis looks at storage in each zone separately, each zone has a large required volume. Excess volume in storage tanks provide water for fire and emergency situations, but can have negative impacts on water quality by preventing turnover in the reservoir and potentially causing disinfectant residual loss and potential formation of disinfectant biproducts. To balance providing adequate storage in a system for fire safety and reducing the risk of water quality issues from excess storage, the fire and emergency storage volume can be shared between multiple reservoirs in different zones. The recommended solutions to improve storage volume analyze the potential for sharing storage in the Upper Zones (Heidelberger Tank, Heidelberger Boosted, and Running Ridge) and the Lower Zones (Main, Saddle Lane, and Signal).

Potential solutions to improve storage in the Upper Zones are described below in 3 alternatives for the Running Ridge Zone. The Running Ridge Zone was the focus for storage improvements because the Running Ridge Tanks are at the end of their useful life and should be abandoned as soon as possible. More detail on the condition of the system is presented in Section 10.

Running Ridge Alternative 1: Convert the Running Ridge Zone into a pumped pressure zone. This will require upgrades at the Arbolada BPS, Valley View BPS, and abandonment of the Running Ridge Tanks. With the abandonment of the Running Ridge Tanks, the Arbolada BPS will require an additional 250 gpm booster pump, increasing the total capacity to 750 gpm, and reliable backup power for each pump. These pumps should either be equipped with VFDs or a hydropneumatic tank should be installed to allow the pumps to cycle on and off. The Valley View BPS should also be upgraded to a capacity of 1,000 gpm (2-250 gpm pumps and a 500 gpm pump) and backup power added. Due to the existing condition of the Valley View BPS and its location below grade, it is recommended that this BPS is completely rebuilt above ground near the existing location. A PRV is also required at the Valley View BPS to allow water from the Heidelberger Tank Zone to feed the Running Ridge Zone during emergency situations, such as during a fire. The risk with using a PRV to provide fire flow for a lower pressure zone is that when PRVs fail, they fail open. If a PRV at the Valley View BPS failed, pressures in the lower part of the Running Ridge Zone may exceed 200 psi, increasing risk of pipes bursting and causing damage. Figure 7-1 depicts this alternative in a revised hydraulic profile of the system.

This alternative does not increase storage volume for the Upper Zones, but rather improves the reliable supply between zones through pump station upgrades, backup power, and a PRV to reduce the storage requirements for each zone. Since only 1 fire is expected to occur at a time in the system, the fire storage can be shared between the Heidelberger Tank and Arbolada Reservoir. With the revised storage requirements based on reliable supply and shared fire storage, the existing storage volume in the Heidelberger Tank and Arbolada Reservoir is sufficient for the Upper Zones.

Running Ridge Alternative 2: Abandon the existing Running Ridge Tanks and construct a new reservoir in the same or an alternative location to serve the Running Ridge Zone. The existing reservoir site is inaccessible by vehicle and it may be too costly to reconstruct at the existing site. On the other hand, land is extremely limited within the Running Ridge Zone, so the existing reservoir site may be the only location available for a new reservoir. There is less risk in zones that contain gravity storage because the supply does not rely on power at a pump station. With this project, CMWD can construct a new tank with a similar amount of storage volume as the current tanks or increase the volume. This will be highly dependent on site restrictions.

- ***Running Ridge Alternative 2A:*** If a similar to the existing volume Running Ridge Tank, 100,000 gallons, were constructed, a PRV at the Valley View BPS will be required to provide fire flow to the Running Ridge Zone. Like Running Ridge Alternative 1, if the PRV fails it can cause pressures exceeding 200 psi in the southern part of the Running Ridge Zone This allows the fire storage volume in the Running Ridge Zone to be shared between the Running Ridge Tank and the Heidelberger Tank. Without improvements at the Valley View BPS, all the fire and emergency storage must be contained in the Heidelberger Tank for the Heidelberger Zone, which predicts a 45,600 gallon storage deficit by 2027. Rather than construct additional storage in the Heidelberger Zone, it is recommended to improve the Valley View BPS with increased capacity and redundancy, so the fire and emergency storage volume can be shared between the Running Ridge and Heidelberger Tanks in both zones. Figure 7-2 portrays this alternative in a revised hydraulic profile of the system.
- ***Running Ridge Alternative 2B:*** If the chosen reservoir site allows additional storage, an adequately sized 200,000 gallon tank will be able to provide operational, fire, and emergency storage for the Running Ridge Zone. This project reduces the risk associated with a PRV failing at the Valley View BPS and extremely high pressures in the Running Ridge Zone. With this project there will still be a 45,600 gallon storage deficit in the Heidelberger Tank Zone for fire and emergency storage. Either additional storage in the Heidelberger Tank Zone can be constructed, which may impact water quality, or improvements can be made to the Valley View BPS, including increased capacity and redundancy so additional fire flow volume can be shared within the larger Running Ridge Tank. Figure 7-3 shows this alternative in the system hydraulic profile.

Running Ridge Alternative 3: Another potential solution to improve storage in the Running Ridge Zone is to utilize existing storage tanks within the main Casitas water distribution system. CMWD staff noted that there is a storage reservoir not currently connected to the Ojai system, named the Fairview Tank, that is at a similar elevation as the existing Running Ridge Tanks. Rather than constructing a new tank, additional piping constructed from the Casitas Fairview Tank to the Running Ridge Zone may improve storage. Further analysis is required to evaluate if this is a feasible solution.

It is recommended that CMWD perform an in-depth alternatives evaluation of the solutions presented above to determine the best solution to improve storage in the Running Ridge and Heidelberger Zones.

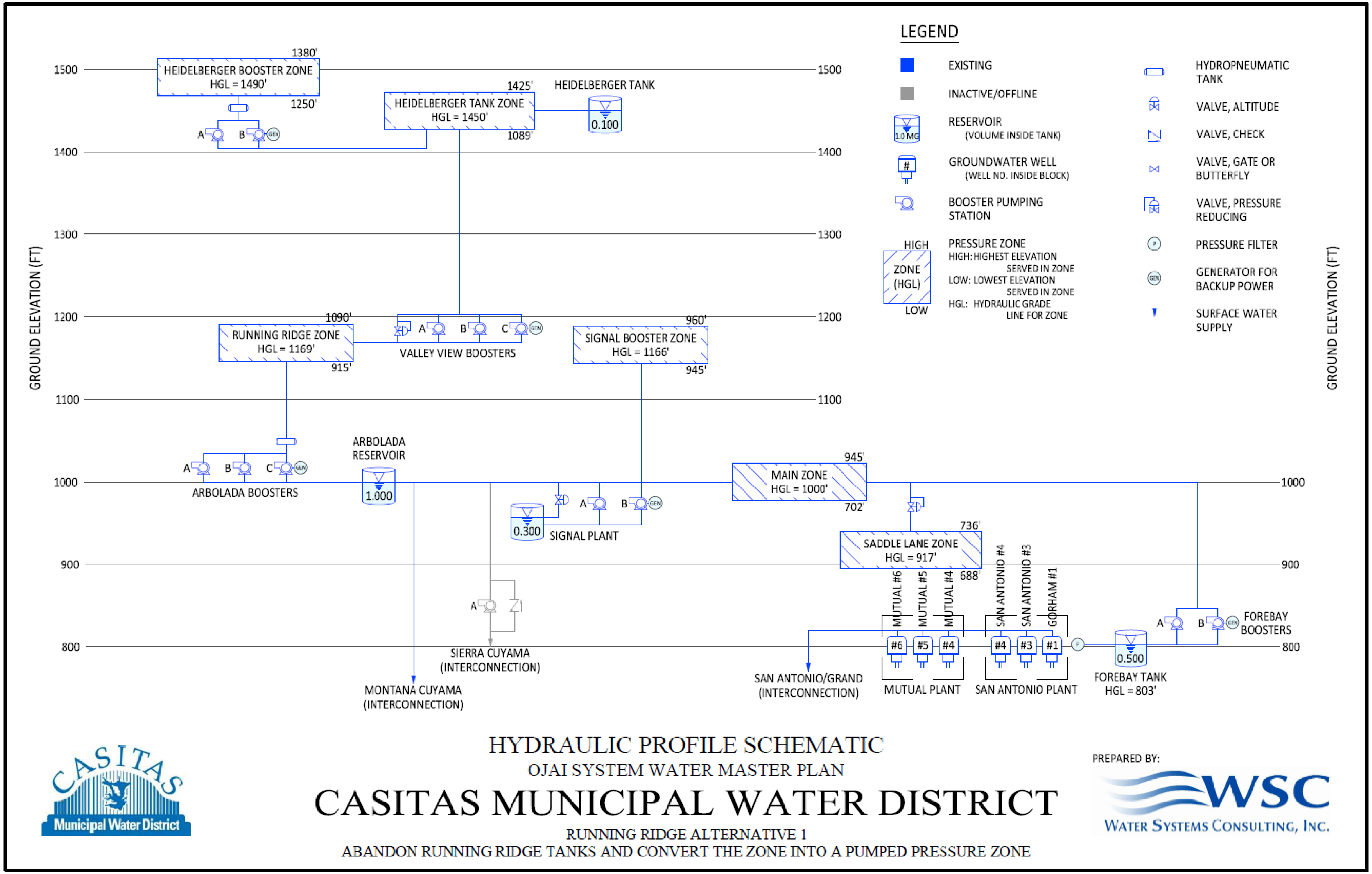
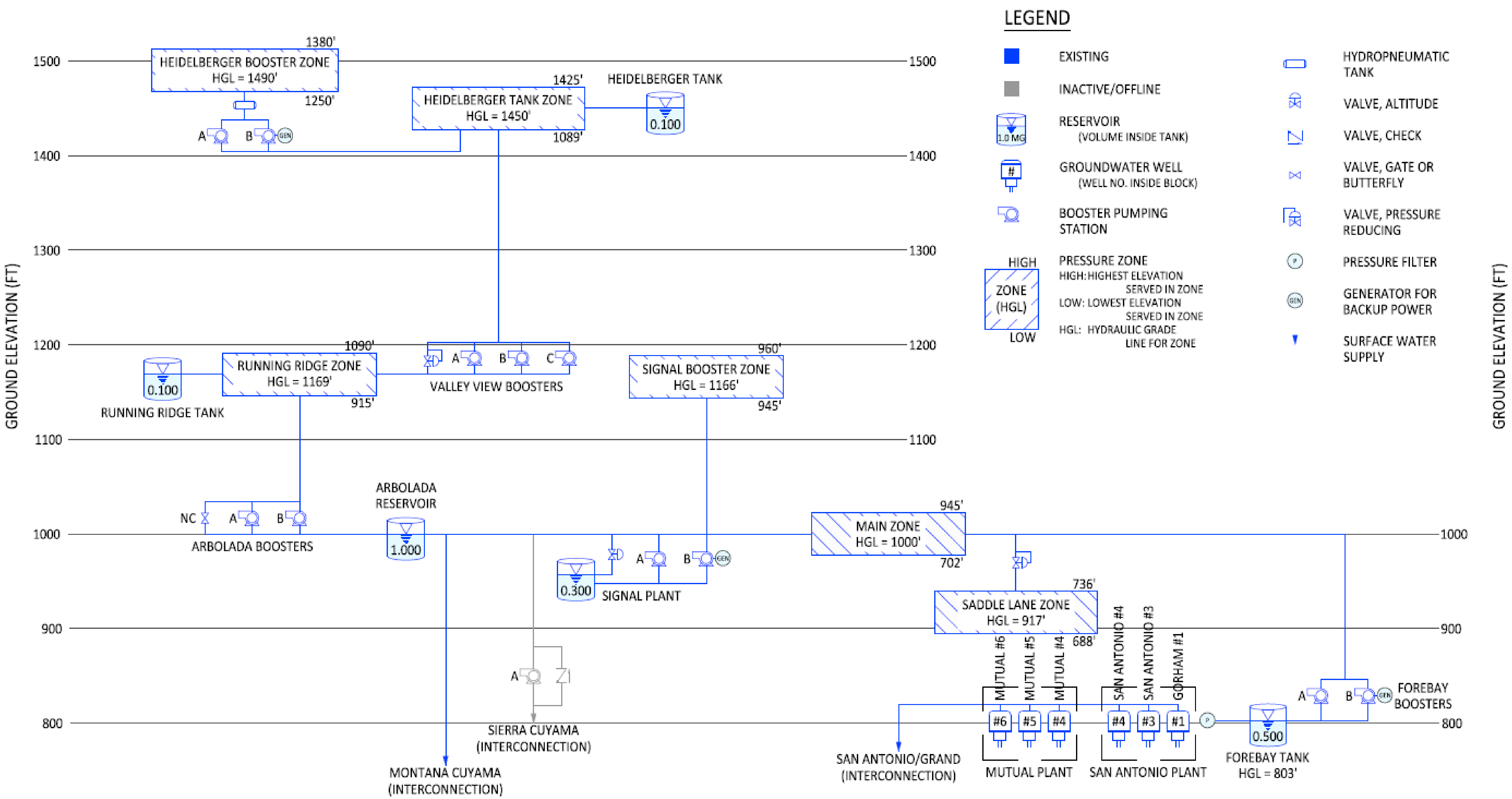


Figure 7-1. Running Ridge Alternative 1



HYDRAULIC PROFILE SCHEMATIC
OJAI SYSTEM WATER MASTER PLAN
CASITAS MUNICIPAL WATER DISTRICT
RUNNING RIDGE ALTERNATIVE 2A
SINGLE 100,000 GALLON STORAGE RESERVOIR

PREPARED BY: WSC WATER SYSTEMS CONSULTING, INC.

Figure 7-2. Running Ridge Alternative 2A

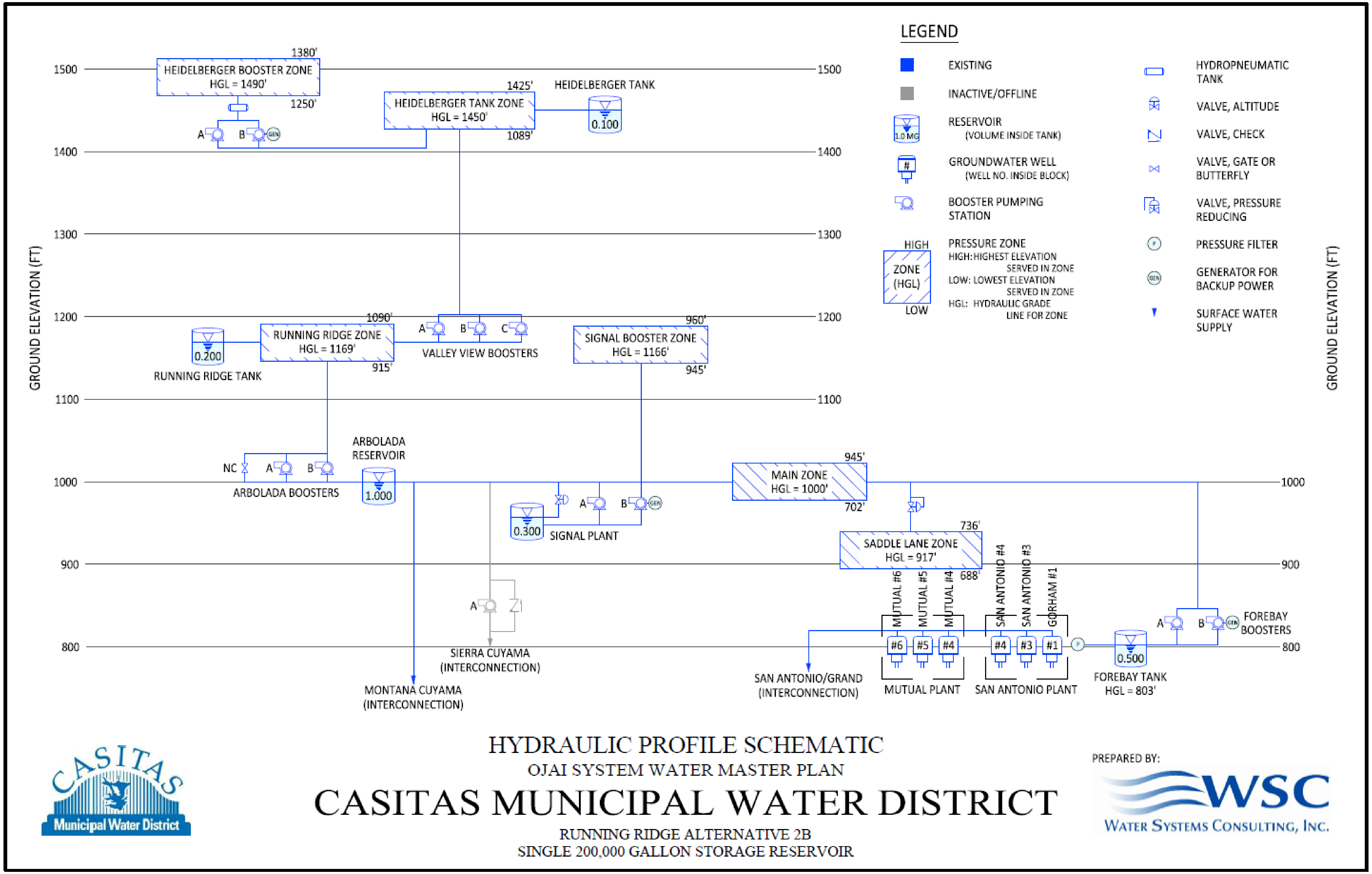


Figure 7-3. Running Ridge Alternative 2B

Similarly, storage for the Lower Zones (Main, Saddle Lane, and Signal) should be analyzed together because they are able to share fire and emergency storage. When the pressure drops in the Main Zone due to a large leak or when a hydrant is opened, water can flow from the Signal Tank through the Signal Booster A Pump manifold to the Main Zone. Although Table 7-14 shows a Main Zone storage deficiency of approximately 333,000 gallons in 2027, the surplus storage in the Signal Tank can be counted towards that deficient volume. When assuming only 1 fire will occur at a time in the system and the storage can be shared, there is only a storage deficiency in the Lower Zones of 39,700 gallons by 2027.

Potential solutions to improve storage in the Lower Zones are described below in 3 alternatives for the Signal Zone. The Signal Zone is the focus for storage improvements because the Signal Tank is reaching the end of its useful life. The tank requires recoating immediately, but due to the tank's age, it may be more cost effective overall to abstain from recoating in lieu of abandoning and reconstructing the tank. More detail on the condition of the system is presented in Section 10. The Signal Tank also has excess storage which can reduce water quality. CMWD has experienced water quality degradation within the Signal Tank and has addressed it with increased tank cycling. All these issues were considered when analyzing solutions to improve storage within the lower zones.

Signal Zone Alternative 1: To keep the system operating as is, the Signal Tank can be reconstructed at the same location with a greater storage volume, closer to 350,000 gallons, to improve storage within the Main and Signal Zones. The main issue with this solution is there is still excess storage in the Signal Tank that may cause water quality issues. Figure 7-4 depicts this alternative.

Signal Zone Alternative 2: If additional land is available in the Signal Zone at a higher elevation, CMWD may be able to abandon the existing Signal Tank and construct a new Signal Tank to hydraulically operate with the Arbolada Reservoir. This is beneficial because it improves storage redundancy with 2 gravity storage reservoirs serving the Main Zone and reduces water quality impacts in the Signal Tank. A new BPS for the Signal Zone will be required to serve the homes at the higher elevations. The BPS should include 2 pumps with backup power and should consider if a check valve or fire pump will be required for fire protection in the Signal Zone during preliminary design. Figure 7-5 portrays this alternative in the system hydraulic profile.

Signal Zone Alternative 3: Another solution is to abandon the Signal Tank entirely and construct a more robust BPS to serve the Signal Zone. The BPS should include 2 booster pumps with backup power equipped with VFDs or adjacent to a hydropneumatic tank and a fire pump for the zone. The feasibility of this alternative is dependent on the suction pressure available at the BPS location. Without the Signal Tank, all the storage for this zone will be contained in the Main Zone, and a new 0.5 MG tank adjacent to the San Antonio Forebay should be constructed to improve storage in the Lower Zones. Figure 7-6 includes this alternative within the system hydraulic profile.

Any of the solutions presented above could improve supply reliability and storage in the Ojai water distribution system, but should be further evaluated in an alternatives evaluation to determine the best solution for the system. Project costs assume conceptual analysis, preliminary engineering, and construction. Depending on the outcome of the recommended alternative, project costs presented in this Water Master Plan may vary greatly.

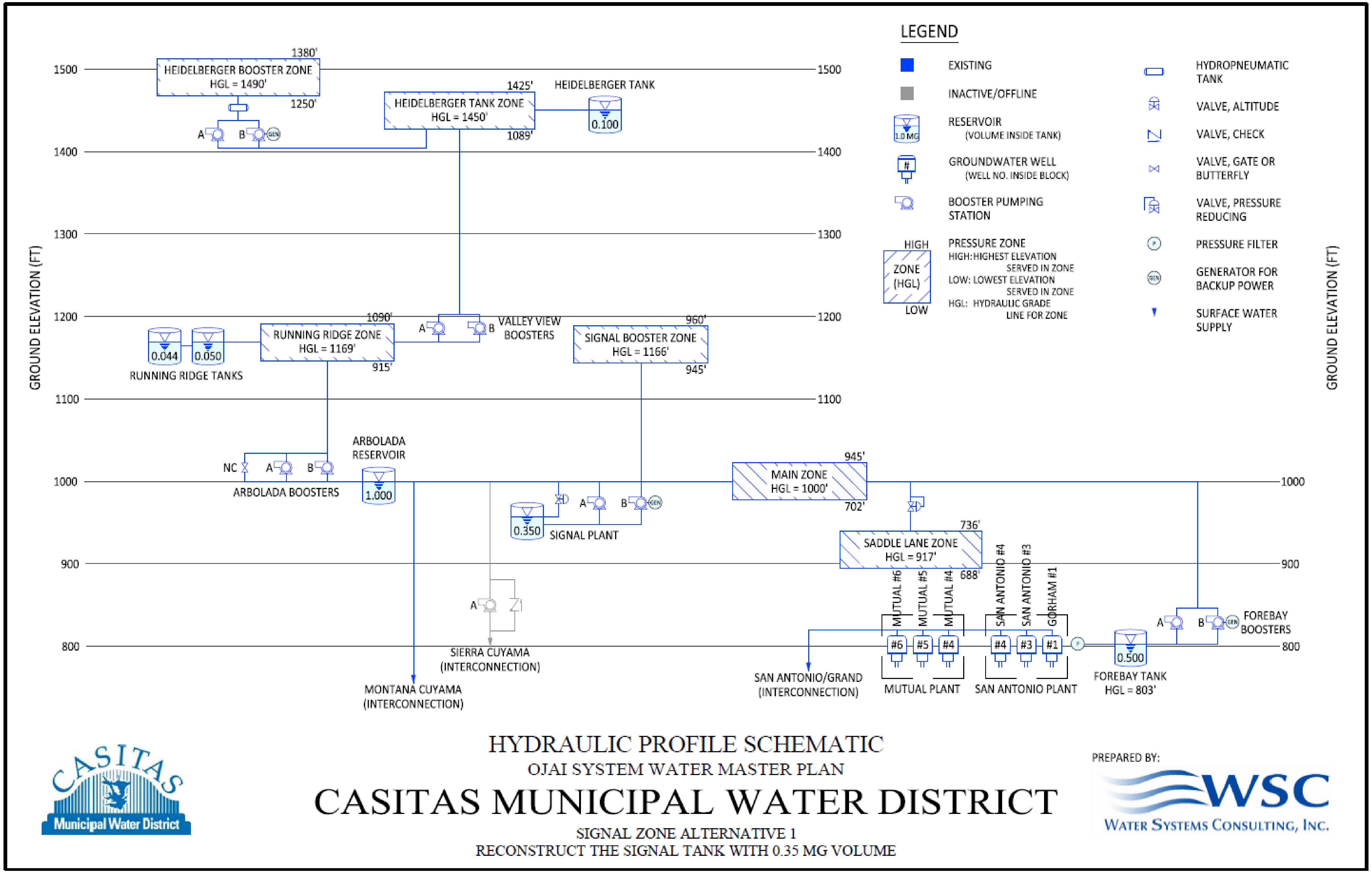


Figure 7-4. Signal Zone Alternative 1

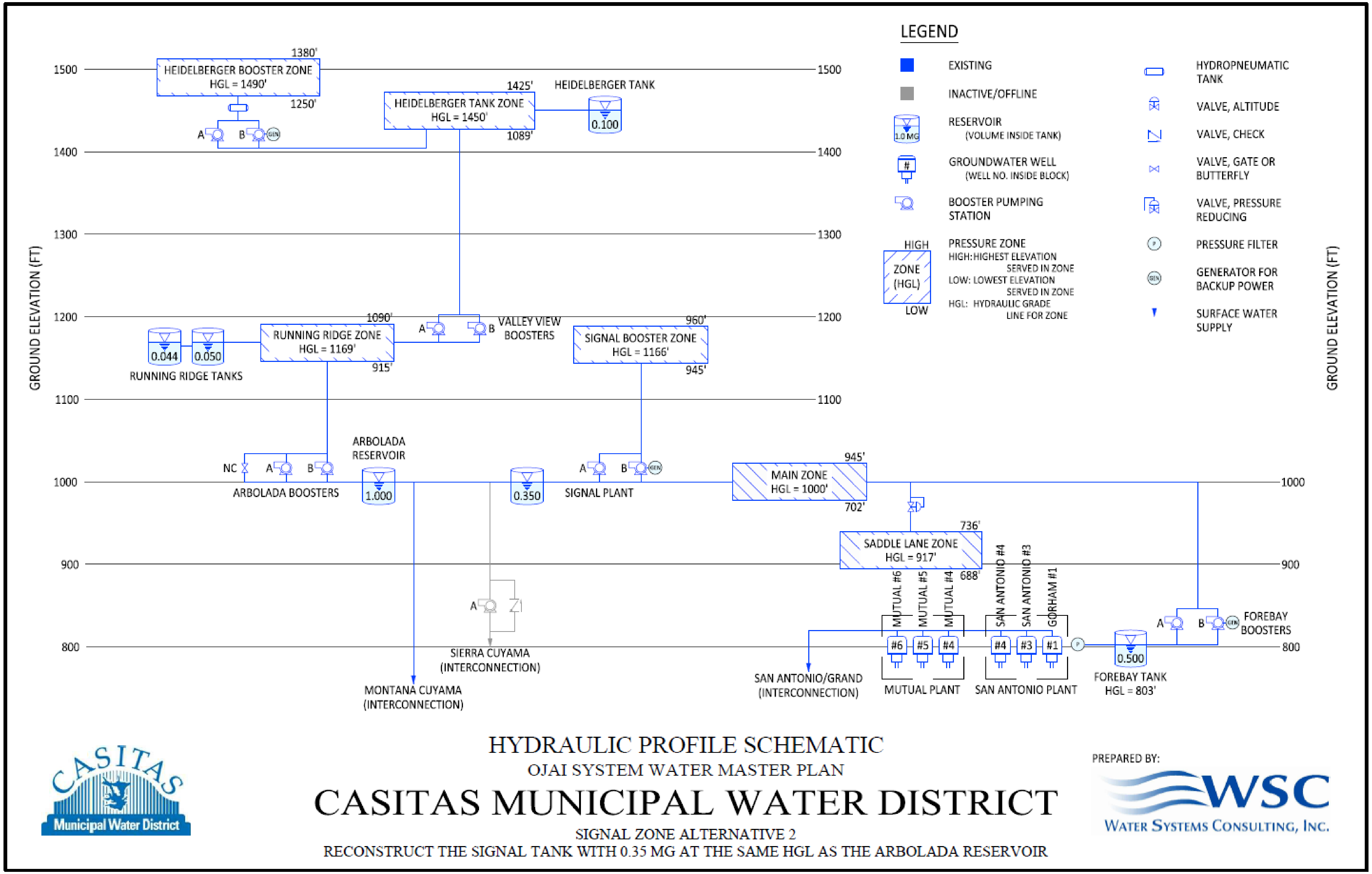


Figure 7-5. Signal Zone Alternative 2

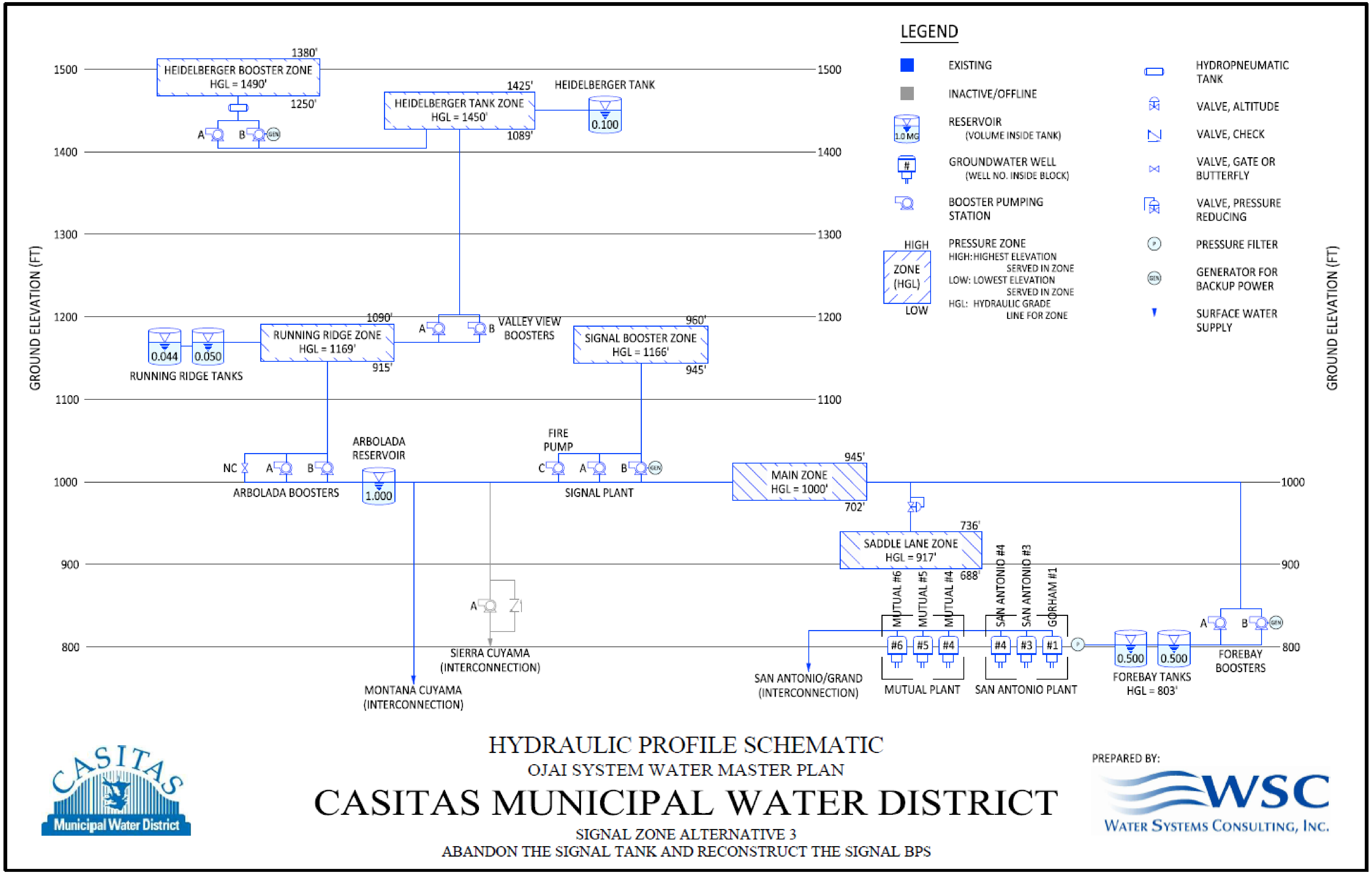


Figure 7-6. Signal Zone Alternative 3

Section 8

SYSTEM CAPACITY ANALYSIS

SECTION 8

System Capacity Analysis

This section analyzes the Ojai water distribution system pressure, available fire flow, pipeline velocities, and fire hydrant spacing. Areas that do not meet pipeline criteria are described and recommendations to improve the system are included in this section.

8.1 Pressure Analysis

IN THIS SECTION

Pressure Analysis

Fire Flow Analysis

Pipeline Velocity

Hydrant Spacing

An important part of a water distribution system is the pressure supplied to consumers. Pressures should be adequate to supply services, but not too high to cause damage to appliances or pipelines. Historically, the Ojai water distribution system has been evaluated based on a minimum pressure of 40 psi and a maximum pressure of 125 psi under ADD, MDD, and PHD for all new developments. Ojai is located just south of Los Padres National Forest and Topatopa Mountains, and mountainous regions can be notoriously difficult to maintain adequate water pressures due to the elevation variation across the distribution system. As mentioned, the Ojai water distribution system supplies water over ground elevations ranging from 675 to 1,427 feet above MSL. Even with careful planning of the water distribution system, it may be difficult for the Ojai water distribution system to maintain pressures between the ideal range at all locations due to the land topology.

The system pressure was evaluated under ADD, MDD, and PHD for 2017, 2020, and 2027 demands. Because the demands over the next 10 years are not expected to increase significantly, the pressure across the distribution system is also not expected to change significantly in the next 10 years. The pressure in the system can change significantly based on the water level in the storage tanks and the pump station operations. To best characterize system pressures, the model used the typical operating status for facilities under each daily demand alternative. Table 8-1 includes the operational assumptions for each demand alternative.

Table 8-1. Operational Assumptions for each Pressure Analysis Demand Scenario

Facility	ADD	MDD	PHD
All Wells	Available	Available	Available
San Antonio BPS	No Pumps Operating	1 Pump Operating	1 Pump Operating
Arbolada BPS	No Pumps Operating	1 Pump Operating	1 Pump Operating
Signal BPS	Signal Booster B Operating	Signal Booster B Operating	Signal Booster B Operating
Valley View BPS	No Pumps Operating	1 Pump Operating	1 Pump Operating
Tank Volume	All Tanks 90% Full	All Tanks 67% Full	All Tanks 67% Full
Turnout Operation	All Turnouts Off	All Turnouts Available	All Turnouts Available

The model was run under each demand alternative with the operational settings in the table above. Between each scenario, the pressures varied 5-10 psi at a location, but the location of pressure deficiencies did not change. Because the Ojai water distribution system is relatively small and has low demands, the pressure does not vary greatly between demand scenarios like in larger distribution systems with large demands and demand fluctuations. This allows the Ojai water distribution system to have relatively steady pressures throughout the year.

Figure 8-1 includes a map of the average pressures experienced across the water distribution system. Overall, the pressure within the Ojai distribution system falls within the acceptable pressure range of 40 -125 psi. There are, however, specific locations with a pressure outside of this range, typically due the location's elevation. These locations and potential mitigation measures to improve service pressures are listed below:

- Within the Main Zone, pressures are modeled below 40 psi along Del Norte Road below the Arbolada Reservoir and at a high elevation point along Rancho Drive west of Del Norte Road. Both these locations may experience low pressure due to their elevation in comparison to the Arbolada Reservoir. Although there is little that can be done to increase the pressure in these locations because it is due to the elevation, CMWD manages the pressure by limiting the services in low pressure areas and connecting the services to higher pressure zones when possible. Currently, the homes south of the Arbolada Reservoir are served by the Running Ridge Zone and the first service below the Arbolada Reservoir is far enough south of the reservoir that pressures typically exceed 40 psi. The other location along Ranch Drive only affects 1 service and is predicted to have pressures from 35 - 40 psi. Since this location is not extensive and the pressures are only just below the 40 psi minimum requirement, no improvements are recommended.

- Also within the Main Zone, there are 3 locations modeled to have high pressures near 125 psi: Near the southern end of Oak Creek Lane, along the southern end of the dead end main along Montgomery Street; and at 1 node along Fulton Street just north of Bryant Circle. Since these locations are limited to a single node, no improvements are recommended. It is important to note that pressures in the southern part of the Main Zone are very high and typically above 80 psi. High water pressures can cause damage to water lines, weaken water heaters, overwhelm expansion tanks and cause water hammer, or overwhelm or break other valves or appliances in the home. Services off main lines with high pressures above 80 psi require a pressure regulator on the service line to reduce pressure at a service per the California Plumbing Code Section 608.2. Reducing water pressure will protect appliances and may also result in saving water by reducing the amount of water flowing from fixtures. CMWD should equip all new and existing services that may experience high pressures above 80 psi with a pressure regulator.
- In the Running Ridge Zone, pressures are below 40 psi just below the Running Ridge Tanks and along the western end of Running Ridge Trail. There are currently no services just below the Running Ridge Tanks, but there are 4 services along Running Ridge Trail modeled to have pressures between 30-35 psi due to their elevation. To increase low service pressures, these homes can install a small booster and bladder tank to improve pressures.
- The Heidelberger Tank Zone has the largest pressure range, with low pressures below 40 psi experienced in the northern part of the zone just below the Heidelberger Tank and high pressures exceeding 150 psi at the very southern portion of the zone along Foothill Road. In the northern part of the zone, pressure along the private road that parallels Foothill Road ranges from 35 - 40 psi. Because the pressure is only slightly below 40 psi, no improvements are recommended. These homes can install a small booster pump and bladder tank on their side of the service line to increase pressures. In the southern portion of the zone on the discharge side of the Valley View BPS, pressures can be up to 150 psi due to the 340 feet elevation difference from the Heidelberger Tank. To alleviate high pressures in the southern portion of this zone, CMWD can relocate the Valley View BPS to a higher elevation. CMWD should guarantee all services in the southern portion of this zone are currently equipped with a pressure regulator to prevent damage from high pressures.

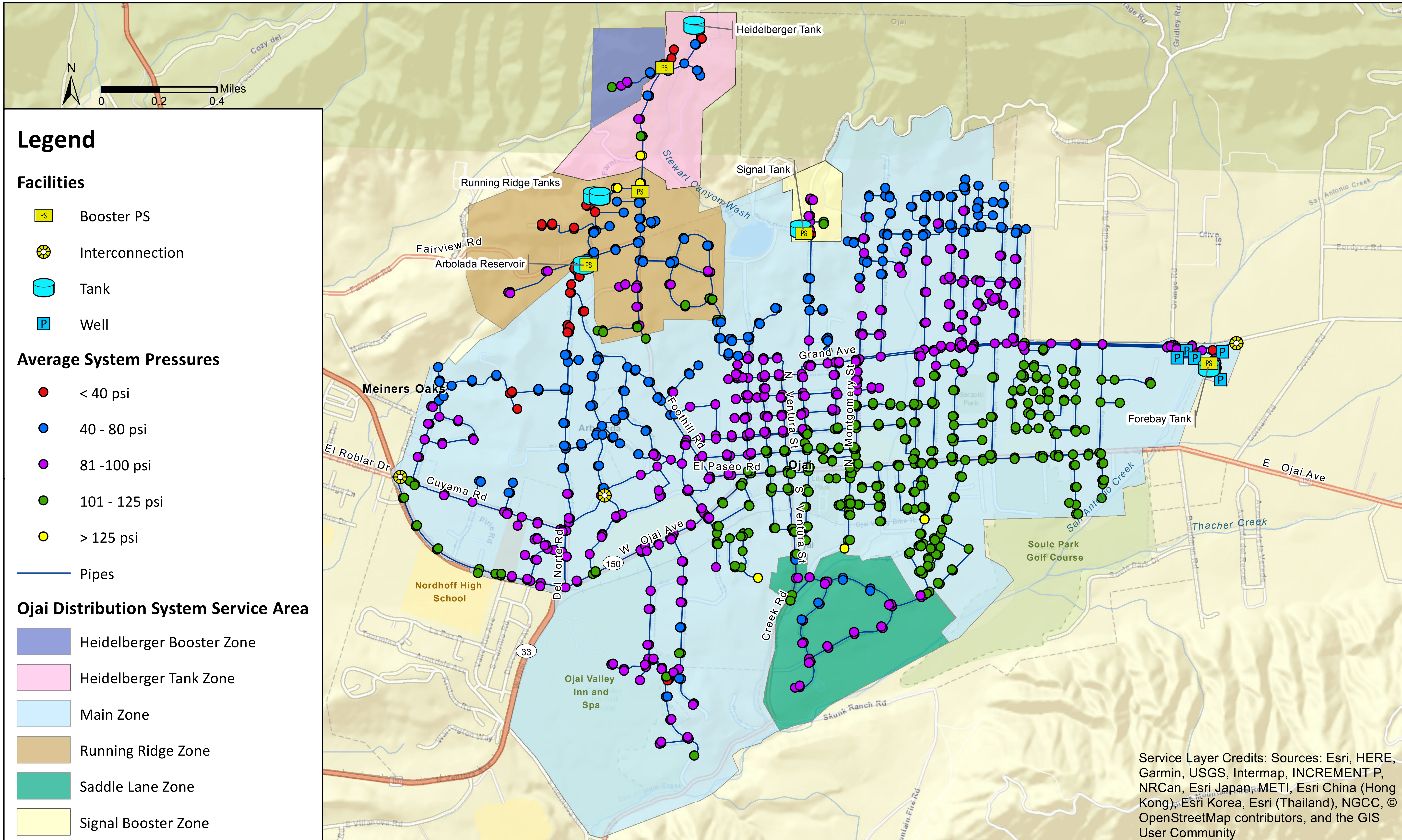


Figure 8-1. Average System Pressure across the Ojai Distribution System

8.2 Fire Flow Analysis

An equally important function of a water distribution system as supplying high-quality water to consumers is providing adequate protection during a fire. The system was designed to provide 500 gpm of fire flow for 1 hour, but current fire flow requirements in Ojai are set using requirements set forth in the California Fire Code by the Ventura County Fire Chief. Ojai's fire flow requirements are based on land use category, and require 2,000 gpm of flow near public facilities, commercial and business areas, schools, and hospitals, 1,750 gpm of flow near parks and recreational facilities, and 1,000 gpm of flow in residential zones. Most of Ojai is zoned as residential with some commercial, mixed use, and public facilities zoning, according to SCAG.

The current available fire flow in the system was modeled using the calibrated hydraulic model. A fire flow scenario was created and run to evaluate the available fire flow at each fire hydrant while maintaining a residual pressure in the zone of 20 psi. For a conservative fire flow analysis, MDD was assumed, the reservoirs were set to half full, all the wells and turnouts were turned off or closed, and all the pumps were turned off except those with backup power. A single pump at the San Antonio BPS was assumed available during a fire event because it is equipped with backup power as well as the Signal Booster B.

The available fire flow was modeled under 2017 MDD, 2020 MDD, and 2027 MDD. Since demands are not expected to increase significantly, the available fire flow under existing demands is similar to the expected fire flow under future demands. Because CMWD does not expect any future developments that would expand the water service area, and growth will only include densification in the system, fire flow improvement projects were modeled under 2027 MDD to guarantee a project will improve the fire flow under current demands and be sufficient for the future. Figure 8-2 displays the available fire flow throughout the distribution system under the conservative settings and the required fire flow based on zoning.

Overall, most locations within the distribution system can meet the required fire flow. Figure 8-3 shows the system fire hydrants and indicates the hydrants that cannot provide the required fire flow. Currently, there are 66 fire hydrants out of a total of 365 hydrants that cannot meet the required fire flow for its zoning. This includes most the hydrants in the Running Ridge, Signal, and Heidelberger Boosted Zones.

The available fire flow is highly dependent on pipeline size and available looping in the distribution system. Locations comprised of small diameter cast iron mains, especially old mains that are likely rough and have tuberculation that further reduce the hydraulic diameter, and locations with limited looping, have the lowest available fire flow. Along with pipe capacity, hydrants that experience low pressures were predicted to also have a low available fire flow. This is because the model predicts fire flow by applying the 20 psi minimum to the hydrant and calculating how much water can be flowed at that pressure. These hydrants are likely to draw more flow than predicted, but the pressure in the system may drop below the 20 psi requirement. The modeling analysis for predicting fire flow with 20 psi residual is conservative and was assumed to be adequate for the development of capacity projects to improve fire flow.

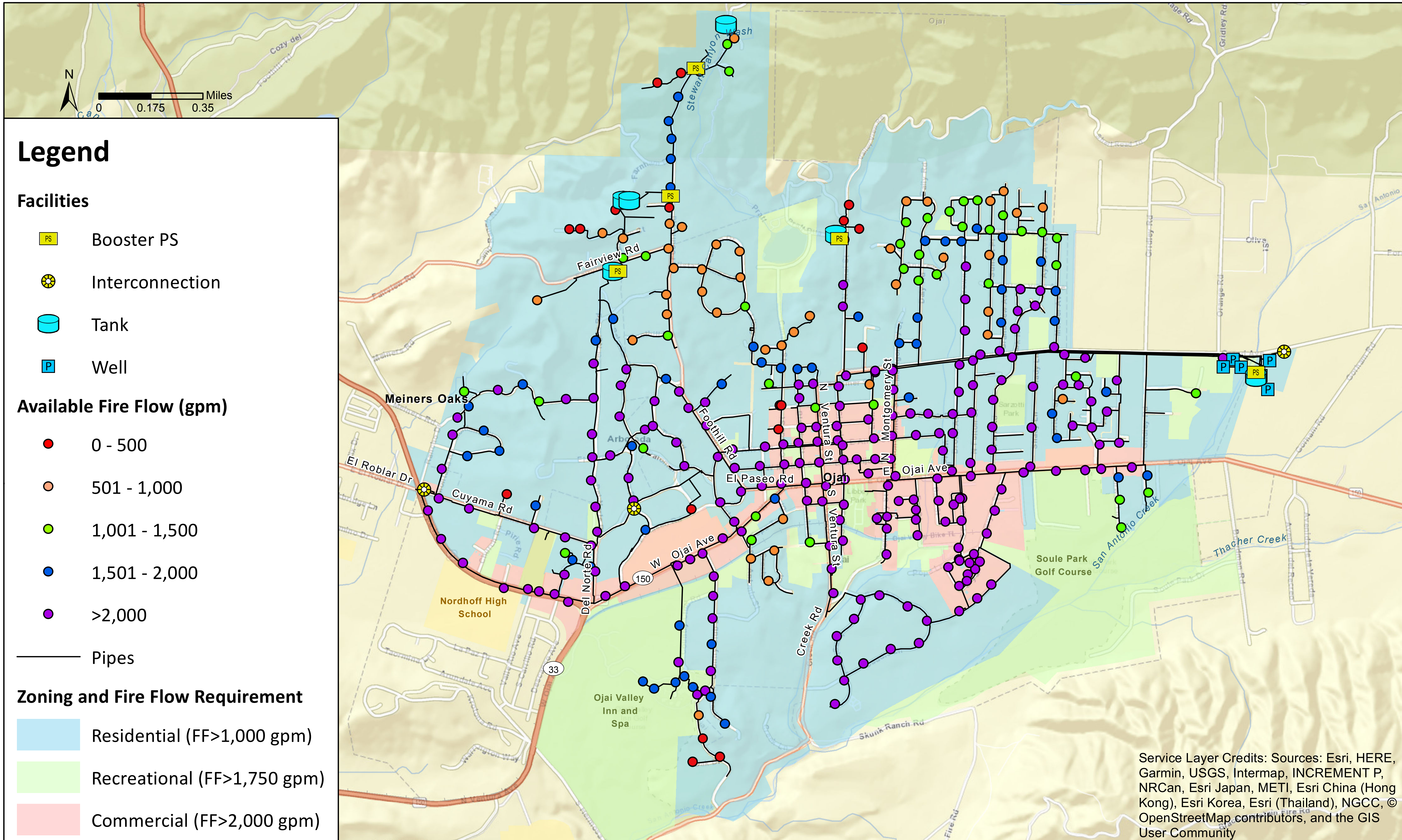


Figure 8-2. Available Fire Flow in the Ojai Distribution System

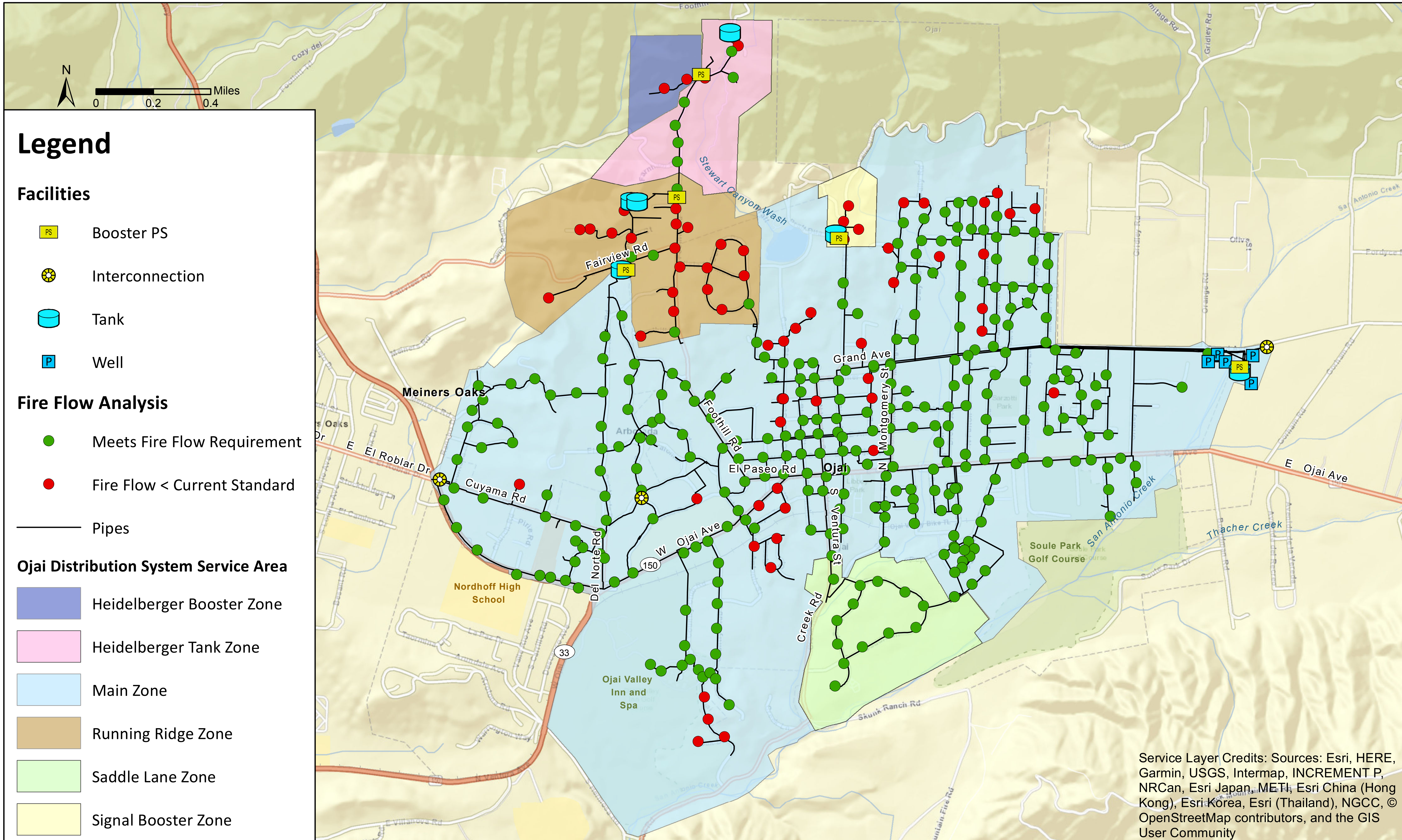


Figure 8-3. Current Fire Flow Deficient Hydrants in the Ojai Distribution System

Projects to improve fire flow were developed by upsizing pipelines that restrict fire flow and adding new pipelines to create additional looping in the system, then rerunning the model. Projects were iterated until the fire flow requirement was met while minimizing costs of the upgrade projects. Projects were also limited to roads in Ojai that have not been paved within the last year. Most of the recommended projects include upsizing aging 4-inch and 6-inch cast iron mains that restrict fire flow or upsizing dead-end mains. Overall, WSC recommends upgrading about 4.5 miles of small diameter pipelines with 8-inch diameter pipe to improve fire flow through the Ojai distribution system. Besides pipeline projects, it is recommended that fire pumps are installed to supply fire flow to the Signal and Heidelberger Boosted Zones and a PRV is added at the Valley View BPS to provide fire flow for the Running Ridge Zone. In addition to automatic fire flow runs in the hydraulic model, the available fire flow was manually checked in the model by applying the fire flow requirement as demands between multiple hydrants and observing the zone's pressure response. During a fire, it is likely that multiple hydrants will be used and their collective flow rate must meet the fire flow requirements.

Table 8-2 lists the recommended fire flow improvement projects in order of priority, and the project number matches that in the final Capital Improvement Plan. The projects have been ranked based on the number of customers impacted by the project, the system's risk if the project is not completed, and the fire flow improvement with the completion of the project. Figure 8-4 includes a map of the recommended fire flow projects in the system and corresponds to the project list.

Figure 8-5 shows the improved system fire flow with all the recommended projects completed. After the completion of the recommended projects most locations will meet or exceed the required fire flow. There are, however, some single isolated hydrants shown that cannot provide 1,000 gpm in residential areas. The hydrants are located off small diameter mains that restrict the fire flow, but are all located adjacent to a hydrant off a larger main that can meet or exceed the fire flow requirement. As mentioned, multiple hydrants will be used during a fire, so these isolated hydrants are considered adequate because the area can still maintain the required fire flow.

However, along the dead end main on Running Ridge Trail there are 3 hydrants shown that cannot provide 1,000 gpm. This location was also identified as having low pressure, and the available fire flow is low because fire flow is calculated while maintaining a 20 psi residual pressure. The fire flow using multiple hydrants was manually checked in the model by applying 500 gpm to 2 adjacent hydrants, running the model, and observing the system pressure response. Using this method, it is expected the hydrants in this area can provide 1,000 gpm using 2 hydrants and maintain a residual pressure of 10 psi. Looping the dead end main back to Fairview Road will improve the fire flow in this area, but it will be extensive and located along private roads and driveways. Since this area is low density residential and the 1,000 gpm can be maintain at 10 psi, the fire flow is considered adequate.

Table 8-2. Recommended Fire Flow Projects

Project No.	Zone	Location	Existing Size and Material	Installation Year	Total Pipe Length	Recommended Size and Material	Recommended Improvement
A1	Running Ridge	Valley View BPS	N/A	N/A	N/A	New 6-inch PRV	Add a PRV at the Valley View Pump Station so the Heidelberger Tank zone can supply Running Ridge zone for fire flow or emergency situations. An alternative to this project is to construct a new Running Ridge Tank at a higher elevation. At a higher elevation, the Running Ridge Tank may be able to meet the fire flow requirements while maintaining 20 psi in the zone. The preferred alternative should be verified in the calibrated model.
A3	Signal	Signal BPS	N/A	N/A	N/A	1,000 gpm minimum capacity fire pump with backup power	Add a fire pump in parallel with the Signal Booster B pump station and hookup backup power to the fire pump.
A4	Main	Cuyama and El Paseo Road, Topa Topa Drive, San Antonio Street, and Crestview Drive	4-inch Cast Iron	1939, 1952, 1955, & 1962	5,615 feet	8-inch PVC	Replace 750 LF of existing 4-inch cast iron pipe with 8-inch PVC pipe along Cuyama Road between Sierra Road and Chico Road. Add 450 LF of new 8-inch PVC pipe and replace 110 LF of existing 4-inch cast iron pipe with 8-inch PVC pipe, for a total of 560 LF of 8-inch PVC pipe, along Cuyama Road between Chico Road and El Paseo Road. Replace 855 LF of existing 4-inch cast iron pipe with 8-inch PVC pipe along El Paseo Road between Cuyama Road and Sierra Road, and add 50 LF of new 8-inch PVC pipe along El Paseo Road to connect the loop to the existing 8-inch ductile iron pipe at the intersection of El Paseo Road and Sierra Road. Replace 1,300 LF of 4-inch CI pipe with 8-inch PVC pipe along Topa Topa Drive between West Ojai Avenue and San Antonio Street. Replace 620 LF of 4-inch CI pipe with 8-inch PVC pipe along San Antonio Street between Topa Topa Drive and south toward the end of the public road. Replace 1,100 LF of 4-inch CI pipe with 8-inch PVC Pipe along Crestview Drive adjacent to West Santa Ana Street. Replace 380 LF of 4-inch CI pipe with 8-inch PVC pipe along the entire length of Oak Creek Lane off Crestview Drive.
A6	Main	Sunset Place	4-inch Cast Iron	1954-1958	1,865 feet	8-inch PVC	Replace 1,865 LF of 4-inch CI pipe with 8-inch PVC pipe along the Sunset Place north of Mountain View Avenue running parallel to Grand View Ave.
A7	Main	West and East Ojai Avenue	4-, 6-, & 8-inch Cast Iron and 8-inch AC	1938, 1939, 1948, 1951, 1955, 1959, 1961, & 1966	6,855 feet	8-inch PVC	Replace 1,130 LF of existing 6-inch cast iron pipe with 8-inch PVC pipe along Ojai Avenue between Bristol Road and Canada Road. Replace 375 LF of 8-inch cast iron pipe with new 8-inch PVC pipe along Ojai Avenue between Ventura Street and Signal Street. Add 880 LF of new 8-inch PVC pipe along Ojai Avenue between Signal Street and Montgomery Street. Replace 4,470 LF of 6-inch and 8-inch cast iron pipe with new 8-inch PVC pipe along Ojai Avenue between Montgomery Street and Gridley Street.

Project No.	Zone	Location	Existing Size and Material	Installation Year	Total Pipe Length	Recommended Size and Material	Recommended Improvement
B3	Main	Country Club Drive	4-inch Cast Iron	1960	2,250 feet	8-inch PVC	Replace 1,700 LF of 4-inch CI pipe with 8-inch PVC pipe along County Club Drive between the PRV at the Ojai Valley Inn and Spa to the end of the pipeline. Replace 550 LF of 4-inch CI pipe with 8-inch PVC pipe along the entire length of Oak Drive off Country Club Drive.
B4	Heidelberger Tank	Heidelberger BPS	N/A	N/A	N/A	1,000 gpm minimum capacity fire pump with backup power	Add a fire pump to the Heidelberger Pump Station with backup power.
B5	Main	Canada Street	4-inch Cast Iron	1938	1,400 feet	8-inch PVC	Replace 1,400 LF of 4-inch CI pipe with 8-inch PVC pipe along Canada Street between Matilija Street and Summer Street.
B6	Main	Lion Street	4-inch Cast Iron	1953	1,230 feet	8-inch PVC	Replace 1,230 LF of 4-inch cast iron pipe with 8-inch PVC pipe along Lion Street between Grand Avenue and Aliso Street.
B7	Main	Pleasant Avenue and Daly Road	6- & 8-inch Cast Iron	1959 & 1962	1,965 feet	8-inch PVC	Replace 775 LF of existing 8-inch cast iron pipe with 8-inch PVC pipe along Pleasant Avenue between Drown Avenue and Daly Road. Replace 1,190 LF of existing 6-inch cast iron pipe with 8-inch PVC pipe along Daly Road between Pleasant Avenue and Montgomery Street.
B10	Main	Verano Drive	3-inch Steel	1956	400 feet	8-inch PVC	Replace 400 LF of 3-inch steel pipe with 8-inch PVC along Verano Drive north of Cuyama Road.
B11	Main	Park Avenue	N/A	N/A	355 feet	8-inch PVC	Add 355 LF of new 8-inch PVC pipe along Park Avenue between Signal Street and Olive Street.
B12	Main	Blanche Street and Santa Ana Street	4-inch Cast Iron	1961	1,020 feet	8-inch PVC	Replace 665 LF of 4-inch cast iron pipe with 8-inch PVC along Blanche Street between Topa Topa Street and Santa Ana Street. Replace 355 LF of 4-inch cast iron pipe with 8-inch PVC along Santa Ana Street between Blanche Street and Signal Street.
B13	Main	Fairway Lane	6-inch Cast Iron	1959	1,220 feet	8-inch PVC	Replace 1,220 LF of 6-inch cast iron pipe with 8-inch PVC pipe along Fairway Lane south of Ojai Avenue.

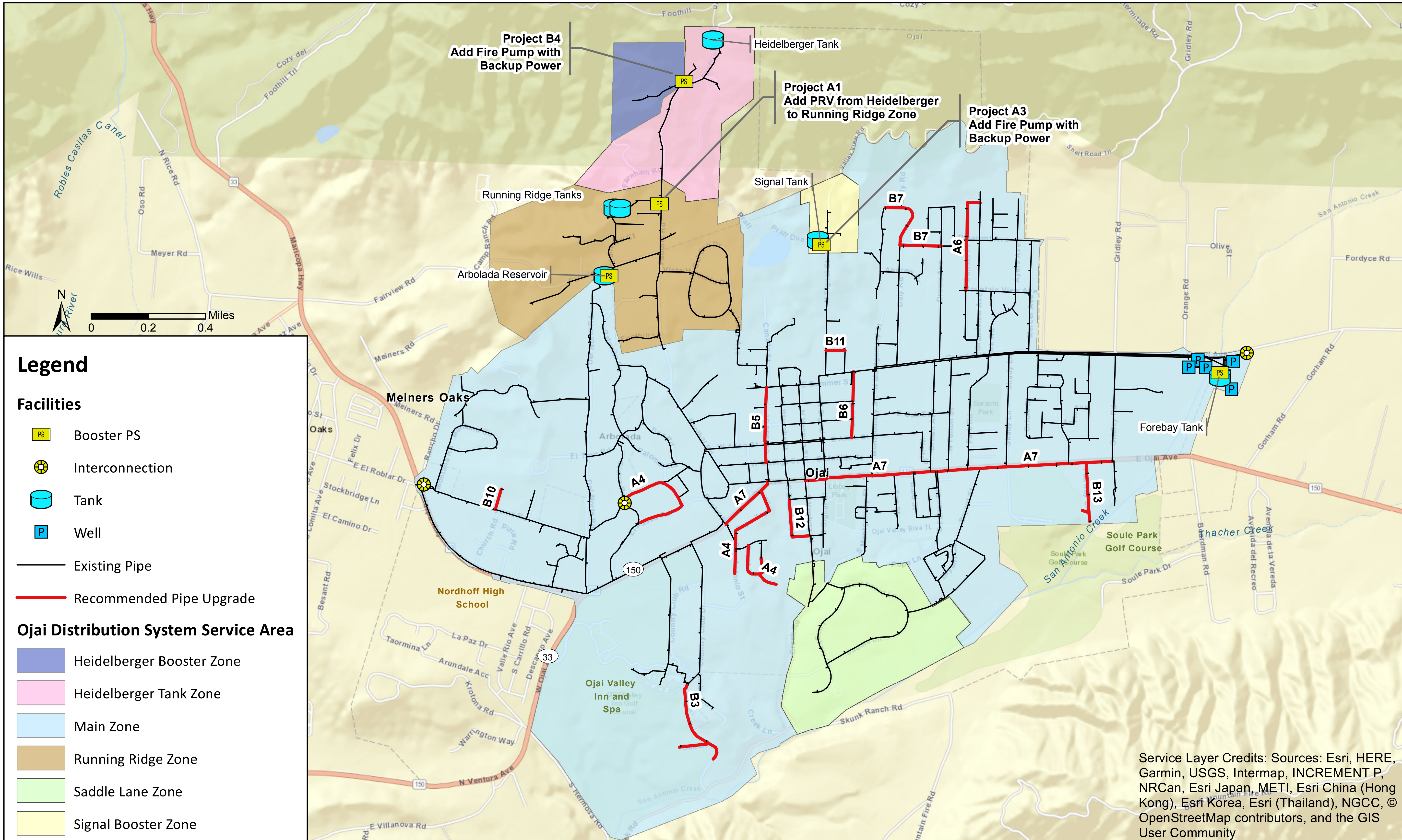


Figure 8-4. Recommended Fire Flow Projects

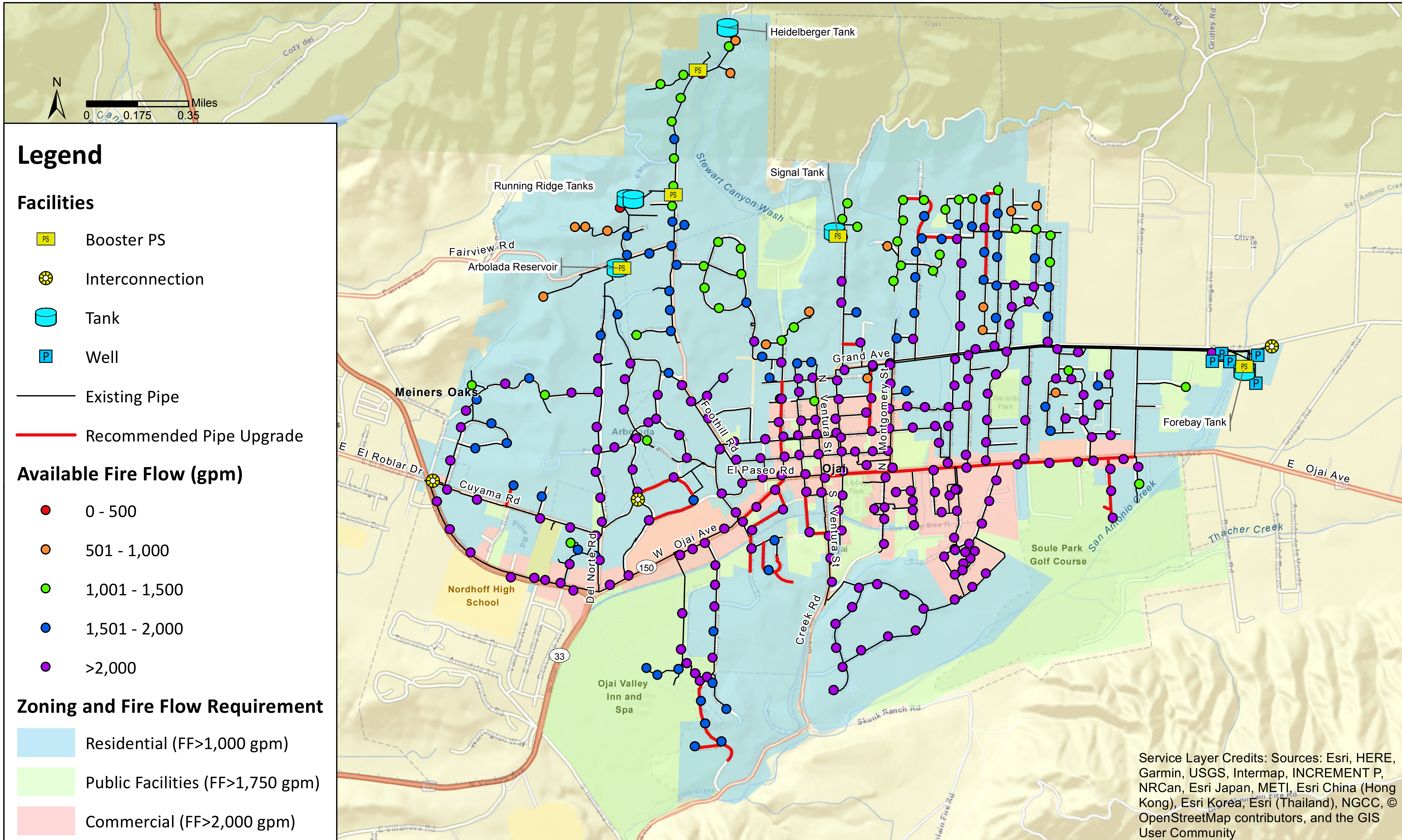


Figure 8-5. Available Fire Flow with Recommended Projects

8.3 Pipeline Velocity

The hydraulic model was used to evaluate the pipeline velocity under existing and future demands. High velocities in pipes can indicate a capacity constraint and that the pipeline should be upsized. As demands increase, pipeline velocities also increase. Historically, the Ojai system has used 2 pipeline velocity criteria to analyze the distribution system:

- Pipeline velocity throughout the distribution shall be less than 5 - feet per second under ADD and MDD; and
- Pipeline velocity throughout the distribution system shall be less than 10 feet per second under PHD and MDD + FF conditions (with an allowance of up to 15 feet per second near the source of the fire under MDD + FF demands).

The pipeline velocity was evaluated for current and buildout demands. In general, the velocity for most pipelines in the Ojai system is adequate under all demand scenarios. There were 2 locations, however, that may experience velocities that exceed the requirement. The first is on the discharge side of the Mutual wellfield. The 3 Mutual Wells (No. 4, 5, and 6) all discharge into a common 8-inch main that conveys water to the filter plant before filling the San Antonio Forebay Tank. When all 3 Mutual Wells are operating, the velocity in the 8-inch main was modeled as high as 5.5 feet per second. This pipe was also identified by CMWD staff as high priority for replacement due to its current condition. It is recommended that the 720-foot section of 8-inch Steel and AC pipe from the Mutual Well plant to the 12-inch AC pipe near the filter plant is replaced with 12-inch PVC pipe to improve velocities. This project (Project A2) is included in the final CIP.

The other location where velocities can exceed the requirements is on the 6-inch steel main south of the Running Ridge Tanks during MDD + FF conditions in the Running Ridge Zone. During a fire event in the Running Ridge Zone, most of supply is provided from the Running Ridge Tanks and the remaining from the Arbolada BPS. The high flow rate from the Running Ridge Tanks can increase velocities up to 10.6 feet per second in the 6-inch steel pipe north of Running Ridge Trail toward the Running Ridge Tanks. It is recommended to remove the Running Ridge Tanks from service immediately, and that project includes abandoning the 6-inch steel inlet and outlet pipe. If a new Running Ridge Tank is constructed, the inlet / outlet pipe should consider pipeline velocity and be sized accordingly.

8.4 Hydrant Spacing

Hydrant spacing requirements are set by the California Fire Code and the Ventura County Fire Department, and historically have required hydrants at intervals not more than 250 feet in commercial zones and not more than 500 feet spacing in Single Family Dwelling areas.

The City of Ojai has hydrants connected to the Ojai water distribution system and the main CMWD water distribution system. Both system's hydrants were used to evaluate the hydrant spacing in the service area. As shown in Figure 8-6, 8 new hydrants are recommended in the distribution system to meet the hydrant spacing requirements. Of these recommended hydrants, 4 can be included with recommended fire flow projects listed in Table 8-2. This leaves 4 remaining hydrants to be installed on their own. Exact hydrant locations should be coordinated with the Ventura County Fire Department during design.

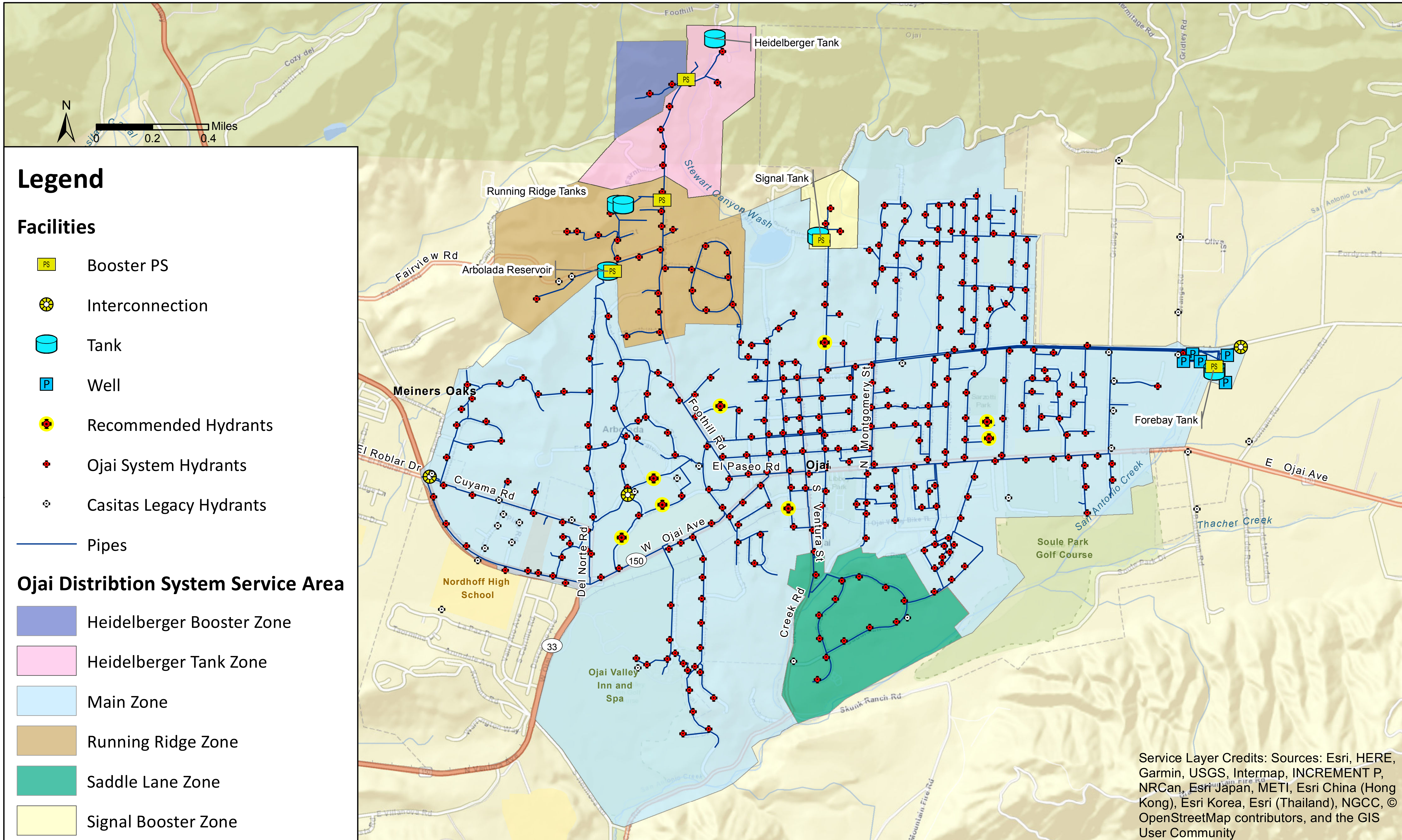


Figure 8-6. Recommended New Hydrants

Section 9

OPERATIONAL ANALYSIS

SECTION 9

Operational Analysis

The calibrated extended period simulation (EPS) was used to evaluate the system operation, including modeling water age and evaluating pumping controls. The water age analysis predicts locations in the system that have a long water age, which could have water quality impacts. The pumping controls analysis evaluates discharge pressures and control set points to provide recommendations to improve pumping efficiencies and allow 2 pumps to operate simultaneously when required during high demands or an emergency. Currently the operators can only run 1 pump at the San Antonio BPS, Arbolada BPS, and Valley View BPS to avoid excessive pressures that can cause main line breaks. The operational analysis presents recommendations for improved water quality and system operations.

IN THIS SECTION

9.1 Water Age Analysis

The calibrated EPS model was used to model water age in the distribution system. There is not a recognized standard for water age, but it is generally accepted that the lower the water age the higher the water quality. Long detention times can lead to loss of disinfectant residual, microbial growth, formation of disinfection byproducts, taste and odor problems, and other water quality problems (7). Generally, it is more difficult for smaller distribution systems to maintain a low water age according to a report prepared by AWWA, because of lower demands and a smaller service area with more dead-end mains compared to larger systems (7). CMWD maintains high water quality in the Ojai water distribution system through regular pipe flushing and water quality monitoring.

The water age was calculated in each pipe during a 14-day model run. Table 9-1 includes the average weighted water age in each zone and Figure 9-1 includes a map of the modeled water age in each pipe. It should be noted that the model was calibrated for only 24 hours and due to modeling limitations, the modeled water age is only an approximate water age.

Overall, most locations in the Ojai system have a low water age. The water age in the Main Zone and Saddle Lane Zone have the lowest water age because they have the largest demands and adequate looping, allowing the water to continue moving. The other smaller zones have a longer modeled water age, mostly likely because these zones have lower demands and less looping. As shown in the water age map, the dead end pipes have the longest water age. The Running Ridge, Heidelberger Tank, Heidelberger Boosted, and Signal Zones all have multiple dead end mains or limited looping.

Table 9-1. Average Water Age per Zone Weighted by Pipe Length

Zone	Average Water Age (Hours)	Average Water Age (Days)
Main	24.8	1.03
Saddle Lane	39.5	1.64
Signal	174.0	7.25
Running Ridge	181.7	7.57
Heidelberger Tank	171.6	7.15
Heidelberger Boosted	323.6	13.48


Ojai water system Mutual Well #6

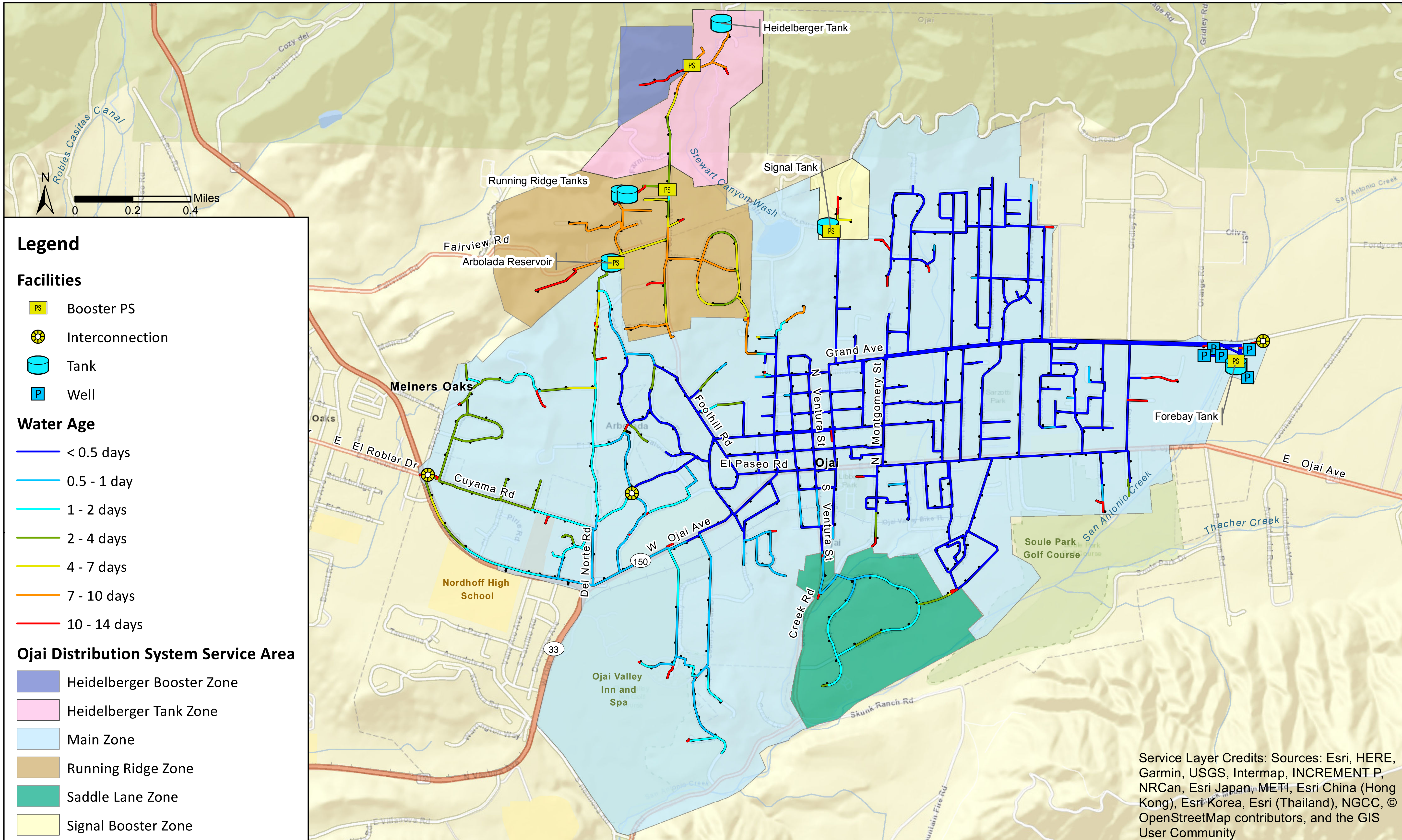


Figure 9-1. Modeled Water Age in the Ojai Distribution System

CMWD, similar to most water agencies, perform pipe flushing to maintain low water age and high water quality in the distribution system. It is recommended that operations staff continue pipe flushing, focusing on dead end mains, especially in the smaller zones. Pipe flushing, though a necessary operation to improve water quality, increases non-revenue water demand. The hydraulic model was used to evaluate potential solutions to reduce water age in the system without increasing non-revenue water, including bleeding water between pressure zones and lowering reservoir levels to increase reservoir turn over. The water age was modeled bleeding water from the Running Ridge Zone to the Main Zone and bleeding water from the Heidelberger Tank Zone to the Running Ridge Zone. When bleeding water between zones, CMWD needs to be careful not to over pressurize the lower pressure zone. Due to storage requirements, only the Signal Reservoir can be significantly lowered and the storage requirements maintained. These 3 scenarios were set up in the model and the water age results are described below:

- The model was used to bleed water from the Running Ridge Zone to the Main Zone through a 1-inch bypass pipe that was added in the model at the Libby Avenue PRV. The bypass was opened on day 6 of a 14 day EPS scenario and the water age in the system was calculated. The average water age in both the Running Ridge and Main Zones was modeled to be reduced by only an hour. Due to these modeling results, it is not recommended to bleed water between the Running Ridge Zone and the Main Zone to improve water age.
- The model was used to simulate water blending from the Heidelberger Tank Zone to the Running Ridge Zone. This was similarly modeled with a 1-inch bypass line located at the Valley View BPS open on day 6 of a 14 day EPS scenario. The modeling results showed the average water age in the Running Ridge Zone dropped 17 hours and the average water age in the Heidelberger Tank Zone dropped 5 hours. The water age in other zones was not significantly affected. Though the water age was not greatly reduced in either zone, CMWD operators can occasionally bleed water between these zones to improve water age without increasing non-revenue water.
- Long detention times in the Signal Tank can lead to an increased water age in the Signal Zone, and lowering the tank can increase turnover and lower the water age. The water age scenario was rerun with the Signal Tank modeled 10 feet lower than it currently operates using the existing altitude valve (fluctuating between a water level of 21.5-23.5 feet). With the Signal Tank operating 10-feet lower than currently, the average water age in the Signal Zone dropped 20 hours. This is another way CMWD can manage water quality in the Signal Zone, but it should be noted that as the volume in the Signal Tank is reduced so is the fire and emergency volume that can be supplied to the Signal and Main Zones.

Overall, the low modeled water age correlates to high water quality in the Ojai water distribution system. There are, however, some locations predicted to have older water that may impact water quality. These locations include dead end mains and are concentrated within the smaller zones with low demands. CMWD flushes water mains as required to maintain water quality, and it is recommended that this practice is continued. CMWD should also consider implementing a pipe flushing operation plan that includes annual pipe flushing of dead end mains. Pipe flushing is expected to improve water quality in the system more than any other operational change. In addition to pipe flushing, CMWD can occasionally bleed water from the Heidelberger Tank Zone to the Running Ridge Zone or lower the operating level of the Signal Tank to improve water age without increasing non-revenue water.

9.2 Pumping Controls Analysis

As described above, CMWD operations staff currently do not run 2 pumps simultaneously at the San Antonio, Arbolada, and Valley View BPSs to prevent excessive pressures that may increase risk of main damage and worsen existing leaks to increase water loss. Excessive pressures can also result in increased pumping costs.

The model was used to evaluate discharge pressures and recommendations for improving excessive pressures at the San Antonio, Arbolada, and Valley View BPSs and evaluate the potential to run 2 booster pumps, as needed. The modeled discharge pressures, including static pressure with no pumps operating, a single booster pump operating, and both booster pumps operating, are listed in Table 9-2. The modeled discharge pressures were compared to discharge pressures recorded in the SCADA system to guarantee modeled pressures represent actual observed pressures. The modeled discharge pressures were all within 5 psi of the observed pressures. The Ojai water distribution system's maximum allowable design pressure is 125 psi, which is always exceeded at the Valley View BPS and when 2 pumps are operating at both the San Antonio BPS.

Table 9-2. Pump Station Discharge Pressures

Pump Station	Booster Pump	Static Discharge Pressure	Single Booster Discharge Pressure	2 Pumps Operating Discharge Pressure
San Antonio	San Antonio Booster A	70 psi	107 psi	140 psi
	San Antonio Booster B		107 psi	
Arbolada	Arbolada Booster A	78 psi	84 psi	95 psi
	Arbolada Booster B		82 psi	
Valley View	Valley View Booster A	160 psi	166 psi	180 psi
	Valley View Booster B		171 psi	

Based on the modeled discharge pressures it is not recommended to operate 2 pumps at the San Antonio and Valley View BPSs simultaneously. The discharge pressures from the Arbolada BPS does not exceed the 125 psi maximum pressure limit, but with 2 pumps operating, the pressures can increase in the lower portion of the Running Ridge Zone to about 125 psi. Currently the Arbolada Booster B is set to turn on at a water level 1 foot below the on-control point for Arbolada Booster A. After reviewing the August 2017 SCADA records provided by CMWD, there was a 10-minute interval on August 3, 2017 where both Arbolada Boosters operated simultaneously to fill the Running Ridge Tanks. This is expected to only occur during high demands or if there is an emergency. Because storage is very limited in the Running Ridge Zone and the Arbolada BPS is required to fill the Running Ridge Tanks, it is recommended to keep the existing Arbolada BPS controls. It is recommended to evaluate solutions to improve storage in the Running Ridge Zone, and the preferred solution should also evaluate pump controls based on how the future Running Ridge Zone is operated.

The Valley View BPS discharge pressure always exceeds the 125 psi limit because of its elevation in comparison the Heidelberger Tank that sets the HGL of the Heidelberger zone. It is recommended to improve these pressures by relocating the Valley View BPS to a higher location closer the Heidelberger Tank. Once the static pressures are resolved, the discharge pressures may be adequate with one or both pumps operating. An alternative for the Running Ridge Zone Improvement project is converting the zone into a pumped pressure zone. This alternative will require major upgrades to the Valley View BPS including relocation to above grade. The static pressures should be considered when determining the future location for the Valley View BPS if this is the preferred alternative.

The San Antonio BPS can cause a 30 - 40 psi pressure increase in the Main Zone with just a single booster pump turning on. The model predicts with both booster pumps operating that discharge pressures will increase to about 140 psi and pressures in the southern portion of the Main Zone can exceed 150 psi. These pressures are dangerously high, and it is recommended CMWD operators continue to prevent both San Antonio Boosters from operating simultaneously.

The model was used to plot the range in system curves for the San Antonio BPS (the system curve varies with the system demands and the Arbolada Reservoir level) against the San Antonio Booster pump curves with 1 and 2 boosters operating, shown in Figure 9-2. The pump will only operate where the pump curve and system curve intersect. The expected flow and discharge pressures based on where the curves intersect are listed in Table 9-3. Based on the curvature of the pump curves and system curves, the large pressure increases can be expected when the San Antonio BPS operates. Note, the modeled pressures and SCADA records indicate slightly higher discharge pressures than shown in Table 9-3 that were determined by the system curve, which may be due to the elevation of the pressure transducer connected to the SCADA system.

There are 2 ways to reduce the operating pressures at the San Antonio BPS: flatten the pump curve or flatten the system curve. The first involves replacing the existing San Antonio Booster Pumps with different pumps that have a flatter pump curve. With a flatter pump curve, the discharge pressures will not increase as greatly when the second pump kicks on, but the flow rate will also not increase greatly with 2 pumps operating. For this reason, it is not recommended to replace the existing pumps with alternative pumps with a flatter pump curve.

Alternatively, the system curve can be flattened by reducing head losses through the Main Zone between the San Antonio BPS and the Arbolada Reservoir. This can be accomplished by replacing aging mains that have roughened over time with new smoother pipes and replacing undersized mains. The 12-inch transmission main through the Main Zone is constructed of cast iron and was installed in 1932. It is expected that this transmission main is very rough due to the material and age, and replacing it will greatly improve head losses through the Main Zone. The model was used to evaluate the system curve after all the recommended pipeline projects have been completed, including the fire flow projects and pipeline condition assessment projects. The system curve was also evaluated with the pipeline projects completed and the 12-inch transmission main increased to a 16-inch main. These system curves are included in Figure 9-2 and the expected future flow and pressures are listed in Table 9-3.

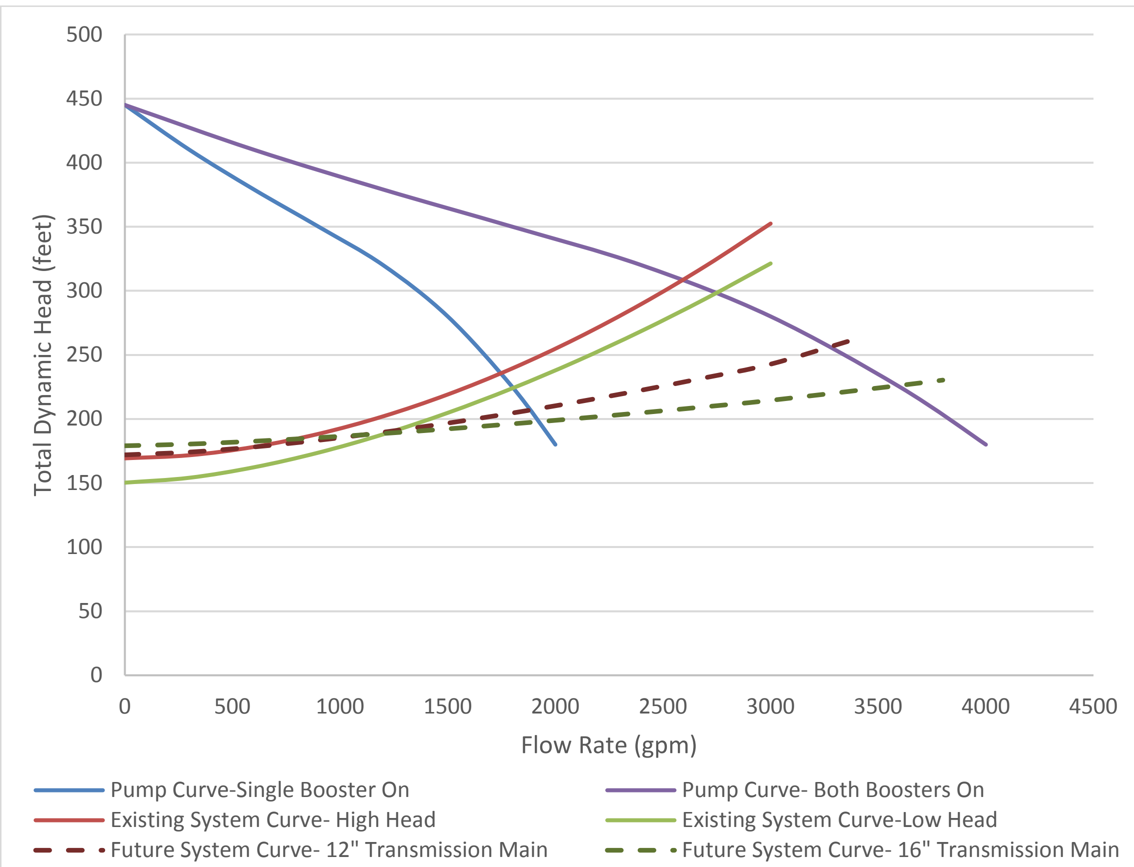


Figure 9-2. San Antonio Pump Station Pump and System Curves

Table 9-3. Expected Flow Rates and Discharge Pressures at the San Antonio Pump Station

Operating Condition	Current System		Future System, 12-inch transmission main		Future System, 16-inch transmission main	
	Single Pump	Both Pumps	Single Pump	Both Pumps	Single Pump	Both Pumps
Expected Flow(s), gpm	1,750-1800	2,600-2,750	1,880	3,280	1,920	3,600
Expected Discharge Pressure(s), psi	95-102	129-134	90	110	87	98

With the reduced head losses from the pipeline replacements and upsizing, the discharge pressures from the San Antonio BPS are greatly reduced, and both pumps may be able to operate together without causing excessive pressures in the system. With a flatter system curve the discharge pressures are expected to decrease, but the system curve also pushed the operating point further from the best efficiency point on the pump curve. A detailed energy evaluation is required to determine if this will greatly affect the pumping energy required at the San Antonio BPS, or if the reduced pump efficiencies will balance with the reduced discharge pressures.

It is recommended to construct the pipeline projects in the CIP to improve discharge pressures at the San Antonio BPS. Replacing the existing cast iron transmission main is likely to have the greatest effect on the discharge pressures at the San Antonio BPS. The 12-inch transmission main is adequate for fire flow and velocity requirements, but CMWD may consider increasing the transmission main to a 16-inch diameter to increase system capacity and improve the San Antonio BPS discharge pressures.

Casitas Municipal Water District

Section 10

CONDITION & ASSET ASSESSMENT

SECTION 10

Condition & Asset Assessment

In addition to evaluating supply, storage, and capacity of the Ojai distribution system, the condition of the system assets and facilities were evaluated. WSC contracted 3 subconsultants to provide thorough inspection of specific facilities, including Advantage Technical Services, Inc. (ATS) for tank assessment and dive inspections, Utility Services Associates (USA) for leak detection services, and Pueblo Water Resources for well assessment and inspection services. Booster pump stations were evaluated based on review of available data and maintenance reports. Pipelines were evaluated based on material, installation year, and leak reports to develop a replacement curve that can be used for annual budgeting of pipeline replacements.

This section summarizes the subconsultant assessment findings and recommended replacement curves. Based on the facility assessment and asset management analysis, there is some critical infrastructure in the distribution system that require immediate attention to guarantee reliable service to the customers. Additional condition assessment projects identified by CMWD operations staff have been included in this section, as well.

IN THIS SECTION

10.1 Tanks

In September 2017, 6 potable water tanks in the Ojai water distribution system were inspected. The inspection services included assessment of the tank exterior and interior, including sediment removal during the dive inspection, and inspection of all tank appurtenances. The tank dive reports also included individual recommendations for each tank. Appendix B includes the tank inspection reports.

According to the EPA's 2003 Assets Management Handbook for Small Water Systems, steel storage tanks (except for coatings) have a 30-60 year lifetime, while concrete reservoirs have a 70+ lifetime. Tanks can last toward the upper end of the lifetime if they were properly designed and constructed and with regular upkeep and maintenance. The Heidelberger Tank and San Antonio Forebay are in good condition and were constructed within the last 10 years, while the Arbolada Tank is in moderate condition having undergone major rehabilitation since 2004 when the tank was previously dived. The additional 3 reservoirs (Signal Tank, and both Running Ridge Tanks) are in poor condition and close to reaching the end of their useful lives. The detailed findings and recommendations for each tank are summarized below.

Arbolada Tank

The Arbolada Tank is a 1 MG partially buried concrete tank that serves as gravity storage for the Main Zone. Overall, the Arbolada Tank was found to be in fair condition. Thin circumferential cracks are scattered on the inside and outside of the tank walls, but there is no visible leaking. The tank interior is in good condition and has been recoated since the last inspection in 2004. No large areas of spalling or roughening of the concrete was visible during the inspection, and only small iron-oxide stains were noted. The guardrail at the roof hatch is broken and should be replaced. There is also no guardrail along the edge of the roof, and it is recommended that a roof edge protection plan be implemented. It is also recommended that the small iron-oxide stains and cracks be monitored to guarantee they do not worsen. There is a white sealant used in the interior of the tank that should also be monitored for softening. Continued softening of the sealant could be detrimental for future containment.

Signal Tank

The Signal Tank is a 300,000 gallon welded steel tank that serves the Signal and Main Zones. The Signal Tank was originally constructed in 1948 and was found to be in poor condition during the tank inspections. The interior and exterior coatings are in immediate need of replacement. Significant chalking is present on the exterior shell due to UV light and weathering of the coatings. There is substantial blistering and peeling, with about 30% coating failures, on the interior shell. There is an area of ponding on the exterior roof with serious localized corrosion, with metal loss estimated to be at full thickness. It is recommended that the interior and exterior coatings be completely replaced. Abrasive blasting for complete coating removal on the interior is recommended, although top coating may be done on the tank exterior if adhesion is adequate and thickness will allow. It is likely that coatings are lead-based and proper precautions should be taken during recoating. The thickness of the roof steel with significant metal loss should be tested to evaluate if a welded steel patch is needed. The site should be spot repaired to slow corrosion. Additionally, it is recommended to install a silt-stop on the inlet / outlet pipe, invest in improved resistance to seismic damage, and consider adding a second manway.

Due to the poor condition of the Signal Tank, the tank age, the excess storage considerations and other previously recommended upgrades including adding a fire pump to the Signal Pump Station, it may be most economical to abandon and construct a new Signal Tank. Previous alternatives for the Signal Zone are mentioned in the Supply and Storage Section and include constructing a new Signal Tank at the same location, constructing a new Signal Tank at a higher elevation to serve the Main Zone by gravity, or demolishing the existing Signal Tank and serving the Signal Zone without a tank at all. It is recommended that CMWD perform an alternatives evaluation to determine the best solution for the rehabilitation, replacement, or abandonment of the Signal Tank and operation of the Signal Zone.

San Antonio Forebay Tank

The San Antonio Forebay Tank was construction in 2011 to replace a smaller forebay tank at the same location. Overall, this 500,000 gallon welded steel tank that serves the Main Zone is in good condition. There were 6 locations on the interior bottom with significant corrosion and pitting, but were repaired during the tank dive with an epoxy approved by the National Sanitation Foundations regulations for potable water treatment or distribution products (NSF 61). There is also significant staining and corrosion on the interior roof structure and most significantly on the interior and exterior roof vent, indicating that the corrosion rate may be higher than normal in the vapor space of the interior tank. The interior ladder is in good condition, but the stainless-steel safety device is severely corroded in the vapor space and the top bracket is broken. It is recommended to repair the broken bracket on the interior ladder safety climb and mitigate corrosion in the vapor space through spot repairs of corrosion sites and consider adding an additional roof vent. It is recommended the tank interior is recoated within 5 years to prevent considerable damage to the roof rafters. It is also recommended to coat the fiberglass interior ladder with an NSF approved epoxy because the ladder is not made with NSF 61 approved materials.

Running Ridge 1

The Running Ridge Zone contains 2 gravity storage reservoirs. The Running Ridge 1 Tank is a 44,000 gallon bolted steel tank constructed in 1956. Upon inspection, this tank is in poor condition due to significant corrosion on the interior shell and roof support. The tank exterior is in poor condition with failing coatings, several caulked, bolted, and welded patches, and areas that are leaking due to significant corrosion. The tank could not be dived because the roof hatch is too small, so the interior could only be visually inspected from the roof. The interior bottom appears to have a white coating over an older black coating that was installed within the last 5 years. The interior shell is also in poor condition with significant corrosion scattered over all surfaces. The shell is coated in a black material, likely a coal tar epoxy, that is not likely to meet NSF 61 standards. The roof is missing bolts in approximately 5 locations, allowing the entry of foreign material. Overall, it is recommended to remove and replace this tank from service as soon as possible based on the significant interior shell corrosion, the presence of coal tar epoxy coatings, and the outdated seismic design. In the meantime, the open bolt holes in the roof should be sealed and the vent screens should be replaced to achieve bug resistance.

Running Ridge 2

The Running Ridge 2 Tank is a 50,000 gallon rectangular concrete reservoir constructed in 1914. This tank is in overall fair condition. There is some minor cracking scattered on the concrete slab roof and concrete beam and column supports. Multiple support beams have spalled concrete, exposing a part of their reinforcing steel that is now significantly corroded. There are cracks present on interior and exterior walls around the entire reservoir, but no visible leaks. The roof opening does not have a curb to protect rain water from entering and the concrete cover fits poorly. There is also a gap in the cover that may allow foreign materials and small animals from entering the reservoir. The roof vent screens are too large and allow bug entry. It is recommended to replace the roof opening with a steel hatch that can keep out foreign materials and rainwater. It is also recommended that the vent screens are replaced with bug proof mesh, and the cracks in the concrete are monitored.

In addition to the poor condition of the Running Ridge Tanks, the Running Ridge Zone also has major storage deficiencies. As described in the Supply and Storage section, it is recommended that additional storage volume is added to this zone or to the Heidelberger Tank Zone and a PRV connection is constructed to provide fire flow to the Running Ridge Zone. Potential alternatives for abandoning the Running Ridge Tanks include, but are not limited to, demolishing the existing reservoirs and reconstructing a reservoir at the same site, reconstructing a new reservoir at an alternative site because the existing Running Ridge Tank site has limited access, constructing a connection from the Running Ridge Zone to an existing reservoir located in the main CMWD water distribution system, or converting the Running Ridge Zone into a pumped pressure zone.

As recommended similar to the Signal Zone, CMWD should perform a detailed alternatives evaluation to determine the best solution for the Running Ridge Zone. The analysis should consider solutions to improve storage volume and fire flow.

Heidelberger Tank

The Heidelberger Tank is a 100,000 gallon bolted steel tank constructed in 2010 and is used as gravity storage for the Heidelberger Zone and provides suction pressure to the Heidelberger BPS. The tank is in overall good condition. At the tank site, there is erosion present on the upward slope facing the northwest of the tank. Soil has deposited against the site fence, foundation, and tank shell. The interior and exterior shells are in good condition with minimal corrosion except for at bolts near the roof joint in the interior shell. It is likely the factory coatings were damaged during construction, causing the corrosion. There is also a 3-foot-long area on the lower interior shell with about 25 scratches and chip locations likely damaged during construction. There is no significant corrosion at this location due to proximity of the cathodic protection anodes. During inspection, there was a heavy build-up of minerals about 5 to 7 inches thick that were removed from the sacrificial anodes. It is recommended that CMWD develop plans to control erosion near the tank site, replace the vent screen to achieve bug resistance, repair the damaged coatings at the 20 bolts in the top ring of the shell and in the lower panel, and repair areas with minor corrosion on the roof vent and hatch surfaces.

The tank condition assessment did not include a seismic evaluation of the existing reservoirs. It is recommended CMWD perform a structural and seismic evaluation of the reservoirs to understand system risks and tank improvements to meet current seismic design standards. It is expected that reservoirs constructed before 1990 that have not been seismically retrofitted may not be compliant with current seismic design standards.

10.2 Wells

An inventory and assessment of the Ojai wellfield that included reviewing well construction, maintenance, and operation documentation, Ojai Basin hydrogeological reports, and historic water level and quality data was completed. The data review was used to evaluate the existing condition of each well and recommendations to improve operation, including how to reach CMWD's short-term goal to improve production capacity at the wellfield of 25%. The complete Ojai Wellfield Assessment Report is included in Appendix C.

The Ojai Wellfield Assessment Report documents the method for drilling each well, original construction date, and any rehabilitation or maintenance projects documented since construction. According to records provided from GSWC, the wellfield on Grand Avenue has had 12 wells constructed and operated since the 1920s, 6 of the older wells have been destroyed, and 6 are currently operating. The 6 operating wells are grouped into 2 groups of 3 on either side of the San Antonio Creek. The Ojai Wellfield Assessment Report documents the historic water levels and the specific capacity for each well. Records of the water level in each well shows the water level fluctuates dramatically in response to hydrological conditions and pumping, and typically vary seasonally and with demand changes. The specific capacity is the ratio of discharge flow rate from the well to the well drawdown. The specific capacity can be correlated to well performance and its change over time can assist in identifying rehabilitation efforts for each well. The report documents that the specific capacities in all wells have declined since construction and all have a specific capacity less than 2 gpm per foot of drawdown. All the well capacities have also dropped since construction. The original well capacities ranged from 400 to 600 gpm, and the current well capacities range from 100 to 300 gpm. The decline in specific capacity and production capacity in all wells is related to well plugging.

Other factors evaluated to determine well condition include the composition of the casing and screen materials, the water quality, and the age of materials. All the Ojai wells, except the 2 most recently drilled wells (Mutual Well #6 and San Antonio Well #4), are constructed of carbon steel casings. The generally accepted useful life of a carbon steel well casing is 30 years due to its inclination to corrode. Based on the well casing age and average corrosion rates of carbon steel, it is suspected that half of the Ojai wells (Mutual well #4, Mutual Well #5, and San Antonio #3) are nearing the end of their useful lives.

The historic water quality from each well was also analyzed for the corrosivity or encrustive (ability to scale) tendency of the wells. Typically, if the water is not corrosive it tends to scale and has an encrustive nature. The water corrosivity is indirectly measured by evaluating the waters ability to form a protective scale to prevent corrosion. The historical water quality evaluation showed the water pumped from the Ojai basin does form a protective scale to prevent corrosion and has encrustive tendencies. Low corrosion potential correlates with the extended well lifetimes of the older wells equipped with carbon steel casings. The formation of scale also correlates to the clogging of the wells and reduced specific capacity and production capacity over time.

It is recommended to improve the combined capacity from the wellfield to perform a full rehabilitation, including mechanical and chemical rehabilitation, of San Antonio Well #4. San Antonio Well #4 was drilled in 2005 and is expected to have a long remaining useful life, so rehabilitation at this well will yield the best long-term investment of all the wells.

There are multiple well rehabilitation strategies that may be suitable for San Antonio Well #4. Effective well rehabilitation requires removal of all deposited material in the well casing to restore specific capacity and pore volume. Well rehabilitation methods should be custom tailored to the problems causing production loss and the well construction type. Chemical rehabilitation includes using chemicals to dissolve material buildup that can clog the well casing, such as injecting CO_2 or acid-based chemicals in the well. Mechanical rehabilitation includes using a mechanical process to unplug the well, such as wire brushing, swabbing, or airburst to break up buildup reducing well production. The specific rehabilitation method best suited for San Antonio Well #4 should be further investigated and determined as part of the rehabilitation project. The San Antonio #4 well rehabilitation project is included in the final CIP, and planning level costs include project development costs to investigate and recommend rehabilitation methods, as well as costs to perform rehabilitation.

Due to the encrustive nature of the groundwater, the production capacity will decline over time after rehabilitation, so it is also recommended that CMWD construct a new well at the Grand Avenue wellfield site to improve production capacity. The new well can also replace 1 of the 3 aging wells, Mutual #4, Mutual #5, or San Antonio #3, that is nearing the end of its useful life. Constructing a new well is also included in the final CIP and includes planning level costs. Other recommendations listed in the Ojai Wellfield Assessment Report that were not included as capital improvement projects are included below, and can be included in routine well maintenance:

- Well performance data should be collected on a routine monthly basis.
- Sounding tubes should be installed whenever a well is serviced or a pump pulled.
- The water meters at each well should be tested for accuracy.
- All the wells should be video surveyed and a rehabilitation plan should be determined based on observed condition.
- A simple hydraulic model should be developed to determine well interference impacts between wells to allow optimization of wellfield operations.
- New wells should be equipped with VFDs due to the large seasonal fluctuation in water levels to allow energy efficient pumping. VFDs should also be considered at existing wells.
- The above ground components of each well, including the mechanical and electrical equipment, should be evaluated for existing condition and the potential to increase production capacity.
- Water quality bioassays should be performed on all wells to determine the presence of microbial populations that may contribute further to reducing the well condition including scale, corrosion, or clogging. This information can also guide appropriate rehabilitation methods for each well.

10.3 Pump Stations

The pump stations were evaluated based on past documentation of maintenance, recent pump tests, and input from CMWD operations staff. There are 5 pump stations in the Ojai distribution system that pump water across the system. Based on an initial review of data and the capacity analysis, it is likely that upgrades will be required at all pump stations. Supply and capacity related upgrades are recommended at the Signal and Heidelberger BPSs, as described in the Supply and Storage and the Capacity Analysis sections. Many of the potential alternatives to improve storage in the Running Ridge Zone also include upgrades to the Arbolada and Valley View Pumps Stations. Descriptions and specific recommendations for each pump station are described below.

San Antonio Pump Station

The San Antonio BPS includes 2 large 1,500 gpm pumps with backup power that pump into the Main Zone. This pump station is a main supply source and would pose a major risk to the operation of the system if it were not operating efficiently. According to the 2016 pump tests, both San Antonio Booster A and B are operating above 70% efficiency. This is an adequate pump efficiency and suggests the pumps are in good condition. The pump age is unknown, but they should be replaced every 15-20 years before they reach they end of their useful life.

Signal Pump Station

The Signal BPS is currently in poor quality. The Signal Booster A is designed to pump to the Main Zone, but only consists of 1 pump without backup power and cannot be considered as reliable. CMWD operations staff also note that this pump is not often used and does not have any controls, and when it is operating, it pumps in a circle back to the Signal Tank. The Signal Booster B supplies the Signal Zone and contains 1 pump equipped with backup power. This single pump maintains adequate pressures for the Signal Zone and can be considered reliable because it has backup power. However, it cannot be taken offline for repairs or replacement because there is not a second pump to cycle between. The age of Signal Booster Pump B is unknown, but the 2016 pump test indicates it is operating at an efficiency of 34.6%. The poor efficiency indicates the pump is operating off its design point and could be losing efficiency due to age or condition.

To improve supply reliability and the Signal Zone's available fire flow, the Signal Pump Station is recommended to be upgraded. This may include complete demolition of the existing pump station and reconstruction of a more reliable pump station including dual booster pumps and a fire pump with backup power. Since the Signal Booster A is not used, it is recommended to remove this pump. The recommended alternatives evaluation for the Signal Tank should also evaluate rehabilitation versus complete reconstruction of the Signal Pump Station.

Arbolada Pump Station

The Arbolada BPS consists of 2 booster pumps that fill the Running Ridge Tanks and is located adjacent to the Arbolada Reservoir. This pump station was constructed in 2004 to replace the previous Arbolada BPS. According to 2016 pump tests, both Arbolada pumps have an efficiency above 75%. Although the pumps are approaching the expected useful life of 15 to 20 years, the high efficiency suggests they were in good condition during the pump test in 2016.

As mentioned, the Running Ridge Tanks are in poor condition and need to be taken out of service immediately. There are multiple alternatives that should be evaluated to determine the ideal solution to improve supply and storage for the Running Ridge Zone after the tanks are removed from service, some alternatives which require upgrades at the Arbolada BPS. It is recommended that the alternatives evaluations for the Running Ridge Zone is completed to understand if upgrades are required at the Arbolada BPS. If no recommendations are required at the Arbolada BPS after the Running Ridge alternatives analysis is complete, a condition assessment should be performed for this pump station and recommendations implemented to continue providing supply reliability for the Running Ridge Zone.

Valley View Pump Station

The Valley View BPS is located off Foothill Road just north of Layton Street and pumps to the Heidelberger Tank. The pump station is located below grade and the pump vault was retrofitted in 2002 with new piping, pumps, motors, electrical, and appurtenances. According to the 2016 pump tests, Booster A has an efficiency close to 50% and Booster B has an efficiency of 80%. If the pumps have not been replaced since 2002, they are over 15 years old and likely nearing the end of their useful life. Efficiency loss can also indicate the pumps are nearing the end of their useful life. According to CMWD operations staff, the pump station is in moderate condition and will require future maintenance to upkeep the pump station.

As discussed, it is recommended that a more detailed alternatives analysis is performed to determine the ideal solution for removing the Running Ridge Tanks and improving storage in the Running Ridge Zone. A potential solution includes converting the Running Ridge Zone into a pumped pressure zone, which will require upgrades at the Valley View BPS. Due to space constraints at the existing pump station, any required upgrades may necessitate the pump station to be completely reconstructed above ground. It is recommended that the Running Ridge Zone alternative evaluation is completed to understand if upgrades will be required at the Valley View BPS. If no upgrades are required at the Valley View BPS in the final recommendation for the Running Ridge Zone, a condition assessment should be performed at the Valley View BPS to understand what maintenance it requires to prolong its lifetime and guarantee reliable service. This can be combined with the Arbolada Pump Station Condition Assessment project.

Heidelberger Pump Station

The Heidelberger BPS serves the Heidelberger Boosted Zone, which is the smallest zone in the system and located at the highest elevation. The Heidelberger BPS pumps from the Heidelberger Tank Zone to a hydropneumatic tank that maintains the pressure along a ridge off Foothill Road. The pump station is equipped with 2 small booster pumps. The pumps are rated for different flow and head, and each has a different sized motor. From the 2016 pump tests, Booster A has a pump efficiency of 20%, while Booster B has an efficiency of 50%. Based on the fire flow analysis, it is recommended that this pump station is equipped with a fire pump to provide adequate fire flow for the Heidelberger Tank Zone. Because this will require a significant upgrade, it is recommended that both booster pumps are replaced simultaneously as the fire pump is installed, or the entire pump station is reconstructed. The booster pumps are reaching the end of their lifetime or operating far from their design point, and should be replaced with adequately sized pumps to supply the small zone.

10.4 Leak Detection

From September 6, 2017 through September 15, 2017 a leak survey was performed on the Ojai water distribution system. The Final Leak Detection Report is included in Appendix D. During surveying, 24 total leaks were identified and pinpointed with an estimated water loss of 94.7 gpm. Of the pinpointed leaks, only 2 were found on a water main, while the remaining leaks were on a service lateral or from a valve or meter.

Each identified leak was categorized into 3 classes:

- **Class I**: Any leak which is hazardous in terms of potential undermining, possibly resulting in surface collapse, encroachment and/or damage to nearby utilities, commercial or private properties, or leaks severe enough to warrant repair.
- **Class II**: All leaks that display water losses significantly enough to be monitored on a regular repair schedule.
- **Class III**: Relatively small leaks that should be repaired as work load permits.

Fortunately, no Class I leaks were identified, but over half of the pinpointed leaks were Class II. Class II leaks account for 91 gpm of the total 94.7 gpm of water loss, while the remaining 3.7 gpm was due to 11 Class III leaks. Since leak detection, additional leaks have been discovered and repaired across the system, for a total of 92 leaks repaired by May 2018 since CMWD acquired the Ojai system in June 2017. Most of the leaks have occurred on service lines, but a total of 7 main leaks have been identified and repaired. Figure 10-1 includes a map of the distribution system and location of the repaired leaks.

During pinpointing, there was also a significant amount of noise identified along 40 feet of the 2-inch steel main on Emily Street that prevented leaks from being pinpointed. Based on conversations with CMWD, they plan to replace the entire length of the main and connect it to nearby mains (350 feet of new pipe) to improve system looping and abandon the aging and undersized 2-inch main. This project (Project B19) is included in the final CIP.

It is recommended that CMWD repair the identified leaks that have not already been repaired, and plan to regularly survey the system to update maps and identify leaks because new leaks are always developing in the water distribution system due to the aging infrastructure. Regularly scheduled leak surveys are beneficial to reduce water loss and it reduces overtime costs due to emergency repairs. Water leaks have also been known to cause damage to nearby roads and other infrastructure, and they typically get larger with age. As a result, it is recommended that CMWD proactively locate and repair leaks on a scheduled basis.

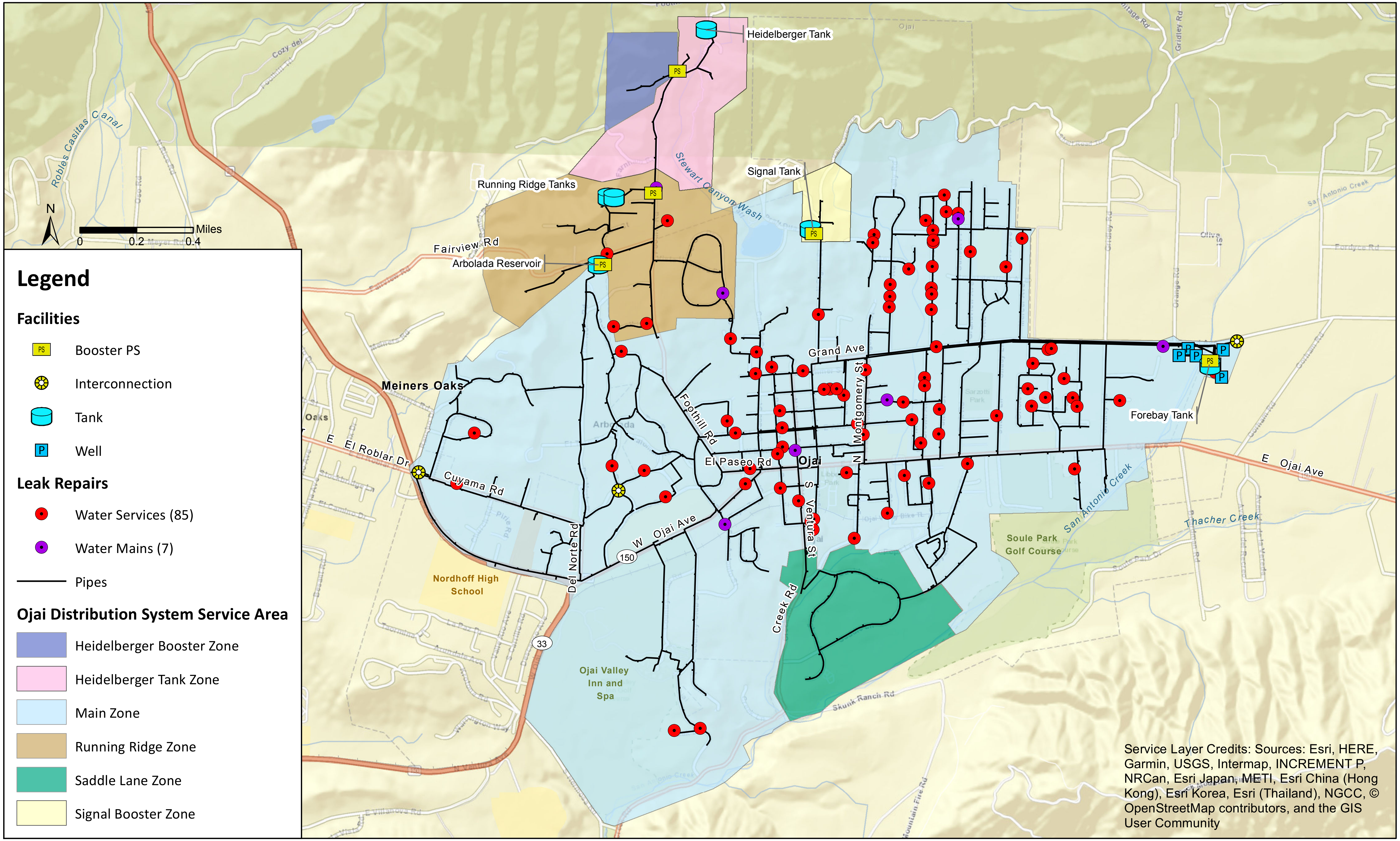


Figure 10-1. Leak Repairs from June 2017 through May 2018

10.5 Pipeline Asset Management

CMWD has the challenge of proactively maintaining a safe and reliable water distribution system while replacing the aging infrastructure and assets in a cost-effective manner. Many of the major facilities are above ground and able to be visually inspected and proactively maintained, such as tanks, wells, and pump stations. Most of the distribution system is underground and not able to be visually inspected. Rather, water purveyors must manage these assets based on regular leak detection surveys, review of installation and maintenance records, and proactive replacement of aging infrastructure based on industry standard expected useful life.

The American Society of Civil Engineers (ASCE) rates the United States Drinking Water infrastructure as a D in its 2017 Infrastructure report card. According to the American Waterworks Association (AWWA), "upgrading existing water systems and meeting the drinking water infrastructure needs of a growing population will require at least $1 trillion in the United States." Most drinking water infrastructure projects are funded through a rate-based system and water sales, but "has been inadequate for decades and continues to be underfunded without significant changes as the revenue generated will fall short as needs grow" (8). The worsening state of infrastructure in the United States is experienced by all water utilities throughout the Country, including in the Ojai water distribution system.

The Ojai water distribution system's underground assets are evaluated based on estimated condition from leak surveys, pipeline material, and pipeline age. Other underground assets, including valves, services, and hydrant laterals are assumed to have a similar condition to the water main that serves them.

As mentioned, CMWD has repaired 92 total leaks since acquiring the Ojai system in June 2017, through May 2018, but only 7 were on water mains and the remaining were service leaks. AWWA and Partnership for Safe Water's Self-Assessment guide for Distribution Systems recommend a maximum of 15 main breaks annually per 100 miles of distribution pipelines. A reduction in main break frequency indicates a progress toward an optimized distribution system. Within a year of CMWD acquiring the Ojai system in June 2017, the average main breaks exceeded the 15 recommended maximum at 15.6 main breaks when scaled to 100 miles of distribution mains. It is expected that as the system's infrastructure approaches the end of its useful lifetime system leaks will likely increase, but can be managed by proactively replacing aging assets.

Industry accepted pipeline useful lifetimes adjusted based leak data, shown in Table 10-1, were used to estimate the decade each pipe is expected to fail. The available year of leak data was used to adjust the estimated useful life for each pipe material, and it was assumed that cast iron pipe can last until the end of the industry accepted range due to the prevalence of functioning old cast iron pipe in the system. It was also assumed that Asbestos Cement (AC) pipe typically failed in the lower end of the accepted useful lifetime range because most main breaks within the first year occurred on 1950s and 1960s AC pipe.

Shown in Figure 10-2, most pipe failures fall into 1 of 3 failure modes: the install defect failure period, the random failure period, and the degradation related failure period. Any failures in the first category should be prevented by proper design, installation, and inspection. Random failures cannot be predicted, but the system should be surveyed regularly to identify and repair these random leaks. This analysis focuses on the pipe failure due to degradation because much of the Ojai water distribution system is reaching the end of its useful lifetime.

Table 10-1. Pipeline Estimated Useful Life Based on Material

Pipe Material	Estimated Useful Lifetime (years)[1]
Asbestos Cement	90
Cast Iron	75
Ductile Iron	100
PVC	100
Steel (unlined/uncoated)	60

[1]Estimated useful life is adapted from Deb, Arun, Herz, Raimund, et al; "Quantifying Future Rehabilitation and Replacement Needs of Water Mains"; WRF 1998, adjusted based on Ojai system leak reports.

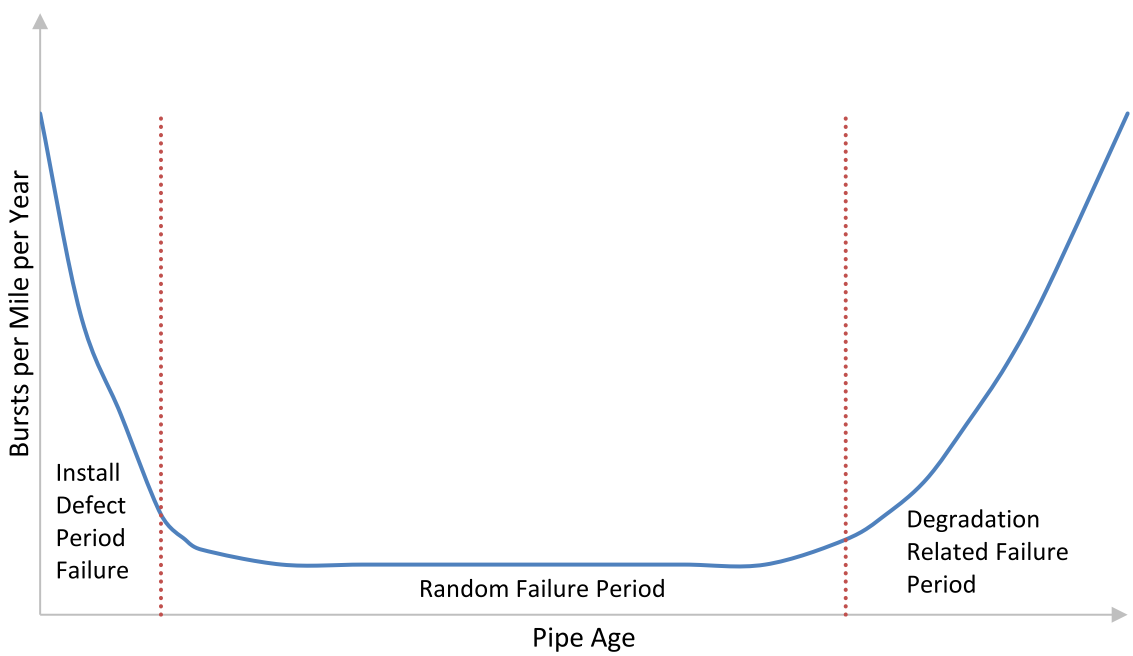


Figure 10-2. Classic Failure Curve for Pipes (9)

Figure 10-3 displays the percentage of each material that currently comprises the water distribution system. 70% percent of the distribution system is comprised of cast iron pipe or asbestos cement pipe.

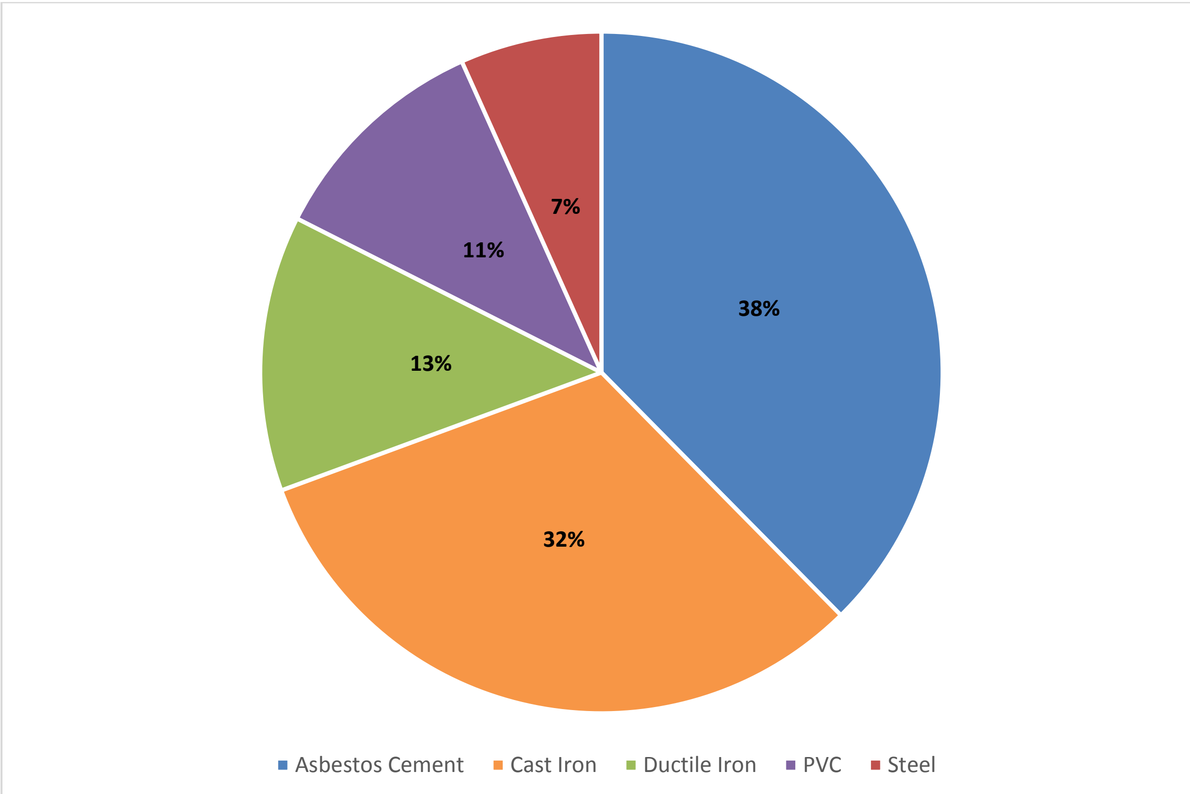


Figure 10-3. Percentage of Pipeline Materials within the Distribution System

Typically, water distribution systems contain multiple types of pipe material. This can be due to site specific requirements where a certain pipe material is preferred for the function of the pipe, but in most cases the pipe material used is a function of the most popular pipe material based on the installation date. Cast iron and steel pipe were popular in the early to mid 1900s, but could not compete with the non-corrosive nature of asbestos cement in the Western United States from the 1960s through the 1980s. Asbestos cement pipe was phased out in the United States in the late 1970s and both ductile iron and PVC pipe are currently some of the more popular pipe materials used in water distribution systems, along with other highly specialized pipe materials. Figure 10-4 shows the number of miles of pipe installed each year by material. In this figure it is clear what the preferred water pipe materials were for each decade in Ojai.

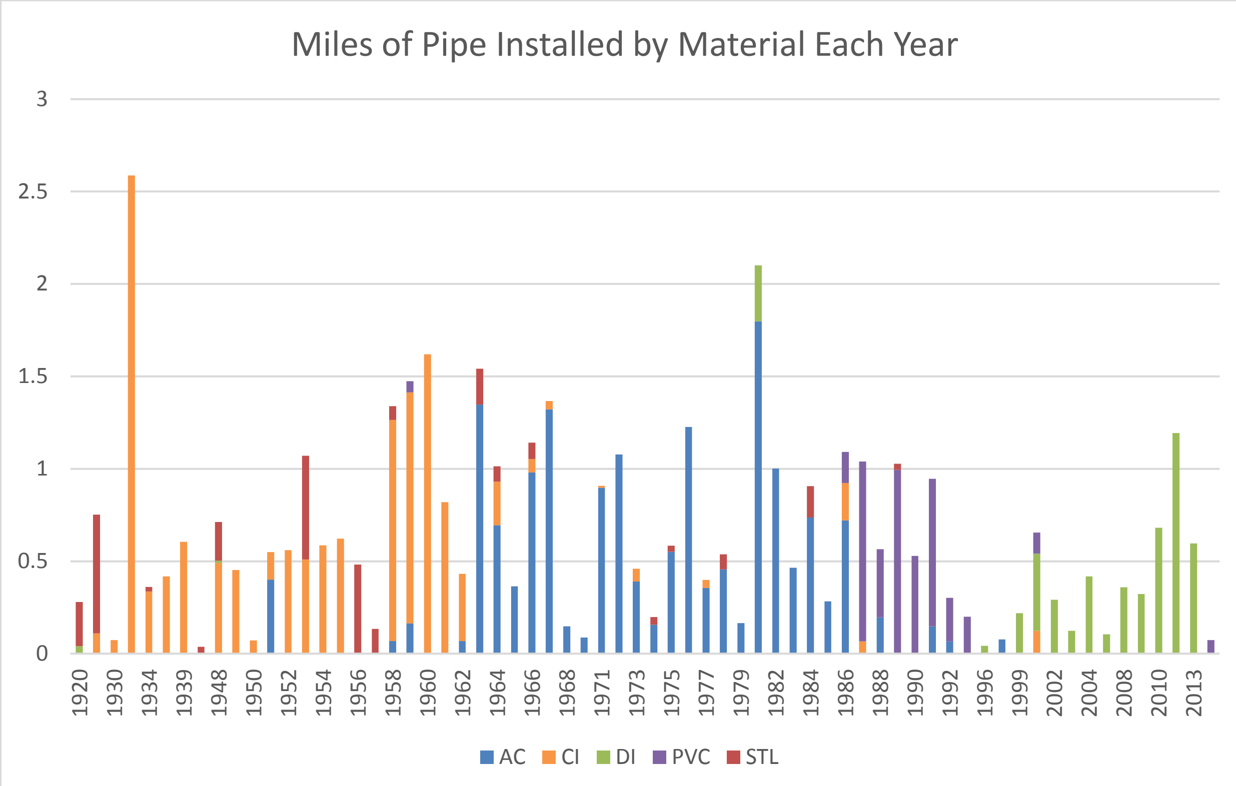


Figure 10-4. Miles of Pipe Installed by Material Each Year

Based on the pipe install data and estimated useful life by material, it is recommended CMWD immediately implement an annual pipeline replacement plan to prevent costly emergency pipe failures. The miles of pipe expected to fail each year by material and in total are shown in Figure 10-5 and Figure 10-6, respectively. To ensure that specific capacity and condition projects are not double counted in this analysis, the recommended pipeline projects listed in the final CIP are assumed to have a future failure date of 2120 with a 100 -year service life for each project. Because of this assumption, the analysis shows a large failure of pipes, predominantly cast iron, in 2120. These pipes are assumed to be replaced by 2020 with PVC pipe and have a useful life through 2120, but are shown below as their current pipe material. Without double counting recommended projects, many for pipelines near the end of their useful lives, this analysis predicts an additional 3.3 miles of pipeline that have currently exceeded their useful lifetime and have a high risk of failure. These pipelines include steel and cast iron pipe originally installed in the 1920s and 1930s.

This analysis also predicts that pipelines will fail in large groups similar to how they were installed, then have periods with little expected pipe failures. It is recommended that pipes are replaced before they are expected to fail to prevent extremely costly repairs during an emergency main break. Typically, emergency repairs of such infrastructure like water mains costs 3 to 4 times higher in an emergency situation compared to regular repairs (10).

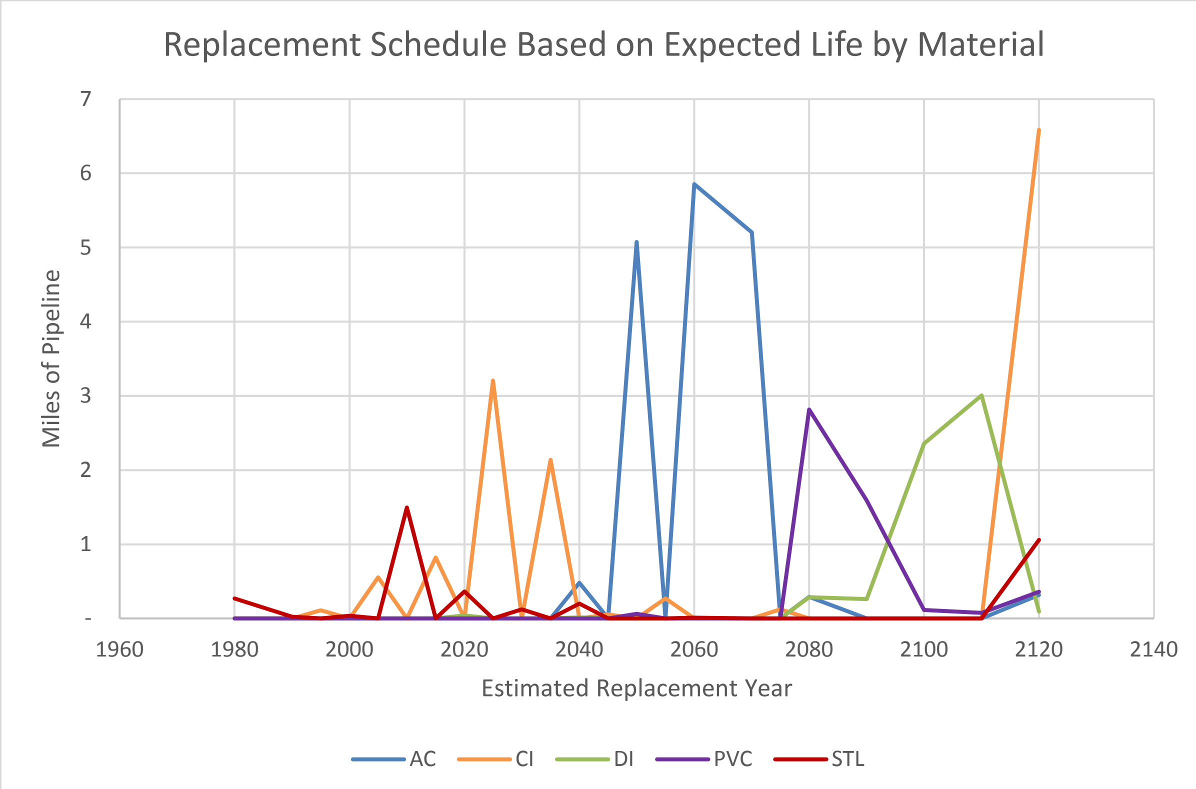


Figure 10-5. Replacement Schedule Based on Expected Life by Material

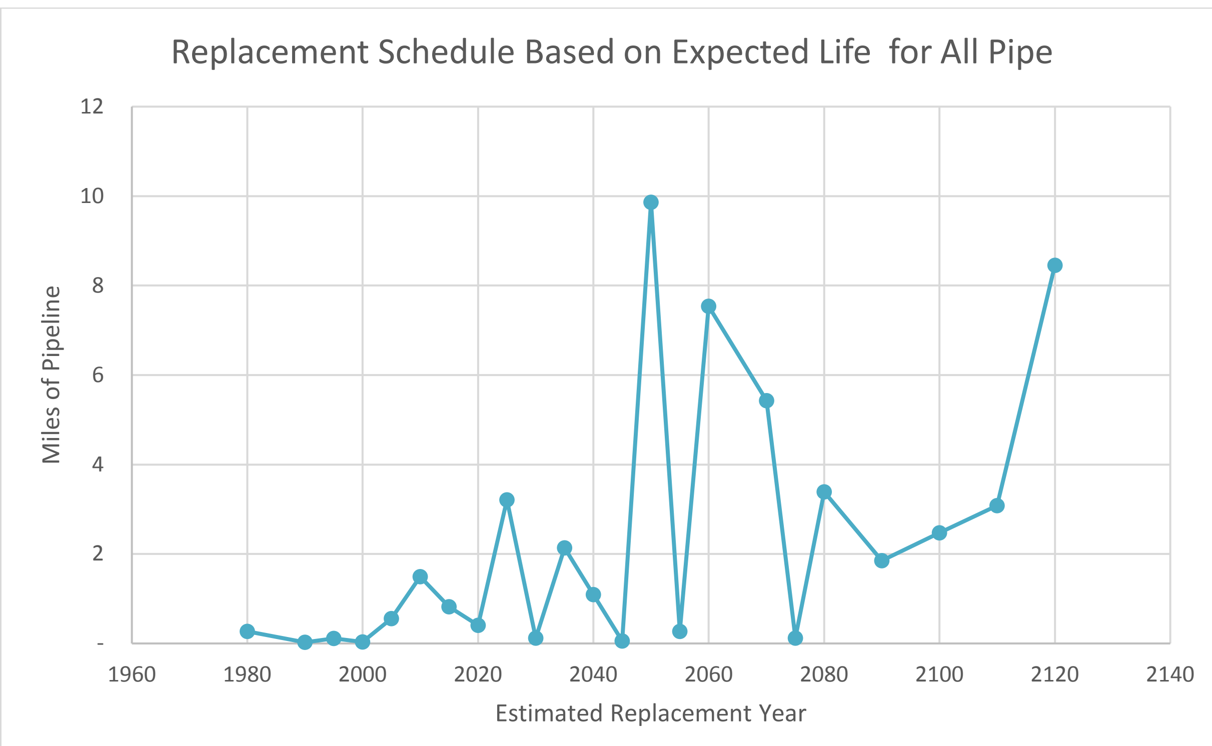


Figure 10-6. Replacement Schedule Based on Expected Life for All Pipe

For planning purposes, and to prevent a massive pipe failure in the distribution system, CMWD should actively replace aging pipelines. Replacement strategies presented in Figure 10-7 include: (1) a linear replacement strategy; (2) a phased replacement strategy that includes an initial large infrastructure improvement plan to better match the estimated pipeline failure curve.

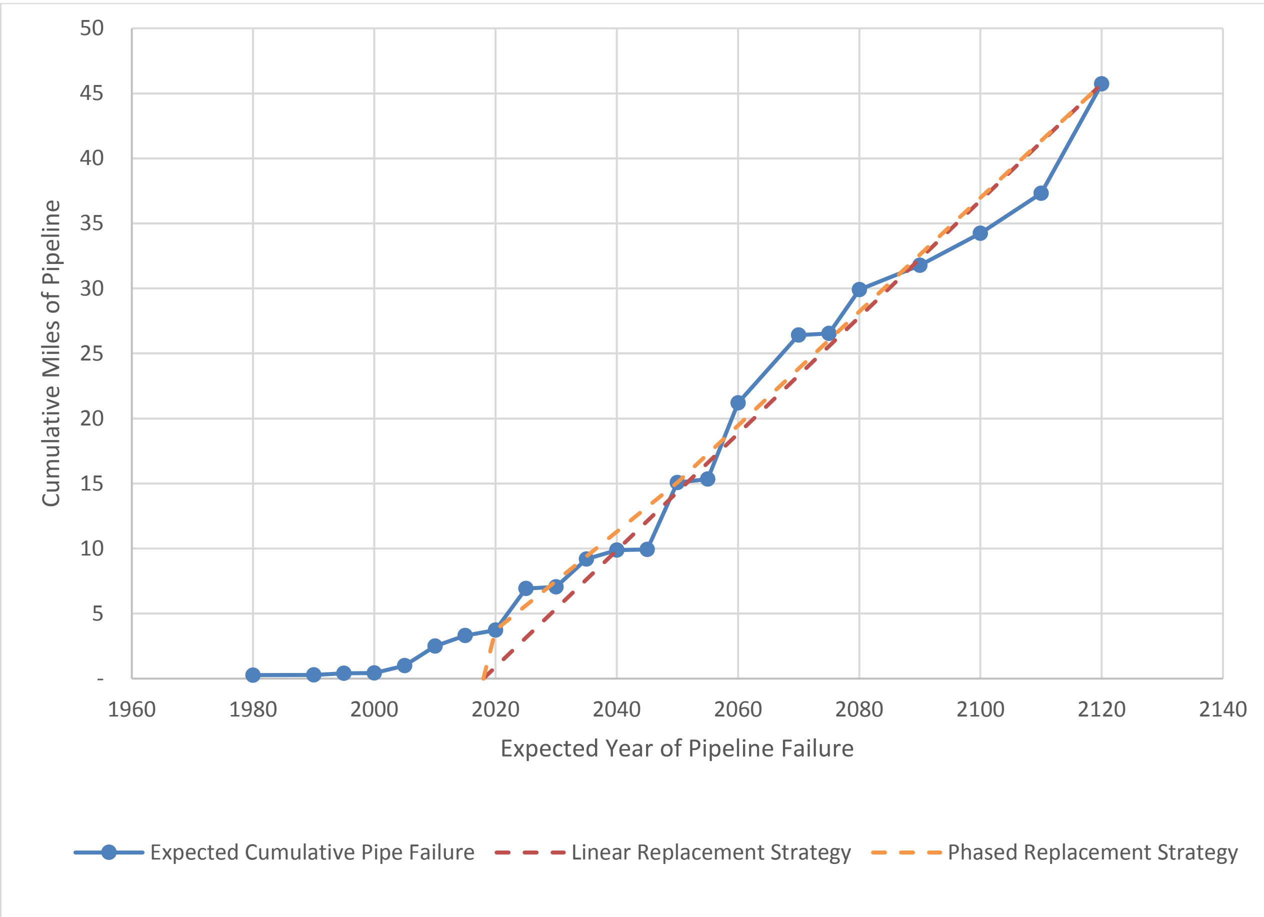


Figure 10-7. Expected Cumulative Miles of Pipeline Failures and Replacement Strategies

Under the linear replacement strategy, pipeline replacement needs to occur at a rate of 0.45 miles per year, about 1% annually. Under the phased replacement strategy, the recommended length and rate of pipe replacement varies based on the year:

- **2018-2020**: 1.86 miles of pipeline each year (4.1%)
- **2020-2050**: 0.38 miles of pipeline each year (0.83%)
- **2050-2120**: 0.44 miles of pipeline each year (0.96%)

Under the linear replacement strategy, CMWD can budget similar amounts per year for pipeline replacements, but does not address the 3.3 miles of pipeline that is expected to have exceeded its useful life. Under this replacement strategy, the expected pipe failure curve is above the replacement curve until about 2040, which suggests that emergency main breaks may occur even as staff appropriately replaces 1% of the aging water mains per year.

In the phased replacement strategy, the 3.3 miles of pipeline expected to have exceed their useful lifetime is recommended to be replaced by 2020. This includes all the pre-1955 steel and pre-1940 cast iron mains. After this initial large replacement of aging pipes, CMWD can budget less annually (0.38 miles per year) for pipeline replacements compared to the linear replacement strategy.

This initial condition assessment is intended to set the stage and inform CMWD of potential asset liability that could arise in the near future. This analysis is limited because it assumes that all pipes will fail at the end of their useful lifetime. Many pipes will likely fail before the predicted end of their useful lifetime and a small percentage can exceed their end of useful life estimate. It is recommended this analysis is periodically updated by staff based on pipe replacements and refined assumptions as more information is available. Information such as historical breaks, in-situ pipe conditions, wall thickness, gasket condition, localized soil properties, and groundwater can be used in conjunction with the pipe material and estimated age to further refine and optimize the replacement strategy.

10.5.1 Pipeline Rehabilitation and Replacement Costs

The pipeline replacement unit costs for various main sizes were estimated using RSMeans CostWorks, adjusted to 2018 dollars (ENR Construction Cost Index of 11069 for June, 2018), and are listed in Table 10-2. The unit costs assume the classic “open trench” replacement approach. Trenchless rehabilitation including coating, pipe-burst and horizontal directional drilling may reduce capital costs when viable.

Table 10-2. Estimated Pipeline Replacement Costs

Pipe Diameter	Pipeline Costs ($/LF)[1,2]
8-inch	$303
10-inch	$322
12- inch	$343

1. Costs developed using RS Means and assumes the project has laterals. Pipes smaller than 8-inch are assumed to be replaced with an 8-inch diameter pipe.
2. Costs include a 25% construction contingency, a 10% Project Development Allowance, and a 10% Construction Phase Allowance.

Under the phased replacement strategy, CMWD will need to budget approximately $2.98 million per year (1.86 miles per year) in 2018, 2019, and 2020 for annual pipeline replacement. After 2020, it is recommended CMWD budget approximately $0.61 million per year for annual pipeline replacement under the phased replacement strategy. Under the linear replacement strategy, CMWD will need to budget approximately $0.72 million per year for pipeline replacements. Due to the high initial costs in the phased replacement strategy, it is recommended CMWD implement the linear replacement strategy.

10.5.2 Priority Pipeline Condition Assessment Projects

In addition to actively replacing aging pipelines each year, CMWD and WSC have identified multiple aging pipes within the system that are near the end of their lifetime and have a high replacement priority, listed in Table 10-3. Theses pipes have been identified due to their history of leaks, condition, and age. They are assumed to be replaced by 2020 and have a failure date of 2120 in the above analysis. The justification for each project is described below:

- Abandon the steel pipes installed in 1929 and 1948 along Grand Avenue between Los Alamos Drive and the Grand Avenue Wellfield. This project has been identified by Casitas operations staff to optimize the system and abandon aging mains. Along this section of Grand Avenue is a 1929-8-inch steel main, a 1948/53-10-inch steel main, a 1932-12-inch main (the transmission main identified in Project B1), and a 2014-16-inch ductile iron main. The 8-inch and 10-inch mains are past their expected useful lives, and the recently constructed 16-inch main provides adequate conveyance for fire flow in the system, so it recommended to abandon the older mains.
- Replace the aging cast iron main along Ventura Street between Ojai Avenue and Summer Street. This main has been identified by operations staff as having multiple inoperable valves. The pipe is a 1934-4-inch cast iron main, and CMWD prefers to replace the entire length of pipe since it is nearing the end of its useful life.
- Replace or reline the 12-inch cast iron transmission main installed in 1932 through the Main Zone. Based on pipe age and material, this pipe is nearing the end of its useful life. There are many aging cast iron mains in the Ojai system and this transmission main represents the backbone of the distribution system and could affect the entire system if there was a major failure. Due to the high risk to the system if this transmission main failed, it has been identified as a projected in this CBA & WMP. The pipe thickness of the 1932 cast iron transmission mains can be evaluated to see if pipe cleaning and lining is feasible, which may be less expensive than classic open-trench replacement.
- Replace the 8-inch steel pipe installed in 1920 south of the Arbolada reservoir along Del Norte Road. Based on the pipe age and material, this pipe is expected to have reached the end of its useful life. The 2014 atlas map shows 1,100 feet of 8-inch steel pipe along Del Norte Road below the Arbolada reservoir, but as-builts from 2014 show a portion of this pipeline has been replaced with 12-inch ductile iron pipe. The as-builts indicate the 2014 ductile iron pipe connects to a 12-inch pipe to the north, but there are no other as-builts that indicate the recommended project has been completed. The extent of this project should be verified in the field, as all the 8-inch steel pipe may have already been abandoned and replaced with 12-inch pipe.

Table 10-3. Recommended Condition Pipeline Projects

Project No.	Zone	Location	Existing Size, Material, and Installation Year	Length	Recommended Project
A8	Main	Grand Avenue	1948/53 10-inch Steel, and 1929 8" Steel	4,965 feet	Abandon 2,815 LF of 10-inch Steel pipe installed in 1948 & 1953 and 2,150 LF of 8-inch steel pipe installed in 1929 along Grand Avenue from Los Alamos Drive to the Grand Avenue Wellfield to simplify the system and reduce maintenance of aging pipes.
A9	Main	Ventura Street	1934 4-inch Cast Iron	1,745 feet	Replace 1,745 LF od 4-inch cast iron pipe with 8-inch PVC along Ventura Street between Ojai Avenue and Summer Street.
B1	Main	Palomar Road, Foothill Road, Aliso Street, Montgomery Street, and Grande Ave	1932 12-inch Cast Iron Transmission Main	14,380 feet 2.7 miles	Sample pipe thickness to determine if it can be cleaned and coated for rehabilitation. If the pipe is thinning, it should be replaced with 12-inch PVC pipe.
B9[1]	Main	Del Norte Road	1920 8-inch Steel Pipe	475 feet	Replace the remaining length of 8-inch steel pipe below the Arbolada Reservoir with 12-inch PVC pipe.

1. The extent of this project should be verified by field inspection.

10.6 Recommendations

Table 10-4 includes the recommended projects based on the condition assessment evaluation. These recommendations also consider the supply, storage, and capacity analysis and try to incorporate capacity recommendations to also improve system condition.

The condition based projects are listed in order of priority and the project number matches that in the final CIP list. The projects have been ranked based on the number of customers impacted by the project, the system's risk if the project is not completed or the existing facilities failed, and the operational improvements with the project completion.

Project No.	Project Type	Zone	Location	Description
A1	Tank	Running Ridge	Unknown location, likely within the Running Ridge Zone	Perform an alternatives evaluation to determine the best solution to remove the existing tanks and improve storage within the zone. This may include converting the zone to a pumped pressure zone, replacing the tanks at the existing site, replacing the tanks at an alternative site, or utilizing existing storage in the main Casitas water distribution system. Storage, pumped supply, and fire flow should all be considered during the evaluation. Depending on the preferred solution, the project may include improvements to the Arbolada and Valley View Pump Stations.
A3	Tank and Pump Station	Signal	Signal Tank and pump station site or other location within the Signal Zone	Perform an alternatives evaluation to determine the best solution for the Signal Zone. The evaluation should consider the condition of the Signal Tank, water quality due to excess storage, required pump station suction pressure and other pump station improvements, and fire flow requirements. Solutions may include recoating the Signal Tank, demolishing and reconstructing the Signal Tank at the same site or an alternative site, or demolishing the Signal Tank and not reconstructing a tank. All solutions will require replacing the Signal BPS.
A5	Well	Main	Grand Avenue Wellfield	Complete chemical and mechanical rehabilitation of San Antonio Well #4.
A8	Pipeline	Main	Grand Avenue	Abandon 2,815 LF of 10-inch steel pipe installed in 1948 & 1953 and 2,150 LF of 8-inch steel pipe installed in 1929 along Grand Avenue from Los Alamos Drive to the Grand Avenue Wellfield to simplify the system and reduce maintenance of aging pipes.
A9	Pipeline	Main	Ventura Street	Replace 1,745 LF of 4-inch cast iron pipe with 8-inch PVC along Ventura Street between Ojai Avenue and Summer Street.
B1	Pipeline	Main	Palomar Road, Foothill Road, Aliso Street, Montgomery Street, and Grande Ave	Sample thickness of the 12-inch cast iron pipe that comprises backbone of the Main Zone. Clean and coat the 14,400 LF of the pipe if thickness allows or replace this main entirely with 12-inch PVC pipe.
B2	Well	Main	Grand Avenue Wellfield	Construct a new well at the Grand Avenue Wellfield.
B4	Pump Station	Heidelberger Boosted	Heidelberger Pump Station Site	Replace booster pumps at the Heidelberger pump stations and add a fire pump to provide fire protection to the zone. Depending on site constraints, this pump station may need to be completely reconstructed.
B9	Pipeline	Main	Del Norte Road	Replace the remaining 475 LF of 8-inch steel pipe below the Arbolada Reservoir with 12-inch PVC pipe.
B14	Tank	Main	Arbolada Reservoir	Minor maintenance at the Arbolada Reservoir. Replace broken guardrail at roof hatch and implement a roof edge protection plan. Monitor cracks and interior white sealant for softening.
B15	Tank	Main	San Antonio Forebay Tank	Minor maintenance at the San Antonio Forebay Tank. Repair the broken bracket on interior safety ladder climb. Mitigate corrosion in the interior vapor space by coating corrosion sites, consider adding an additional vent, and planning to recoat the interior within the next 5 years. Coat the fiberglass interior ladder with a NSF 61 compliant epoxy.
B16	Tank	Heidelberger	Heidelberger Tank	Minor maintenance at the Heidelberger Tank. Develop and implement an erosion control plan at the tank site. Replace the vent screens to achieve bug resistance. Repair damaged coatings at the 20 bolts in the upper interior shell and the corrosion locations near the roof vent and roof hatch.
B17	Tank	Multiple	Multiple	Conduct a structural and seismic evaluation for all the system reservoirs to understand system risks and if reservoirs require seismic retrofit and what each reservoir's seismic retrofit will entail.
B18	Pump Station	Multiple	Multiple	Perform a CBA of the San Antonio, Arbolada, and Valley View Pump Stations if upgrades are not required at these pump stations. If upgrades are required as a part of other projects, pump station maintenance should be included in the upgrade project.
B19	Pipeline	Main	Emily Street	Replace the 175 LF of 2-inch steel pipe along Emily Street with 325 LF of 8-inch PVC and connect to the existing 6-inch AC main on the south end of Emily Street to increase system looping.

Section 11

RECOMMENDED IMPROVEMENTS

SECTION 11

Recommended Improvements

The Casitas Municipal Water District conducted a Condition Based Assessment and Water Master Plan for their newly acquired water distribution system within the City of Ojai. Through this process, capacity and condition projects for pipeline, booster pump stations, storage tank / reservoirs, and other system improvements have been identified. Projects are categorized into 2 categories. Priority A projects include the highest priority improvements that are needed to provide safe and reliable service to CMWD ratepayers. Priority B projects include lower priority improvements that will enhance system reliability and longer term needs. These improvements, including cost opinions, are include in the Capital Improvement Plan within this section.

11.1 Project Prioritization

This CBA & WMP identifies the need for capacity and condition projects for pipeline improvements as well as booster pump, storage tank, and other water system improvements. Projects are ranked within 2 categories:

- "A" projects are highest priority and are needed to comply with current or anticipated future regulations, correct recurring failures, address significant safety concerns (including correcting fire flow that is well under the required flow), or ensure that adequate water supplies are available to meet projected demands. Priority A includes pipeline rehabilitation projects for 1 to 3 years from the date of this CBA and WMP.
- "B" projects address lower priority, longer term existing needs, and are improvements that enhance system reliability or other low-level risks. Priority B includes pipeline rehabilitation projects for 4 to 10 years from the date of this CBA and WMP.

IN THIS SECTION

11.2 Cost Opinion Basis and Assumptions

The cost opinions (estimates) with the recommended projects in this CIP have been prepared in conformance with industry practices as planning level cost opinions and are classified as Class 4 Conceptual Report Classification of Opinion of Probable Construction Costs as developed by the Association for the Advancement of Cost Engineering (AACE International). The purpose of a Class 4 estimate is to provide a conceptual level of effort that is expected to range in accuracy from -30% to +50%. A Class 4 estimate also includes an appropriate level of contingency so that it can be used in future planning and feasibility studies. The design concepts and associated costs presented in this CIP are conceptual in nature due to the limited design information that is available at this stage of project planning. These cost estimates have been developed using a combination of data from RS Means CostWorks® and recent bids, experience with similar projects, current and foreseeable regulatory requirements, and an understanding of necessary project components. As the projects progress, the designs and associated costs could vary significantly from the project components identified in this CIP.

The recommended projects and these cost opinions are based on the following assumptions. Detailed cost estimates for each project can be found in Appendix E.

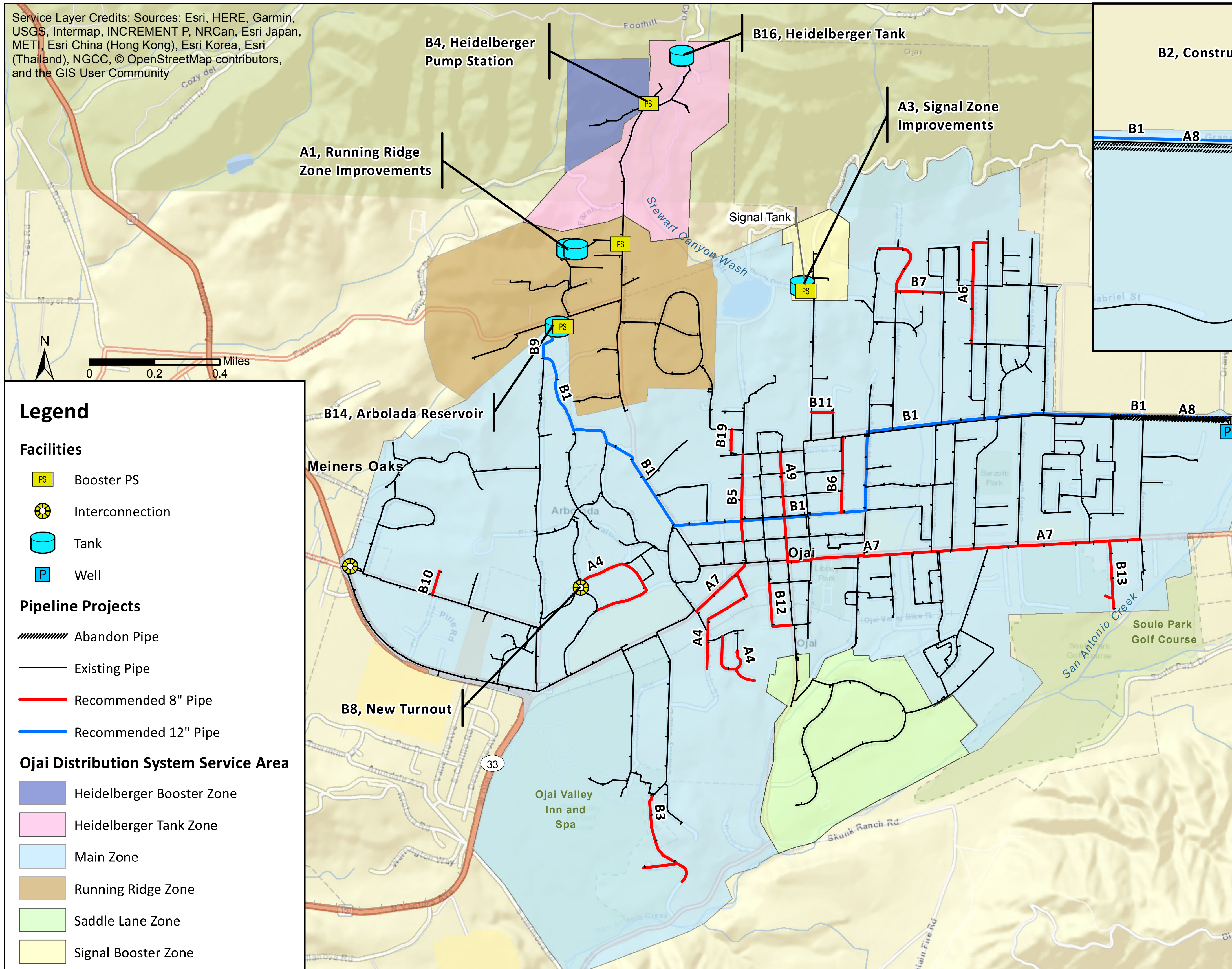
1. For projects where applicable cost data is available in RS Means CostWorks® (e.g. pipeline installation), cost data released in Quarter 2 of 2018, adjusted for Oxnard, CA is used. Materials prices were further adjusted in some cases to provide estimated that align closer with actual local bid results.
2. For projects where RS Means CostWorks® data is not available, cost opinions are generally derived from bid prices from similar projects, vendor quotes, material prices, and labor estimates, with adjustments for inflation, size, complexity, and location.
3. Cost opinions are in 2018 dollars (ENR Construction Cost Index of 11069 for June, 2018). When budgeting for future years, appropriate escalation factors should be applied. The past 5-year average increase of the ENR CCI 20 City Average is considered a reasonable factor to use for escalation.
4. Cost opinions are "planning-level" and may not fully account for site-specific conditions that will affect the actual costs, such as soil conditions and utility conflicts.
5. Construction Costs include the following mark-up items:
    a. 5% of construction item subtotal to account for unknown items not included in the opinion of cost.
    b. 25% construction contingency based on construction subtotal.
6. Total Project Costs include the following allowances:
    a. 10% of Construction Total for project development, including administration, alternatives analysis, planning, engineering, surveying, etc.
    b. 10% of Construction Total for construction phase support services, including administration, inspection, materials testing, office engineering, construction administration, etc.

11.3 Capital Improvement Plan

Table 11-1 includes the list of capital improvement projects. Figure 11-1 and Plate 1, enclosed with study, shows a large-scale map of the distribution system improvements.

Table 11-1. Capital Improvement Plan

Project No.	Zone	Project Category	Recommended Improvement	Length	Diameter	Project Cost
A1	Running Ridge	Zone Improvements	Alternatives Evaluation and Design of the Running Ridge Zone Improvements	N/A	N/A	$2,583,000
A2	Main	Velocity Improvement	Mutual Wellfield Discharge Pipe	720 feet	12"	$216,000
A3	Signal	Zone Improvements	Alternatives Evaluation and Design of the Signal Zone Improvements (and Main Zone storage)	N/A	N/A	$1,434,000
A4	Main	Fire Flow Improvement	Cuyama and El Paseo Road, Topa Topa Drive, San Antonio Street, and Crestview Drive	5,615 feet	8"	$1,827,000
A5	Main	Well Condition Improvement	Complete rehabilitation of San Antonio Well #4	N/A	N/A	$125,000
A6	Main	Fire Flow Improvement	Sunset Place	1,865 feet	8"	$670,000
A7	Main	Fire Flow Improvement	West and East Ojai Avenue	6,855 feet	8"	$2,145,000
A8	Main	Pipeline Condition Improvement	Grand Avenue Pipe Optimization (abandon aging mains)	4,965 feet	N/A	$20,000
A9	Main	Pipeline Condition Improvement	Ventura Street	1,745 feet	8”	$568,000
					3-Year Budget	**$9,588,000**
B1	Main	Pipeline Condition Improvement	Evaluate and reline or replace the 12" Cast Iron Transmission Main	14,400 feet	12-inch	$4,846,000
B2	Main	Supply Reliability	Construct a new well at the Grand Ave. Wellfield	N/A	N/A	$925,000
B3	Main	Fire Flow Improvement	Country Club Drive	2,250 feet	8-inch	$641,000
B4	Heidelberger Boosted	Fire Flow Improvement & Condition Assessment	Rehabilitate or Reconstruct Heidelberger Pump Station. Add a 1,250 gpm Fire Pump with backup power	N/A	N/A	$920,000
B5	Main	Fire Flow Improvement	Canada Street	1,400 feet	8"	$452,000
B6	Main	Fire Flow Improvement	Lion Street	1,230 feet	8-inch	$409,000
B7	Main	Fire Flow Improvement	Pleasant Avenue and Daly Road	1,965 feet	8-inch	$733,000
B8	Main	Supply Reliability	Construct a new turnout from the main Casitas system	N/A	N/A	$124,000
B9	Main	Pipeline Condition Improvement	Del Norte Road (below the Arbolada Reservoir)	475 feet	12-inch	$158,000
B10	Main	Fire Flow Improvement	Verano Drive	400 feet	8-inch	$122,000
B11	Main	Fire Flow Improvement	Park Avenue	355 feet	8-inch	$99,000
B12	Main	Fire Flow Improvement	Blanch Street and Santa Ana Street	1,020 feet	8-inch	$337,000
B13	Main	Fire Flow Improvement	Fairway Lane	1,220 feet	8-inch	$392,000
B14	Main	Tank Condition Improvement	Arbolada Reservoir Improvements	N/A	N/A	$10,000
B15	Main	Tank Condition Improvement	San Antonio Forebay Improvements	N/A	N/A	$205,000
B16	Heidelberger Tank	Tank Condition Improvement	Heidelberger Tank Improvements	N/A	N/A	$25,000
B17	Various	Tank Seismic Evaluation Study	Structural and Seismic Evaluation for all Reservoirs	N/A	N/A	$25,000
B18	Various	Pump Station Condition Assessment Study	San Antonio, Arbolada, and Valley View BPS Condition Assessment	N/A	N/A	$10,000
B19	Main	Pipeline Condition Improvement	Emily Street	350 feet	8-inch	$115,000
					10-Year Budget	**$10,548,000**
					Grand Total	**$20,136,000**



Project No.	Recommended Improvement	Length (feet)	Diameter	Project Cost[1]
	3-Year Projects			
A1	Running Ridge Zone Improvements			$2,583,000
A2	Mutual Well Field Discharge Pipe	720	12"	$216,000
A3	Signal Zone Improvements			$1,434,000
A4	Cuyama and El Paseo Road, Topa Topa Drive, San Antonio Street, and Crestview Drive	5615	8"	$1,827,000
A5	San Antonio #4 Rehabilitation			$125,000
A6	Sunset Place	1,865	8"	$670,000
A7	West and East Ojai Avenue	6,855	8"	$2,145,000
A8	Grand Avenue Pipe Optimization	4,965		$20,000
A9	Ventura Street	1,745	8"	$568,000
	10-Year Projects			
B1	12" Cast Iron Transmission Main	14,400	12"	$4,846,000
B2	Construct a new well			$925,000
B3	Country Club Drive	2,250	8"	$641,000
B4	Heidelberger Pump Station			$920,000
B5	Canada Street	1,400	8"	$452,000
B6	Lion Street	1,230	8"	$409,000
B7	Pleasant Avenue and Daly Road	1,965	8"	$733,000
B8	Construct a new turnout			$124,000
B9	Del Norte Road	475	12"	$158,000
B10	Verano Drive	400	8"	$122,000
B11	Park Avenue	355	8"	$99,000
B12	Blanch Street and Santa Ana Street	1,020	8"	$337,000
B13	Fairway Lane	1,220	8"	$392,000
B14	Arbolada Reservoir Improvements			$10,000
B15	San Antonio Forebay Improvements			$205,000
B16	Heidelberger Tank Improvements			$25,000
B17	Tank Seismic Evaluation			$25,000
B18	BPS Condition Assessment			$10,000
B19	Emily Street	350	8"	$115,000

1- Project costs include a 5% markup of construction subtotal to account for unknown items not included in the cost opinion, and a 25% construction contingency based on construction subtotal. Total project costs include a 10% allowance (of construction total) for project implementation and a 10% allowance (of construction total) for construction phase support.

Figure 11-1. Capital Improvement Projects

Section 12

REFERENCES

SECTION 12

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CASITAS
Municipal Water District
WSC
Water Systems Consulting, Inc.