Prepared for:
Palmdale Water District

2016 Water System Master Plan

December 2016

Costs have been updated to July 2018 and Chapters 10 and 11 have been revised plus Appendix E and F have been added (Nov. 2018)

MWH
BUILDING A BETTER WORLD

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EXECUTIVE SUMMARY

The primary objective of the Palmdale Water District's (PWD) 2016 Water Distribution System Master Plan (WSMP) is to provide cost-effective and fiscally responsible water services that meet the water quantity, water quality, system pressure, and reliability requirements of its customers. This WSMP has a planning horizon of the year 2040. This report is prepared as an update to PWD's previous Draft Water System Master Plan completed in year 2007. This evaluation includes determining needs to address existing system deficiencies and facility requirements to meet rising demands over the next twenty-five years. The report also provides details for a proposed Capital Improvement Program (CIP) for the water system through year 2030, including prioritization and construction cost estimates.

ES.1. Existing Water System

PWD provides water services to the City of Palmdale and unincorporated areas in Los Angeles County. The water system currently includes seven main pressure zones. Within these zones, there are approximately 414 miles of pipelines ranging in diameter from 4 inches to 42 inches, 21 storage reservoirs with an approximate total storage capacity of 50 million gallons (MG), 17 booster pump stations, and 23 active groundwater wells. The District's existing water system facilities are described in detail in **Section 2**. **Figure ES-1** shows the Study Area considered for this WSMP.

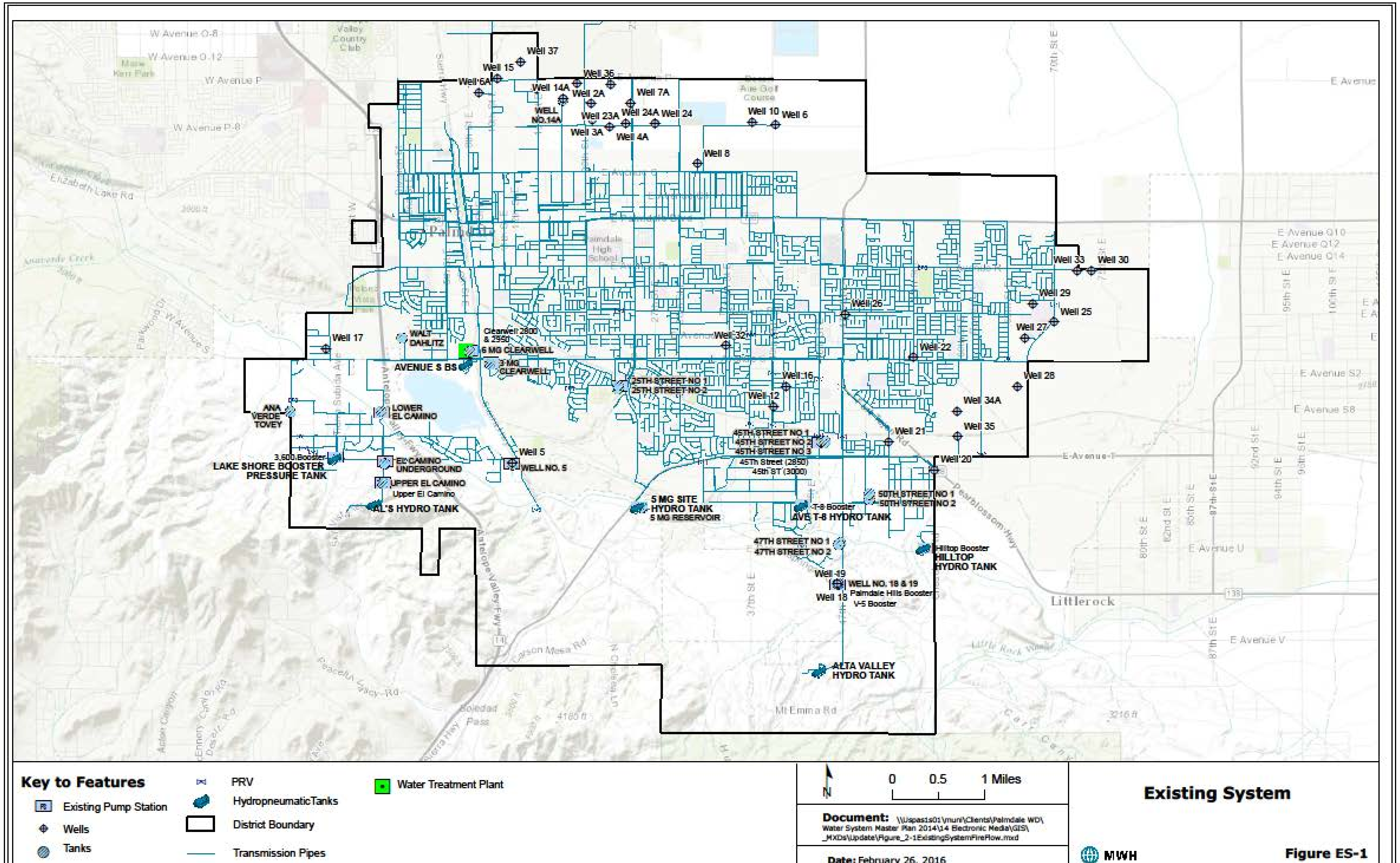
ES.2. Projected Water Demands

A review of existing and future development and demands within PWD's service area is presented in **Section 3**. Based on the growth projections, projected water demands have been prepared. The projected demands are smaller than the previously projected demands from the 2007 Draft Water System Master Plan due to the economic downturn of 2008, the current drought, and the strict conservation requirements established by the State of California. Water demands for future scenarios are determined based on water demand factors (WDF), specific plans, and future projected growth. Maximum day demands were determined by applying a peaking factor of 1.8 to the anticipated average day demands. **Table ES-1** summarizes the projected water demands.

Table ES-1
Projected Water Demands

Year	Water Demands		
	Average Annual		Maximum Day (mgd)
	(acre-ft/yr)	(mgd)	
2015	21,400	19.1	34.4
2020	25,900	23.1	42.6
2025	27,200	24.2	43.6
2030	28,500	25.4	45.7
2035	29,800	26.6	47.8
2040	31,100	27.7	49.9
Build-out	**44,600**	**39.8**	**71.6**

Figure ES-1
Facility Map



This map has been designed to print size 11" by 17". Aerial Basemap Source: Esri and CNES/Airbus DS

ES.3. Water Supply

PWD obtains its potable water supplies from local groundwater from the Antelope Valley Groundwater Basin, local surface water from Littlerock Creek Reservoir, and imported water from the State Water Project (SWP). The local groundwater is of excellent mineral and bacteriological quality, although the basin was becoming overdrafted due to annual pumping that exceeded replenishment. Therefore, the Antelope Valley Groundwater Basin was recently adjudicated by the Courts in December 2015. The PWD portion of the Antelope Valley Groundwater Basin is 2,770 AFY, although PWD will receive approximately 5,000 AFY of return flow credits for imported water used. The Littlerock Creek Dam and Reservoir was rehabilitated in 1992, with an estimated 2,765 AF of capacity. The Littlerock Creek Reservoir water rights are shared between PWD and the Littlerock Creek Irrigation District. Imported water is obtained from the State Water Project. State Water Project and the Littlerock Creek water are stored in Lake Palmdale, which has a capacity of about 4,129 acre-ft. PWD's goal is to use any available recycled water for groundwater replenishment as part of the optimal blend of water supply alternatives to address future needs. Palmdale has completed feasibility studies to investigate groundwater recharge and recovery programs, using recycled water supplied to PWD from the Los Angeles County Sanitation District No. 20 Palmdale Water Reclamation Plant. The groundwater recharge and recovery program will provide an additional 13 mgd by 2030 and an anticipated 21.6 mgd by build-out. **Table ES-2** summarizes the existing and planned potable water supplies that are currently part of PWD's capital improvement program.

Table ES-2
Existing and Future Potable Water Supplies

Water Supply Source	Capacity (mgd)
Existing Supplies	
Groundwater (Extraction)	15.8
Littlerock Creek	2.62 - 21.9 (depending on availability)
State Water Project	0.95 - 19.0 (depending on availability)
Leslie O Carter WTP	35
Total - Existing Supplies	**50.8**
Future Supplies (2030)	
Palmdale Regional Groundwater Recharge and Recovery Program (2030)	13
New Wells / Banked Groundwater (2030)	3.6
Total - Future Supplies (2030)	**16.6**
Total Supplies by 2030	**67.4**

ES.4. Hydraulic Evaluation

The adequacy of PWD's system under existing and future demand conditions is evaluated using a calibrated hydraulic model of PWD's water system. A well calibrated model serves as an excellent planning tool and results in the development of defensible recommendations. The hydraulic model, built using PWD's robust GIS database, contains all the pipes within the potable water system and is an accurate representation of the water distribution system. This model is used to identify pressure, supply, and storage deficiencies in the water system. Recommendations are made to address these deficiencies. The development and the calibration of the hydraulic model are discussed in **Section 6** of this report. The details of the hydraulic analyses are discussed in **Section 8** and **Section 9** of this report.

ES.5. Recommended Improvements

Based on these evaluations, the recommendations are divided into two categories; 1) Near-term system (2015-2020) improvements addressing existing water system deficiencies, and 2) future system (2021-2030) improvements necessary to meet the needs under 2030 conditions.

ES.5.1 Near-Term Existing System Improvements

Details of the existing system analysis are discussed in **Section 8**. The near-term improvements are divided into the following four categories:

- Pipeline improvements to address fire flow deficiencies (FF)
- Storage improvements (ES)
- Booster improvements (EB)
- Water supply improvements

These recommendations are summarized in **Table ES-3**.

Table ES-3
Summary of Near Term System Improvements

Category	Improvements Description	Quantity	Unit
FF(1)	Pipeline Improvements for fire flow deficiencies	1.3	miles
ES	Reservoirs Improvements – construction of new reservoirs	8.3	MG
EB	Pumping Improvements – construction/expansion of pump stations	12.2	MGD
	Supply Improvements – Groundwater Banking Program (Phase 1)	6.7	MGD

1) The fire flow improvements were developed in the 2007 Draft Water System Master Plan

ES.5.2 Future System Improvements

Details of the future system analysis are discussed in **Section 9**. The future improvements are divided into the following four categories:

- Future Transmission pipeline improvements to serve future customers (FT)
- Storage improvements (FS)
- Booster improvements (FB)
- Water supply improvements

These recommendations are summarized in **Table ES-4** and are briefly described below.

Table ES-4
Summary of 2030 System Improvements

Category	Improvements Description	Quantity	Unit
FT	Pipeline Improvements for future growth	146.6	miles
FS	Reservoirs Improvements – construction of new reservoirs	14.5	MG
FB	Pumping Improvements – construction/expansion of pump stations	5.7	MGD

	Supply Improvements – Groundwater Banking Program (Phase 1)	6.7	MGD

ES.6. Capital Improvement Program

The Capital Improvement Program (CIP) lists the improvements needed by PWD to address existing system deficiencies and meet future growth. Capital improvement projects are phased according to system needs. Future system recommendations are predicated on the projected growth identified in **Section 3**. The timing of the implementation of the proposed recommendations may vary if growth within PWD's service area occurs at a different rate. Future system facilities must be installed prior to the demand increase so that water will be available continuously.

A summary of the recommended CIP by project type and by funder are shown in **Table ES-5** and **Table ES-6**, respectively, with a total cost of $321,000,400 through 2030.

Table ES-5
Summary of Capital Improvement Program by Project Type (Year 2015 Dollars)

Phase	Pipelines(1)	Storage Tanks	Pumps(2)	Water Supply(3)	Miscellaneous(4)	Total
2015-2020	$56,966,800	$10,890,000	$5,040,000	$39,000,000	$1,000,000	$112,896,800
2021-2025	$55,166,800	$11,010,000	$4,420,000	$40,800,000	$1,000,000	$112,396,800
2026-2030	$55,486,800	$22,560,000	$2,260,000	$2,400,000	$13,000,000	$95,706,800
TOTAL	**$167,620,400**	**$44,460,000**	**$11,720,000**	**$82,200,000**	**$15,000,000**	**$321,000,400**

1) The pipelines category includes fireflow projects, age based pipeline improvements, and pipeline expansion projects
2) The pumps category includes deficiency projects and age based improvements
3) The future water supply category includes the Phase 1 Palmdale Regional Groundwater Recharge and Recovery Project and recommended wells in the Palmdale service area. The future supply does not include costs for expanding recycled water system or funds required for SWP leased water
4) Miscellaneous costs are estimated costs for facility assessment maintenance costs in **Appendix B** and increased staffing in the 2026-2030 phase.

Table ES-6
Summary of Capital Improvement Program by Funder (Year 2015 Dollars)

Phase	Existing Ratepayers	Future Ratepayers	Total
2015-2020	$15,010,000	$97,886,800	$112,896,800
2021-2025	$7,040,000	$105,356,800	$112,396,800
2026-2030	$9,440,000	$86,266,800	$95,706,800
TOTAL	**$31,490,000**	**$289,510,400**	**$321,000,400**

SECTION 1 INTRODUCTION

This section provides overview of the project and an outline of the 2016 Water System Master Plan (WSMP) for Palmdale Water District (PWD). A brief background of the master planning work conducted to date, a discussion of the objectives and scope of work, a description of the report sections to follow, and a listing of abbreviations and definitions used in this report are included in this section.

1.1 Project Background

PWD's last WSMP was a draft report completed by Carollo Engineers in 2007. Since the completion of the 2007 draft WSMP, there has been a significant change in water demand within PWD's service area due to the economic downturn that followed the collapse of the housing market in 2008. When development activity slowly started resuming in 2012, California entered into a four-year drought with strict conservation goals established by the State. In 2015, PWD served the least amount of water they have served in the past 30 years.

The intent of the 2016 WSMP is to develop a document that can be used as a guideline for the planning of the PWD's potable water system. This WSMP has a planning horizon of year 2030 and for build-out conditions which is expected to occur beyond the year 2040. The WSMP evaluates the PWD's potable water system under existing and future conditions.

The 2016 WSMP covers the service area of the PWD, which is composed of the City of Palmdale and portions of un-incorporated areas in Los Angeles County. With over 27,300 water connections, the PWD currently serves a population of approximately 120,000. The proposed developments and in-fill growth within PWD's service area offer a significant potential for growth, since approximately 68 percent of PWD's service area is vacant. The planning and sizing of new facilities to serve the new developments are an important focus in this WSMP.

1.2 Objectives

This water master plan is developed to assist PWD in their objective of "providing high quality water to our current and future customers at a reasonable cost" by meeting the following goals:

- Developing an infrastructure plan that balances reliability and cost
- Creating an accurate and usable calibrated hydraulic model
- Evaluating water system performance and water resources
- Identifying needed capital improvement projects
- Transferring knowledge to PWD's staff

For this WSMP, a 24-hour extended period simulation (EPS) computer model of the potable water system is updated from the previous WSMP. The calibrated potable water model includes all water pipelines within PWD's water system. Future system elements that will become necessary to meet the year 2030 and build-out service conditions are added to analyze the future conditions and make recommendations for system improvements.

A Capital Improvement Program (CIP) is prepared that includes all system improvements required to meet the potable water system needs through the year 2030. These improvements are identified by analyzing the potable water system under existing and future demand conditions. The CIP includes a list of the recommended improvements, proposed phasing, and cost estimates. The CIP will provide PWD with a water system planning road map for the future.

1.3 Scope of Work

The Scope of Work (SOW) of this WSMP consists of the following tasks:

- Create a calibrated, static and 24-hour hydraulic potable water model of PWD's system
- Project potable water demands in the service area in five year increments to 2040
- Perform a water supply analysis
- Update water quality regulations and current water quality
- Conduct storage, booster station, and system reliability analysis
- Analyze the potable water distribution system under existing conditions
- Analyze the potable water distribution system under future conditions
- Identify potable water system improvements
- Prepare a CIP for the potable water system
- Provide discussion of financing options
- Consult PWD staff on needs of the system

1.4 Data Sources

In preparation of this WSMP, the PWD staff supplied many reports, maps, studies and other sources of information. In addition, material was obtained from other sources such as United States Geographical Survey (USGS), Environmental Systems Research Institute, Inc. (ESRI), and others. Pertinent materials included water system maps, planning and development information, general plan land use, historical records, billing data, and detailed facility information. A complete list of reference documents is provided in **Appendix A**. Numerous meetings were held with the PWD staff. In addition, extended interactions were held with the PWD's operational staff during the hydraulic model development and calibration stages to utilize their knowledge and information.

1.5 Authorization

This water master plan has been developed in accordance with a purchase requisition between the PWD and MWH (Montgomery Watson Harza) dated March 25, 2014.

1.6 Acknowledgements

MWH wishes to acknowledge and thank all of PWD's staff for their support and assistance in completing this project with special thanks to; James Riley (Engineering / Grant Manger), Dennis LaMoreaux (General Manager), Matthew Knudson (Assistant General Manager), Peter Thompson (Water and Energy Resource Director), and Richard Heinonen (GIS Coordinator).

1.7 Project Staff

The following MWH staff was principally involved in the preparation of this WSMP:

Principal-in-Charge:	Ajit Bhamrah, P.E.
Technical Reviewer:	David Ringel, P.E.
Project Manager:	Parag Kalaria, P.E., PMP
Project Engineer:	Brett Singley, P.E. Nathan Griffin, P.E.
GIS Specialist:	Jackie Silber, GISP

1.8 Master Plan Outline

The WSMP is divided into 11 sections. **Section 2** discusses PWD's existing water facilities and water supply. **Section 3** focuses on the study area, land use and development, existing water production, existing demands, and projected demands. **Section 4** evaluates the existing water supply and future water supply options. **Section 5** discusses water quality regulations and PWD water quality. **Section 6** entails the model development and calibration, and **Section 7** describes the planning and evaluation criteria. **Section 8** and **9** discuss the existing and future system evaluations, respectively. Based on these system evaluations, the Capital Improvement Program (CIP) for the potable water system is developed and is discussed in **Section 10**, and **Section 11** provides financing options to fund the CIP projects.

1.9 List of Abbreviations

To conserve space and improve readability, abbreviations have been used in this report. Each abbreviation has been spelled out in the text the first time it is used in each section. Subsequent usage of the term is usually identified by its abbreviation. **Table 1-1** is a list of the abbreviations used in this WSMP.

Table 1-1
List of Abbreviations

Acronym	Definition
AC	Acre
AC-FT/YR or AF/YR or AFY	Acre feet per year
ADD	Average day demand
AMSL	Above mean sea level
ASR	Aquifer Storage Recovery
AWWA	American Water Works Association
BDCP	Bay Delta Conservation Plan
CCR	Consumer Confidence Reports
CFS	cubic feet per second
CII	Commercial-industrial-institutional
CIP	Capital Improvement Program
COP	Certificates of Participation
DBP	Disinfection By-Product
D/DBPR	Disinfectants and Disinfectants Byproducts Rule
DDW	Division of Drinking Water
DLR	Detection Limit for Reporting
DWR	Department of Water Resources
DWSRF	Drinking Water State Revolving Fund
EIR/EIS	Environmental Impact Report / Environmental Impact Statement
EPS	Extended Period Simulation
ESRI	Environmental Systems Research Institute, Inc.
FPS	Feet per second
FT	Feet
GAC	Granular Activated Carbon
GIS	Geographic Information System
G.O.	General Obligation
GPCD	Gallons per capita per day
GPD	Gallons per day
GPED	Gallons per employee per day
GPM	Gallons per minute
HAA5	Five of the haloacetic acids
HDPE	High Density Polyethylene
HGL	Hydraulic Grade Line
HP	Horse power
HPC	Heterotrophic Plate Count
IRR	Irrigation
IRWM	Integrated Regional Water Management Plan
KCWA	Kern County Water Agency
LACSD	Los Angeles County Sanitation District
LCID	Little Creek Irrigation District
LCRMR	Lead and Copper Rule Minor Revisions
LOCWTP	Leslie O. Carter Water Treatment Plant
LRAA	Locational Running Annual Average
LRSR	Littlerock Reservoir Sediment Removal
LT2ESWTR	Long-Term 2 Enhanced Surface Water Treatment Rule
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
MDD	Max day demand
MDL	Method Detection Limit
MG	Million gallons

Acronym	Definition
MGD	Million gallons per day
mg/L	Milligram per Liter
MinDD	Minimum Day Demand
MMM	Multimedia Mitigation
MRF	Multi residential family
MTBE	Methyl Tertiary Butyl Ether
MWH	Montgomery Watson Harza
ND	Non Detectable
NED	National Elevation Dataset
NOP	Notice of Preparation
NTU	Nephelometric Turbidity Units
P3	Public-Private Partnership
PCE	Tetrachloroethylene
PVC	Polyvinyl Chloride
PHD	Peak Hour Demand
PRGRRP	Palmdale Regional Groundwater Recharge and Recovery Project
PRS	Pressure Reducing Stations
PRV	Pressure Reducing Valve
PRWA	Palmdale Recycled Water Authority
PSI	Pounds per square inch
PSV	Pressure Sustaining Valve
PWD	Palmdale Water District
RAA	Running Annual Averages
SBx7-7	California Legislature's Water Conservation Act
SCADA	Supervisory Control and Data Acquisition
SCAG	Southern California Association of Governments
SCE	Southern California Edison
SFR	Single Family Residential
Sq ft / SF	Square feet
SOC	Synthetic Organic Chemicals
SOW	Scope of Work
SUVA	Specific Ultraviolet Absorbance
SWP	State Water Project
SWRP	Strategic Water Resources Plan
SWTR	State Water Treatment Rules
T&O	Taste and Odor
TCR	Total Coliform Rule
TDS	Total Dissolved Solids
THM4	All four trihalomethanes
TOC	Total Organic Carbon
USACE	U.S. Army Corp of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geographical Survey
UWMP	Urban Water Management Plan
VOC	Volatile Organic Compounds
WDF	Water demand factor
WSMP	Water System Master Plan
WTP	Leslie O. Carter Water Treatment Plant

SECTION 2 EXISTING POTABLE WATER SYSTEM

This section describes the Palmdale Water District (PWD or the District) potable water system facilities and provides an understanding of the water system operations. The existing water system consists of 21 storage reservoirs, 17 booster pumping stations, 23 active groundwater wells, 14 pressure reducing stations, and approximately 412 miles of pipeline. **Appendix B** is a facility assessment of the PWD facilities with recommendations of facility improvements. A summary of the water system components is shown in **Table 2-1**. The locations of the water facilities are shown on **Figure 2-1**. A hydraulic schematic representation of all of the facilities and their interactions is presented on **Figure 2-2**.

Table 2-1
Summary of Water Distribution System Components

Facility Type	Number
Littlerock Dam and Reservoir	1
Lake Palmdale	1
Service connection from State Water Project (SWP)	1
Water Treatment Plant	1
Pressure Zones	10
Wells (active)	23
Wells (inactive)	4
Booster pump stations	17
Booster pumps	39
Storage tanks	21
Operational hydropneumatic tanks	6
Pipeline (miles)(1)	412.5
Pressure regulating stations	14
Pressure reducing valves	25
Fire hydrants	2,867
Customer meters	25,700

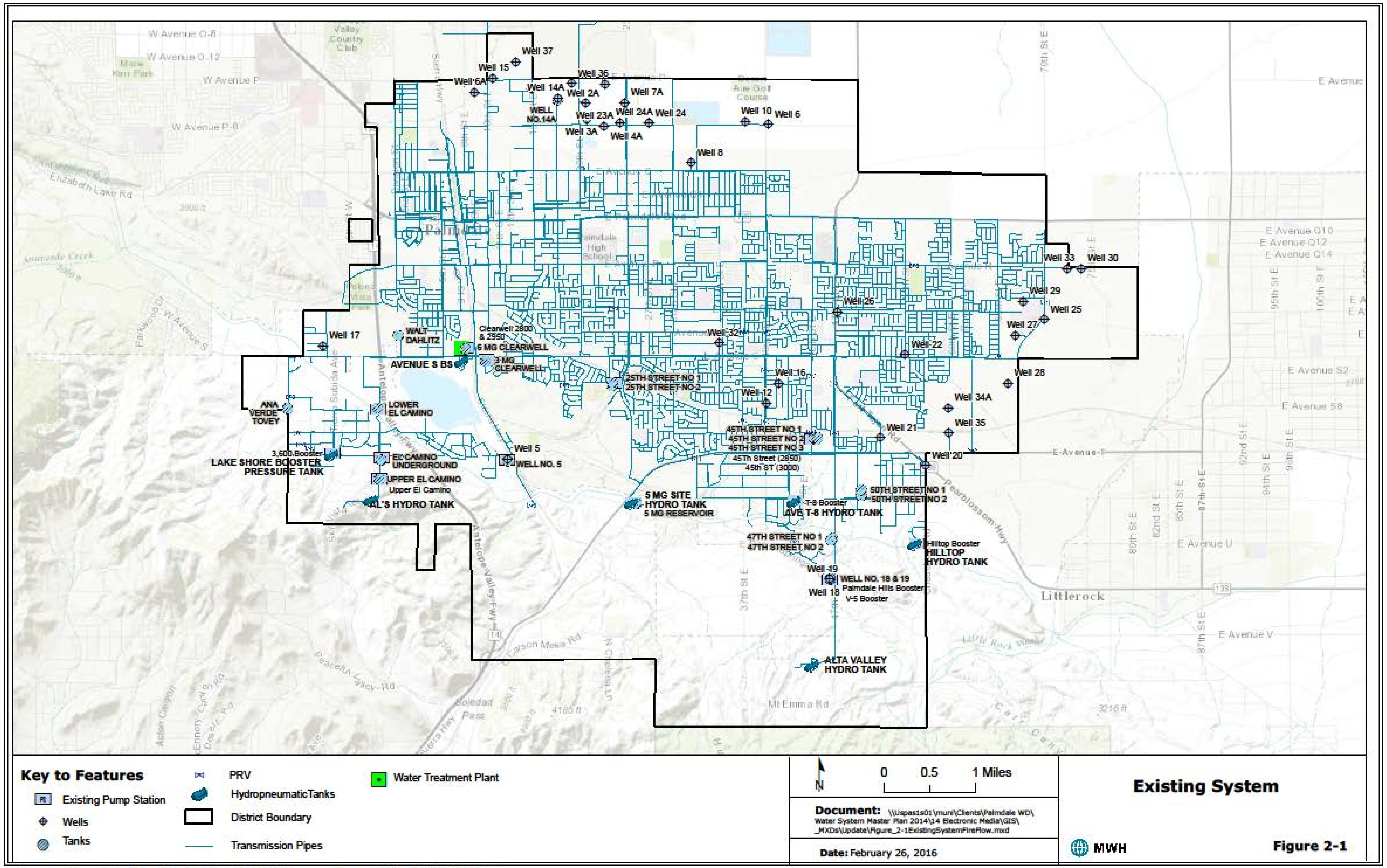
Source: Information presented is based on data provided by PWD and the PWD hydraulic model as of August 2014
1) Pipeline length was updated on August 2016

A computer hydraulic model has been developed that represents the existing water system, including all key water facilities, besides fire hydrants and customer meters. This model is used for the evaluation of existing and future conditions, as well as to identify areas for improvements. The model creation and calibration are described in **Section 4**, while the system analyses for the existing and future conditions are described in **Section 6** and **Section 7,** respectively.

2.1 Pressure Zones

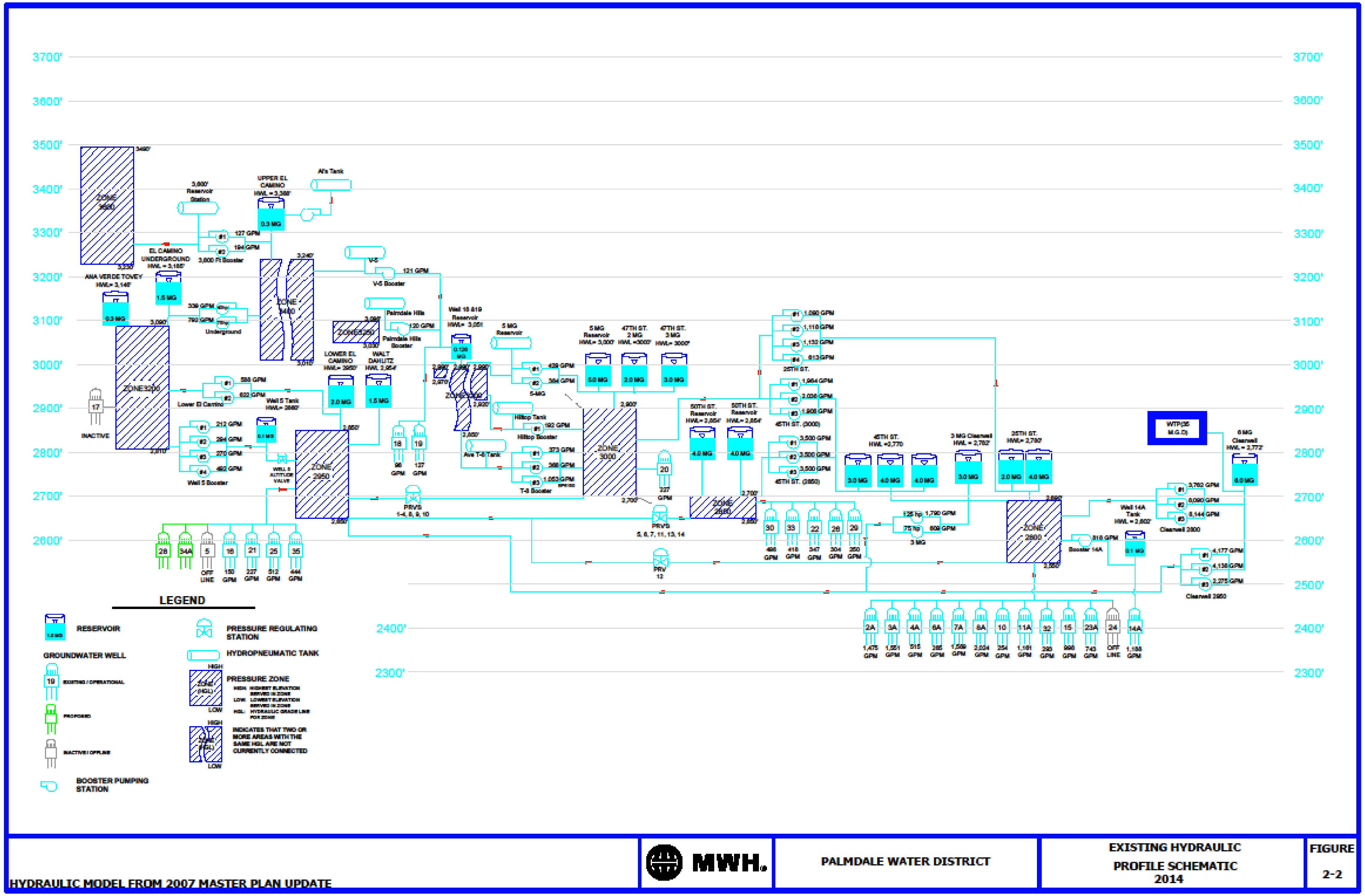
The current water system is divided into seven main pressure zones which are labeled by the approximate hydraulic grade line (HGL) within the zone: the 2800 Zone, 2850 Zone, 2950 Zone, 3000 Zone, 3200 Zone, 3250 Zone, and the 3400 Zone. There are also two smaller zones, the 2835 Zone and the 3600 Zone. All pressure zones in the existing and future system are gravity-fed from storage reservoirs, through pressure reducing stations, or by hydropneumatic tanks. The 3600 zone is served from booster stations and hydropneumatic tanks. The maximum hydraulic grade elevation for each main pressure zone is determined by the high water level of the reservoirs feeding the zone or the normal pressure setting of the PRVs. Booster pumping stations are used to pump water from lower to higher pressure zones, where needed. The names of the pressure zones

Figure 2-1
Existing Water System Facilities



This map has been designed to print size 11" by 17". Aerial Basemap Source: Esri and CNES/Airbus DS

Figure 2-2
Hydraulic Schematic of the Existing System



and their respective hydraulic characteristics are listed in **Table 2-2** and the pressure zone boundaries are shown on **Figure 2-1**. The 3400 pressure zone consists of two regions that are hydraulically separated from each other but have the same HGL, and the 3200 zone consists of three areas with the same HGL but are noncontiguous.

Table 2-2
Pressure Zones

Pressure Zone Name	Ground Elevation Range (feet-amsl[1])	Static Pressure Range[2] (psi)
2800	2552-2782	8-107
2835	2788-2808	12-20
2850	2637-2828	10-92
2950	2656-2938	5-127
3000	2712-2974	11-125
3200	2814-3166	15-167
3250	2850-3108	61-173
3400	3060-3302	42-147
3600	3195-3490	48-175

1) Feet above mean sea level
2) Calculated based on difference between hydraulic grade elevation and ground elevation range

2.2 Water Supply

PWD has three sources of water supply: local surface water from Littlerock Creek Reservoir, imported surface water from the California State Water Project (SWP), and local groundwater pumped from PWD-owned wells in the Antelope Valley groundwater basin. The water from Littlerock Creek and the SWP is treated at the Leslie O. Carter Water Treatment Plant (WTP). Each of these sources is described below.

2.2.1 Surface Water

Littlerock Dam and Reservoir, constitutes the District's local surface water supply source and is located about seven miles southeast of the Palmdale Civic Center. The Littlerock Dam and Reservoir is fed by natural run-off from the San Gabriel Mountains, and intercepts flow from Littlerock and Santiago Canyons. The 65 square mile watershed is located within the Angeles National Forest. Inflow to the reservoir is seasonal and varies from year to year. When the Littlerock Dam was constructed in 1922, the reservoir had a storage capacity of about 4,300 acre-ft. Deposition of sediment from the watershed reduced this capacity to about 1,600 acre-ft by 1991. In 1992, the dam was raised by 12 ft increasing the storage capacity to about 3,300 acre-ft). Continued sedimentation has reduced the capacity to about 2,800 acre-ft.

Since 1922, the District has shared water rights with Littlerock Creek Irrigation District (LCID) for 5,500 acre-feet per year (acre-ft/yr). LCID has rights to the first 13 cubic feet per second (cfs) from the Littlerock Creek, and then the two districts share any flow over 13 cfs with 25 percent of the flow allocated to LCID and the other 75 percent allocated to the District. Each district is entitled to 50 percent of the storage in the reservoir. On average, the District takes approximately 4,000 acre-ft of water from Littlerock Creek Dam each year.

In 1992, when the District and LCID agreed to rehabilitate the Dam, it was decided that LCID would give up their water rights to the District for the fifty year agreement in exchange for not providing monetary support with the improvements. LCID is able to purchase water from the District for either 1,000 acre-ft/yr or 25% of the yield from the Littlerock Creek Dam Reservoir, whichever is less. Historically, the District receives approximately 0 to 15 percent of its water supplies from Littlerock Dam Reservoir, depending upon the year.[1] Over the last 20 years, the PWD has received on average approximately 12 percent (2,944 AFY) of its water supplies from Littlerock Dam and Reservoir.

PWD plans to commence a program to remove approximately 1 million cubic yards of accumulated sediment from the reservoir to maintain capacity and preserve habitat of the arroyo toad, a federally listed endangered species. A joint environmental impact report/environmental impact statement (EIR/EIS), prepared by PWD and the U. S. Forest Service is expected to be finalized in late fall 2016. A Record of Decision by the Forest Service is expected to occur during the 2017 calendar year. This project will restore and maintain the reservoir capacity at about 3,500 acre-ft.

Water from the Littlerock Reservoir is conveyed through the Palmdale Ditch to Lake Palmdale where it mixes with SWP water and is subsequently treated at the Leslie O. Carter Water Treatment Plant.

2.2.2 Imported Water

The District receives approximately 50 percent of its water supply from imported water from the State Water Project. The District is one of the 29 contracting agencies that have contracts with the State of California for SWP water. The District was first able to receive SWP water in 1985 from the East Branch of the California Aqueduct, which runs through the District's service area. The water is conveyed into the District from a 30 cfs connection through a 30 inch pipeline into Lake Palmdale, where it mixes with Littlerock Creek water. The District has a SWP contract Table A Amount of 21,300 acre-ft/yr of SWP water[i2]; however, the availability of water is reduced during dry years. Historically, over the past decade, the District receives between 41 percent and 77 percent of its Table A Amount. [3]

2.2.3 Groundwater Wells

Groundwater pumping comprises approximately 40 percent of the District's water supply in an average year. Since 1995, groundwater pumping has averaged about 10,300 acre-ft/yr.[4] The District pumps water from its 21 active wells from the Antelope Valley Groundwater Basin. For all except three wells, the groundwater is treated with chlorine disinfection, and is pumped directly into the distribution system. Water from Well Nos. 14A, 18, and 19 is disinfected and pumped into adjacent storage tanks, then boosted into nearby pressure zones. Well Nos. 4A, 5, 9, 17, 22, and 24 are currently inactive. The physical and operational data of the District's wells are presented in

[1] 2010 Palmdale UWMP

[2] Each SWP contract contains a "Table A" exhibit which defines the maximum annual amount of water each contractor can receive excluding certain interruptible deliveries. Table A Amounts are used by DWR to allocate available SWP supplies and some of the SWP project costs among the contractors.

[3] 2010 Palmdale UWMP

[4] 2010 Palmdale UWMP

Table 2-3, while the location of the groundwater wells is shown on **Figure 2-1**. An “A” denotes wells that were replaced due to age or performance and are not the originally constructed well.

Table 2-3
Groundwater Well Characteristics

No.	Location	Status	Pressure Zone	Capacity (gpm)(7)	Total Head (feet)	Depth to Groundwater (feet)(8)	Pumping Elevation (feet)	Ground Elevation (feet)(9)	Year Drilled	Pump (hp)
2A	39400 20th St. East	Active	2800	1,242	765	535	2,582	2,575	1968	500
3A	2163 East Ave. P-8	Active	2800	1,181	761	562	2,586	2,586	1960	500
4A(3)	2475 East Ave. P-8	Standby	2800	499	823	541	2,578	2,571	1970	350
5(3)	1036 Barrel Springs Rd.	Out of Service	2950	99	84	n/a(6)	n/a	n/a	1965(1)	5
6A	39455 10th St. East	Active	2800	157	728	560	2,604	2,598	1983	125
7A	39395 25th St. East	Active	2800	1,186	773	541	2,570	2,563	1985	500
8A	2200 East Ave. P	Active	2800	1,667	785	544	2,570	2,562	1987	600
10	3701 East Ave. P-8	Active	2800	140	672	478	2,572	2,568	1956	100
11A(2)	39501 15th St. East	Active	2800	639	738	558	2,590	2,583	1963	n/a
14A	39401 20th St. East	Active	2800	653	578	551	2,584	2,580	1965	250
15(2)	1003 East Ave. P	Active	2800	549	794	600	2,596	2,592	1960	n/a
16	4125 East Ave. S-4	Active	2950	127	425	224	2,692	2,690	1960	40
17(3)	718 Denise Ave.	Inactive	3200	245	309	n/a	n/a	n/a	1966(1)	20
18	4640 Barrel Springs Rd.	Active	3250	68	84	73	3,032	3,060	1954	5
19	4640 Barrel Springs Rd.	Active	3250	106	138	75	3,055	3,060	1961	5
20	5680 Pearblossom Hwy.	Active	3000	125	406	265	2,772	2,765	1973(1)	60
21	36525 52nd St. East	Active	2950	283	388	190	2,740	2,738	1973(1)	30
22(3)	5401 East Ave. S	Inctive	2850	191	297	163	2,700	2,700	1974	75
23	2202 East Ave. P-8	Active	2800	872	790	565	2,582	2,580	1977	500
24(3)	2701 East Ave. P-8	Converted to monitoring well	2800	n/a	757	n/a	n/a	n/a	1985	150
24A	27th St E and Ave P-8	Active	2800	1,000					2009	
25	37520 70th St. East	Active	2950	282	406	218	2,700	2,709	1989	125

No.	Location	Status	Pressure Zone	Capacity (gpm)[7]	Total Head (feet)	Depth to Groundwater (feet)[8]	Pumping Elevation (feet)	Ground Elevation (feet)[9]	Year Drilled	Pump (hp)
26	4701 Katrina Place	Active	2850	167	434	260	2,664	2,661	1989	50
27[4,5]	Future Well	Capped	2950	n/a	n/a	n/a	n/a	n/a	1989	n/a
28[4,5]	Future Well	Not Equipped	2950	n/a	n/a	n/a	n/a	n/a	1989	n/a
29[4.5]	Future Well	Active	2950	n/a	n/a	198	2,686	2,689	1989	n/a
30	7392 East Ave. R	Active	2950	274	453	229	2,670	2,668	1989	150
32	37301 35th St. East	Active	2800	274	490	388	2,670	2,675	1989	60
33	7160 East Ave. R	Active	2950	230	497	266	2,672	2,667	1991	150
34[4.5]	Future Well	Not Equipped	2950	n/a	n/a	n/a	n/a	n/a	1991	n/a
35	36549 60th St. East	Active	3000	379	513	308	2,756	2,753	1991	150
Total Capacity				**11,290**						

1) Exact age unknown; drilled prior to the year shown.
2) Gas driven.
3) Well is out of service due to water quality problems.
4) SCE test data was not available.
5) Not included in existing system computer model.
6) n/a indicates the information is not available.
7) Data for well obtained from Palmdale model
8) Depth to Groundwater is determined from the Palmdale water model
9) Ground elevation from "Well Static and Pumping Level" PDFs provided by PWD staff

All the wells have constant speed pumps that are periodically tested by Southern California Edison (SCE). SCE tests are used, along with manufacture pump curves, to develop pump curves in the hydraulic model. Pump design points are used to develop curves if pump manufacture curves and SCE data is unavailable.

2.3 Booster Pumping Stations

The District operates 17 booster pump stations which consist of 39 booster pumps within its service area. Some of the booster pumps are used only on an as-needed basis. These booster pumping stations either transfer water between zones or pump groundwater into the distribution system. The number of pumps at each station ranges from one to five pump units. The individual booster pump capacities vary from about 120 gpm to 9,800 gpm (0.17 MGD to 14.1 MGD). The total capacity of all booster stations is approximately 61,500 gpm (88.5 MGD). The booster pumping stations are operated when either the adjacent well is operating or when reservoirs in higher pressure zones need replenishment. Details of each booster station are summarized in **Table 2-4.** The booster pumping stations are located in close proximity to the reservoirs or hydropneumatic tanks that the pump is associated too and the booster pumping station locations are schematically represented on **Figure 2-2**.

Table 2-4
Booster Pumping Stations Characteristics

Booster Pump	Location	Motor Horse-power (hp)	Design Head (ft)	Design Flow (gpm)	Suction Facility	Discharge Zone
Clearwell 2800 No.1	700 East Ave. S	100	35	4,830	6 MG Clearwell	2800
Clearwell 2800 No.2	700 East Ave. S	200	29	9,270	6 MG Clearwell	2800
Clearwell 2800 No.3	700 East Ave. S	200	25	9,806	6 MG Clearwell	2800
Clearwell 2950 No.1	700 East Ave. S	250	179	4,049	6 MG Clearwell	2950
Clearwell 2950 No.2	700 East Ave. S	250	185	3,691	6 MG Clearwell	2950
Clearwell 2950 No.3	700 East Ave. S	150	169	2,355	6 MG Clearwell	2950
Well 14A	39401 20th St. E	75	240	626	Well No. 14	2800
3MG 150hp No. 1(1)	850 East Ave. S	150	202	1,790	3 MG Clearwell	2950
3MG 50hp No. 2(1)	850 East Ave. S	50	198	609	3 MG Clearwell	2950
45th St. No. 1	36510 45th St. E	150	243	1,858	45th St. Res.	3000
45th St. No. 2	36510 45th St. E	150	243	1,668	45th St. Res.	3000
45th St. No. 3	36510 45th St. E	150	243	1,614	45th St. Res.	3000
45th St. (2850) No. 1	36510 45th St. E	150	94	2,830	45th St. Res.	2850
45th St. (2850) No. 2	36510 45th St. E	150	94	2,890	45th St. Res.	2850
45th St. (2850) No. 3	36510 45th St. E	150	96	2,842	45th St. Res.	2850
25th St. No. 1	25th St. E, S/O Ave. S	50	225	986	25th St. Res.	3000
25th St. No. 2	25th St. E, S/O Ave. S	100	226	953	25th St. Res.	3000
25th St. No. 3	25th St. E, S/O Ave. S	100	227	1,033	25th St. Res.	3000

Booster Pump	Location	Motor Horse-power (hp)	Design Head (ft)	Design Flow (gpm)	Suction Facility	Discharge Zone
25th St. No. 4	25th St. E, S/O Ave. S	100	225	557	25th St. Res.	3000
25th St. No. 5(2,3)	25th St. E, S/O Ave. S	100	N/A	N/A	25th St. Res.	3000
Hilltop	35609 Cheseboro Rd.	10	146	136	Hilltop Res.	3250
Ave. T-8 No. 1	4250 East Ave. T-8	15	101	373	3000 Zone	3250
Ave. T-8 No. 2	4250 East Ave. T-8	15	109	337	3000 Zone	3250
Ave. T-8 No. 3(4)	4250 East Ave. T-8	50	105	363	3000 Zone	3250
Lower EC No. 1	36809 El Camino Dr.	75	280	576	Lower El Camino Res.	3200
Lower EC No. 2	36809 El Camino Dr.	75	283	629	Lower El Camino Res.	3200
Underground No. 1	36336 El Camino Dr.	75	241	352	El Camino Underground Res.	3400
Underground No. 2	36336 El Camino Dr.	40	282	650	El Camino Underground Res.	3400
5 mg No. 1(3)	2404 Old Nadeau Rd	20	167	694	5 MG Res.	3250
5 mg No. 2(3)	2404 Old Nadeau Rd	20	165	694	5 MG Res.	3250
Palmdale Hills	4640 Barrel Springs	10	132	121	Well Nos.18 & 19 Res.	3250
V-5	4640 Barrel Springs	30	375	136	Well Nos.18 & 19 Res.	3250
Well 5 No. 1	S/O Barrel, W/O Sierra	30	362	201	Well No. 5 Res.	3200
Well 5 No. 2	S/O Barrel, W/O Sierra	50	343	317	Well No. 5 Res	3200
Well 5 No. 3	S/O Barrel, W/O Sierra	50	336	307	Well No. 5 Res	3200
Well 5 No. 4	S/O Barrel, W/O Sierra	100	342	523	Well No. 5 Res	3200
3900 Booster(3)	36200 El Camino Dr.	50	N/A	N/A	Upper El Camino Res.	3600
3600 ft. No. 1	601 Lakeview Dr.	20	170	405	3400 Zone	3600
3600 ft. No. 2	601 Lakeview Dr.	20	179	400	3400 Zone	3600

1) Currently used only under emergency conditions
2) Emergency pump
3) Not included in computer model.
4) Fire pump.

2.4 Water Storage Reservoirs

There are 20 storage reservoirs within the District with capacities ranging from 0.04 million gallons (MG) to 6 MG. There are 16 storage tank sites of which three sites (25th St., 47th St., and 50th St.) have two tanks on site and one site (45th St.) has three tanks on site. The District has a total reservoir storage capacity of approximately 50 MG. **Table 2-5** summarizes the reservoir capacities by their respective pressure zones. The hydraulic grade elevation in each pressure zone is controlled by the high water elevation of the reservoirs that feed the zones by gravity. **Table 2-6** shows the details of PWD's storage reservoirs. Their locations are shown on **Figure 2-1** and are schematically represented on **Figure 2-2**.

There are six hydropneumatic tanks within PWD's system. Hydropneumatic tanks are typically installed in isolated portions of the distribution system having ground elevations that are too high for gravity service, to reduce cycling of pumps, or to provide surge protection to the distribution system. The majority of the hydropneumatic tanks in PWD's water system serve small clusters of homes in the mountain foothills. **Table 2-7** shows a summary of hydropneumatic tank information. The hydropneumatic tanks are schematically represented in **Figure 2-2** and their locations are included in **Figure 2-1**.

Table 2-5
Storage Reservoir Capacity by Pressure Zone

Pressure Zone	Storage Capacity (MG)	Percent Total
WTP	6.0	13%
2800	18.1	38%
2850	8.0	17%
2950	3.6	8%
3000	10.0	21%
3200	1.8	4%
3250	0.15	<1%
3400W	0.3	1%
Total Storage Capacity	**47.95**	**100%**

Source: Schematics and data provided by PWD

Table 2-6
Storage Reservoir Characteristics

Reservoir ID	Pressure Zone	Bottom Elevation (ft)	Overflow Elevation (ft)	Dia. (ft)	Volume (MG)	Type	Year of Const.
6 MG Clearwell	WTP	2,748	2,772	206	6	Steel	1999
3 MG Clearwell	2800	2,748	2,782	124	3	Steel	1960
25th Street (2 MG)	2800	2,750	2,780	106	2	Steel	1976
25th Street (4 MG)	2800	2,750	2,780	154	4	Steel	1987
45th Street (3 MG)	2800	2,738	2,770	130	3	Steel	1988
45th Street (4 MG)	2800	2,738	2,770	150	4	Steel	1990
New 45th Street (4 MG)	2800	2,738	2,770	150	4	Steel	2005
Well No. 14(1)	2800	2,580	2,602	27	0.10	Steel	n/a
50th Street-Res A (4 MG)	2850	2,824	2,854	150	4.0	Steel	2005
50th Street-Res B (4 MG)	2850	2,824	2,854	150	4.0	Steel	2005

Reservoir ID	Pressure Zone	Bottom Elevation (ft)	Overflow Elevation (ft)	Dia. (ft)	Volume (MG)	Type	Year of Const.
Walt Dahlitz	2950	2,923	2,954	104	1.5	Steel	1993
Lower El Camino	2950	2,918	2,950	106	2.0	Steel	1988
Well No. 5(1)	2950	2,838	2,860	30	0.1	Steel	1963
47th Street (2 MG)	3000	2,970	3,000	106	2.0	Steel	1987
47th Street (3 MG)	3000	2,970	3,000	132	3.0	Steel	1990
5 MG Reservoir	3000	2,966	2,999	160	5.0	Steel	1988
El Camino Underground	3200	3,159	3,185	104	1.5	Concrete	1994
Ana Verde Tovey	3200	3,114	3,146	40	0.3	Steel	1963
Well Nos. 18 & 19(1)	3250	3,064	3,079	27	0.04	Steel	n/a
Hilltop	3250	3,082	3,118	9	0.016	Steel	1966
Upper El Camino	3400W	3,356	3,388	40	0.3	Steel	1963
Total Capacity					**49.85**		

1) Holding Tanks
2) Source: Schematics and data provided by PWD

Table 2-7
Hydropneumatic Tank Characteristics

Location	Suction Facility	Service Area	Size (gallons)	Operational
Ave. T-8 Booster Sta.	3000 Zone	3250 Zone	3,800	Yes
3600-ft Booster Sta.	3400 Zone	3600 Zone	6,900	Yes
5 MG Reservoir	5 MG Reservoir	3250 Zone	6,000	Yes
Palmdale Hills	Well 18 & 19 Res.	3250 Zone	1,500	Yes
Al's Tank	3400 Zone	3400+ Zone	5,200	Yes
V-5	Well 18 & 19 Res.	3400 Zone	5,200	Yes

Source: PWD hydraulic model and 2000 Master Plan

2.5 Pressure Reducing Stations

There are 14pressure regulating stations (PRSs) and 25 pressure reducing valves (PRVs) in PWD's water service area. The pressure reducing stations have two or more pressure reducing valves: a primary valve and one or more supplemental valves. The primary valve, the smaller in diameter, is normally open and has the highest pressure setting. Water continuously flows through this primary valve with a downstream pressure equal to the main valve's pressure setting. Supplemental valves are larger in diameter and have a slightly lower pressure setting than the main valve. If the downstream water pressure drops (due to large water demand) below the supplemental valve's pressure setting, the supplemental valve will open to provide additional water. In addition, pressure relief valves are generally present at each PRS. These valves protect the water system from abnormally high pressure should the regulating valves fail to work properly. **Table 2-8** summarizes the details of all pressure regulating stations as modeled. The pressure regulating stations are shown in **Figure 2-1** and are schematically represented on **Figure 2-2**.

Table 2-8
Pressure Regulating Stations

Station No.	From Zone	To Zone	Size (inches)	Pressure Setting (psi)	Ground Elevation (feet)
Well 20	3000	2950	12	65	2,770
Well 20	3000	2950	4	75	2,770
3RD E / 75' N/O Q-10	2950	2800	6	42	2,683
3RD E / 75' N/O Q-10	2950	2800	2	42	2,683
25TH E / 125' N/O RR	3000	2950	8	60	2,712
25TH E / 125' N/O RR	3000	2950	2	70	2,712
S/O 30TH E / FAIRFIELD	3000	2950	12	91	2,697
S/O 30TH E / FAIRFIELD	3000	2950	3	91	2,697
37th St. East / N/O RR	3000	2950	12	72	2,738
37th St. East / N/O RR	3000	2950	3	77	2,738
40th St. East / S-11	3000	2950	12	74	2,629
40th St. East / S-11	3000	2950	3	79	2,629
40th St.East/ SORRELL	2950	2850	8	70	2,675
40th St.East/ SORRELL	2950	2850	4	78	2,675
45th St.East/ Penca Ave.	3000	2950	8	65	2,739
47th St. East /S/O RR	2950	2850	20	59	2,730
47th St. East /S/O RR	2950	2850	3	74	2,730
47th/Fort Tejon Blvd	2950	2850	8	59	2,689
65th St. East/ S	2950	2850	8	63	2,712
65th St. East / S	2950	2850	4	58	2,712
45th St. East / AVOCA	2950	2850	3	44	2,675
70th Street / (Well 25)	2850	2800	12	72	2,688
70th Street / (Well 25)	2850	2800	4	72	2,688
Tovey/ S-4 North	3400W	3200	8	32	3,061
Tovey/ S-4 South	3400W	3200	4	37	3,062

Source: Provided by PWD Staff – Control Set Points Record – February 4, 2014 and from PWD model data

2.6 Distribution System Network

PWD's distribution system network consists of 412.5 miles of pipeline, which range in diameter from 2-inches to 48-inches. The distribution of pipeline diameters is summarized in **Table 2-9,** and **Figure 2-3** shows the pipelines colored by diameter. It should be noted that the numbers presented in **Table 2-9** are based on the GIS pipe mainlines updated in August 2016.

As shown in **Table 2-9**, about 56 percent of the distribution system network consists of pipes with diameters between six and eight inches, while 20 percent of the distribution system network is comprised of pipes that are 12 inches in diameter.

All pipes in PWD's water distribution system network are installed between the years 1950 and 2015. The distribution of pipe age is shown in **Table 2-10**.

Table 2-9
Summary of Pipelines by Diameter

Diameter (inches)	Total Length (feet)	Total Length (miles)	Percentage of Total Length (%)
2	11,662	2.2	0.54%
4	32,843	6.2	1.51%
6	347,509	65.8	15.95%
8	870,287	164.8	39.96%
10	110,083	20.8	5.05%
12	438,429	83.0	20.13%
14	18,716	3.5	0.86%
16	173,194	32.8	7.95%
18	12,202	2.3	0.56%
20	99,789	18.9	4.58%
24	56,900	10.8	2.61%
30	2,579	0.5	0.12%
36	1,073	0.2	0.05%
42	2,206	0.4	0.10%
48	441	0.1	0.02%
Unknown	160	0.0	0.01%
Total	**2,178,074**	**412.5**	**100%**

Source: Information presented is based on PWD pipe mainline GIS shapefile on August 2016

Table 2-10
Summary of Pipelines by Installation Period

Installation Period	Length (feet)	Length (miles)	Total (percent)
1950 - 1959	32,199	6.1	1%
1960 - 1969	120,360	22.8	6%
1970 - 1979	69,877	13.2	3%
1980 - 1989	769,874	145.8	35%
1990 - 1999	598,853	113.4	27%
2000 - 2009	324,590	61.5	15%
2010 - 2015	92,794	17.6	4%
Unknown	169,526	32.1	8%
Total Length	**2,178,074**	**412.5**	**100%**

Source: Information presented is based on PWD pipe mainline GIS shapefile on August 2016

As shown in **Table 2-10,** approximately 8 percent of the pipelines have an unknown installation date, while approximately 62 percent of the pipelines were installed between 1980 and 1999. The most common pipe material is ductile iron pipes, which covers approximately 40 percent of the total pipeline length in the system. **Figure 2-4** shows the pipeline material by color, while **Table 2-11** summarizes the total lengths of pipelines by material type. **Table 2-12** combines both **Table 2-10** and **Table 2-11** and presents the distribution of pipe material by age.

Table 2-11
Summary of Pipelines by Material

Material	Total Length (feet)	Total Length (miles)	Total Length (percent)
Steel Pipes			
Steel (Unspecified)	39,921	7.6	1.8%
Dipped and Wrapped (DD&W)	52,447	9.9	2.4%
Cement Lined and Wrapped (CL&W)	73,868	14.0	3.4%
Cement Mortar Lined and Coated (CML&C)	307,348	58.2	14.1%
Subtotal Steel Pipes(1)	**473,584**	**89.7**	**21.7%**
Iron Pipe			
Galvanized (GAL)	7,794	1.5	0.4%
Ductile Iron (DIP)	877,362	166.2	40.3%
Subtotal Iron Pipes(1)	**885,156**	**167.6**	**40.6%**
Other Pipe Material			
Polyvinyl Chloride (PVC)	204,527	38.7	9.4%
Asbestos Cement (AC)	576,796	109.2	26.5%
Copper (COP)	1,486	0.3	0.1%
Subtotal Other Material Pipes(1)	***782,809***	**148.3**	**35.9%**
Unknown (UNK)	**36,524**	**6.9**	**1.7%**
Grand Total(1)	**2,178,074**	**412.5**	**100%**

Source: Information presented is based on PWD pipe mainline GIS shapefile on August 2016
1) Subtotals and Grand Totals may not add up due to rounding.
2) PVC includes PVC-DR18, PVC-DR14, PVC-DR, and Plastic

Table 2-12
Summary of Pipe Material by Installation Period

Installation Period	Pipe Length by Material (miles)										
	STL	DD&W	CL&W	CML&C	GAL	DIP	PVC	AC	COP	UNK	Total
1950 - 1959	0.3	5.2	-	0.5	0.1	-	-	-	-	<0.1	6.1
1960 - 1969	0.3	3.4	1.1	16.6	0.1	0.1	<0.1	1.1	-	<0.1	22.8
1970 - 1979	0.0	-	0.4	5.9	0.1	<0.1	0.1	6.2	-	0.5	13.2
1980 - 1989	1.6	-	10.4	22.1	0.4	28.6	<0.1	82.5	-	0.2	145.8
1990 - 1999	<0.1	<0.1	1.0	7.0	0.2	74.8	23.5	6.7	-	0.2	113.4
2000 - 2009	-	-	0.3	0.8	<0.1	53.1	7.0	-	0.1	<0.1	61.5
2010 - 2015	-	-	0.7	0.1	<0.1	8.8	7.9	-	<0.1	-	17.6
Unknown	5.3	1.3	0.0	5.1	0.6	0.8	0.1	12.8	0.1	6.0	32.1
Total	**7.6**	**9.9**	**14.0**	**58.2**	**1.5**	**166.2**	**38.7**	**109.2**	**0.3**	**6.9**	**412.5**

Source: Information presented is based on PWD pipe mainline GIS shapefile on August 2016

Figure 2-3
Pipelines by Diameter

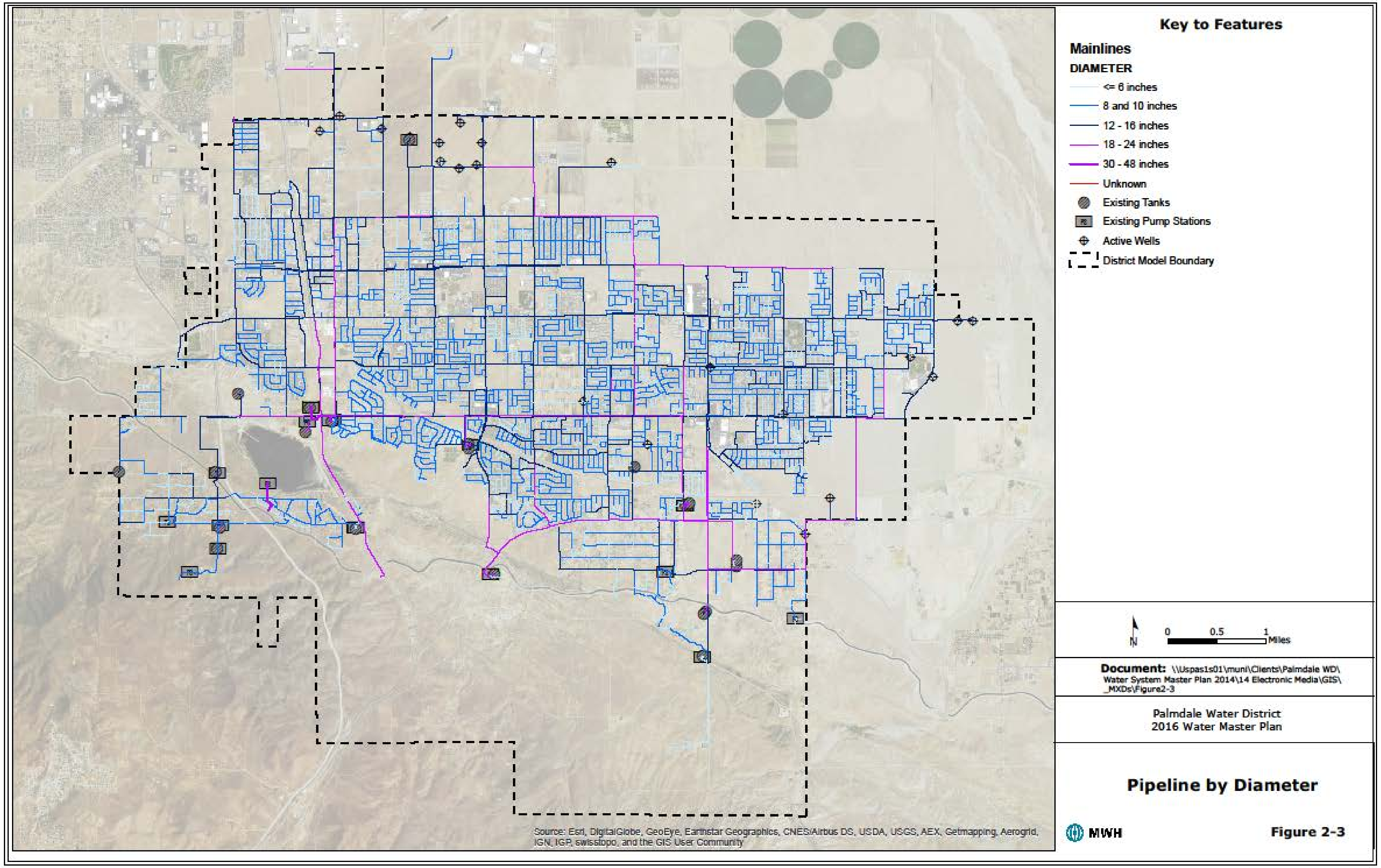
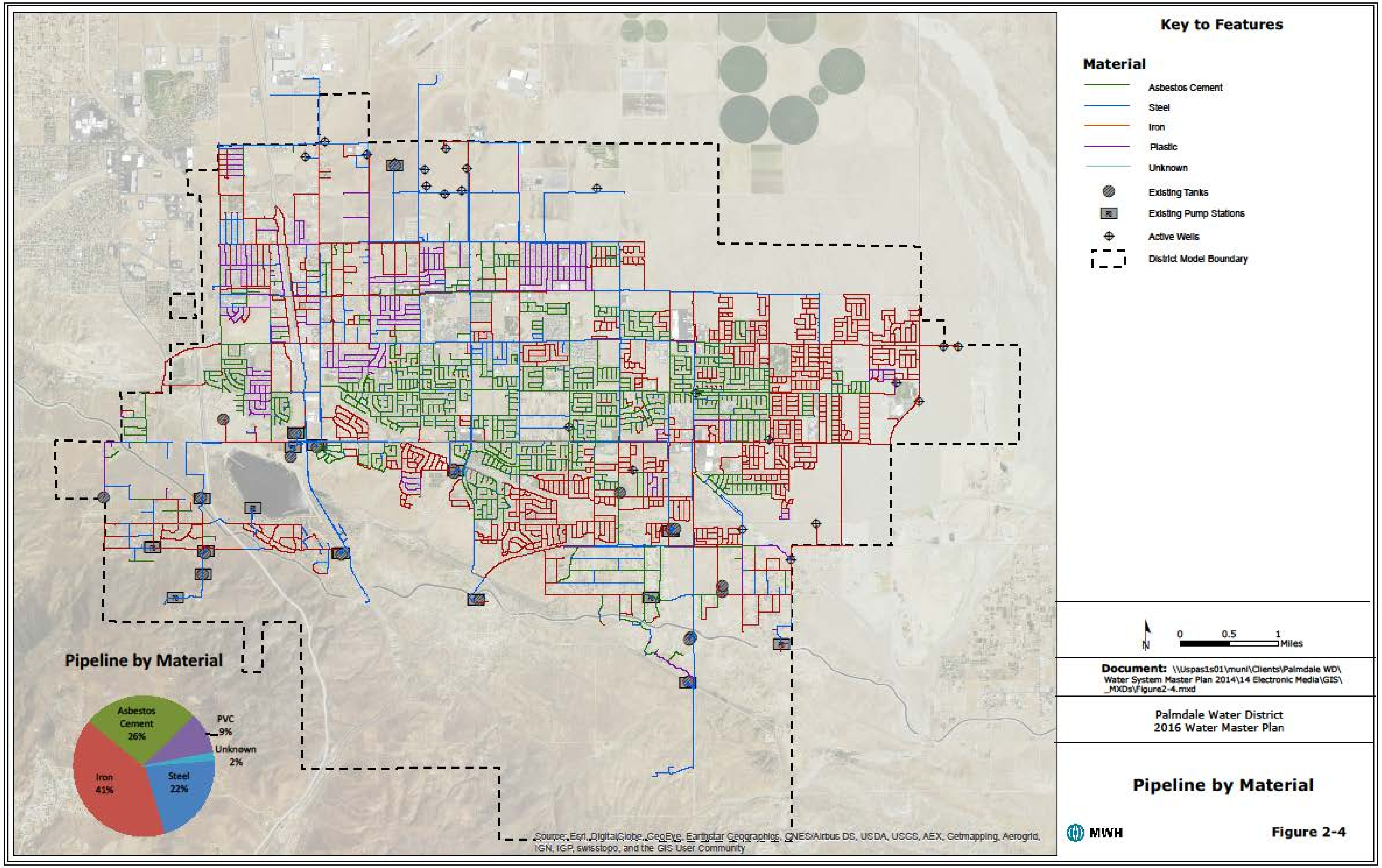


Figure 2-4
Pipelines by Material



2.7 Other Facilities and Assets

In addition to the facilities described above, PWD's system includes many other smaller facilities, including fire hydrants, customer meters, and a Supervisory Control and Data Acquisition (SCADA) system to control and monitor system facilities. PWD maintains a GIS database to map and track its system assets.

2.7.1 Fire Hydrants

The Districts distribution system network contains approximately 2,867 fire hydrants, based on data provided by PWD in a GIS shapefile. Of the 2,867 fire hydrants, there are 2,690 fire hydrants that are six inches, 175 fire hydrants that are four inches, and two fire hydrants that are 2.5 inches. **Table 2-13** presents the number of hydrants per zone.

Table 2-13
Summary of Fire Hydrants by Zone

Zone	Total Number of Fire Hydrants	Percentage of Total Hydrants (%)
2950	691	24.1%
2800	1,350	47.1%
3400	38	1.3%
3000	254	8.9%
3200	57	2.0%
2850	433	15.1%
3250	35	1.2%
3600	9	0.3%
Total	**2,867**	**100.0%**

2.7.2 Customer Meters

The PWD's distribution system network includes approximately 27,394 customer meters in 2015. There are a total of five customer classes: single family residential (SFR), multi-family residential (MFR), commercial and industrial (CII), irrigation (IRR), and fire service.

2.7.3 Supervisory Control and Data Acquisition System (SCADA)

PWD has a SCADA system that allows it to remotely monitor and control system facilities within the water system. PWD recently switched their SCADA system software from Wonderware to ClearSCADA. The well production was not recorded for all wells in the previous SCADA software and thus data provided by PWD included only 8 of 24 wells with flow data recorded and a few booster stations. Flow data is now being recorded for all sites. PWD also has the capability to control pumps and wells remotely. Any SCADA system improvements will be identified and included as part of the existing Capital Improvement Plan (CIP).

2.7.4 GIS Database

PWD maintains a geographic information system (GIS) database of its existing facilities. Data are stored as feature classes within a geodatabase, with separate feature classes for facility types. GIS data includes laterals, contours, booster pumps, hydrants, hydropneumatic tanks, mains, tanks, pressure regulating stations, and wells. Data for each facility includes installation year, material, diameter, etc. as appropriate. This data is updated as old facilities are repaired or replaced and as new facilities are installed.

SECTION 3 WATER DEMANDS

This section describes the historical water production and the projected future water demands of the Palmdale Water District (PWD) water service area. Potable water demand projections are developed using population-based and land use-based methods, and are then compared against the PWD *2010 Urban Water Management Plan* (UWMP). Work on this Water System Master Plan (WSMP) was initiated in 2014 prior to the PWD beginning work on the 2015 UWMP. Considerable work on the WSMP had been completed before data from the 2015 UWMP became available. Unless significant changes between the 2010 and 2015 UWMPs occurred, data from the 2010 UWMP continued to be used as the basis for this WSMP. Water demand factors (WDF) are developed using PWD consumption data, general plan land use information, and vacant/undeveloped parcel information for the PWD service area. Future demands are projected using these WDFs, the 2010 UWMP, and population and employment projection data obtained from the Southern California Association of Governments (SCAG). The assumptions and methodologies adopted for projecting PWD demands are contained within this section.

3.1 Historical Water Demands

Water demands are characterized by the terms production and consumption. Water production is the metered amount of water produced from all sources of supply and delivered to the water distribution system. Water consumption is the metered amount of water used by individual water customers. The difference between production and metered consumption is designated non-revenue water (formerly called unaccounted-for water or water loss).

3.1.1 Historical Production and Consumption

Water conservation measures have been implemented throughout the region, including the PWD service area. **Table 3-1** shows the number of service connections over the past seven years. The average increase in connections over the five year span is 727 connections and the total growth from 2009 to 2015 years is 4,360.

Table 3-1
Water System Evaluation Criteria

Year	Total Service Connections(1)	Annual Growth (Connections)
2009	23,034	
2010	25,030	1,995
2011	25,173	143
2012	25,544	371
2013	25,743	200
2014	27,373	1,630
2015	27,394	21
2009-2015 Average	**25,613**	**727**

1) Service connection data are obtained from PWD Consumption data

Over the past 20 years, the highest annual production occurred in 2007 (28,200 acre-ft/yr) and the lowest production occurred in 2015 (17,015 acre-ft/yr). This is illustrated on **Figure 3-1** and shown in **Table 3-2**. The demand decreased significantly from 2007 to 2011 likely as a result of conservation efforts, rate structure changes, and the economy. From 2013 to 2015, production and demand has decreased due to the current drought and strict conservation goals. The production values are compared to the historical service connections for the period 2009 to 2015 to calculate a demand per service connection. These values are calculated by dividing the historical production values by the number of service for the period 2009 to 2015. The average demand per service connection over the 2009-2015 period is 714 gallons per day per connection (gpd/connection).

Table 3-2
Summary of Historical Water Production

Year	Historical Production[(1)] (acre-ft/yr)	Total Service Connections[(2)]	Demand per Connection[(3)] (gpd/connection)
1994	20,600		
1995	22,200		
1996	23,500		
1997	23,200		
1998	20,600		
1999	23,400		
2000	25,900		
2001	25,200		
2002	25,700		
2003	24,900		
2004	25,600		
2005	26,100		
2006	27,900		
2007	28,200		
2008	25,300		
2009	22,300	23,034	860
2010	19,800	25,030	710
2011	19,600	25,173	700
2012	21,500	25,544	750
2013	21,600	25,743	750
2014	20,700	27,373	670
2015	17,000	27,394	550
		Average Demand per Connection	714

1) Production data are obtained from PWD Monthly Production Data worksheet and are based on fiscal year
2) Connection data are obtained from PWD billing data
3) Production numbers are converted to gallons per day and divided by the number of total service connections

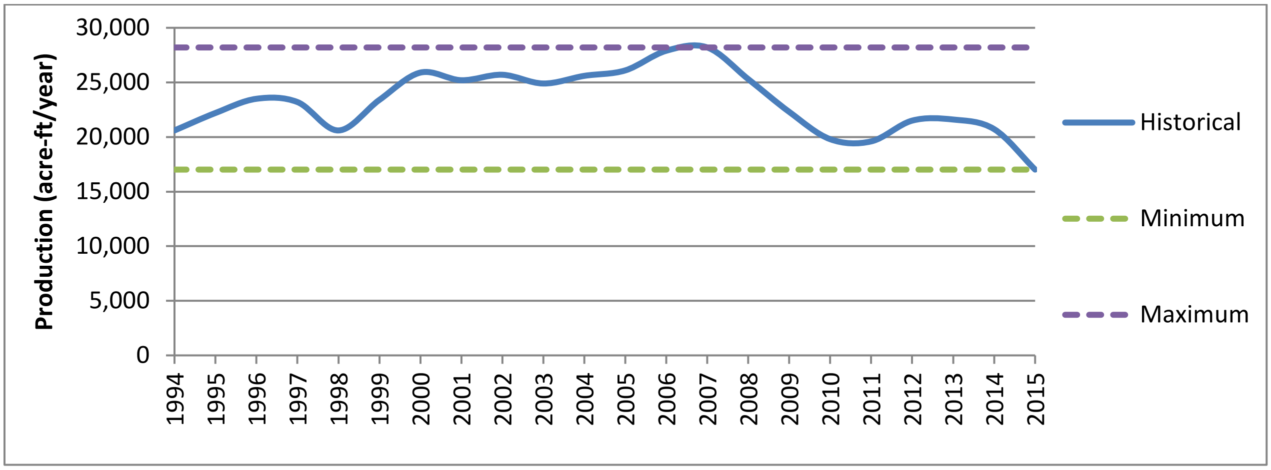


Figure 3-1
Annual Water Production from 1994 to 2015

3.1.2 Non-Revenue Water

The difference between water production and consumption (billed to customers) is defined as non-revenue water. The American Water Works Association (AWWA) defines non-revenue water as the sum of Unbilled Authorized Consumption (water for firefighting, flushing, etc.) plus Apparent Losses (customer meter inaccuracies, unauthorized consumption, and systematic data handling errors) plus Real Losses (system leakage and storage tank overflows)[1]. Non-revenue water may be attributed to leaking pipes, spills, unmetered or unauthorized water use, inaccurate meters, or other events causing water to be withdrawn from the system and not measured. The primary reason for water loss in a newer system is attributed to inaccurate or faulty meters. The annual non-revenue water for the PWD system for the period 2009 to 2015 averaged 2,300 AFY, or about 11 percent of production (Water consumption data provided by PWD), as seen in **Table 3-3**. Except for 2011, non-revenue water has been relatively constant for the past seven years in spite of the reduction in water demand. It is recommended that PWD conduct a water audit consistent with AWWA Manual 36 to evaluate non-revenue water and assess measures to reduce losses.

Table 3-3
Summary of Historical Water Production

Year	Total Production(1) (AFY)	Total Consumption(1) (AFY)	Non-Revenue Water (AFY)
2009	23,500	21,000	2,500
2010	19,800	17,600	2,200
2011	19,600	18,000	1,600
2012	21,500	19,000	2,500
2013	21,600	19,200	2,400
2014	20,700	18,000	2,700
2015	17,000	14,800	2,200
Average	**21,200**	**19,000**	**2,300**

1) Production and consumption data are obtained from PWD Monthly Production Data worksheet and billing data based on the calendar year

3.1.3 Historical Peaking Factors

Average day demand (ADD) for a year-long operating period of record is the baseline for computing peaking factors. Historical monthly and daily production data are used to calculate these peaking factors. The historical Maximum Day Demand (MDD) factors for the period 2009 to 2015 are presented in **Table 3-4**. The average MDD peaking factor (MDD/ADD) over the last seven years is 1.70. During this time, the annual MDD peaking factors varied between 1.47 and 1.95. The MDD/ADD factor of 1.8 will be used for sizing water distribution system pipelines and facilities, which is an above-average (conservative) value for planning purposes.

[1] AWWA, 2012. Water Loss Control Terms Defined.
http://www.awwa.org/Portals/0/files/resources/water%20knowledge/water%20loss%20control/water-loss-control-terms-defined-awwa.pdf

Table 3-4
Historical Demands and Peaking Factors

Year	Average Day Demand (mgd)	Maximum Day Demand (mgd)	Peaking Factor (MDD/ADD)
2009	21.0	30.9	1.47
2010	17.7	28.7	1.63
2011	17.5	30.6	1.75
2012	19.2	30.1	1.57
2013	19.3	33.1	1.72
2014	16.1	31.3	1.95
2015	13.2	30.7	1.79
Average (2009-2015)	**17.7**	**29.8**	**1.70**

Note: Data provided by PWD staff based on the calendar year.

3.2 Population-Based Demand Projection

In the first method of demand projection, the future demand within the PWD service area is forecasted based on population and employment projections developed by SCAG for the Regional Transportation Plan. The SCAG methodology for forecasting population takes into consideration several parameters including the total number of occupied housing units, the number of persons per household, and the average number of employees. The methodology also involves the use of mathematical and statistical models. Discussion of these parameters and models is beyond the scope of this report; however, the SCAG website provides a description of the methodology used (www.scag.ca.gov).

3.2.1 Existing Population and Employment

Based on the 2010 US Census and SCAG employment projections (SCAG, 2012), the year 2010 population of the City of Palmdale was estimated to be approximately 152,800 with an employment count of 33,700. Using census data collected in 2010, the PWD service area population is calculated, by census block, to be 112,800. Using the ratio of population for the City of Palmdale to population of the PWD service area, the PWD employment count is estimated to be 24,900. The PWD 2010 UWMP estimated the service area population to be 109,400 in 2010. A comparison of these populations is shown on **Figure 3-2**.

3.2.2 Population and Employment Projections

Based on the SCAG projections adopted in 2012, the City of Palmdale population is projected to increase from 154,800 in 2010, to 215,000 in the year 2040. According to SCAG, Palmdale employment numbers will increase from 33,700 in 2010 to 50,000 in the year 2040. By using SCAG growth percentages and applying them to the population recorded in the 2010 census within the PWD boundary, MWH estimates a 30-year growth rate of 40 percent. The PWD UWMP population projection showed that the population will increase from 109,400 in year 2010 to 280,200 in year 2035, a total increase of about 56 percent. The UWMP projections were based on the SCAG projections adopted in 2008 which were made during the high growth period before the recession. The 2012 SCAG projections have a much lower growth rate than the UWMP projections. **Table 3-5** compares the population and employment projections for the city of Palmdale, the PWD service area, and the projections from the 2010 UWMP. The 2015 UWMP calculated the 2015 demand as 118,227 based on the Department of Water Resources (DWR) population tool.

Table 3-5
Population and Employment Projections

Year	SCAG Population Projections for City of Palmdale(1)	SCAG Employment Projections for City of Palmdale(1)	Adjusted SCAG Population Projections for PWD(1)	Adjusted SCAG Employment Projections for PWD(1)	PWD 2010 UWMP Population Projections
2010	152,800 (2)	33,700 (2)	112,800 (2)	24,900 (2)	109,395
2015	166,800 (2)	36,300 (2)	122,000 (2) 118,227 (4)	26,600 (2)	164,312
2020	179,300	38,900	131,200	28,500	195,404
2025	188,200 (3)	41,700 (3)	137,700 (3)	30,500 (3)	225,208
2030	197,200 (3)	44,400 (3)	144,300 (3)	32,500 (3)	253,791
2035	206,100	47,200	150,800	34,500	280,206
2040	215,000 (3)	50,000 (3)	157,300 (3)	36,600 (3)	Not available

1) Based on SCAG population and employment projections for Palmdale (2012)
2) Calculated based on the linear interpolation between year 2008 and year 2020
3) Calculated based on the trend between year 2020 and year 2035
4) The 2015 UWMP population values based on the DWR population tool

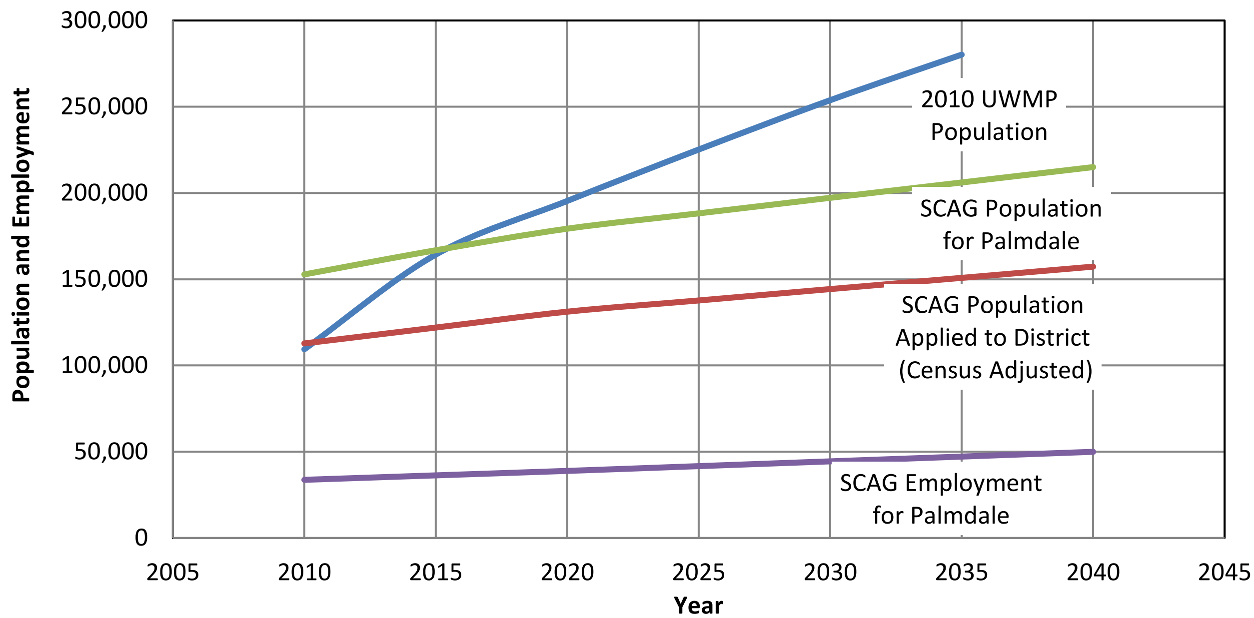


Figure 3-2
Population and Employment Projections

3.2.3 Residential- and Employment-Based Water Demand Projections

The consumption (billing) data obtained from the District for the past five years (year 2009 to 2013) includes the customer classes; single family residential, multi-family residential, commercial, industrial, irrigation, fire service, and other. The data is sorted into a residential class, (single and multi-family), a commercial-industrial-institutional (CII) class, which consists of commercial, industrial, and irrigation. Fire services and other classes account for less than 1% of the total flow. The percentages of the two groups by water consumption in 2010 (80% - Residential, 20% - CII) are calculated and then multiplied by the 2010 production of 19,800 acre-ft/yr to obtain the calculated residential water demand (15,800 acre-ft/yr) and CII water demand (4,000 acre-ft) for year 2010. Based on a residential water demand of 15,800 acre-ft/yr and a census population of 112,800 in 2010, the residential WDF (demand per person per day) is estimated to be 125 gallons/person/day. Using this per capita residential consumption and the projected population from SCAG, future residential demands are calculated as shown in **Table 3-6**, excluding future conservation. Based on a CII water demand of 4,000 acre-ft/yr and an estimated service area employment of 24,900 in 2010, the employment WDF (demand per employee per day) is 143 gallons/employee/day. Using this per capita employment consumption and the projected employment figures from SCAG, projected future CII demands are calculated as shown in **Table 3-6**. The total water demand is calculated by adding the residential and CII demands and dividing by the service area population. The per capita demand was 156 gallons per capita per day (gpcd) in 2010.

The 2010 UWMP describes the methodology used to establish water conservation goals that comply with the California Legislature's Water Conservation Act of 2009 (SBx7-7) requirement to achieve a 20 percent reduction in urban water demand for 2020 compared to a ten-year baseline. According to the UWMP, the baseline water usage was 220 gpcd for the period 1995-2004. PWD adopted a target demand of 176 gpcd by 2020. In order to achieve this goal and using the SCAG population projections for 2020, the total demand for 2020 should be 25,900 acre-ft/yr. Currently, PWD's per capita water demand is less than the 2020 target. The total demand including UWMP conservation target is calculated assuming PWD has a demand of 176 gpcd, and that PWD continues at this rate until 2040. PWD re-evaluated its baseline water use and 2020 conservation target using the 2010 census data and service area population in the 2015 UWMP. The 2015 UWMP had a ten year baseline per capita use of 231 GPCD, requiring a reduction to 185 GPCD by 2020 and an interim target of 208 GPCD by 2015. The demands in the WSMP are slightly different from the 2015 UWMP due to different populations used for 2015.

Table 3-6
Residential- and Employment-Based Demand Projections

Year	Residential Demand(1) (acre-ft/yr)	CII Demand(2) (acre-ft/yr)	Total Demand(3) (acre-ft/yr)	Total Demand Based on UWMP Conservation Target(4) (acre-ft/yr)
2010	15,800	4,000	19,800	n/a
2015	17,100	4,300	21,400	27,100
2020	18,400	4,600	23,000	25,900
2025	19,300	4,900	24,200	27,200
2030	20,200	5,200	25,400	28,500
2035	21,100	5,500	26,600	29,800
2040	22,000	5,900	28,000	31,100

1) Residential demand is comprised of the single-family and multi-family residential demands and is based on a WDF of 125 gpcd.
2) CII demand is comprised of commercial, industrial, public authority, municipal, and other demands and is based on a WDF of 143 gpd/employee.
3) Total Demand is calculated by adding the residential demand and the CII demand.
4) Based on an interim conservation target of 198 gpcd by 2015 and a 2020 target of 176 gpcd.

3.3 Land Use-Based Demands

The demand projection based on land use focuses on the demand that will be added to the system by the development of currently vacant or undeveloped parcels. The annual growth within the PWD service area has averaged 540 service connections in the last five years. Recent growth is slow due to the economic conditions within District's service area and surrounding region. However, future growth (to year 2040) will occur due to development on vacant parcels within the PWD service area.

3.3.1 Vacant Parcels

GIS land use data is obtained from the City of Palmdale. The city provides GIS shapefiles that contain the general plan land use. The general plan land use is applied to the existing parcel boundaries provided by PWD. The city does not record which parcels are currently vacant; however, estimates can be made based on geocoded water meters throughout the service area. Parcels are assumed to be occupied if a meter has had flow in the past year. Parcels with no flow or without a geocoded meter are assumed to be vacant. These vacant parcels within PWD service area are illustrated in **Figure 3-3**. The vacant parcels outside of the current service area boundary are not included in this analysis.

The vacant parcels account for approximately 68 percent of the PWD service area. CII land use types account for 31 percent of the total vacant acreage, whereas the residential land use types account for 65 percent of the total vacant acreage. The remaining 4 percent of the vacant land is classified as non-recreational open space or has an unknown land use type. The total acreage of the vacant parcels categorized by land use type is listed in **Table 3-7.**

Table 3-7
Summary of Vacant Parcels by Land Use Type

Land Use Type	Area (acre)	% of Total Vacant Area
Commercial	4,950	27%
Industrial	650	4%
Public	200	1%
Low Density Residential	10,010	54%
Medium Density Residential	1,620	9%
High Density Residential	370	2%
Non-Recreational Open Space	350	2%
Unknown	370	2%
Total Vacant Area	18,520	
District's Service Area	**27,110**	

3.3.2 Land Use-Based Water Demand Factors

The WDF for a given land use type is the average daily water use in gallons per day per acre (gpd/acre) of a land use type. This method of determining WDFs differs from the WDFs calculated using the population method because the land use-based WDF method calculates water production per acre while the population-based WDF calculates water production per person (capita) or employee. The land use-based WDFs are calculated by relating geocoded (spatially referenced) consumption (billing) data to parcels with known land use types. The total water consumption for a parcel is divided by the area of the parcel to yield the WDF for that parcel. The WDF is scaled to the production to account for the 2010 non-revenue water by multiplying the WDF by a scaling factor (1.12). The accuracy of this method is dependent on the accuracy of the geocoded consumption data and the parcel data provided by PWD and the City of Palmdale. WDFs are listed below in **Table 3-8**.

Table 3-8
Water Demand Factors for the Palmdale Water District

Land Use Type	WDF (gpd/acre)	Adjusted WDF(1) (gpd/acre)
Commercial	1,120	1,260
Industrial	960	1,070
Public	2,230	2,500
Low Density Residential	640	720
Medium Density Residential	2,950	3,310
High Density Residential	3,690	4,130
Non-Recreational Open Space	1,210	1,360
Unknown	300	330

1) A scaling factor of 1.12 is used to normalize consumption to trended production and to account for non-revenue water.

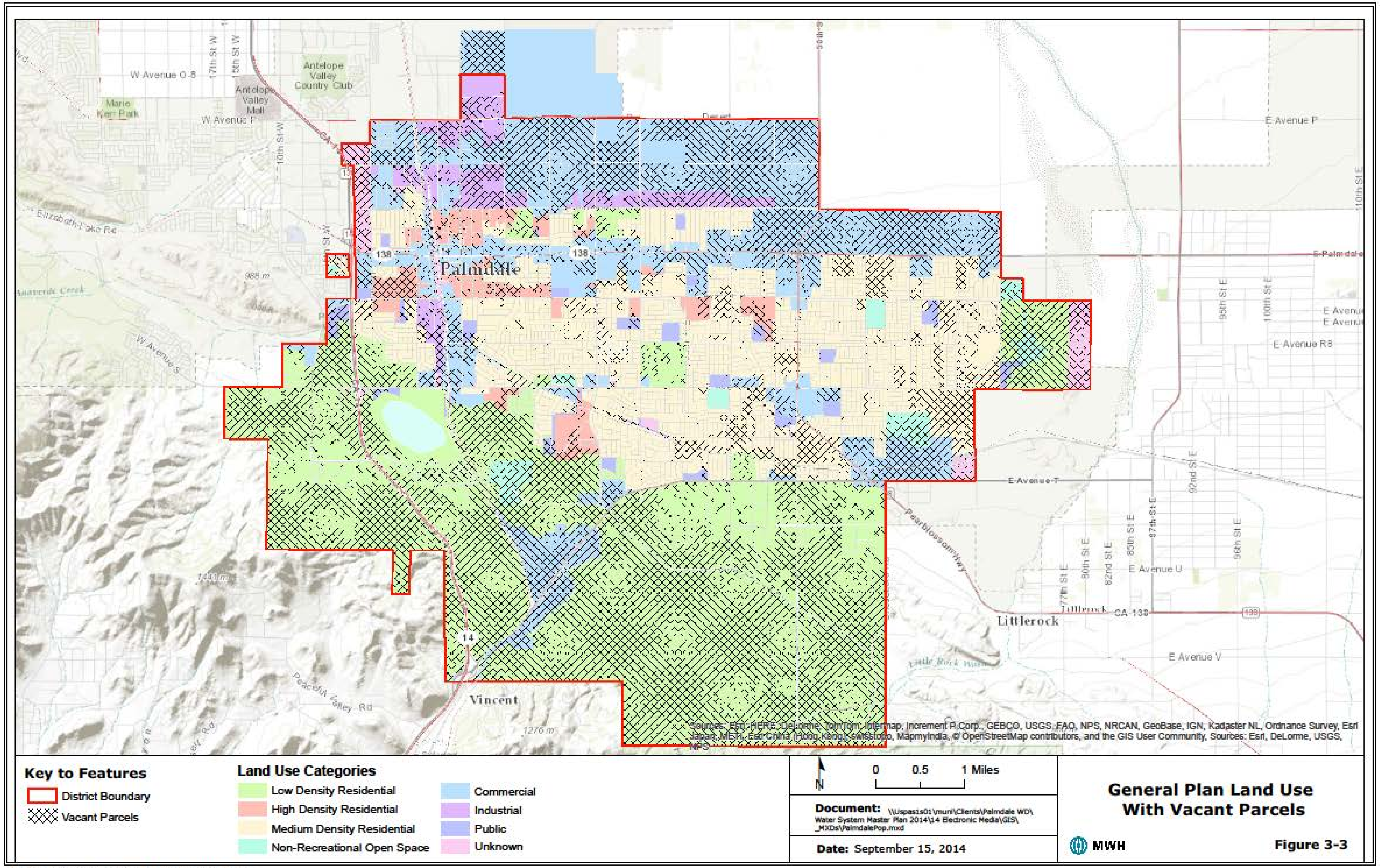
3.3.3 Land Use Demand Projections

It is assumed that the existing non-vacant land use types within the PWD service area have reached their full development potential. The possibility of redevelopment exists in the future, but because there is so much vacant land within the service area, the build out demand is projected based on the vacant parcels being developed under the general plan land use. The existing water demand (year 2010) for the PWD service area is 19,800 acre-ft/yr. Future water demands for the build out system are calculated by multiplying the total area of each vacant parcel by its corresponding WDF. This procedure yields a projected total build-out demand of 44,600 acre-ft/yr, as shown in **Table 3-9**. The total increase in demand from existing to build-out conditions is 24,800 acre-ft/yr, which is approximately 125 percent greater than the existing demand. This is the maximum total growth expected from all the vacant parcels being developed.

Table 3-9
Land Use Method Demand Projections

Land Use Type (Vacant Parcels)	Area (acres)	WDF (gpd/acre)	Demand (mgd)	Demand (acre-ft/yr)
Commercial	4,950	1,258	6.23	6,980
Industrial	650	1,074	0.70	790
Public	200	2,500	0.50	570
Low Density Residential	10,010	717	7.18	8,040
Medium Density Residential	1,620	3,309	5.36	6,000
High Density Residential	370	4,130	1.53	1,720
Non-Recreational Open Space	350	1,357	0.47	524
Unknown	373	330	0.12	140
Total Vacant Parcel Demand				**24,800**
Existing Demand (2010)				19,800
Total Demand Excluding Conservation				**44,600**

Figure 3-3
General Plan Land Use With Vacant Parcels



This map has been designed to print size 11" by 17".

3.4 Comparison of Demand Projection methodologies

The land use and the population methodologies are used to project the PWD future water demands. These demands are compared with the future demands projected in the PWD 2010 UWMP updated worksheet and are shown in **Table 3-10** and on **Figure 3-4**. The demands listed in the UWMP for year 2035 conditions are 128 percent higher than the demands projected using the population methodology. When comparing the demands listed in the UWMP to build out demands calculated by the land use method, results indicate that PWD would achieve build out by 2030. In reality the most recent data indicates that build-out would occur beyond year 2040. Because nearly 70 percent of the acres within the district are not developed, the UWMP demand projection appears to be unreasonably high.

In the last five years, the per capita water demand has been substantially lower than the historical records. Using average water use per capita based on these five years may underestimate demand under better economic conditions. For this purpose, MWH applied the more realistic population projections to the UWMP conservation target of 176 gpcd. These targets are higher than the projection based on the last five years of data by nearly 20 percent. MWH recommends using these projections for analysis through the year 2040.

Land use based demand projections will be used in build out system analysis. It is very unlikely that build out will occur within the 2040 planning horizon of this master plan.

Table 3-10
Comparison of Projected Water Demand Methodologies

Year	PWD 2010 UWMP Demand Projections (acre-ft/yr)	Demand Projections based on Population Projections (1) (acre-ft/yr)	Demand Based on UWMP Conservation Target (2) (acre-ft/yr)
2010	19,800	19,800	n/a
2015	35,000	21,400	27,100
2020	40,000	23,000	25,900
2025	45,000	24,200	27,200
2030	55,000	25,400	28,500
2035	60,000	26,600	29,800
2040	n/a	28,000	31,100
Build out Demand Projection (land use method) – 44,600 acre-ft/yr			

1) Projection assumes continuation of the existing water demand patterns in the future.
2) Projection assumes a future water demand of 176 gpcd.

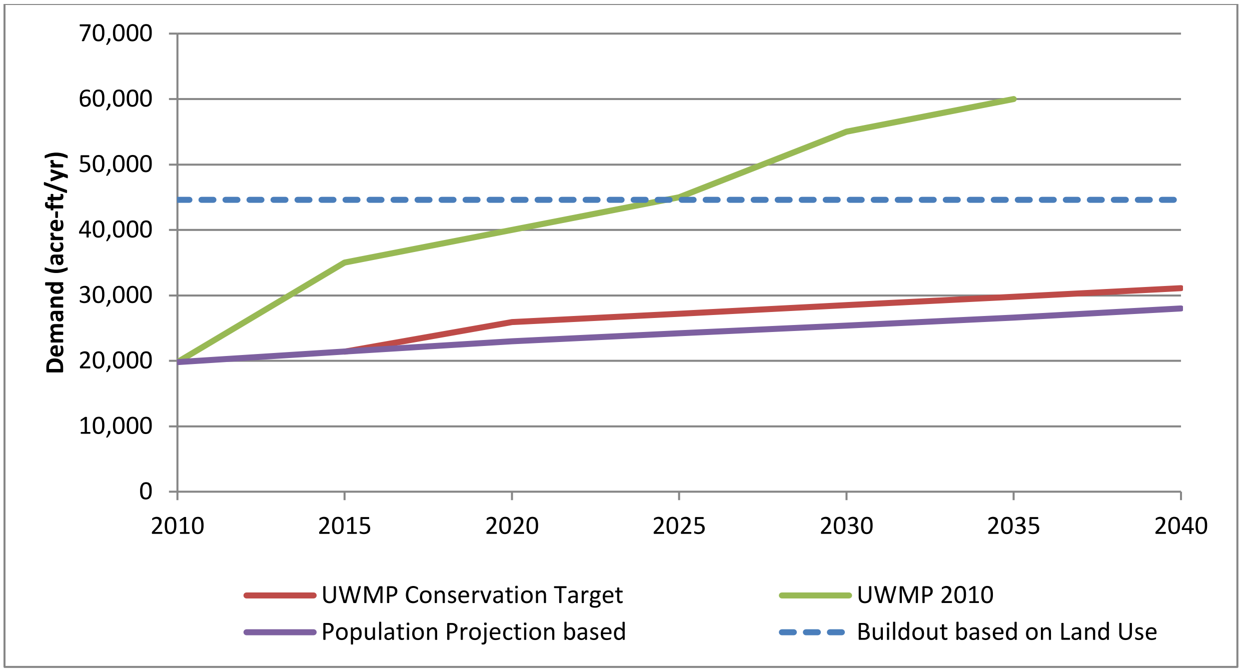


Figure 3-4
Water Demand Projections

The recommended ADD projection developed by the population based method and adjusted with the UWMP conservation target is shown in **Table 3-11.** Using the MDD factor (1.8) derived in **Table 3-4**, the projected MDD including and excluding conservation are shown in **Table 3-11**. The MDD projected demand from the land use analysis will be used to evaluate the system under build out demands.

Table 3-11
Recommended Demand Projections

Year	Recommended Average Annual Demand Projection (acre-ft/yr)	Recommended Average Day Demand Projection (mgd)	Recommended Maximum Day Demand Projection (mgd) (3)
2015(4)	21,400	19.1	34.4
2020(1)	25,900	23.1	42.6
2025(1)	27,200	24.2	43.6
2030(1)	28,500	25.4	45.7
2035(1)	29,800	26.6	47.8
2040(1)	31,100	27.7	49.9
Build out(2)	**44,600**	**39.8**	**71.6**

1) Based on SCAG population for the PWD service area with a gpcd based on the UWMP conservation target of 176 gpcd.
2) Based on land use methodology.
3) MDD/ADD factor of 1.8
4) Based on SCAG population projections

SECTION 4 WATER SUPPLIES

This section describes the evaluation of the water supplies for the Palmdale Water District (PWD, District). The scope of this investigation consists of reviewing the 2010 Strategic Resources Plan and incorporating those recommendations. Since work commenced on this WSMP Update, PWD completed a feasibility study to evaluate groundwater banking near Littlerock Creek, in the eastern portion of the PWD service area. The feasibility study recommended a change to PWD's water supply strategy. This section evaluates PWD's water supplies in light of the groundwater banking recommendations.

4.1 Existing Sources

The District has three existing sources of water supply: local groundwater, surface water from Littlerock Creek Reservoir, and imported water from the State Water Project (SWP). The surface water is treated at the Leslie O. Carter Water Treatment Plant (LOCWTP). Each of these sources is described below. **Figure 4-1** depicts the historical production from groundwater and the LOCWTP. Over the past twenty years, surface and imported water has supplied 59 percent of the water demands.

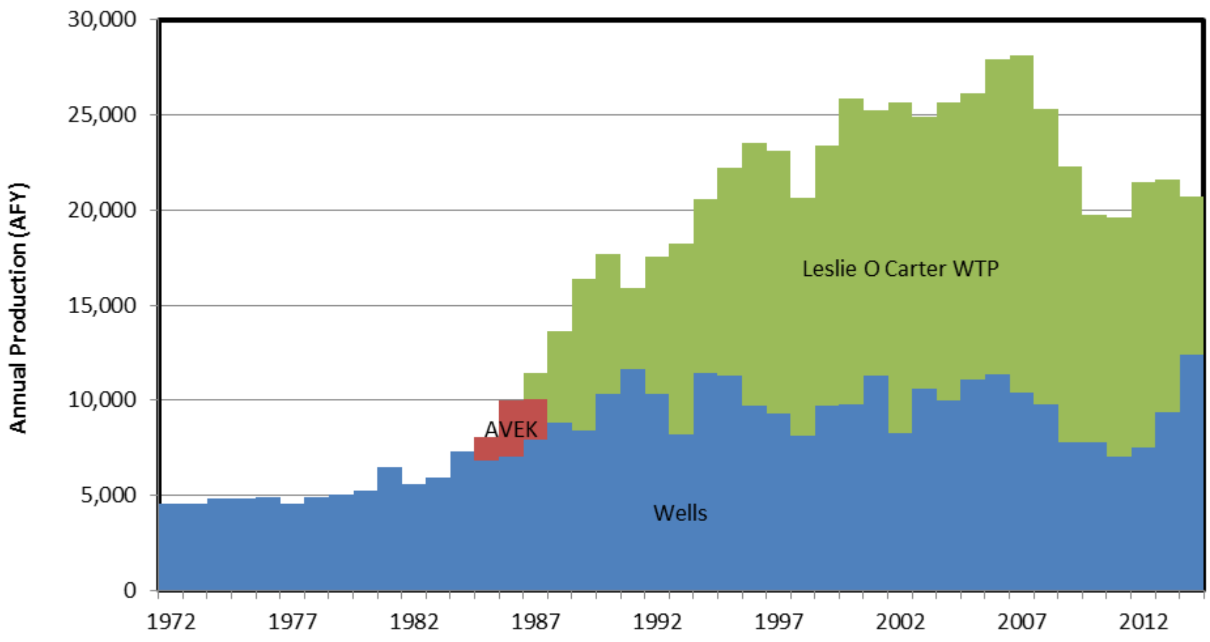


Figure 4-1
Historical Annual Water Production

4.1.1 Groundwater

The District's service area has historically been supplied with groundwater pumped from deep wells. Generally, the groundwater in the area is of excellent mineral and bacteriological quality. Over the past twenty years, PWD has pumped an average of 9,633 AFY with pumping ranging from 7,000 AFY to 12,400 AFY.

The Antelope Valley Groundwater Basin is divided by the USGS into twelve subunits. Groundwater basins are generally divided based upon differential groundwater flow patterns, recharge characteristics, and geographic location, as well as controlling geologic structures. PWD extracts groundwater from the Lancaster and Pearland subbasins, as well as the San Andreas Rift zone. The District overlies but does not pump groundwater from the Buttes subbasin. As discussed in **Section 2 – Existing Potable Water System**, PWD has 23 active wells with a combined capacity of 10,980 gallons per minute (gpm). In addition, PWD has four unequipped wells that could provide about 2,500 gpm of capacity. Two additional wells (36 and 37) were proposed for construction in 2008 but were deferred because of the recession.

The groundwater supplies in much of the Antelope Valley are in overdraft because annual pumping exceeds replenishment. Previously, many of Antelope Valley pumpers did not consider adjudication, and instead, a basin management approach was being pursued. However, in the fall of 1999, a farming company filed two lawsuits against water agencies seeking to define their overlying water rights. In late 2004, the County of Los Angeles Waterworks District No. 40 filed a civil complaint for the adjudication of all the groundwater rights in the Antelope Valley Groundwater Basin. In 2011, the court ruled that the safe yield (equivalent to natural recharge plus return flows) of the Basin is 110,000 acre-feet per year (AFY). The District later joined in the adjudication, and the adjudication was completed in December 28, 2015.[1]

Prior to the judgment, PWD had an unquantified right to pump water for beneficial use and assumed a projected pumping volume of 12,000 AFY. However, the adjudication resulted in the PWD receiving a groundwater production right of 2,770 AFY. The judgment is on appeal, but the PWD believes that it is unlikely their groundwater production rights will change significantly because of the appeal. The judgment allowed PWD seven years to ramp down pumping and to meet full compliance of their production right by 2023.

Under the judgment, the unused portion of the federal government right to pump, which is 7,600 AFY, is allocated among certain public water suppliers. Currently, the federal government does not pump their entire groundwater rights, and PWD is entitled to some of the unused portion of the federal government. Currently, PWD's share of the unused reserved water rights for the federal government is 1,370 AFY. Although the federal government has the right to increase pumping at any time, PWD believes they will be able to pump this amount until at least 2025.[2]

The PWD is also entitled to a pumping allocation of a return flow credit for any imported water used. The return flow credit is equal to 39.1% of all water used at the Leslie O. Carter Water Treatment Plant or water used for the Palmdale Regional Groundwater Recharge and Recovery Project (PRGRRP). Based on a study performed for the PRGRRP planning reports, the return flow credits are projected to range between 4,900 AFY and 6,000 AFY through 2040.

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[1] Judgment, Antelope Valley Groundwater Cases, Los Angeles County Superior Court, Judicial Council Coordination Proceeding No. 4408 (filed Dec. 28, 2015)

[2] Palmdale Water District 2015 Urban Water Management Plan, Kennedy/Jenks Consultants (June, 2016)

4.1.2 Littlerock Creek

Littlerock Creek Dam and Reservoir, located about seven miles southeast of the Palmdale Civic Center, intercepts flows from Littlerock and Santiago Canyons. These two watercourses are fed by runoff from a 65 square mile watershed in the Angeles National Forest. Inflow to the reservoir is seasonal and varies widely from year to year.

Since 1922, the District has shared water rights with Littlerock Creek Irrigation District (LCID) for 5,500 acre-feet per year (acre-ft/yr). LCID has rights to the first 13 cubic feet per second (cfs) from the Littlerock Creek, and then the two districts share any flow over 13 cfs with 25 percent of the flow allocated to LCID and the other 75 percent allocated to the District. Each district is entitled to 50 percent of the storage in the reservoir. On average, the District takes approximately 4,000 acre-ft of water from Littlerock Creek Dam each year.

In 1992, when the District and LCID agreed to rehabilitate the Dam, it was decided that LCID would give up their water rights to the District for the fifty-year agreement period in exchange for not providing monetary support with the improvements. LCID is able to purchase water from the District for either 1,000 acre-ft/yr or 25% of the yield from the Littlerock Creek Dam Reservoir, whichever is less. Over the past 20 years, the District has received on average approximately 12 percent (2,944 AFY) of its water supplies from Littlerock Dam Reservoir.

The initial design capacity of Littlerock Reservoir was 4,300 acre-feet (AF); however, deposition of sediment behind Littlerock Dam has substantially reduced this capacity over time. By 1991, the capacity of the Reservoir was approximately 1,600 AF. As a result, in 1992 the height of Littlerock Dam was raised to increase the Reservoir capacity by approximately 1,723 AF. The current Littlerock Reservoir storage capacity is estimated at 2,765 AF. Calculations conducted by PWD indicate the Reservoir capacity is further reduced by siltation at an annual rate of approximately 54,000 cubic yards of sediment amounting to a loss of approximately 35 AFY of water.

The Littlerock Reservoir Sediment Removal (LRSR) Project proposes to restore the capacity of the reservoir to 3,325 AF through removal of 900,000 net cubic yards (equivalent to 560 AF) of accumulated sediment behind the Littlerock Dam. In addition, the LRSR Project proposes to construct a grade control structure that will prevent sediment loss and head-cutting upstream of the Reservoir beyond Rocky Point to protect and preserve habitat for the federally endangered arroyo toad. The USFS and PWD prepared a joint environmental impact statement (EIS) and Environmental Impact Report (EIR), referred to as an EIS/EIR, to assess the environmental effects of the proposed LRSR Project. In addition to the Notice of Preparation (NOP), a Draft EIS/EIR was published in May 2016, and a Final EIS/EIR is expected to be published in late 2016 or early 2017.

Previous WSMPs evaluated the supply available from Littlerock Reservoir. Using a 50-year hydrologic period (October 1949 through September 1999), the average yield available to PWD is estimated to be 4,000 AFY (Montgomery Watson, 2001).

4.1.3 State Water Project

The SWP is managed by Department of Water Resources (DWR) and includes storage facilities, 660 miles of aqueduct and conveyance facilities extending from Lake Oroville in northern California to Lake Perris in the south. The SWP has contracts to deliver up to 4.172 million AFY to 29 SWP contracting agencies.

SWP water and Littlerock Creek water are stored in Lake Palmdale, which has a capacity of about 4,129 acre-ft and a maximum surface area of 234 acres. Stored water is conveyed from the lake through a 42-inch pipeline to the District's water treatment plant.

4.1.3.1 Table A Amount

PWD initially contracted for water from the SWP in 1963 with an original SWP water allocation (Table A Amount[3]) of 15,000 AFY. PWD's Table A Amount was amended to 17,300 AFY in 1964. In 1999, PWD completed the acquisition of 4,000 AFY of Table A Amount from Kern County Water Agency that was allotted to Belridge Water Storage District. PWD's total Table A Amount has been 21,300 AFY since 2000.

Each year, DWR determines the amount of water available for delivery to SWP contractors based on hydrology, reservoir storage, the requirements of water rights licenses and permits, water quality, and environmental requirements for protected species in the Sacramento-San Joaquin Delta. The available supply is then allocated according to each SWP contractor's Table A Amount. Because of the on-going California drought, the final SWP allocation for 2014 was five percent of the Table A Amounts, the lowest since the SWP began operating. The SWP allocation to contractors for 2015 was 20 percent of the Table A Amount.

4.1.3.2 SWP Reliability

DWR evaluates SWP reliability every two years. In the most recent assessment published in December 2014, DWR estimates SWP average deliveries to be 62 percent of Table A Amounts under current (2015) conditions and 61 percent under future (2035) conditions assuming existing SWP facilities (California Department of Water Resources, 2016). The future reliability could be less than 61 percent due to risks not quantified by DWR, including levee failure and unforeseen environmental restrictions if the Bay Delta Conservation Plan (BDCP) and related facilities are not completed. For the 2005 through 2014 time period deliveries from the SWP to the PWD average 10,400 acre-feet which is equivalent to 49% of its Table A allocation of 21,300 acre-feet.

SWP reliability could potentially increase to more than 70 percent with completion of the BDCP and related facilities, including additional storage. Analyses in the 2013 BDCP public draft EIS/EIR indicate a SWP reliability range of 52 percent to 68 percent with implementation of the BDCP facilities (Bureau of Reclamation; U.S. Fish and Wildlife Service; National Oceanic and Atmospheric Administration; National Marine Fisheries Service; and California Department of

3 Each SWP contract contains a "Table A" exhibit that defines the maximum annual amount of water each contractor can receive excluding certain interruptible deliveries. Table A Amounts are used by DWR to allocate available SWP supplies and some of the SWP project costs among the contractors

Water Resources, 2013). DWR may revise these SWP reliability values in the recirculated BDCP EIS/EIR, which is expected to be released in 2015.

4.1.4 Water Transfers

In addition to the acquisition of the 4,000 AFY Table A transfer from Kern County Water Agency (KCWA), PWD executed a long-term agreement with Butte County to lease 10,000 AFY of Table A Amount through 2021. Under this agreement, PWD pays Butte the relevant Delta Water Charge plus a water rate (currently $55.44/AF escalating annually) and a proportionate amount of any future SWP charges levied against Butte. PWD separately arranges for conveyance of the leased water through the California Aqueduct. PWD has a first right of refusal to acquire any additional SWP water that Butte County may have available annually. The agreement may be renewed in 2020 for an additional five-year period with the amount subject to the needs of Butte County's wholesale contractors.

4.2 Future Sources

PWD prepared a Strategic Water Resources Plan (SWRP) in 2010 to establish guiding objectives and identify necessary steps in order to meet the projected future needs of its customers. The SWRP considered a range of alternatives including imported water, groundwater, local runoff, recycled water, conservation and water banking. To understand where PWD should be placing its emphasis, PWD developed the SWRP that considered the different options available to it, evaluated these options with respect to a variety of factors including cost, reliability, flexibility, implementability and sustainability. Through this evaluation process, PWD developed the following recommended water resource strategy (RMC, 2010):

- Acquire and/or develop new imported supplies.
- Create a combination of local surface spreading facilities to percolate untreated SWP water and Aquifer Storage Recovery (ASR) wells to inject potable water .
- Add additional pumping capacity to achieve a target of delivering 70 percent of supply to customers through groundwater pumping.
- Pursue a recycled water exchange program with nearby agriculture in-lieu of groundwater pumping.

In addition, PWD will begin to embark on a strategy to diversify its supplies and provide for near-term drought reliability with the following steps (RMC, 2010):

- Expand conservation programs.
- Recover storage capacity in Littlerock Reservoir through sediment removal.
- Implement a recycled water system for non-potable uses (e.g. primarily irrigation but possibly some industrial uses).
- Further research using treated recycled water to replenish the groundwater basin as is now being done in Orange County through advanced water treatment processes, blending with SWP water, and surface spreading and percolation.
- Evaluating additional groundwater banking programs (options presented in 2015 Urban Water Management Plant (UWMP).

Since the SWRP was adopted, the growth rate in the Antelope Valley has significantly declined and water demands have declined because of the on-going drought and implementation of water conservation measures. PWD has continued to implement many of the recommended actions of the SWRP through the acquisition of additional SWP water by long-term lease, development of a recycled water distribution system for non-potable uses with the City of Palmdale, and evaluation of the feasibility of a groundwater recharge program, and increased water conservation.

4.2.1 Recycled Water for Non-potable Irrigation

PWD and the City of Palmdale are taking proactive steps towards expanding the use of non-potable water to meet a variety of non-potable and indirect potable uses through the formation of the Palmdale Recycled Water Authority (PRWA) in 2012. The PRWA manages all aspects of recycled water use within the PWD service area, including the agreements to obtain recycled water from the Los Angeles County Sanitation Districts (LACSD), planning, designing, and constructing supporting facilities, and financing these efforts (Environmental Science Associates, 2014).

A Recycled Water Backbone System has been proposed for the Antelope Valley that would connect the Lancaster Wastewater Recycling Plant (LWRP) and Palmdale Wastewater Recycling Plant (PWRP), allowing recycled water from both plants to be used throughout the region. Portions of the Recycled Water Backbone System have already been constructed by the City of Lancaster, City of Palmdale, and Waterworks No. 40. Additionally, the City of Palmdale has partnered with Waterworks No. 40 to design and construct a portion of the Recycled Water Backbone System that will complete the connection of the LWRP and PWRP and serve the proposed Palmdale Hybrid Power Plant, and the Antelope Valley Country Club. The portions of the Recycled Water Backbone System that have been designed or constructed, are all located outside of the service area of the PRWA. The primary benefit to the PRWA of these portions is the potential ability to move recycled water between the LWRP and PWRP. However, the majority of the tertiary treated water that will be used in the PRWA service area will originate at PWRP (Environmental Science Associates, 2014).

The PRWA is proposing to implement their 2014 Recycled Water Facilities Plan, which includes construction and operation of distribution pipelines and laterals and pumping facilities. The proposed long-term project would provide approximately 1,700 AFY of tertiary-treated recycled water to PRWA customers for direct reuse, primarily for landscape irrigation at parks, schools, and golf courses. The proposed project would be constructed in Phases with the initial Phase having been constructed. The next phase to be constructed is the Phase 2 Water Line for Direct Reuse, which is shown in **Figure 4-2**. The projected time frame for start of construction is year 2017.

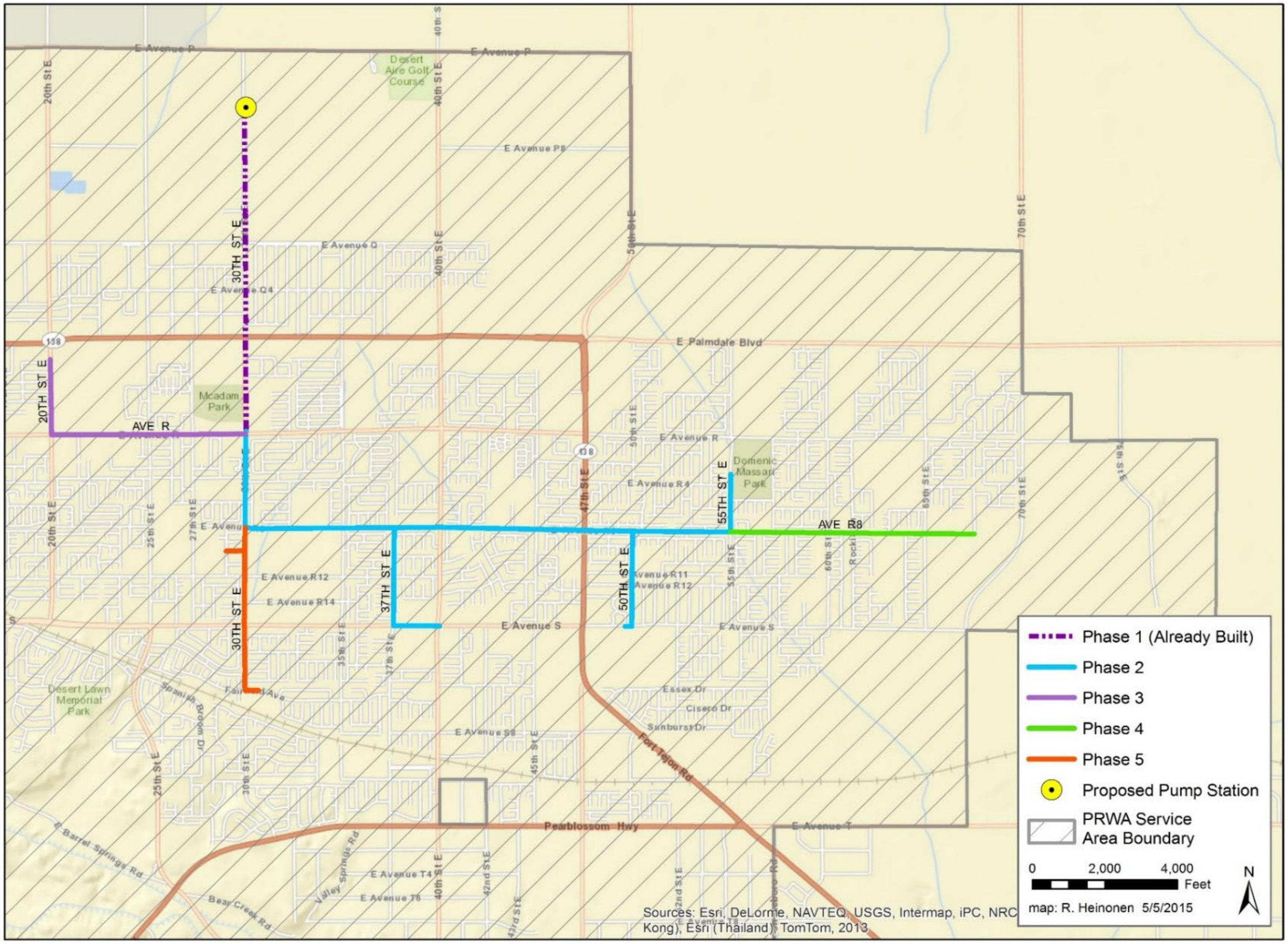

Figure 4-2
Proposed Recycled Water Distribution System

The proposed recycled water project would use 500 acre-feet of recycled water from the PRWP and would consist of the following components:

- Construction of approximately 16,000 linear feet of 24-inch recycled water main trunk line pipe connecting to the existing main at Avenue R and 30th Street East then south in 30th Street East to Avenue R-8, then east in Avenue R-8 to 55th Street East
- Construction of approximately 7,800 linear feet of either 6-inch, 8-inch, or 12-inch lateral line pipe to provide service to Palmdale Oasis Park, Yellen Park, and Domenic Massari Park located near Avenue S & 40th Street East, Avenue S & 52nd Street East, and Avenue R-4 & 55th Street East, respectively

The other direct recycled water user would be the Palmdale Hybrid Power Plant with an estimated demand of 400 AFY.

4.2.2 Palmdale Regional Groundwater Recharge and Recovery Project

One of the PWD goals is to use any available recycled water for groundwater replenishment as part of the optimal blend of supply alternatives to address future needs. PWD is developing a groundwater banking program using recycled water and imported water to supplement its existing water supplies. The recycled water would be supplied to PWD from the LACSD Palmdale WRP, which currently produces about 10,000 AF/yr of Title 22 recycled water. Recycled water flows are projected to increase to about 12,500 AFY by build-out which would occur after the year 2040. After deducting 1,700 AFY for non-potable irrigation and 400 AFY for power plant cooling, the demand for recycled water supply for recharge is estimated to be 6,500 AFY in 2040. This would leave another 3,900 acre-feet of recycled water available for other uses as other needs arise. (Kennedy/Jenks, February 2015).

The Palmdale Regional Groundwater Recharge and Recovery Project (PRGRRP) Feasibility Study investigated the feasibility of a groundwater banking, storage, and extraction program on behalf of the PWD (Kennedy/Jenks, February 2015). The selected project alternative would use 6,500 acre-feet of recycled water from PRWP. This would help meet future water demands and improve water supply reliability to the year 2040. New facilities will be constructed to recharge and recover SWP water as well as recycled water. Infrastructure will include new spreading grounds to recharge water as well as recovery facilities. Recycled water will be replenished continuously with surplus SWP water stored during normal and wet years allowing for the efficient utilization of SWP water when available, while meeting regulatory requirements for recycled water contribution percentage. The recovery of potable groundwater would also be continuous as a base flow potable water supply at production rates to enable PWD to meet all future water demands when combined with existing supply facilities (Kennedy/Jenks, February 2015).

Following the evaluation of ten conceptual alternatives and detailed evaluation of four refined alternatives, Alternative 10C was selected as the preferred alternative. Alternative 10C is located east of Littlerock Creek with a recharge site near 105th Street East and Avenue L. This alternative utilizes a location in which approximately 35 percent of the land is owned by LACSD for its proposed Effluent Management area.

The recommended project will require the following facilities as shown in **Figure 4-3**:

Figure 4-3
Palmdale Regional Groundwater Recharge and Recovery Project

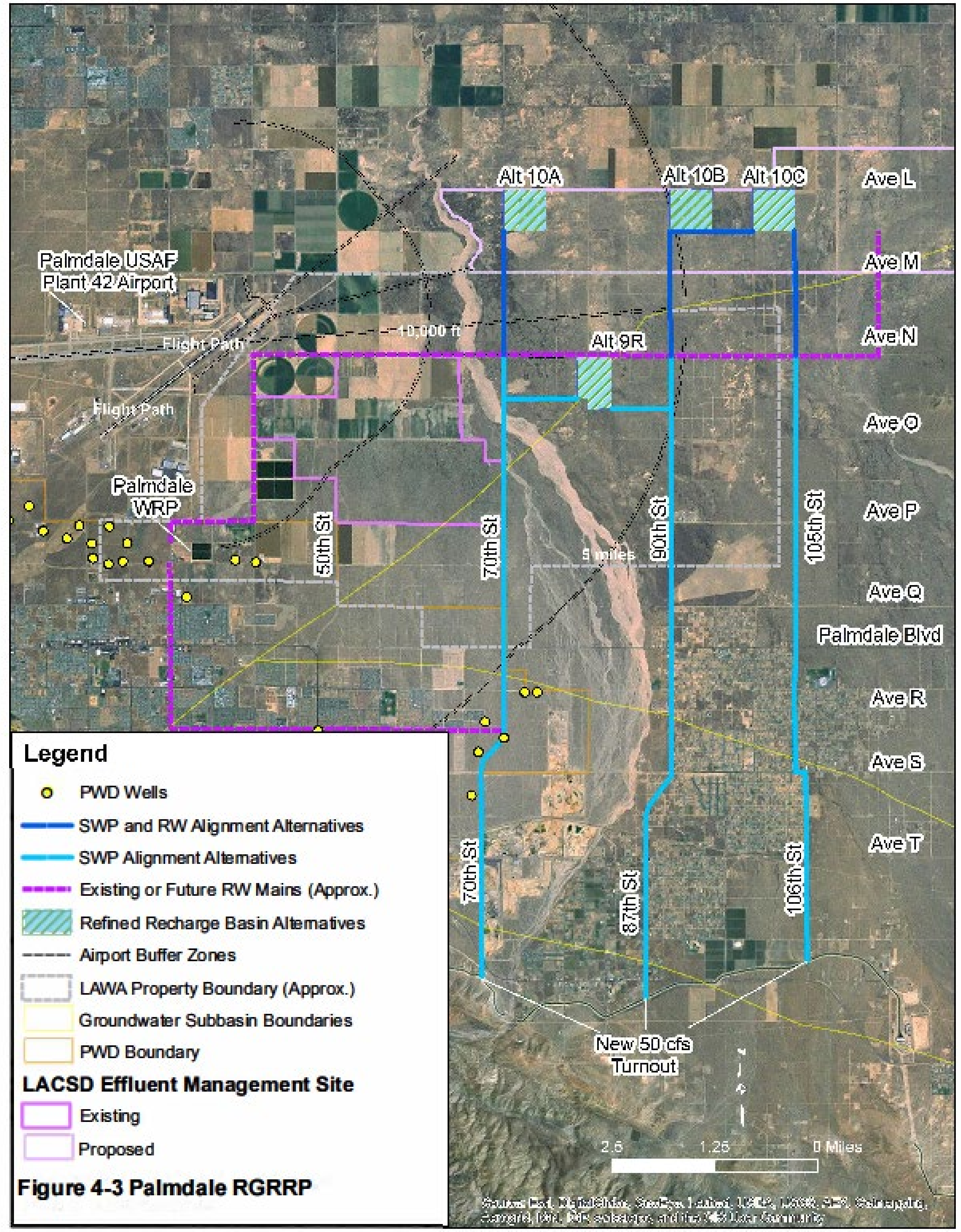

Figure 4-3 Palmdale RGRRP

- 50-cfs turnout from the SWP
- Nine miles of 30-36 inch diameter pipeline to convey SWP water to the recharge site (depending on final alignment)
- Use of an existing LACSD recycled water pipeline from the Palmdale WRP to convey recycled water to the recharge site
- 160 acre recharge site
- 16 1,200 gpm extraction wells (8 wells each in Phase 1 and Phase 2)
- Extracted water disinfection facility, clearwell, and booster station
- 8.6 miles of 30-inch diameter pipeline to convey extracted water to the PWD distribution system

The estimated capital cost of Phase 1 is $78 million in 2015 dollars. The annual operating and water purchase costs are estimated to range from $2.6 million/year in 2018 to $4.6 million/year in 2040 (in 2015 dollars) (Kennedy/Jenks, February 2015).

MWH reviewed the potential operation of the water bank under a range of hydrologic conditions to verify supply adequacy and evaluate the need for additional supply capacity. The following assumptions are made using information from the PRGRRP feasibility report, the PWRA Recycled Water Facilities Plan Initial Study/Mitigated Negative Declaration, and the SWP Delivery Reliability Report:

- Available recycled water supply for extraction is 7,500 AFY.
- Initial recycled contribution is 20 percent, increasing to 30 percent after 5 years, and 40 percent in the future.
- Normal groundwater pumping limited to 7,200 AFY based on estimated safe yield allocation.
- LOCWTP operated at 25 percent of demand unless surface water supply is limited in dry years.
- Remaining available SWP and Littlerock Creek water used for dilution of recycled water
- RW used up to available supply as limited by 10-year running average dilution requirement
- Groundwater bank operates continuously to supply remaining water needs up to a maximum capacity of 14,125 AFY for Phase 1.
- Extraction of additional banked water in excess of the PRGRRP capacity could occur in extreme dry years.

Figure 4-4 presents a summary of water bank operations assuming long-term average hydrologic conditions. **Figure 4-5** presents the range of water bank operation based on 2030 demand levels and a repeat of 1922-2003 hydrologic conditions. In normal and wet years, available supplies are sufficient to meet the water treatment goal and provide water for the water bank. In series of dry years, the availability of SWP and Littlerock Creek dilution water may limit the amount of recycled water that can be recharged while maintaining meeting the recycled water contribution requirements. Imported and surface water is delivered first to the LOCWTP, with little to no water available for recharge. The water bank would be used to extract stored water to supply. If the water bank extraction capacity is insufficient to meet required demand, additional banked water could be extracted from existing or future PWD wells. High extraction caused by drought in the early years of water bank operation could result in temporary overdraft that would require offsetting in future years as illustrated in **Figure 4-5**.

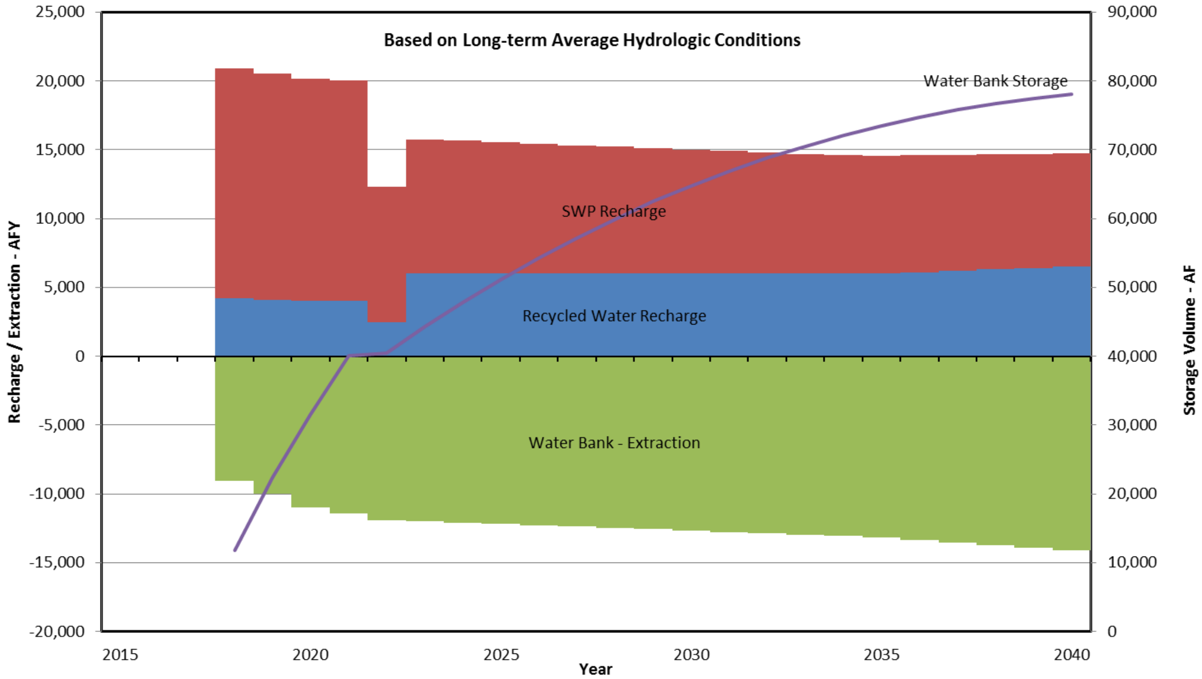

Figure 4-4
Estimated Water Bank Operations

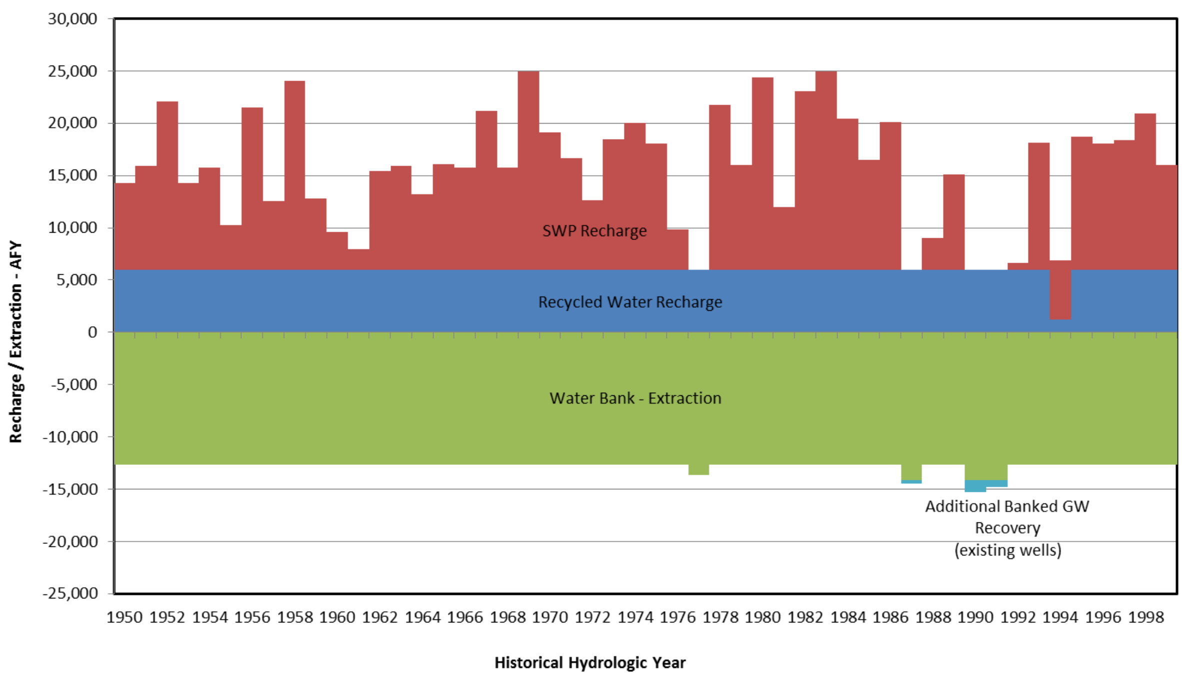

Figure 4-5
Estimated Range of Water Bank Operation – 2030 Demand Level

4.2.3 SWP Acquisition/Lease

As discussed previously, PWD has a long-term lease agreement with Butte County for 10,000 AFY of Table A supply which is effective through 2021. PWD also has a first right of refusal for additional SWP water from Butte County as available. The Butte County transfer can be renewed in 2020 for an additional five years under the same terms, although the amount of water available may be reduced based on Butte County's needs.

Evaluations performed as part of the PRGRRP indicate that additional Table A water may need to be acquired after 2040. In addition, supplemental water could be acquired on an option basis if needed during dry years. PWD may wish to establish agreements with other agencies to purchase water in dry years on an option basis to provide additional supply redundancy.

4.3 Supply Evaluation

PWD's surface water sources are treated at the LOCWTP that has a capacity of 35 mgd. The plant receives and treats Littlerock Creek and SWP water that has been stored in Lake Palmdale, which has a capacity of about 4,129 acre-ft and a maximum surface area of 234 acres. The LOCWTP typically produces about 20 mgd of treated water during the peak summer months; this amount varies based on available surface water supplies. The operating strategy for the PRGRRP is to reduce the amount of water treated at LOCWTP to 25 percent of demand.

Water supplies are typically evaluated based on their ability to meet maximum day demand (MDD) with the largest source out of service. This criterion is intended to provide redundancy in the event of equipment failure or other outages. However, it does not directly address the ability of the system to meet demands during normal or dry periods and does not consider planning uncertainty. To address supply uncertainty and redundancy, it is recommended that a 10 percent buffer be added to both the average annual and maximum day demands. The supply buffer is intended to account for future uncertainty resulting from changes in water demands, loss of existing supplies, inability to develop the recommended supplies, uncertainty of future yield, and other unanticipated changed conditions. The supply buffer does not need to be implemented immediately. Rather, it is intended to provide PWD with potential projects that could be implemented if needed.

4.3.1 2030 Demand Analysis

Table 4-1 presents a summary of the PWD water analysis for the year 2030 under maximum day and annual conditions.

4.3.1.1 Capacity Analysis

The MDD in 2030 is projected to be 45.7 mgd (31,740 gpm). With the 10 percent supply buffer, the planning target is 50.3 mgd (34,930 gpm). As shown in **Table 4-1,** existing production capacity is adequate to meet the projected demand with the buffer. However, implementation of the non-potable recycled water system and the PRGRRP will increase production capacity by 13.0 mgd (9,000 gpm). PWD has drilled several additional wells that are not equipped (Wells 24A, 27, 28, and 34). These wells could produce about 3.6 mgd (2,500 gpm); however, several of these wells have operational constraints that limit their ability to produce water. MWH conducted a well location investigation for PWD that resulted in the construction of Well 24A. Two additional wells

(Wells 36 and 37) were to be drilled, but the economic downturn resulted in these wells being deferred. It is recommended that Well 24A be equipped and Wells 36 and 37 be drilled to produce 3.6 mgd. These wells can be used for the banking programs.

4.3.1.2 Annual Supply Analysis

Three annual hydrologic scenarios are presented in **Table 4-1** – average year representing the long-term hydrologic average, single dry year representing the single worst case hydrologic year, and multiple dry year representing the four lowest consecutive dry years.

The existing water supplies consist of Antelope Valley groundwater, Littlerock Creek surface water, and SWP water. The analysis is based on the following assumptions:

- Antelope Valley groundwater yield is based on PWD's newly allocated portion of 2,770 AFY despite the basin safe yield of 7,200 AFY. This supply is expected to be available in all hydrologic years.
- Littlerock Creek supply is based on the hydrologic analyses performed for the 2001 WMP. For average conditions, the supply is expected to be 3,640 AFY after accounting for delivery to LCID. The minimum year supply is 200 AFY based on 1951 hydrology. Multiple dry year supply is 2,010 AFY based on a repeat of the 1960-1963 hydrology.
- SWP supply is based on the DWR's 2015 SWP Delivery Reliability Report (California Department of Water Resources, 2016). Average reliability is 61 percent of PWD's Table A Amount of 21,300 AFY. DWR estimates that SWP can deliver a total Table A supply of 11 percent for the single dry year. However, due to the extremely dry sequence of the California drought, the 2014 SWP allocation was a historic low of 5 percent of Table A Amounts. Therefore, the WSMP will use a single dry year supply of 5 percent of Table A based on the 2014 allocation. Multiple dry year supply is 33 percent of Table A based on a repeat of the 1931-1934 hydrology.

Future water supplies consist of the existing supplies plus recycled water delivered for non-potable irrigation uses and recharged at the PRGRRP. The following assumptions are made:

- No decrease of existing supplies.
- Recycled water delivered for non-potable irrigation is 1,700 AFY by 2035.
- Recycled water delivered for groundwater replenishment and extraction at the PRGRRP is 7,500 AFY by 2020.
- Water banked in excess of the extraction capacity of the PRGRRP is extracted at existing PWD wells during dry years in addition to the safe yield allocation.
- PWD is entitled to a pumping allocation for return flow credit of imported water used equal to 39.1 percent of all SWP water utilized. The flow credits are assumed to be 5,000 AFY.
- Leased SWP Table A is available from Butte County until 2021, with an ability to update the lease every five years until 2035. Future leased water may be required to augment average supplies and provide additional water for banking if existing SWP supplies are not sufficient.

Table 4-1
Evaluation of Future Water Sources – 2030 Demand Levels

Name	Capacity (gpm)	Capacity (mgd)	Average Year Yield (AFY)	Single Dry Year Yield (AFY)	Four Consecutive Dry Year Yield (AFY)	Comments / Assumptions
Existing Supplies						
Antelope Valley Groundwater	10,980	15.8	2,770	2,770	2,770	Allocation from adjudication
Littlerock Creek	-	-	4,000	230	2,010	Based on 1950-2013 hydrologic conditions
SWP Water	-	-	13,000	1,065	7,000	Based on 61% average reliability, 5% in single dry year, 33% in multiple dry years
Leslie O Carter WTP	24,300	35.0	-	-	-	Annual supply is included for Littlerock Creek and SWP supplies
Total Existing Supplies	35,280	50.8	19,770	4,065	11,780	
Demand						
2030 Demand	31,740	45.7	28,500	28,500	28,500	
2030 Demand with Buffer	34,930	50.3	31,400	31,400	31,400	10% water supply planning buffer
Supply Surplus (Deficit)	3,540	5.1	(8,730)	(24,435)	(16,720)	
Supply Surplus (Deficit) with Buffer	350	0.5	(11,630)	(27,335)	(19,620)	
New Supplies						
Recycled Water (PRWA)	-	-	1,700	1,700	1,700	Recycled water pump station sized to meet peak hour demands
Palmdale Regional GRRP	9,000	13.0	4,000	7,500	7,500	Water bank yield minus recycled water recharge
New Wells/Banked Groundwater	2,500	3.6	-	4,370	720	Based on supply analysis - increased groundwater banking program
Groundwater Return Flow Credits			5,000	5,000	5,000	Estimated return flow credits
Butte Transfer Agreement			6,100	500	3,300	Based on SWP Table A Amounts as described above of 10,000 AFY
Water Conservation/Rationing			-	5,700	-	20% Mandatory water conservation on extreme dry years
Total Additional Supply	11,500	16.6	16,800	24,770	18,220	
Total Future Supply	46,780	67.4	36,570	28,835	30,000	
Supply Surplus (Deficit)	15,040	21.7	8,070	335	1,500	
Supply Surplus (Deficit) with Buffer	11,850	17.1	5,170	(2,565)	(1,400)	

Based on the analysis in **Table 4-1**, there is sufficient water for normal and multiple dry year conditions. However, in a single dry year, PWD should plan on implementing water rationing at 20 percent of demand to maintain its meet demands.

4.3.2 Build-out Demand Analysis

Table 4-2 presents a summary of the PWD water analysis for maximum day and annual demand conditions at build-out.

4.3.2.1 Capacity Analysis

The build-out MDD is projected to be 71.6 mgd (49,720 gpm). With the 10 percent supply buffer, the planning target is 78.8 mgd (54,720 gpm). As shown in **Table 4-2,** existing production capacity is not adequate to meet the projected demand both without and with the buffer; 28 mgd of additional capacity is required. Implementation of Phase 2 of the PRGRRP will provide 21.6 mgd (15,000 gpm) of capacity. Additional well capacity is recommended to provide redundancy and capability to pump additional groundwater during dry years from the groundwater banking programs. In addition to the wells recommended for the 2030 analysis, two or three additional wells are recommended with a combined capacity of 2.9 mgd (2,000 gpm).

4.3.2.2 Annual Supply Analysis

The build-out supply analysis includes the recommended supplies from the 2030 analysis and includes the capacity of the PRGRRP to be 10,250 AFY with expansion likely to take place after 2040. In addition, it is expected that about 20,000 AFY of Table A water will be needed to maximize recycled water recharge and provide banked water for use during dry years. Like the 2030 evaluation, PWD should plan on the maintaining the ability to implement water rationing at 20 percent of demand to meet supply in a single dry year.

4.3.3 Recommendations

Based on the foregoing analysis, the following supply recommendations are made:

- Modify the treatment target for the LOCWTP from 60 percent of annual demand to 25 percent of annual demand. To meet peak summer demands, plant production should be greatest in the summer months. In dry years, Littlerock Creek and SWP should be preferentially delivered to the WTP to meet demands.
- Implement the PWRA program to deliver recycled water for non-potable uses in the Palmdale area.
- Implement the PRGRRP Phase 1 as recommended in the feasibility study using recycled water and imported water with groundwater banking to provide dry year yield.
- Equip the existing wells to produce groundwater during dry years; extracted water would be excess banked water from the PRGRRP. If the existing wells cannot be suitably equipped due to their locations or yields, drill replacement wells.
- Drill two to three additional wells to meet MDD at build-out conditions.

Table 4-2
Evaluation of Future Water Sources – Build-out Demand Levels

Name	Capacity (gpm)	Capacity (mgd)	Average Year Yield (AFY)	Single Dry Year Yield (AFY)	Four Consecutive Dry Year Yield (AFY)	Comments / Assumptions
Existing Supplies						
Antelope Valley Groundwater	10,980	15.8	2,770	2,770	2,770	Allocation from adjudication
Littlerock Creek	-	-	4,000	230	2,010	Based on 1950-2013 hydrologic conditions
SWP Water	-	-	13,000	1,065	7,000	Based on 61% average reliability, 5% in single dry year, 33% in multiple dry years
Leslie O Carter WTP	24,300	35.0	-	-	-	Annual supply is included for Littlerock Creek and SWP supplies
Total Existing Supplies	35,280	50.8	19,770	4,065	11,780	
Demand						
Build-out Demand	49,720	71.6	44,600	44,600	44,600	
Build-out Demand with Buffer	54,720	78.8	49,100	49,100	49,100	10% water supply planning buffer
Supply Surplus (Deficit)	(14,440)	(20.8)	(24,830)	(40,535)	(32,820)	
Supply Surplus (Deficit) with Buffer	(19,440)	(28.0)	(29,330)	(45,035)	(37,320)	
New Supplies						
Recycled Water (PRWA)	-	-	2,000	2,000	2,000	Recycled water pump station sized to meet peak hour demands
Palmdale Regional GRRP	15,000	21.6	-	10,250	10,250	Water bank yield minus recycled water recharge
New Wells/Banked Groundwater	2,000	2.9	-	13,000	6,000	Based on supply analysis - increased groundwater banking opportunities
Groundwater Return Flow Credits	-	-	5,000	5,000	5,000	Estimated return flow credits
Butte Transfer Agreement	-	-	6,100	500	3,300	Based on SWP Table A Amounts as described above of 10,000 AFY
SWP Lease	-	-	12,200	1,000	6,600	20,000 Table A Lease to provide buffer
Water Conservation/Rationing	-	-	-	8,920	-	20% Mandatory water conservation on extreme dry years
Total Additional Supply	17,000	24.5	25,300	40,670	33,150	
Total Future Supply	52,280	75.3	45,070	44,735	44,930	
Supply Surplus (Deficit)	2,560	3.7	470	135	330	
Supply Surplus (Deficit) with Buffer	(2,440)	(3.5)	(4,030)	(4,365)	(4,170)	

- Maintain the Butte County SWP lease to provide additional imported water for banking to build up storage for use in subsequent dry years and maximize the recharge of recycled water.
- Lease or purchase additional Table A Amount to augment future recycled water recharge and provide sufficient dilution water to meet the groundwater recharge regulations. If additional imported water cannot be obtained, PWD may need to consider advanced treatment of recycled water to allow increased recharge in the future.
- Maintain a program of water conservation to maintain the current per capita water use and allow water rationing if need to provide a supply buffer during extreme dry years.

Figure 4-6 shows the expected supply contributions for average hydrologic conditions. The wells value includes both the 2,770 AFY basic right plus the anticipated flow return credit of 39 percent of the imported water used.

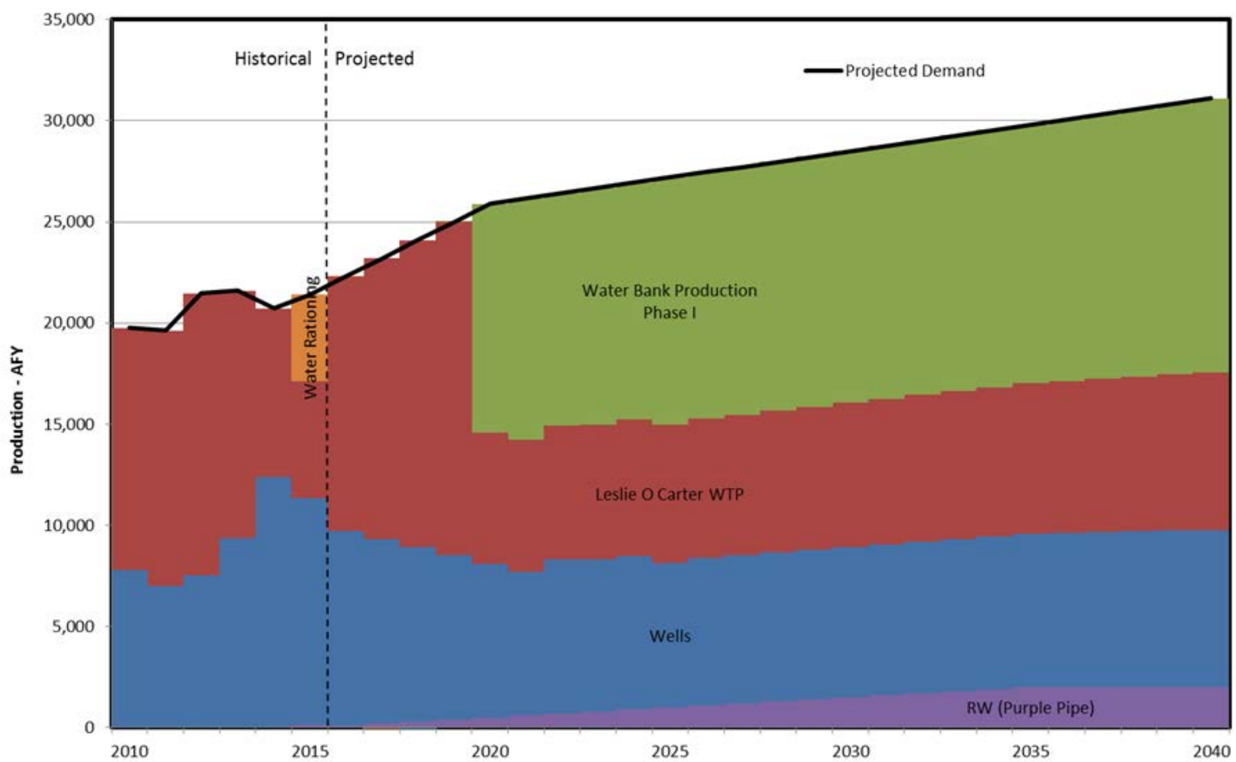

Figure 4-6
Future Water Supplies For Average Hydrologic Conditions

SECTION 5 WATER QUALITY

Palmdale Water District (District) seeks to provide its customers with high-quality drinking water that meets or exceeds all state and/or federal drinking water regulations. It is important to consider current and anticipated future water quality issues when developing a long-term master plan for the District's system.

5.1 Section Objectives

Objectives of this section are as follows:

1. Summarize the District's potential water quality concerns associated with its water supply sources.
2. Highlight current and pending water quality regulations, both at federal and state levels that may affect the District's water system.
3. Examine the District's water quality data with respect to current and pending regulations.
4. Summarize current monitoring programs the District has in place to improve water quality and identify concerns associated with these practices.
5. Summarize findings and develop recommendations to improve water quality throughout the District's water system.

5.2 Treatment of Existing Water Supplies

The District receives water both from groundwater and surface water supplies, each of which presents their own unique water quality challenges. This section provides a brief discussion on the treatment of the District's surface and groundwater supplies.

5.2.1 Groundwater

Groundwater extracted from the District's wells is chlorinated prior to distribution. Each well is equipped with an on-site chlorine generator that produces a 0.8-percent liquid sodium hypochlorite (NaOCI) solution. No other treatment or chemicals are applied at the wellhead.

5.2.2 Surface Water

The District's WTP provides treatment for water extracted from Palmdale Lake, which receives water from the SWP and Littlerock Dam. The WTP has a rated capacity of 35 MGD.

Copper sulfate has been used to control algae growth within Lake Palmdale. Cutrine® Plus and Cutrine® Plus Extra (copper-based algaecides/herbicides) are also used for algae control. Facilities are also in place to add potassium permanganate to control taste and odors. Granular activated carbon (GAC) contactors were added to the WTP in 2008 for enhanced disinfectant by product (DBP) precursor removal and taste and odor (T&O) control.

Since June 2003, seven SolarBee hydraulic mixing units have been installed in Palmdale Lake. These solar powered devices float on the surface of the water and gently mix the water in both a horizontal and vertical direction. These mixers have been successful at limiting algae growth, and thus, the use of copper treatments has decreased significantly.

Other upgrades have been made since the previous master plan to enhance performance, operability, and reliability of the plant. The following improvements were completed between 2007 and 2009:

1. Construction of a new traveling influent screen.
2. Expansion of the flocculation basins (from two-stage to three-stage).
3. Equipment replacement in the existing flocculation/sedimentation basins.
4. Addition of plate settlers to the sedimentation basins.
5. Construction of a building over the flocculation and sedimentation basins to lessen effects of wind and sunlight on these processes.
6. Construction of new chemical handling systems with an associated building.
7. Addition of carbon dioxide, ferric chloride, and caustic soda.
8. Provisions were made for a future sulfuric acid storage and feed system.
9. Upgrades to the SCADA.
10. Retrofit of existing filters from self-backwashing type to externally supplied backwash.
11. Two new filters.
12. New post filter GAC contactors
13. New Solids handling engineered lagoons.

5.2.3 Water Quality Analysis of the Groundwater and Surface Water Supplies

Water quality data received from the District were examined with respect to current and pending regulatory requirements.

- Complete well water quality data for 2001, 2004, 2007, 2010 and 2013, (complete screenings are conducted every three years), including additional data for radon, chromium, and vanadium.
- WTP source water quality, including bromide, total organic carbon (TOC), microorganisms, and volatile organic compounds (VOCs).
- Surface water quality reports from 2001 to 2013 for water treated at the WTP. Surface water quality data for 2002 and 2003 were not provided as drought conditions during that year significantly affected the data.
- Consumer Confidence Reports (CCRs) for 2012, 2013, and 2014.

Commented [AW1]: Palmdale Lake – missing 2003 data
SWP – missing 2002 & 2003 data
Littlerock Dam – missing 2002 & 2003 data

Commented [AW2]: Are these CCRs from data of these years or distributed in these years?
Because the data analysis in this section does not appear to include 2014 data.

The following subsections present the results of the source water quality data analysis, beginning with groundwater and then surface water sources. Water quality data analyses of treated water are presented in the second half of this section. Maximum contaminant levels (MCLs) for each parameter discussed are presented in **Appendix C - Water Quality Regulations**.

5.2.4 Groundwater Supply

The District pumps groundwater from three different subbasins of the Antelope Valley Basin: the Lancaster Subbasin; the Pearland Subbasin; and the San Andreas Rift Zone. Water quality data from each subbasin were analyzed separately.

In general, wells located along the San Andreas Rift Zone have the highest total dissolved solids (TDS) concentrations, hardness, and alkalinity. The San Andreas Rift Zone also showed the highest values of turbidity and the highest average concentrations of chloride, nitrate, sulfate, calcium, and magnesium. The highest concentration of chloride and sulfate on average occurred in Well 11A (Lancaster Subbasin) and the highest concentration of nitrate and calcium on average occurred in Well 26 (Pearland Subbasin). Radionuclides are detected at the greatest frequency in the San Andreas Rift Zone, although concentrations remain relatively low compared to the MCL. This subbasin also has the highest arsenic concentration, with levels of up to 6.3 microgram per liter (µg/L) as recorded in 2001 at Well 5A, which was then taken out of service in 2001. Arsenic was also detected in the Lancaster Subbasin, although at lower concentrations than in the San Andreas Rift Zone.

Additional observations were derived from water quality analysis. Concentration of some chemical parameters has increased over the past few years, including TDS, chromium, chloride, nitrate, sulfate, and several inorganic chemicals. However, this trend was not as obvious in the San Andreas Rift Zone as it was in the other subbasins.

5.2.4.1 Lancaster Subbasin

Water quality data analyses were performed on the following wells from the Lancaster Subbasin: Wells 2A, 3A, 4A, 6A, 7A, 8A, 10, 11A, 14A, 15, 23A, and 24. Well 24 is currently inactive.

General Water Quality Parameters

General water quality parameters, measured from the Lancaster Subbasin in 2001, 2004, 2007, 2010, and 2013, are summarized in

Table 5-1. As shown, TDS concentrations were within an acceptable range, although TDS increased from 2001 to 2013. Hardness and alkalinity are at moderate levels. Considering that finished water pH has a secondary standard of 6.5 to 8.5, pH of the groundwater tends to be on the high end of the acceptable range and at times exceeds the secondary standard. Addition of NaOCI at the wellhead may exacerbate conditions by increasing pH even more. In 2001, Well 24 showed a higher pH value, however, in July 2002, Well 24 was taken out of service due to well failure. In 2004, 2007, 2010 and 2013, Well 4A showed the highest pH value. Turbidity data in 2001 were at or below 0.3 NTU, except Well 6A, which showed a turbidity of 3.3 NTU. In 2004, 2007, 2010, and 2013, turbidity was also at or below 0.3 NTU.

Inorganic Chemicals

A summary of anion data was provided by the District and is presented in **Table 5-2**. All concentrations are well within the MCL or secondary standards, as applicable, for both federal and state regulations. A few wells tend to be responsible for anion concentrations that are significantly higher than others: Well 6A tends to have the highest concentrations of fluoride and nitrate, Well 11A tends to have the highest concentrations of chloride and sulfate, and Wells 10 has shown high nitrate concentrations at times. Overdrafting of the groundwater basin may lead to declining water quality. This is evidenced in **Table 5-2** by the increasing concentrations of chloride and nitrate sulfate from 2002 to 2013.

Commented [AW3]: Highest average chloride of all subbasins, though, highest concentration of chloride on average occurred in Well 11A (Lancaster Subbasin)

Commented [AW4]: Highest average nitrate of all subbasins, though, highest concentration of nitrate on average occurred in Well 26 (Pearland Subbasin)

Commented [AW5]: Highest average sulfate of all subbasins, though, highest concentration of sulfate on average occurred in Well 11A (Lancaster Subbasin)

Commented [AW6]: Highest average calcium of all subbasins, though, Well 26 (Pearland Subbasin) had equally high calcium concentrations on average

Commented [AW7]: Well 5A was taken out of service in April 2001. San Andreas Rift Zone still has the highest arsenic but the highest concentration occurred in Well 18 at 3.2 µg/L in 2001.

Table 5-1
General Water Quality Parameters in the Lancaster Subbasin

Year	TDS (mg/L)	Hardness (mg/L CaCO3)	Alkalinity (mg/L CaCO3)	pH
2001	110 – 290 Average: 173 Median: 155	19 – 110 Average: 59 Median: 54	90 – 140 Average: 106 Median: 105	7.4 – 8.6 Average: 8.1 Median: 8.0
2004	130 – 310 Average: 187 Median: 180	20 – 126 Average: 61 Median: 71	90 - 130 Average: 105 Median: 100	7.9 – 8.6 Average: 8.3 Median: 8.2
2007	140 – 370 Average: 206 Median: 180	18 – 148 Average: 65 Median: 57	90 – 130 Average: 104 100	7.2 – 8.8 Average: 8.2 Median: 8.3
2010	110 – 270 Average: 176 Median: 155	20 – 95 Average: 55 Median: 49	80 – 120 Average: 95 Median: 90	8.1 – 8.7 Average: 8.3 Median: 8.3
2013	150 – 420 Average: 235 Median: 200	27 – 200 Average: 84 Median: 75	79 – 120 Average: 96 Median: 94	7.9 – 8.3 Average: 8.1 Median: 8.1
Secondary Standards	500	None	None	6.5-8.5

Table 5-2
Anion Data as measured in the Lancaster Subbasin

Year	Fluoride (mg/L)	Chloride (mg/L)	Nitrate (mg/L NO_3^-)	Sulfate (mg/L)
2002	0.11 – 0.53 Average: 0.23 Median: 0.21	2.92 – 48.8 Average: 11.7 Median: 9.76	0.99 – 5.73 Average: 2.34 Median: 1.64	14.6 – 73.3 Average: 26.6 Median: 20.8
2003	0.09 – 0.55 Average: 0.24 Median: 0.22	3.15 – 54.0 Average: 13.7 Median: 8.38	0.92 – 6.88 Average: 2.59 Median: 1.77	15.3 – 85.6 Average: 28.8 Median: 21.9
2004	0.10 – 0.60 Average: 0.26 Median: 0.23	4.00 – 57.9 Average: 16.8 Median: 13.0	1.34 – 5.79 Average: 2.73 Median: 2.02	16.0 – 91.4 Average: 32.3 Median: 23.1
2005	0.10 – 0.56 Average: 0.23 Median: 0.21	4.47 – 65.9 Average: 16.2 Median: 10.5	1.28 – 6.59 Average: 2.59 Median: 1.89	16.2 – 104 Average: 31.2 Median: 23.6
2006	0.09 – 0.58 Average: 0.22 Median: 0.21	5.11 – 61.6 Average: 20.1 Median: 13.4	1.29 – 6.75 Average: 2.80 Median: 2.08	17.5 – 99.2 Average: 36.6 Median: 24.6
2007	0.00 – 0.58 Average: 0.22 Median: 0.20	4.00 – 66.7 Average: 21.1 Median: 17.0	1.20 – 6.98 Average: 2.95 Median: 2.26	15.0 – 107 Average: 36.2 Median: 25.7
2008	0.10 – 0.60 Average: 0.23 Median: 0.19	5.12 – 60.5 Average: 17.7 Median: 12.2	0.87 – 7.34 Average: 2.95 Median: 3.26	15.8 – 96.2 Average: 30.9 Median: 25.1
2009	0.12 – 0.54 Average: 0.24 Median: 0.20	5.75 – 37.5 Average: 19.1 Median: 19.0	0.87 – 8.84 Average: 3.67 Median: 2.59	16.3 – 62.3 Average: 29.8 Median: 24.6
2010	0.00 – 0.55 Average: 0.23 Median: 0.20	6.00 – 41.4 Average: 19.8 Median: 18.7	1.45 – 6.09 Average: 3.38 Median: 3.43	17.5 – 64.5 Average: 32.7 Median: 25.0

Year	Fluoride (mg/L)	Chloride (mg/L)	Nitrate (mg/L NO_3^-)	Sulfate (mg/L)
2011	0.11 – 0.48 Average: 0.24 Median: 0.22	7.04 – 61.1 Average: 25.9 Median: 22.0	0.00 – 10.3 Average: 3.75 Median: 3.22	17.5 – 79.2 Average: 31.5 Median: 24.8
2012	0.10 – 0.47 Average: 0.21 Median: 0.19	6.37 – 55.2 Average: 21.7 Median: 16.8	1.90 – 10.7 Average: 4.90 Median: 4.05	11.2 – 80.5 Average: 34.0 Median: 25.0
2013	0.08 – 0.55 Average: 0.21 Median: 0.17	6.75 – 64.4 Average: 24.4 Median: 23.7	1.30 – 13.3 Average: 6.25 Median: 5.74	17.0 – 120 Average: 39.0 Median: 31.0
MCLs	Federal: 4.0 State: 2.0	Federal: 250 State: 250(1)	Federal: 10 mg/L N State: 45 mg/L NO_3^-	Federal: 250(1) State: 250(1)

1) Secondary standard
2) Data is from quarterly anions results from 2002 - 2013

Arsenic data collected in 2001 showed that some of the wells located in the Lancaster Subbasin (Wells 6A, 15, and 24) have arsenic concentrations ranging from 2.7 to 3.4 µg/L. In 2004 and 2007, arsenic was detected in one well, Well 11A, at 2 µg/L. In 2010, arsenic was not detected in any of the wells. In 2013, arsenic was detected in one well, Well 15, at 2 µg/L; all other wells within this subbasin had concentrations below the detection limit for reporting (DLR). These concentrations remain below the federal MCL of 10 µg/L.

A variety of other inorganic chemicals including aluminum, barium (DLR = 100 µg/L), cadmium (DLR = 1 µg/L), iron, lead (DLR = 5 µg/L), manganese, mercury (DLR = 1 µg/L), nickel, and zinc were measured in 2004, 2007, 2010 and 2013. The concentrations for barium, cadmium, lead, and mercury were below the DLR for all results, and none of these chemicals were detected in 2001. In 2004, iron, manganese and zinc were detected only in Well 6A at 1,130 µg/L, 20 µg/L and 60 µg/L, respectively. In 2007, none of these chemicals were detected. In 2010, aluminum (at 130 µg/L) and nickel (at 16 µg/L) were detected only in Well 3A. In 2013, none of these chemicals were detected. With the exception of iron, all of these concentrations were below the federal and state MCLs or secondary standards. In 2004, iron was detected in Well 6A at a concentration over 1 mg/L, which is greater than the secondary standard of 300 µg/L.

Commented [AW8]: Barium DLR = 100 µg/L; all results <DLR = ND

Commented [AW9]: Cadmium DLR = 1 µg/L; all results <DLR = ND

Commented [AW10]: Lead DLR = 5 µg/L; all results <DLR = ND

Commented [AW11]: Mercury DLR = 1 µg/L; all results <DLR = ND

Commented [AW12]: Should result units be consistent with results above?

Detailed chromium data for 2001 through 2013 were provided by the District and are summarized in **Table 5-3**. Total Chromium data is only available in Tri-Annual Sampling and Hexavalent Chromium data is collected twice annually. The District is in compliance with the federal and state chromium standards. Chromium exists primarily in two valence states, trivalent chromium (Cr(III)) and hexavalent chromium (Cr(VI)). Well 4A is the only well greater than the 2014 California hexavalent chromium standard MCL of 10 µg/L, and therefore this well has not been used for production purposes since the standard implementation. The chromium concentration measured in the Lancaster Subbasin did not change significantly from 2001 to 2013.

Commented [AW13]: Total Chromium data is only available in Tri-Annual Sampling

Hexavalent Chromium data is collected twice annually

Commented [AW14]: Well 4A is the only well >10 µg/L CrVI and we have not used it for production purposes since the implementation of the new CA standard (July 2014)

Vanadium levels were measured in all wells in 2002, 2003, 2004, 2007, and 2010. Results are summarized in **Table 5-3**. Wells 4A, 7A, and, to some extent, Well 8A are the primary wells responsible for the measurable vanadium concentrations. The U.S. Environmental Protection Agency (USEPA) has not regulated this contaminant yet, but the California State Resources Control Board's Division of Drinking Water Programs (DDW) has issued a notification level of 50 µg/L. As such, vanadium concentrations measured in the Lancaster Subbasin are close to the notification level. Data suggests that vanadium concentrations did not change significantly from 2002 to 2010.

Table 5-3
Chromium and Vanadium Concentrations as Measured in the Lancaster Subbasin

Year	Chromium VI Concentrations (µg/L)[(1)]	Chromium Concentrations (µg/L)[(2)]	Vanadium Concentrations (µg/L)
2001	-	ND Average: - Median: -	N/A
2002	3.60 – 10.3 Average: 6.40 Median: 6.12	-	9.5 – 50.0 Average: 26.1 Median: 23.5
2003	3.62 – 11.3 Average: 6.83 Median: 6.56	-	10.0 – 46.0 Average: 21.9 Median: 19.5
2004	3.08 – 11.7 Average: 6.71 Median: 6.26	ND – 11.0 Average: 5.8 Median: 6.0	ND – 40 Average: 21.1 Median: 19.0
2005	5.77 – 12.5 Average: 8.03 Median: 7.79	-	-
2006	3.17 – 12.9 Average: 6.86 Median: 6.65	-	-
2007	3.33 – 14.7 Average: 7.39 Median: 6.60	4.0 – 14.0 Average: 7.3 Median: 7.0	12.0 – 45.0 Average: 22.8 Median: 19.0
2008	3.88 – 15.2 Average: 6.94 Median: 6.35	-	-
2009	4.90 – 13.0 Average: 7.66 Median: 7.42	-	-
2010	-	3.0 – 12.0 Average: 6.8 Median: 6.5	12.0 – 40.0 Average: 22.1 Median: 20.5
2011	3.90 – 13.0 Average: 6.67 Median: 5.90	-	-
2012	3.60 – 11.0 Average: 6.82 Median: 6.95	-	-
2013	3.60 – 11.0 Average: 6.56 Median: 6.35	2.0 – 10.0 Average: 4.8 Median: 4.6	-
MCL and notification level	Federal MCL: None State MCL: 10	Federal MCL: 100 State MCL: 50	State notification level: 50

1) Analyzed semiannually
2) Analyzed tri-annually

Commented [AW15]: Analyzed twice yearly
Commented [AW16]: Analyzed tri-annually

Other inorganic chemicals including boron, copper, foaming agents, selenium, silver, nitrite, cyanide, antimony, beryllium, nickel, thallium, and asbestos were measured in the Lancaster Subbasin in 2001,2004, 2007, 2010, and 2013, but were not detected.

Organic Chemicals

In 2004, 2007, 2010, and annually since 2012, a variety of organic chemicals were measured from each well, including benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1 -dichloroethylene, 1,3-dichloropropene, ethylbenzene, monochlorobenzene, 1,1,2,2-tetrachloroethane, tetrachloroethylene, toluene, thiobencarb, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, vinyl chloride, xylenes, cis-1 ,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1-dichloroethane, 1,2-dichloropropane, trichlorofluoromethane and 1,1,2-trichloro-1,2,2-trifluoroethane. All of these compounds had concentrations below the DLR.

Radionuclides and Radon

Between 2001 and 2006, gross alpha particle activity ranged from ND to 6.92 pCi/L, with average and median values (0.83 and 0 pCi/L, respectively) below the DLR, and therefore considered ND. These values are below the federal and state MCL of 15 pCi/L. Wells 3A, 8A, and 14A were the main wells responsible for radionuclide activity in the Lancaster Subbasin. Because of the relatively low gross alpha particle activity measured, the District is not required to measure other radionuclides (i.e., gross beta particle activity, tritium, and strontium). In addition, some radionuclide concentrations are considered to be fairly constant and, therefore, the frequency of monitoring is reduced to every 3, 6, or 9 years based on the past result. If gross alpha results are <DLR, then monitoring is once per every nine years. If the results are greater than DLR but less than half of the MCL, then it is once per every six years. If the results are greater and half of the MCL but less than the MCL, then it is every three years. Radionuclide data was again collected between 2010 and 2015, and gross alpha particle activity concentrations were found in the range of ND to 5.7 pCi/L, with average and median values (1.31 and 0.85 pCi/L, respectively) below the DLR, and therefore considered ND (Wells 2A, 4A, 6A, 7A, 8A, 10, 14A, 15, and 23A).

Commented [AW17]: Gross Alpha DLR = 3 pCi/L, results <DLR = ND

Commented [AW18]: If gross alpha results are <DLR, then monitoring is once per every (9) years. If it is >DLR but <1/2MCL, then it is once per every (6) years. If it is >1/2MCL but <MCL, then it is every (3) years.

The District provided detailed radon data for each well. Results are summarized in **Table 5-4.** When examining these data in light of the proposed Radon Rule referenced previously, the District could be in violation if the DDW or the District does not develop a multimedia mitigation (MMM) program plan. Without such a plan, the MCL would be 300 pCi/L, whereas with a plan, the MCL would be much higher at 4,000 pCi/L. High radon concentration levels were measured in almost all of the Lancaster wells. However, no specific wells appeared to be the cause. **Table 5-4** suggests that radon concentrations did not change significantly from 1999 to 2001. Analysis of more recent data would be required to assess trends over the past few years.

Table 5-4
Radon Concentrations (pCi/L) Measured in the Lancaster Subbasin

Year	Radon Concentrations (pCi/L)		
	Range	**Average**	**Median**
1999	176-615	393	413
2000	<100-506	301	303
2001	140-520	369	370
Proposed Federal MCL	None	4,000 (with MMM) or 300 (without MMM)	None

Summary of Water Quality in the Lancaster Subbasin

Analysis of the Lancaster Subbasin water quality data indicates that the following wells are responsible for higher concentrations of constituents measured.

- Well 4A: Higher pH, vanadium concentration close to the DDW notification level, and hexavalent chromium exceeds California MCL. As of July 2014, the District placed the well in Standby, and therefore is not used for production and will be continue to be monitored.
- Well 6A: Higher fluoride and nitrate concentrations, all below state and federal standards. Iron concentrations exceeded the secondary standard twice: January 2004 (1,130 µg/L) and October 2006 (890 µg/L). Presence of arsenic below applicable standards.
- Well 7A: Higher pH at times; Vanadium concentration close to the DDW notification level.
- Well 8A: Higher pH at times; Presence of arsenic, below applicable standards.
- Well 11A: Higher concentrations of chloride and sulfate, presence of arsenic; each detected below applicable standards.
- Well 15: Presence of arsenic, below applicable standards.

Commented [AW19]: If based on average over study period, then Well 4A is the only well with pH >8.5

If based on maximum pH observed, then Well 4A, 7A, 8A, 23A and 24 considered to have higher pH

Commented [AW20]: Well 6A average pH = 8.1, max pH = 8.2

Commented [AW21]: Since 2004, iron analyzed quarterly. Average = ND with a range of ND – 1130 µg/L. Exceeded Secondary Standard two times: January 2004 (1130 µg/L) and October 2006 (890 µg/L)

Radon was detected throughout the entire subbasin at concentrations that could place the District in violation of the proposed Radon Rule if this chemical is not controlled.

5.2.4.2 Pearland Subbasin

Water quality data analyses were performed on the following wells from the Pearland Subbasin: Wells 16, 20, 21, 22, 25, 26, 29, 30, 32, 33, and 35.

General Water Quality Parameters

General water quality parameters measured from the Pearland Subbasin in 2001, 2004, 2007, 2010, and 2013 are summarized in

Table 5-5. All parameters were within an acceptable range of secondary standards set by the USEPA and DDW, except for the TDS in Well 22 in 2010 which measured on the upper bounds of the acceptable range. All turbidity values measured from the Pearland wells in 2001, 2004, 2007, 2010, and 2013 were less than or equal to 0.4 NTU. Except, in 2007, Well 26 and Well 29 had unusually high turbidity values of 3.8 NTU and 2.5 NTU, respectively. No significant changes in water quality occurred from 2001 to 2013.

Inorganic Chemicals

The District provided a summary of anion data, which is presented in **Table 5-6**. Concentrations are below the MCL or secondary standards, as applicable, of both federal and state regulations. However, nitrate levels are close to the MCL, which is 45 mg/L as NO_3^-. A few of the wells have significantly higher anion concentrations than others. Wells 22 and 26 tend to have the highest concentrations of chloride and nitrate. Most of these anions (i.e., chloride and nitrate) tend to increase in concentrations from 2002 to 2013.

Table 5-5
General Water Quality Parameters in the Pearland Subbasin

Year	TDS (mg/L)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	pH
2001	130 – 290 Average: 202 Median: 205	90 – 190 Average: 131 Median: 130	88 – 140 Average: 124 Median: 130	7.1 – 8.4 Average: 7.8 Median: 7.9
2004	170 – 250 Average: 205 Median: 210	92 – 154 Average: 122 Median: 122	100 – 130 Average: 119 Median: 120	7.6 – 8.1 Average: 7.9 Median: 8.0
2007	140 – 380 Average: 230 Median: 240	27 – 227 Average: 127 Median: 124	80 – 150 Average: 119 Median: 120	6.9 – 8.4 Average: 7.8 Median: 7.8
2010	180 – 500 Average: 265 Median: 250	98 – 335 Average: 153 Median: 126	100 – 200 Average: 126 Median: 120	7.6 – 8.1 Average: 7.9 Median: 7.8
2013	170 – 380 Average: 239 Median: 230	100 – 230 Average: 143 Median: 130	110 – 160 Average: 120 Median: 115	7.8 – 8.1 Average: 8.0 Median: 8.0
Secondary Standards	500	None	None	6.5-8.5

Table 5-6
Anion Data as measured in the Pearland Subbasin

Commented [AW22]: This data is from quarterly anion results from 2002 - 2013

Year	Fluoride (mg/L)	Chloride (mg/L)	Nitrate (mg/L NO_3^-)	Sulfate (mg/L)
2002	0.11 – 0.22 Average: 0.17 Median: 0.16	4.80 – 26.4 Average: 10.7 Median: 9.34	1.39 – 15.5 Average: 4.83 Median: 3.69	18.8 – 48.6 Average: 31.3 Median: 32.4
2003	0.10 – 0.26 Average: 0.17 Median: 0.17	4.24 – 70.3 Average: 15.4 Median: 11.3	1.31 – 44.0 Average: 7.50 Median:3.91	18.9 – 83.0 Average: 35.9 Median: 34.4
2004	0.12 – 0.30 Average: 0.19 Median: 0.19	5.00 – 49.7 Average: 13.6 Median: 13.8	1.47 – 22.8 Average: 5.01 Median: 3.80	19.0 – 59.5 Average: 34.1 Median: 34.0
2005	0.11 – 0.22 Average: 0.17 Median: 0.18	5.28 – 37.5 Average: 14.5 Median: 11.6	1.52 – 18.5 Average: 4.92 Median: 3.82	19.9 – 48.9 Average: 34.7 Median: 37.7
2006	0.13 – 0.21 Average: 0.17 Median: 0.17	6.86 – 37.2 Average: 14.6 Median: 12.4	1.47 – 28.3 Average: 5.68 Median: 3.74	20.9 – 46.2 Average: 33.8 Median: 35.8
2007	ND – 0.22 Average: 0.17 Median: 0.18	4.99 – 52.0 Average: 14.8 Median: 10.0	1.47 – 32.0 Average: 6.55 Median: 3.75	16.0 – 57.8 Average: 32.6 Median: 34.9
2008	0.12 – 0.26 Average: 0.19 Median: 0.19	5.83 – 67.9 Average: 14.7 Median: 8.83	1.36 – 32.2 Average: 5.24 Median: 3.70	18.5 – 66.1 Average: 32.5 Median: 34.6
2009	0.10 – 0.26 Average: 0.17 Median: 0.18	5.30 – 59.3 Average: 16.8 Median: 10.9	1.89 – 27.4 Average: 7.34 Median: 4.47	19.2 – 60.1 Average: 33.1 Median: 35.5
2010	ND – 0.21 Average: 0.14 Median: 0.15	4.98 – 74.0 Average: 21.1 Median: 11.9	2.18 – 32.1 Average: 8.86 Median: 4.52	19.2 – 74.0 Average: 36.8 Median: 37.0

Year	Fluoride (mg/L)	Chloride (mg/L)	Nitrate (mg/L NO_3^-)	Sulfate (mg/L)
2011	0.09 – 0.18 Average: 0.14 Median: 0.14	5.57 – 68.5 Average: 25.2 Median: 15.0	ND – 33.1 Average: 8.58 Median: 4.90	20.0 – 69.5 Average: 41.0 Median: 41.1
2012	0.07 – 0.22 Average: 0.15 Median: 0.14	6.41 – 52.6 Average: 18.4 Median: 11.7	2.21 – 28.4 Average: 8.20 Median: 5.67	21.1 – 57.1 Average: 35.7 Median: 37.0
2013	0.08 – 0.21 Average: 0.15 Median: 0.15	5.53 – 51.0 Average: 18.3 Median: 12.9	4.09 – 28.2 Average: 9.51 Median: 7.22	18.3 – 58.3 Average: 35.7 Median: 37.7
MCLs	Federal: 4.0 State: 2.0	Federal: 250 State: 250[(1)]	Federal: 10 mg/L N State: 45 mg/L NO_3^-	Federal: 250[(1)] State: 250[(1)]

1) Secondary standard
2) Data is from quarterly anion results from 2002 - 2013

A variety of other inorganic chemicals including aluminum, barium, cadmium, iron, lead, manganese, mercury, nickel, and zinc were measured in 2001, 2004, 2007, 2010 and 2013. None of these chemicals were detected in 2001, except for iron (120 µg/L). In 2004, iron and zinc were detected in Well 26 at 210 µg/L and 60 µg/L, respectively. In 2007, aluminum (60 µg/L), barium (111 µg/L), chromium (12 µg/L), iron (960 µg/L) and manganese (20 µg/L) were detected in Well 26, and chromium (10 µg/L), iron (420 µg/L) and manganese (20 µg/L) were also detected in Well 29. In 2010, only barium was detected at 120 µg/L in Well 22, and in 2013, none of these chemicals were detected. All of these concentrations were below the federal and state MCLs or secondary standards, except for iron. In 2007, iron was detected in Well 26 and Well 29 at concentrations of 0.96 mg/L and 0.42 mg/L, respectively. Both of which are greater than the secondary standard of 0.3 mg/L.

Detailed chromium data for 2002 through 2013 were provided by the District and are summarized in **Table 5-7**. With the state chromium MCL at 50 µg/L and the federal chromium MCL at 100 µg/L, the District is in currently in compliance with both regulations. The District is also currently in compliance with the new state hexavalent chromium MCL of 10 µg/L. **Table 5-7** suggests that chromium concentrations have not changed significantly from 2002 to 2013.

Vanadium was measured in all of the wells in 2002, 2003, 2004, 2007, and 2010. Results are summarized in **Table 5-7**. Although close to the DDW notification level of 50 µg/L in 2003, these concentrations remain below the notification limit. Well 33 is the main well responsible for high concentrations of vanadium measured. No significant changes in vanadium concentrations occurred from 2002 to 2010.

Other inorganic chemicals including boron, cadmium, copper, foaming agents, mercury, selenium, silver, nitrite, cyanide, antimony, beryllium, nickel, thallium, and asbestos were measured in the Pearland Subbasin in 2001, 2004, 2007, 2010, and 2013 but were not detected.

Table 5-7
Chromium and Vanadium Concentrations as Measured in the Pearland Subbasin

Commented [AW23]: Analyzed twice yearly

Year	Chromium VI Concentrations (µg/L)	Chromium Concentrations (µg/L)	Vanadium Concentrations (µg/L)
2001	-	ND Average: - Median: -	N/A
2002	0.33 – 4.90 Average: 1.96 Median: 1.58	-	6.4 – 31.0 Average: 11.9 Median: 9.6
2003	0.36 – 4.92 Average: 2.02 Median: 1.73	-	6.0 – 35.0 Average: 11.3 Median: 10.0
2004	0.34 – 5.06 Average: 2.15 Median: 1.61	ND – 5.0 Average: 1.7 Median: 2.0	7.0 – 15.0 Average: 10.4 Median: 10.5
2005	0.45 – 5.39 Average: 2.02 Median: 1.85	-	-
2006	0.29 – 4.48 Average: 1.52 Median: 1.41	-	-
2007	0.29 – 5.02 Average: 1.61 Median: 1.52	ND – 12.0 Average: 3.7 Median: 2.0	7.0 – 31.0 Average: 11.6 Median: 9.0
2008	0.20 – 2.70 Average: 1.27 Median: 1.37	-	-
2009	0.33 – 3.40 Average: 1.73 Median: 1.66	-	-
2010	-	ND – 3.0 Average: 1.6 Median: 2.0	7.0 – 14.0 Average: 9.1 Median: 9.0
2011	0.71 – 3.20 Average: 1.80 Median: 1.60	-	-
2012	0.68 – 4.40 Average: 1.92 Median: 1.70	-	-
2013	0.67 – 3.20 Average: 1.87 Median: 1.80	ND – 6.9 Average: 1.7 Median: 1.5	-
MCL and notification level	Federal MCL: None State MCL: 10	Federal MCL: 100 State MCL: 50	State notification level: 50

1) Analyzed semiannually

Organic Chemicals

In 2004, 2007, 2010, and annually since 2012, a variety of organic chemicals were measured from each well, including benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethylene, 1,3-dichloropropene, ethylbenzene, monochlorobenzene, 1,1,2,2-tetrachloroethane, trichloroethylene, vinyl chloride, xylenes, cis-1,2-dichloroethylene, trans-1,2-

dichloroethylene, 1,1-dichloroethane, 1,2-dichloropropane, trichlorofluoromethane, and 1,1,2-trichloro-1,2,2-trifluoroethane. All of these compounds had concentrations below the DLR.

Radionuclides and Radon

Between 2001 and 2007, gross alpha particle activity ranged from ND to 7.31 pCi/L, with average and median values below the DLR, and therefore, considered ND (or: of 0.77 and 0.35 pCi/L, respectively). These values are below the federal and state MCL. Because of the relatively low gross alpha particle activity measured, the District is not required to measure other radionuclides (i.e., gross beta particle activity, tritium, and strontium). In addition, some radionuclide concentrations are considered to be fairly constant and therefore, the frequency of monitoring is reduced to every 3, 6, or 9 years based on the past result. Radionuclide data was again collected between 2009 and 2015, and gross alpha particle activity concentrations were found in the range of ND to 6.12 pCi/L, with average and median values below the DLR and therefore considered ND (or: of 1.67 and 1.16 pCi/L, respectively). In 2010, gross alpha particle activity and uranium were detected in Well 22 at 6.12 pCi/L and 9.47 pCi/L, respectively. Gross alpha particle activity was also dectected in Well 26 at 3.32 pCi/L. In 2012, gross alpha particle activity was detected at 3.0 pCi/L in Well 33. Radionuclides were not detected in any other wells.

The District provided detailed radon data for each well; results are summarized in **Table 5-8**. When examining these data with respect to the proposed Radon Rule, the District could be in violation if the DDW or the District does not develop an MMM program plan. Wells 16 and 32 were the main wells responsible for the higher radon concentrations measured. **Table 5-8** suggests that no significant changes in radon concentration occurred from 1999 to 2001. More recent data would be required to ascertain that this trend continued.

Table 5-8
Radon Concentrations as Measured in the Pearland Subbasin

Year	Radon Concentrations (pCi/L)		
	Range	Average	Median
1999	140 – 667	365	330
2000	<100 – 584	263	229
2001	<100 – 475	283	313
Proposed Federal MCL	None	4,000 (with MMM) or 300 (without MMM)	None

Summary of Water Quality in the Pearland Subbasin

Analyses of water samples collected from wells in the Pearland Subbasin provided the following information:

- Well 16: Highest radon concentrations measured, could place the District in violation of the proposed Radon Rule.
- Well 22: Highest nitrate concentrations measured, range from 8.77 to 44.0 mg/L and an average of 16.8 mg/L; nitrate concentrations tend to fluctuate but do not appear to increase over time.
- Well 26: Highest nitrate concentrations measured, range from 4.89 to 33.1 mg/L and an average of 21.4 mg/L; nitrate concentrations may be increasing over time. Iron

concentrations (960 µg/L) exceeded the secondary standard (300 µg/L) in 2007, but was ND in 2010 and 2013.

Commented [AW24]: Well 26 Iron Concentrations:
- 2001: 120 µg/L
- 2004: 210 µg/L
- 2007: 960 µg/L (exceeds Secondary Standard)
- 2010: ND
- 2013: ND

- Well 29: Iron concentrations (420 µg/L) exceeded the secondary standard in 2007, but was ND in 2010 and 2013.
- Well 32: Highest radon concentrations measured, could place the District in violation of the proposed Radon Rule.
- Radon was detected from most of the wells throughout the subbasin and many at concentrations that could place the District in violation of the proposed Radon Rule if this chemical is not controlled.

5.2.4.3 San Andreas Rift Zone

Three wells are located along the San Andreas Fault: Wells 5A, 18, and 19. In April 2001, Well 5A was taken out of service.

General Water Quality Parameters

General water quality parameters measured from the San Andreas Rift Zone between 2001 and 2013 are summarized in **Table 5-9**. Turbidity values measured along the San Andreas Fault in 2001, 2004, 2007, and 2010 were below 0.2 NTU. In 2013, the turbidity at Well 19 was 2.6 NTU, an unusually high value. Other parameters did not appear to change significantly over this period.

Table 5-9
General Water Quality Parameters in the San Andreas Rift Zone

Year	TDS (mg/L)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	pH
2001	210 – 640 Average: 357 Median: 220	140 – 360 Average: 217 Median: 150	160 – 270 Average: 200 Median: 170	7.5 – 7.9 Average: 7.7 Median: 7.8
2004	270 – 390 Average: 330 Median: 330	175 – 221 Average: 198 Median: 198	180 – 210 Average: 195 Median: 195	7.9 – 8.0 Average: 8.0 Median: 8.0
2007	280 – 390 Average: 335 Median: 335	177 – 232 Average: 205 Median: 205	180 – 200 Average: 190 Median: 190	7.8 – 8.1 Average: 8.0 Median: 8.0
2010	400 – 570 Average: 485 Median: 485	229 – 296 Average: 263 Median: 263	210 – 260 Average: 235 Median: 235	7.7 – 7.7 Average: 7.7 Median: 7.7
2013	320 – 490 Average: 405 Median: 405	190 – 300 Average: 245 Median: 245	180 – 220 Average: 200 Median: 200	7.9 – 8.0 Average: 8.0 Median: 8.0
Secondary Standards	500	None	None	6.5 – 8.5

Inorganic Chemicals

A summary of anion data provided by the District is presented in **Table 5-10**. All concentrations were below primary or secondary standards, as applicable, of both federal and state regulations. No noticeable changes in concentrations of these anions are observed from 2002 to 2013, although concentrations were significantly lower in 2005.

Table 5-10
Anion Data as measured in the San Andreas Rift Zone

Commented [AW25]: This data is from quarterly anion results from 2002 - 2013

Year	Fluoride (mg/L)	Chloride (mg/L)	Nitrate (mg/L NO_3^-)	Sulfate (mg/L)
2002	0.15 – 0.23 Average: 0.18 Median: 0.18	3.27 – 83.3 Average: 21.0 Median: 8.42	0.70 – 15.5 Average: 3.93 Median: 1.66	17.7 – 68.6 Average: 33.1 Median: 28.6
2003	0.14 – 0.27 Average: 0.20 Median: 0.19	10.8 – 71.0 Average: 28.8 Median: 16.1	2.16 – 14.4 Average: 5.96 Median: 3.61	25.3 – 68.4 Average: 38.2 Median: 29.6
2004	0.16 – 0.30 Average: 0.20 Median: 0.19	5.90 – 80.3 Average: 30.2 Median: 20.0	1.22 – 19.1 Average: 5.88 Median: 3.19	19.7 – 69.1 Average: 35.2 Median: 28.7
2005	0.13 – 0.18 Average: 0.16 Median: 0.16	5.09 – 8.10 Average: 6.78 Median: 7.04	0.90 – 1.30 Average: 1.16 Median: 1.17	18.3 – 23.1 Average: 20.9 Median: 21.3
2006	0.14 – 0.21 Average: 0.16 Median: 0.16	5.96 – 13.6 Average: 8.96 Median: 8.13	0.78 – 3.39 Average: 1.65 Median: 1.50	19.3 – 23.8 Average: 21.6 Median: 21.7
2007	0.14 – 0.20 Average: 0.16 Median: 0.15	18.0 – 88.1 Average: 55.5 Median: 43.0	3.80 – 26.1 Average: 15.6 Median: 11.6	25.0 – 73.0 Average: 50.8 Median: 42.4
2008	0.15 – 0.30 Average: 0.21 Median: 0.21	19.6 – 87.7 Average: 46.0 Median: 36.1	4.68 – 26.3 Average: 12.9 Median: 10.3	30.2 – 71.3 Average: 46.1 Median: 40.4
2009	0.16 – 0.23 Average: 0.20 Median: 0.21	30.7 – 93.1 Average: 63.5 Median: 63.2	7.47 – 26.9 Average: 17.9 Median: 17.5	37.4 – 72.3 Average: 55.3 Median: 55.5
2010	0.10 – 0.23 Average: 0.15 Median: 0.15	8.72 – 92.4 Average: 50.8 Median: 49.8	1.95 – 26.9 Average: 14.3 Median: 13.9	22.2 – 73.7 Average: 48.1 Median: 47.1
2011	0.21 – 0.21 Average: - Median: -	23.3 – 23.3 Average: - Median: -	1.50 – 5.78 Average: 3.27 Median: 2.50	20.9 – 29.0 Average: 25.0 Median: 25.0
2012	0.12 – 0.16 Average: 0.15 Median: 0.15	5.17 – 58.4 Average: 18.1 Median: 9.67	3.50 – 16.0 Average: 6.50 Median: 4.92	18.4 – 53.9 Average: 27.7 Median: 21.9
2013	0.11 – 0.22 Average: 0.15 Median: 0.15	11.0 – 87.9 Average: 37.3 Median: 26.5	7.10 – 23.7 Average: 12.4 Median: 9.80	27.0 – 71.5 Average: 42.5 Median: 33.5
MCLs	Federal: 4.0 State: 2.0	Federal: 250 State: 250(1)	Federal: 10 mg/L N State: 45 mg/L NO_3^-	Federal: 250(1) State: 250(1)

1) Secondary standard
2) Data is from quarterly anion results from 2002 - 2013

Data collected in 2001 showed that wells located along the San Andreas Fault (Wells 5, 18, and 19) have arsenic concentrations at 6.12 µg/L, 3.2 µg/L and 3.0 µg/L, respectively. In April 2001, Well 5 was taken out of service due to water quality issues. In 2004, Wells 18 and 19 both showed arsenic concentrations of 3 µg/L. In 2007, arsenic was detected in Well 19 at 2 µg/L and in 2010, Wells 18 & 19 showed arsenic concentrations at 2 µg/L. In 2013, arsenic was not detected in either well. These concentrations were well below the MCL of 10 µg/L.

A variety of other inorganic chemicals including aluminum, barium, cadmium, iron, lead, manganese, mercury, nickel and zinc were measured in 2002 through 2013. Barium was consistently detected in Well 18 from 2004 to 2013 between 103 µg/L and 170 µg/L. In 2004, zinc was detected in Well 19 at 190 µg/L. In 2010, barium was also detected in Well 19 at 103 µg/L and selenium was detected in Well 18 at 5 µg/L. In 2013, iron was detected in Well 19 at 220 µg/L. All of these detected concentrations were below the federal and state MCLs and secondary standards.

Detailed chromium data for 2001 through 2013 were provided and are summarized in **Table 5-11**. With the state chromium MCL at 50 µg/L and the federal chromium MCL at 100 µg/L, the District is currently in compliance with both regulations. The District is also currently in compliance with the new state hexavalent chromium MCL of 10 µg/L.

Other inorganic chemicals, including antimony, asbestos, boron, beryllium, cadmium, copper, cyanide, foaming agents, manganese, mercury, nickel, nitrite, silver, and thallium were measured along the San Andreas Fault between 2001 and 2013. In 2004 and 2010, boron was detected in Well 18 at 100 µg/L and 200 µg/L, respectively, but no other chemicals were detected.

No significant changes in vanadium concentration occurred from 2002 to 2010 in the San Andreas Rift Zone.

Organic Chemicals
In 2002, 2004, 2007, 2010 and annually since 2012, a variety of organic chemicals were measured from each well, including benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethylene, 1,3-dichloropropane, ethylbenzene, monochlorobenzene, 1,1,2,2-tetrachloroethane, tetrachloroethylene, toluene, thiobencarb, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, vinyl chloride, xylenes, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1-dichloroethane, 1,2-dichloropropane, trichlorofluoromethane, and 1,1,2-trichloro-1,2,2-trifluoroethane. All of these compounds had concentrations below the DLR.

Radionuclides and Radon
In 2003 and 2004, gross alpha particle activity ranged from 1.78 to 4.98 pCi/L, with average and median values of 3.36 and 3.17 pCi/L. These values are below the federal and state MCL. Because of the relatively low gross alpha particle activity measured along the San Andreas Fault, the District is not required to measure other radionuclides (i.e., gross beta particle activity, tritium and strontium). In addition, radionuclide concentrations are considered to be fairly constant and therefore, the frequency of monitoring is reduced to every 3, 6, or 9 years based on the past result. Radionuclide data was again collected between 2005 and 2010. In 2006, uranium was detected in Well 18 at a range of 1.07 to 3.64 pCi/L, with an average of 2.64 pCi/L. In 2008, gross alpha particle activity was again detected in Well 18 at a range of 1.87 to 5.76 pCi/L, with an average of 3.61 pCi/L. Uranium was also detected in Well 18 at a range of 2.11 to 7.92 pCi/L, with an average of 5.39 pCi/L. In 2010, gross alpha particle activity and uranium were detected in Well 19 at 4.78 pCi/L and 1.85 pCi/L, respectively.

Table 5-11
Chromium and Vanadium Concentrations as Measured in the San Andreas Rift Zone

Commented [AW26]: Analyzed twice yearly

Year	Chromium VI Concentrations (µg/L)	Chromium Concentrations (µg/L)	Vanadium Concentrations (µg/L)
2001	-	ND Average: - Median: -	N/A
2002	0.79 – 1.61 Average: 1.23 Median: 1.27	-	10.0 – 20.0 Average: 14.3 Median: 13.5
2003	0.73 – 1.64 Average: 1.24 Median: 1.30	-	13.0 – 18.0 Average: 15.4 Median: 15.0
2004	0.41 – 1.71 Average: 1.18 Median: 1.30	1.0 – 2.0 Average: 1.5 Median: 1.5	15.0 – 16.0 Average: 15.5 Median: 15.5
2005	0.75 – 1.08 Average: 0.91 Median: 0.91	-	-
2006	1.26 – 1.83 Average: 1.44 Median: 1.33	-	-
2007	1.70 – 2.51 Average: 2.04 Median: 1.98	2.0 – 2.0 Average: - Median: -	12.0 – 16.0 Average: 14.0 Median: 14.0
2008	0.69 – 1.57 Average: 1.21 Median: 1.29	-	-
2009	1.69 – 1.77 Average: 1.73 Median: 1.73	-	-
2010	-	2.0 – 3.0 Average: 2.5 Median: 2.5	15.0 – 15.0 Average: - Median: -
2011	0.67 – 0.75 Average: 0.71 Median: 0.71	-	-
2012	0.60 – 1.70 Average: 1.28 Median: 1.40	-	-
2013	2.00 – 2.00 Average: - Median: -	ND – 1.7 Average: 0.9 Median: 0.9	-
MCL and notification level	Federal MCL: None State MCL: 10	Federal MCL: 100 State MCL: 50	State notification level: 50

1) Analyzed semiannually

Commented [AW27]: Deleted table because data is not represented in a way comparable to the other subbasins

Commented [AW28]: Deleted

Detailed radon data for each well were provided by the District. Results are summarized in **Table 5-12**. When examining these data in light of the proposed Radon Rule presented above, the District could be in violation of this rule if the DDW or the District does not develop an MMM program plan. Along the San Andreas Fault, Well 5 is the main well responsible for higher radon concentrations measured. **Table 5-12** suggests that radon concentrations tended to decrease from 1999 to 2001. More recent data would be required to ascertain this trend.

Table 5-12
Radon Concentrations (pCi/L) Measured in the San Andreas Rift Zone

Year	Radon Concentrations (pCi/L)		
	Range	**Average**	**Median**
1999	211 – 568	417	454
2000	136 – 420	275	283
2001	215 – 465	310	249
Proposed Federal MCL	None	4,000 (with MMM) or 300 (without MMM)	None

<u>Summary of Water Quality in the San Andreas Rift Zone</u>

Based upon sampling results of three wells along the San Andreas Fault (Wells 5, 18, and 19), analysis of groundwater quality in the rift zone has shown the following observations.

- Well 5: Highest concentrations of hardness, calcium, magnesium, sodium, alkalinity, chloride, nitrate, TDS and arsenic. In April 2001, taken out of service due to water quality issues.
- Well 18: Tends to have higher concentrations of hardness, calcium, magnesium, sodium, and alkalinity. Nitrate, arsenic, and boron were detected at higher concentrations, but were below their applicable standards; TDS which was detected in 2010 at 570 mg/L, which exceeds the secondary standard of 500 mg/L.
- Well 19: Presence of arsenic, below applicable standard.
- On average, the San Andreas Rift Zone has the highest concentrations of hardness, calcium, magnesium, alkalinity, sulfate, chloride, TDS, and boron compared to the other two subbasins. Radon concentrations were high and could place the District in violation of the proposed Radon Rule.

5.2.5 Surface Water Supply

Both surface water sources, which include Littlerock Dam water and SWP, flow into Palmdale Lake prior to treatment at the District's WTP. The first subsection presents a summary of source water quality data analysis for each water source examined individually. Results of analysis of untreated water quality data or their resulting blend in Palmdale Lake is presented. The last part of this subsection presents analyses of treated water quality data.

5.2.5.1 Source Waters

Approximately 60 percent of the District's water supply has historically come from surface water sources. When comparing both water sources, the following general observations were made.

- SWP showed higher TDS, but lower alkalinity than Littlerock Dam water.
- SWP had higher concentrations of several inorganic chemicals, including chloride, sulfate, aluminum, and iron. However, manganese was found at higher concentrations in Littlerock Dam water than in SWP.

- Sodium and magnesium concentrations were higher in SWP, but calcium concentrations were higher in Littlerock Dam water.
- Concentrations of radionuclides, as measured by gross alpha particle activity, were similar in both source waters. However, Littlerock Dam has higher gross beta particle activity.
- Although occurrence of inorganic chemicals in both source waters increased over the years, none of the other parameters examined suggested a significant change in source water quality.

From 2001 to 2013, no objectionable water quality characteristics were noticed from Littlerock Dam water or SWP, with the exception of pH, iron and manganese, which were detected at concentrations greater than their respective secondary standards at times.

5.2.5.2 Palmdale Lake

SWP water blends with inflow from Littlerock Dam in Palmdale Lake and is subsequently treated at the WTP. General water quality parameters measured from Palmdale Lake are summarized and presented in **Table 5-13**. At times the pH values exceed the secondary standard of 8.5. With the exception of pH, all parameters were within the acceptable range of secondary standards set by the USEPA and DDW. No noticeable changes in water quality occurred from 2001 to 2013.

The District initiated a monthly sampling program in September 2004 to March 2006 to gather data required for compliance with the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). Results from 21 analyses showed turbidity concentrations ranging from 0.7 to 12.8 NTU, with median and average concentrations of 2.3 and 3.9 NTU, respectively.

The LT2ESWTR monitoring data was submitted to DDW and the USEPA in late 2006. The data were accepted and the District was grandfathered into compliance. The District voluntarily continued this monitoring program through January 2008 to better characterize the influence of the Littlerock Dam, as this source was present in low quantities compared to historical availability during the 2004 to 2006 monitoring period.

Inorganic Chemicals
Inorganic chemicals analyzed from Palmdale Lake included arsenic, barium, cadmium, chromium, fluoride, lead, mercury, nickel, nitrate, selenium, silver, and nitrite. Between 2001 and 2013, the only chemicals detected were arsenic (ND to 3.0 µg/L) and fluoride (ND to 0.3 mg/L). These concentrations were below their respective federal and state MCLs. All other parameters had concentrations below the MDL.

Additional inorganic chemicals monitored include aluminum, chloride, copper, foaming agents (MBAS), iron, manganese, sulfate, and zinc. Between 2001 and 2013, the only chemicals detected were aluminum (ND to 380 µg/L), chloride (59 to 94 mg/L), copper was only detected in 2008 at 60 µg/L, iron (ND to 470 µg/L), manganese (ND to 150 µg/L), and sulfate (30 to 57 mg/L). In 2006, manganese was detected at 150 µg/L, which exceeded its secondary standard of 50 µg/L. In 2007, 2008, and 2011, manganese was detected at 50 µg/L, which equals its secondary standard. In 2011, iron was detected at 0.47 mg/L, which exceeded its secondary standard of 0.3 mg/L. The other chemicals detected were measured at concentrations below federal and state secondary standards. Other chemicals listed were below their respective DLRs between 2001 and 2013.

Commented [AW29]: Data compiled from Daily, Weekly and Monthly analyses

Commented [AW30]: TDS calculated from conductivity measurements

Table 5-13
General Water Quality Parameters in Palmdale Lake

Year	TDS(1) (mg/L)	Hardness (mg/L CaCO3)	Alkalinity (mg/L CaCO3)	pH	Turbidity (NTU)
2001	310 – 383 Average: 339	120 – 180 Average: 140	98 – 146 Average: 112	7.7 – 8.9 Average: 8.3	2.7 – 9.9 Average: 4.9
2002	356 – 416 Average: 386	120 – 152 Average: 138	96 – 121 Average: 107	7.6 – 10.0 Average: 8.5	2.4 – 18.8 Average: 5.4
2003	277 – 422 Average: 339	106 – 152 Average: 130	88 – 105 Average: 97	7.6 – 9.0 Average: 8.3	2.0 – 11.6 Average: 4.8
2004	290 – 350 Average: 323	106 – 154 Average: 130	83 – 130 Average: 106	7.3 – 8.6 Average: 7.7	0.5 – 19.1 Average: 3.7
2005	231 – 363 Average: 285	102 – 160 Average: 129	86 – 105 Average: 94	7.3 – 8.4 Average: 7.6	0.8 – 18.8 Average: 3.0
2006	172 – 271 Average: 221	90 – 124 Average: 105	75 – 93 Average: 83	7.2 – 8.7 Average: 7.7	0.6 – 8.0 Average: 2.0
2007	224 – 323 Average: 280	100 – 124 Average: 113	80 – 95 Average: 88	7.3 – 9.3 Average: 8.4	0.8 – 16.1 Average: 2.9
2008	271 – 356 Average: 320	108 – 128 Average: 119	81 – 101 Average: 92	7.9 – 9.1 Average: 8.5	1.3 – 15.1 Average: 3.7
2009	284 – 416 Average: 342	106 – 132 Average: 118	79 – 97 Average: 88	7.9 – 8.9 Average: 8.3	0.4 – 6.6 Average: 1.5
2010	224 – 330 Average: 266	100 – 124 Average: 112	73 – 93 Average: 83	7.6 – 9.4 Average: 8.2	0.6 – 12.5 Average: 1.6
2011	170 – 310 Average: 246	80 – 120 Average: 101	63 – 100 Average: 79	7.3 – 9.2 Average: 8.2	0.9 – 9.4 Average: 3.1
2012	246 – 360 Average: 294	84 – 132 Average: 112	70 – 92 Average: 81	7.7 – 9.1 Average: 8.4	0.6 – 9.2 Average: 3.2
2013	360 – 408 Average: 377	100 – 144 Average: 122	73 – 114 Average: 94	7.8 – 9.4 Average: 8.5	0.4 – 10.7 Average: 2.4
Secondary Standards	500	None	None	6.5-8.5	None

1) Calculated from conductivity measurements
2) Data compiled from daily, weekly, and monthly analyses

From 2002 to 2010, cyanide and boron were also measured. Cyanide was not detected in Palmdale Lake. Boron was found at concentrations ranging from ND to 200 µg/L, below its notification level of 1,000 µg/L in California.

Organic Chemicals.
A variety of organic chemicals were measured, including: endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP silvex, atrazine, bentazon, benzene, carbon tetrachloride, 1,2-dibromo-3-chloropropane, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1 -dichloroethylene, 1,3-dichloropropene, ethylbenzene, methyl-tert-butyl-ether, ethylene dibromide, molinate, monochlorobenzene, simazine, 1,1,2,'2-tetrachloroethane, tetrachloroethylene, toluene, thiobencarb, 1,1,1-trichloroethane, 1,1,2- trichloroethane, trichloroethylene, vinyl chloride, xylenes, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1-dichloroethane, 1,2-dichloropropane, trichlorofluoromethane, 1,1,2-trichloro-1,2,2-trifluoroethane, carbofuran, glyphosate, chlordane, heptachlor, heptachlor epoxide, di(2-ethylhexyl)phthalate, and diquat. All of these compounds had concentrations below their respective MDLs from 2001 to 2013.

The District is also required by DDW to sample the raw water intake of Palmdale Lake for Methyl Tertiary Butyl Ether (MTBE), benzene, toluene, ethylbenzene, and xylene, at least quarterly, unless fuel-based motor boats are banned from the lake. Data collected in February 2006 during the opening of fishing season were provided by the District and showed that all VOCs analyzed were non-detectable at the plant influent, with the exception of 1-chloro-dodecane (36.5 μg/L), which is not regulated at the federal nor state level. Data collected between 2007 and 2013, also showed that all VOC's analyzed were non-detectable at the plant influent. Although VOC concentrations were higher in some parts of the lake, such as the boat ramp, concentrations measured were below federal and state MCLs as well as state notification levels.

In 2005, 2008, 2011, 2012, and 2013, a variety of synthetic organic chemicals (SOCs) were measured including pentachlorophenol (PCP), picloram, polychlorinated biphenyls (as total PCBs), aldicarb (TEMIK), aldicarb sulfone, aldicarb sulfoxide, aldrin, bromacil, butachlor, carbaryl (Sevin), chlorothalonil (DACONIL< BRAVO), diazinon, dicamba (BANVEL), dieldrin, dimethoate, (CYGON), 3-hydroxycarbofuran, methomyl, metolachlor, metribuzin, prometryn (CAPAROL), and propachlor. All of these chemicals were below their respective MDLs.

Radionuclides.
In 2004, gross alpha particle activity was not detected in Palmdale Lake. Some radionuclide concentrations are considered to be fairly constant and therefore the frequency of monitoring is reduced to every 3, 6, or 9 years based on the past result. Radionuclide data was again collected between 2005 and 2013. In 2013, gross alpha particle activity and uranium were detected at 3.2 pCi/L and 1.4 pCi/L, respectively. These results are below the federal and state MCLs. All other radionuclides (including: radium, gross beta particle activity, strontium and tritium) analyzed were below their respective MDLs.

Microbial Water Quality.
As part of the District's water quality monitoring program and in conjunction with the recently promulgated LT2ESWTR (see **Appendix C**), *Cryptosporidium*, and *Giardia* were analyzed monthly from Palmdale Lake between 2003 and 2008, whereas *E. coli* has been enumerated on a weekly basis. This procedure is consistent with the District's permit requirements, which require weekly monitoring for total coliform and either fecal coliform or *E.coli* using density analyses at least weekly.

Between 2003 and 2008, 59 samples were analyzed for *Cryptosporidium* and *Giardia*. *Cryptosporidium* was only detected in one sample collected in April 2004 (concentration 1 cyst/-11L. Based on the results of *Cryptosporidium* monitoring, the District was classified in Bin 1 of the LT2ESWTR, which does not impose any additional treatment requirement.

Giardia was detected in 8 of the 59 samples analyzed: Four samples in 2003 (concentrations ranging from 1 to 4 cysts/-11 L), three samples in 2004 (concentrations ranging from 1 to 2 cysts/-11 L), and one sample in 2005 (1 cyst/-11 L).

Results from 564 analyses between 2003 and 2013, showed *E. coli* concentrations ranging from <1 to 1,600 MPN/100 ml, with median and average concentrations of 12 and 58 MPN/100 ml, respectively. The presence of *E. coli* appears to be seasonal, with higher concentrations during the November to March period.

The second round of LT2ESWTR began in April 2015 and requires the District to monitor for *Cryptosporidium*, *Giardia*, *E. coli* and turbidity monthly for 24 months. To date, Cryptosporidium and Giardia have not been detected in this second round of source water monitoring.

Summary of Water Quality at Palmdale Lake

Currently, the pH of Palmdale Lake is higher than the range recommended by secondary standards. From 2001 to 2013, no other objectionable water quality characteristics were noted from Palmdale Lake. It is difficult to state whether water quality is changing at the WTP intake. Although an increasing number of inorganic chemicals were detected in recent years, others seemed to decrease, such as sodium. The District is in compliance with the LT2ESWTR.

5.3 Water Quality Analysis of the Treated Water

An assessment of the treated water quality data obtained from the District was conducted, and the data were examined with respect to current and future regulations. Key observations from this assessment are presented below, starting with CCRs, which were used to conduct a preliminary overview assessment.

5.3.1 Consumer Confidence Reports

The most recent CCRs (year 2011, 2012, 2013, and 2014) indicate that according to water quality analyses conducted from January 1 to December 31 for each year, drinking water distributed by the District met or exceeded all primary and secondary standards, both at federal and state levels.

Disinfection By-Product

DBP data (i.e., all four trihalomethanes (THM4) including chloroform, bromodichloromethane, dibromochloromethane, and bromoform, and five of the haloacetic acids (HAA5) including monochloro-, dichloro-, trichloro-, monobromo-, and dibromo- acetic acids) from 2002 to 2013 were obtained from the District.

Stage 1 of the USEPA Disinfectants and Disinfectants Byproducts Rule (D/DBPR) required the system-wide running annual average (RAA) of THM4 to be below the MCL of 80 µg/L. Sixteen sites were chosen throughout the District to represent the system and RAA was calculated by averaging the prior four quarters of results. Between 2002 and 2012, THM4 concentrations tend to be high, with RAA's exceeding the MCL of 80 µg/L at times. However, HAA5 concentrations were much lower. A summary of THM4 and HAA5 RAAs for the 2002 to 2012 period is presented in **Table 5-14**. In 2003, the District exceeded the THM4 MCL, and therefore, implemented operational improvements to optimize detention time and chlorine residual within the distribution system. In addition, post-filtration GAC contactors became operational at the WTP in November 2008 to reduce total organic carbon (TOC), a disinfection by-product precursor. **Table 5-14** illustrates how THM4 concentrations are linked to changes in bromide levels. To a lesser extent, HAA5 concentrations are also affected by bromide levels. THM4 and HAA5 concentrations vary with changes in TOC concentrations.

Table 5-14
THM4, HAA5, Bromide, and TOC Concentrations of the Treated Water

Year	Highest THM4 RAA (µg/L)	Highest HAA5 RAA (µg/L)	Average Bromide in Palmdale Lake (µg/L)	Average TOC in Source Water (mg/L)	Average TOC in Treated Water (mg/L)
2002	74	23	326	4.1	2.4
2003	**85**	25	224	3.1	2.2
2004	65	17	168	3.1	2.1
2005	54	11	145	2.9	1.8
2006	52	12	125	3.4	2.0
2007	55	13	210	3.0	1.9
2008	55	16	235	2.5	1.2
2009	44	14	274	2.3	0.8
2010	31	5.7	234	2.6	1.0
2011	33	6.1	233	3.2	0.9
2012(1)	38	5.6	246	2.8	0.9
2013(2)	40	7.3	243	3.4	0.9
Federal MCL	80	60	None	Treatment requirement	None

Note: values highlighted in bold exceed the 80 µg/L MCL
1) Stage 2 of the D/DBPR began April 1, 2012
2) Data does not accurately reflect system wide RAA since Stage 2 sites are different from Stage 1.

Commented [AW31]: *Stage 2 D/DBPR began April 1, 2012

Commented [AW32]: Data may be removed because it does not accurately reflect system-wide RAA since Stage 2 sites are different from Stage 1.

In April 2012, the Stage 2 D/DBPR began. Stage 2 D/DBPR requires the locational running annual average (LRAA) to be evaluated for each site rather than calculating RAA on the system as a whole. Results are presented in **Table 5-15** for THM4 and **Table 5-176** for HAA5. The District has been in compliance with the Stage 2 D/DBPR for THM4 and HAA5.

Table 5-15
Stage 2 D/DBPR - THM4 LRAA (µg/L) at Sampling Locations for 2013

Sampling Location	2013 – Q1	2013 – Q2	2013 – Q3	2013 – Q4
3212 E. Avenue T-2	47	44	42	36
703 Denise St	60	56	55	50
1005 Lakeview Dr.	46	43	45	43
5001 E. Ave T-8	39	37	35	31
2404 Old Nadeau Rd.	49	47	48	43
2508 Desert Oak Dr.	33	34	36	33
36457 Harold 3rd	36	31	28	25
37419 E. 3rd St.	18	17	18	17

Note: There are only 8 sites for Stage 2 D/DBPR and some of them are different from Stage 1 D/DBPR sites.

Commented [AW33]: There are only 8 sites for Stage 2 D/DBPR and some of them are different from Stage 1 D/DBPR sites.

Table 5-16
Stage 2 D/DBPR – HAA5 LRAA (µg/L) at Sampling Locations for 2013

Sampling Location	2013 – Q1	2013 – Q2	2013 – Q3	2013 – Q4
3212 E. Avenue T-2	6	5	5	4
703 Denise St	11	11	10	10
1005 Lakeview Dr.	9	9	10	9
5001 E. Ave T-8	7	7	7	7
2404 Old Nadeau Rd.	9	9	9	8
2508 Desert Oak Dr.	4	5	5	4
36457 Harold 3rd	7	6	6	6
37419 E. 3rd St.	4	4	4	4

Note: There are only 8 sites for Stage 2 D/DBPR and some of them are different from Stage 1 D/DBPR sites.

Commented [AW34]: There are only 8 sites for Stage 2 D/DBPR and some of them are different from Stage 1 D/DBPR sites.

Speciation of quarterly THM and HAA5 data was reviewed in light of the maximum contaminant level goals (MCLGs) adopted in Stage 1 and Stage 2 D/DBPRs. With exception of those species that have MCLGs of zero (i.e., chloroform according to the Stage 1 D/DBPR (the MCLG for chloroform was reviewed and updated to 70 µg/L in the Stage 2 D/DBPR), bromodichloromethane, bromoform, and dichloroacetic acid), the THM and HAA species did not exceed MCLGs.

Disinfection By-Product Precursors

TOC was examined as a surrogate parameter for DBP precursors. A summary of source and treated water TOC concentrations are presented above in **Table 5-14** for the 2002 to 2013 period.

TOC removal achieved through processing at the WTP was examined with respect to the TOC removal requirement, as stated in the Stage 1 D/DBPR. Results showed that the WTP was in compliance with this rule between 2002 and 2013. However, between 2003 and 2004, 6 months showed the percent TOC removal was lower than required by the Stage 1 D/DBPR. When the percent TOC removal ratio was <1.00 mg/L, the District was able to assign a monthly value of 1.00 (in lieu of calculating the TOC percent removal ratio) because the finished water specific ultraviolet absorbance (SUVA) was < 2.0 L/mg-m. While still in compliance, the District made improvements to the WTP to address this concern, as described in an earlier subsection.

Chlorine Residual and Microorganisms

Chlorine residual is measured in conjunction with Total Coliform Rule (TCR) compliance samplings. All chlorine residuals were less than 4.0 mg/L, as required under the Stage 1 and Stage 2 D/DBPRs. A residual of at least 0.2 mg/L is required by the TCR. Chlorine residuals were, at times, lower than 0.2 mg/L. Low residuals occurred mainly during a warm summer period. When a residual lower than 0.2 mg/L is measured, the District collects a sample for heterotrophic plate count (HPC) analysis at that sampling site. An HPC less than 500 CFU/mL is considered equivalent to a detectable disinfectant residual, as per DDW's permit requirements. During the 2001 to 2013 period, all HPCs analyzed in conjunction with low chlorine-residual measurements were below 500 CFU/ml.

TCR sampling results were reviewed for the 2001 to 2013 period. Although some of the samples were positive for total coliform, *E. coli* was always absent. All TCR-positive samples occurred during the summer: two events occurred in 2001 (in June and August), one event in 2002 (in July), and one event in 2005 (in June). Repeat samples were always conducted the day following a measurement of a TCR-positive sample. Results of repeat samples were negative for total coliforms.

5.4 Monitoring Practices

Monitoring programs practiced by the District to assess source water quality, performance of the WTP, and distribution system water quality are discussed below.

5.4.1 Source Water Quality Monitoring

Two source water monitoring programs are currently in place at the District, one to assess groundwater quality and one for Palmdale Lake.

Groundwater Monitoring

The District's groundwater sources are monitored in accordance with the Vulnerability Assessment and Monitoring Frequency Guidelines prepared by the DDW and most recently dated December 31, 2013. Vulnerability Assessments are updated every three-years based on the three-year compliance period of the nine-year compliance cycle.

Palmdale Lake Monitoring

Monitoring is conducted at Palmdale Lake by periodic grab samples. Periodic grab samples are collected in two ways: from a sample line that flows continuously from the lake outlet structure to the laboratory sink and from designated sampling locations on the lake shoreline. From the laboratory sink, samples are collected and analyzed every two hours for temperature, pH and turbidity. Total coliforms, *E. coli*, conductivity, hardness, alkalinity, color, and odor are analyzed weekly. *Giardia* and *Cryptosporidium* are collected from the laboratory sink and analyzed once per month for Round 2 - LT2ESWTR. MTBE and other VOC's are collected from designated sample locations around Palmdale Lake and from the Plant Influent sample line in the laboratory. MTBE and the gasoline byproducts are analyzed quarterly during the boating season, which is generally from February through November. Other parameters such as inorganic chemicals, VOCs, and SOCs are monitored from the Lake sample line at the laboratory sink as required by the DDW in Title 22 of the California Code of Regulation.

5.4.2 Water Treatment Plant Performance Monitoring

Samples are collected on a regular basis from various locations throughout the plant to monitor performance of the plant processes, to determine whether chemical doses are appropriate, and ensure that the plant is in compliance with regulatory requirements. Performance monitoring is categorized according to type: continuous monitoring, which is done by installed, online analyzers, and grab samples, which are collected at particular times. **Table 5-17** details the grab-sampling program. Samples are only collected when the plant is in service.

Table 5-17
Grab Sampling Program at the District's WTP

Parameter	Location			
	Raw Water (Lake Outlet)	Settled Water	Combined Filter Effluent	Finished Water (Plant Effluent)
Turbidity	Every two hours	Every two hours	Every two hours	Every two hours
pH	Every two hours	Every two hours	--	Every two hours
Chlorine Residual	--	Every two hours(1)	Every two hours	Every two hours
Temperature	Every two hours	Every two hours	--	Every two hours
Aluminum	--	--	--	Monthly
Iron	--	--	--	Monthly
Manganese	--	--	--	Monthly
Zinc	--	--	--	Monthly
Total Hardness	Weekly	--	--	Weekly
Alkalinity	Weekly	--	--	Weekly
Calcium Hardness	Weekly	--	--	Weekly
Color(2)	Weekly	--	--	Weekly
Odor(2)	Weekly	--	--	Weekly
Total Coliform and *E. coli*	Weekly(3)	--	--	Twice Daily(3)
HPC	Weekly	--	--	--

1) Chlorine residual readings from the settled water are not taken if chlorine is not being fed upstream of this location
2) Color and odor readings are taken more frequently if customer complaints indicate problems with tastes and odors.
3) The MPN method is used for raw water, the P/A method is used for all other sources. If coliform levels in raw waters are elevated (>1,600 MPN), then samples are collected daily instead of weekly until levels decrease to less than 1,600 MPN.

Table 5-18 details the continuous monitoring program. Only water quality analyzers are shown in this table; other devices such as flowmeters, pressure gauges, position switches, and level indicators exist throughout the plant and data are transmitted continuously to the plant's SCADA system. The monitoring program meets the requirements of the District's Domestic Water Supply Permit issued by the DDW on May 7, 2003.

Table 5-18
Online Analyzers Located at the District's WTP

Location	Parameters Monitored
Coagulated Water (Downstream of Flash Mix)	pH
Settled Water	Turbidity
Individual Filter Effluents (10)	Turbidity
Combined Filter Effluent	Turbidity, Chlorine residual
Clearwell Effluent	Temperature, pH, Chlorine residual

5.4.3 Distribution System Monitoring

The District has implemented several monitoring programs to assess distribution system water quality, including bacteriological and chlorine residual monitoring for compliance with the SWTR and the TCR, DBP monitoring for compliance with the Stage 1 and Stage 2 D/DBPR, and lead and copper monitoring for compliance with this rule.

Commented [AW35]: THM4 and HAA5 data was discussed earlier under the CCR section, woule it be more appropriate in this section?

Commented [NG36R35]: I think above we were looking at the results, and this section we are looking at the monirtoring practices. I included some brief information about the monitoring program below

Commented [AW37R35]: Sounds good.

Bacteriological and Chlorine Residual Monitoring

According to the current population served and the TCR, a minimum of 30 samples per week must be collected and analyzed for total coliform and *E. coli*. The District's standard coliform monitoring program includes samples from 39 different sites each week, as detailed in the Sample Site Plan, last updated in June 2008. Samples are collected from dedicated sample stations, which are kept locked when not in use to prevent contamination. All pressure zones and eight of the tanks are included in the regular monitoring program.

Each time a coliform sample is collected, the chlorine residual is measured, as required by the SWTR. Per DDW, any chlorine residual reading of less than 0.1 mg/L on the test kit is considered "non-detect" for compliance purposes. If the chlorine residual at a particular sampling site is lower than 0.2 mg/L, then a sample is collected for HPC. If no chlorine is detected in a routine sample, but the HPC value is less than 500 CFU/ml, then this is deemed equivalent to a detectable chlorine residual. In addition to temperature, coliform, chlorine residual, and HPC, samples are collected each month from these 39 sites for other parameters such as pH, conductivity, turbidity, color and odor.

Disinfectant By-Product Monitoring

Eight sites were chosen throughout the District to measure the THM4 and HAA5 concentration per the Stage 2 D/DBPR. Some of these eight sites were different than the sixteen sites chosen in Stage 1 D/DBPR. The eight sites chosen represent the longest detention times and the highest THM4 concentrations of the distribution system. Stage 2 D/DBPR requires the locational running annual average (LRAA) to be evaluated for each site rather than calculating RAA on the system as a whole. THM4 and HAA5 concentrations are monitored monthly and then averaged for each quarter for each sites.

Commented [AW38]: We monitor THM4 and HAA5 concentrations monthly and average the quarter (ex. Jan-Mar). The quarterly average is then used toward the RAA.

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Lead and Copper Rule Monitoring

The District conducted a customer tap sampling program for lead and copper, as well as required water quality parameter monitoring throughout the distribution system. Due to very low lead and copper levels measured at customer taps for two consecutive monitoring periods, the District was allowed to reduce the required monitoring frequency. According to the LCRMR (Lead and Copper Rule Minor Revisions, effective April 2000), the District's corrosion control program has been deemed "optimized," and the District has been classified as a 141.81 (b)(3) system. This classification means that customer tap samples are required once every 3 years and water quality parameter monitoring from the distribution system is not required.

5.5 Findings and Recommendations

This water quality analysis has resulted in a number of conclusions regarding existing and future regulations or water quality concerns that may impact the District's system.

1. There are multiple water quality regulations pending that may impact operations of the District's domestic water system. The District should continue to remain up-to-date on the

status of these regulations to ensure that the District's water supply complies with all new and future water quality regulations. New regulations of particular concern include the Stage 2 D/DBPR (began April 1, 2012), the Round 2 - LT2ESWTR (began April 1, 2015), the Ground Water Rule (effective December 2009), the Unregulated Contaminant Monitoring Rule 3 (completed in 2015), and revisions to the Total Coliform Rule (effective April 1, 2016). At the federal level, pending regulations of particular concern include the Radon Rule and the Contaminant Candidate List 4. At the state level, new regulations of concern include the hexavalent chromium standard (effective July 1, 2014), the perchlorate standard, the arsenic standard, and the radionuclide rule. Upcoming state regulations include those regarding Surface Water Augmentation Using Recycled Water and a possible Distribution System (Cross-Connection Control) Rule.

2. Examination of the District's groundwater quality data suggests that quality may be deteriorating. Although not obvious in all subbasins, concentration of some parameters, such as TDS, chloride, nitrate, sulfate, and several inorganic chemicals, has increased over the past few years. This trend could be due to overdrafting of the groundwater supply. If this is the case, it is likely that groundwater quality will continue to deteriorate as long as the basin continues to be overdrafted. The District may want to consider treatment strategies for key parameters (i.e., hexavalent chromium, vanadium, iron, nitrate, and aluminum) that are already measured at concentrations exceeding or close to the secondary standards or California notification levels.

3. In general, the wells located along the San Andreas Fault show the poorest water quality of the groundwater supplies used by the District. This subbasin has the highest concentrations of TDS, hardness, alkalinity, chloride, nitrate, sulfate, sodium, calcium, magnesium, and arsenic; however, none of these constituents were measured above their applicable state or federal standards. Radionuclides are also detected at the greatest frequency in the San Andreas Rift Zone. Considering this, and the fact that the Pearland Subbasin appears to have the highest water quality, it is advisable that the District considers drawing more water from the subbasin that shows the best water quality.

4. Constituents found in the District's groundwater that may pose a challenge to the District include hexavalent chromium (detected in some groundwater wells at concentrations close to or above the California MCL), vanadium (detected in some groundwater wells at concentrations close to the DDW notification level), iron (concentrations greater than the secondary standard were measured in some wells), nitrate, and aluminum (nitrate and aluminum concentrations close to the secondary standard were measured in some wells).

5. When comparing both surface water sources, it appears that Littlerock Dam water may show better water quality characteristics than SWP water. SWP water showed higher TDS and higher concentrations of several inorganic chemicals. However, iron and manganese may pose a challenge to the District, as these compounds were detected in Littlerock Dam water at concentrations greater than their respective secondary standards. Littlerock Dam water also has significantly higher TOC and higher gross beta particle activity than SWP.

Commented [AW40]: Began April 1, 2012
Commented [AW41]: Began April 1, 2015
Commented [AW42]: Effective December 2009
Commented [AW43]: Completed in 2015
Commented [AW44]: Effective April 1, 2016
Commented [AW45]: Effective July 1, 2014

6. Quality of both surface water sources does not appear to be declining over time, and the few detections occurred below the DLR and are considered ND.

7. Radon has been detected in all of the District's water sources. If the proposed Radon Rule is promulgated without changes, the District could violate this rule if neither the DDW nor the District develop an MMM program plan. As such, the District could begin discussions with the DDW to examine possible ways of meeting this upcoming rule's requirements.

8. THM4 data showed high concentrations at times. Further data analysis also showed that THM4 are correlated with source-water bromide and TOC concentrations. Improvement projects at the WTP, notably the addition of post-filter GAC contractors, have resolved this issue.

9. Monitoring programs implemented by the District to address source water quality, performance of the treatment plant, and distribution system water quality appear to be adequate.

10. The District may want to consider performing a preliminary assessment for the treatment of potential contaminants with regulations pending. These studies may include technology evaluation, cost analyses, and footprint requirements so that expansion can be accommodated in the future if treatment is required. This will help to ensure that the District continues to comply with all water quality regulations and help to plan for the capital and operating expenses associated with treatment.

Contents

No table of figures entries found.

SECTION 6 HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

This section describes the processes utilized to develop and calibrate the hydraulic model of Palmdale Water District's (PWD's) potable water system. First, the development of the model distribution network from PWD's GIS database is described. Subsequently, the system facilities, ground elevations, and diurnal water demands are discussed. This section concludes with a discussion of the model calibration process, which is performed to verify the model results with field measurements. The calibrated model is used to perform system analyses of the system under existing and future demand conditions.

6.1 Hydraulic Model Development

The hydraulic model of the PWD's potable water system is created using Innovyze's InfoWater® software.PWD provided the GIS shape files for the distribution system network which are used as a base for creating the hydraulic model for this Water System Master Plan (WSMP). This distribution model was last updated in 2008. PWD's hydraulic model is updated with new or abandoned pipelines constructed since the last update. The updated hydraulic model now contains all pipelines and facilities (booster pumps, storage tanks, wells, and pressure reducing valves) present in the PWD GIS files.

6.1.1 Data Collection

Data used for the development of the hydraulic model is obtained from a variety of sources. Key information includes:

- GIS file of all water mains, laterals, and water facilities
- Hydraulic schematic of the water system
- Dimensions for storage reservoirs
- As-built drawings of infrastructure
- Pump controls and pressure regulating valve settings
- Water production records (1994-2013)
- Customer usage billing records (2009-2013)
- Supervisory Control and Data Acquisition (SCADA) data
- General Plan and land use information
- Street centerline data
- Aerial photography coverage
- Imported and emergency water connections, including locations, sizes, and capacities

Detailed information on water system facilities is presented in **Section 2**.

6.1.2 Pipelines

All pipelines and facilities in the model are checked for accuracy and some pipelines and facilities are redrawn to resolve model connectivity issues and more accurately depict the system configuration. There are approximately 19,200 pipe segments in the model. Model attributes for pipelines include the pipe number, pipeline length, diameter, material, roughness (Hazen Williams C-Factor), and pressure zone. While most of these attributes are provided by PWD, for pipes without roughness values from the previous model, the roughness attribute is based on the age and material of the pipeline as shown in **Table 6-1**. C-factors calibrated in the previous model are not adjusted because C-factor adjustment normally occurs during steady-state calibration. Fire flow tests are not performed due to the current drought; instead, steady-state validation is performed using previous fire flow tests. This is further described in **Section 6.2 Model Calibration**.

Table 6-1
Pipeline Roughness

Material	Hazen Williams C-Factor(1)
Asbestos Cement	120-135
Galvanized Steel	105-120
Cement Mortar Lined Steel	120
Ductile Iron	120-130
Plastic (poly vinyl chloride - PVC)	120-140
Steel	105-130
Unknown	120

1) C Factors are estimated based on the age and the material of the pipeline.

6.1.3 Junctions and Valves

Junctions are defined as the intersections of two or more pipelines, or the location where any pipeline changes diameter or material. Attribute information for junctions include elevation, demand, and pressure zone. There are approximately 17,800 junctions in the updated model. Zone isolation valves are modeled where the model indicates the presence of normally closed valves. The zone isolation valves are modeled with an initial status set to “CLOSED”.

Fire hydrants are specifically in the model as one of the informational fields for junctions, and are provided as a GIS shapefile. While performing the fire flow test calibration, the fire flows are assigned to the junction nearest to the hydrant locations, which are typically within 20 feet from where the fire hydrant test sheet indicates a fire hydrant.

6.1.4 Pressure Regulating Valves

Pressure regulating valves (PRVs) are modeled with information such as valve diameter, pressure zones, valve settings, and minor loss coefficients. Pressure settings provided by PWD are used for each active valve. There are 25 PRVS in the system, and detailed information on PRVs is presented in **Section 2**. Minor loss coefficients are set at a standard value of 6.1 times velocity head.

6.1.5 Storage Tanks

All of the storage tanks in PWD’s system are modeled as cylindrical tanks. Their locations and pressure zones are determined from the system map provided by PWD and other information included in the previous model. Attributes such as elevation, diameter, tank height, material, capacity, and installation year are included based on a GIS shapefiles provided by PWD. There are 27 active storage tanks and hydropneumatic tanks in the model. For model calibration, the initial water level of each tank is set to the SCADA recorded water level at 12:00 AM on July 24, 2014. The initial water level represents the water depth at the beginning of a hydraulic simulation (midnight). Detailed information on storage tanks is presented in **Section 2**.

6.1.6 Pumps and Wells

The pump database in the model is populated with information from manufacturer's pump curves and the most recent Southern California Edison Company (SCE) test data. Where manufacturer's pump curves are not available, the SCE recorded test data is used as a design point in the model. The model creates pump curves based on the design point, which allow the pumps to produce a shut off head of 133 percent of the recorded head and a runout flow of two times the recorded flow. It is recommended that as new pumps are installed throughout the system, the model be updated with the manufacturer's pump curve. Of the 65 pumps in the model, 15 of the pumps use design point curves and the other 50 use multiple point curves, based on the pump curve data and SCE test data. The previous model had design head and design flow values for every pump; however, some of these values are updated during this WSMP using recent pump performance data.

Each well is modeled as a reservoir and a pump, where the reservoir represents the groundwater aquifer and the pump represents the well pump. The reservoirs are modeled as "fixed head" (i.e. unlimited volume of water at a specified elevation) reservoirs with a water elevation equal to the static groundwater elevation minus drawdown. The groundwater elevation is determined from the depth to water in the well pumping data for the month of calibration, July, 2014. The groundwater elevations are adjusted during calibration to match calibration flows and pressures, but confirmed that the elevations are within reasonable ranges.

The design flow and head for the well pumps and booster pumps are based on manufacturer's pump curves where available. The curves are then adjusted by using the SCE pump test data to account for pump deterioration over time. There were a few locations where the adjusted pump curves still did not match the calibration data. Most notably the curves for the Clearwell boosters to the 2800 zone did not match the observed flow. In these cases, curves are adjusted to match flow in the system.

Detailed information on pumps and wells is presented in **Section 2**.

6.1.7 Surface Water Treatment Plant

The surface water treatment facility is modeled with its associated booster pumps and 6 MG clearwell supplying the 2950 zone and the 2800 zone. The treatment facility is modeled as a fixed head reservoir connected to a flow control valve ensuring a steady flow of water into the system. The flow control valve is adjusted based on the average flow observed for each calibration period.

6.1.8 Facility Nomenclature

The identification scheme used in the existing system model is based on the type of facility. The nomenclature for the infrastructure had been maintained from the previous model:

- Wells begin with “GW”,
- Booster pumps begin with in “BP”,
- Well pumps begin with “W”,
- Valves begin with “V”,
- Tanks start with the letter “T”,
- Hydropneumatic tanks start with an “HT”, and
- Water treatment plants begin with “WTP”

6.1.9 Facility Elevation Data

A majority of the facilities and junctions had elevations assigned to them from the previous model. The elevations for new storage tanks and pumps are recorded by as-build drawings and summary sheets provided by PWD, while the elevations for new junctions are derived from contour data from the National Elevation Dataset (NED) at one third arc-second resolution. Using the contour data, ground elevations are extracted and assigned to all new junctions in the model. The extracted ground elevations are compared with the previous model elevations and similar values are observed.

6.1.10 Geocoding

The process of geographically locating each billing record is known as geocoding. PWD maintains a GIS database of meter data that is used to correlate consumption with a geographical location. Where meter data is unclear each billing record is geographically located using the street addresses in the billing data and street centerline GIS coverage. The geocoding process electronically places the location of each service connection on a map.

Demands are allocated to “demand” junctions based on proximity to the geocoded consumption data. Demand junctions are selected based on pressure zone boundaries and proximity to customer meter locations. Customer demand data is then aggregated and assigned to each demand junction. All junctions associated with water facilities or transmission pipes are excluded from the demand allocation process. The demands are then scaled up to account for the non-revenue water in the system.

Future demands are allocated geographically based on the location of vacant parcels in the existing land use GIS coverage. Information regarding the locations of proposed developments (described in **Section 3**) is considered. The total demand for each parcel (or group of parcels) is calculated based on the size of the parcel, land use classification, and the appropriate water duty factor. Once the future demands are determined, the demands are assigned to the closest existing demand node in the hydraulic model. Where system extensions are anticipated, new demands are assigned to relevant nodes within the new system.

6.1.11 Diurnal Curve

A diurnal curve represents the average hourly demand fluctuation in a water system. The diurnal curve for PWD’s potable distribution system is created based on hourly production and tank level information downloaded from the Supervisory Control and Data Acquisition (SCADA) system. Total system inflow data is based on the production data provided by PWD. The diurnal curve is created by preparing an hourly mass balance using treatment plant and well production, and change in reservoir/tank storage.

The calculated diurnal curve is presented on **Figure 6-1**. This curve represents the average hourly demand fluctuation of all pressure zones on July 24, 2014 relative to the average demand on that day. This curve is considered representative of a typical hot summer day for the year 2014. As shown on **Figure 6-1**, the peak hour occurs around 9:00 PM, which has a demand of 1.7 times the average demand of that day with a slightly lower peak around 6:00-7:00 AM.

The diurnal curve peaks in the morning and evening and is at a relatively low point during the middle of the day. This pattern is typical in most systems that are predominately residential with a significant commuter population. Morning and evening peaks are higher due to landscaping, and higher home occupancy in the morning and evening.

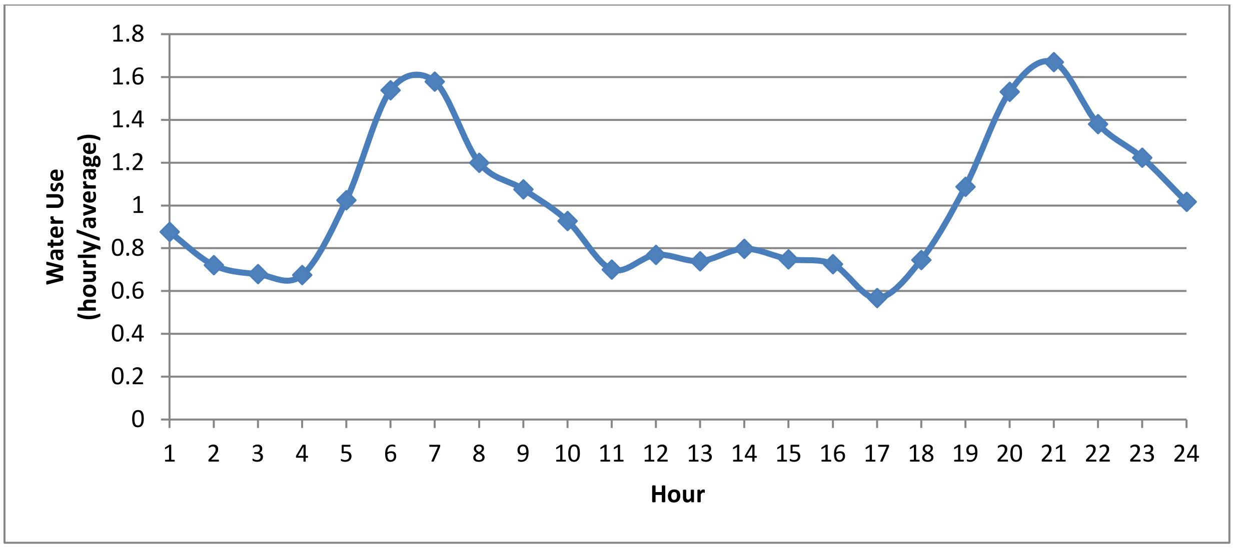


Figure 6-1
System Wide Diurnal Curve (July 24, 2014)

6.2 Model Calibration

The hydraulic model with the existing system configuration and demands is calibrated to enhance the accuracy of the model results and provide a planning tool that can be used to identify system deficiencies and recommend pipelines and facilities to address those deficiencies. Model calibration is the process of comparing model results with field results and making model modifications where appropriate to simulate the field results as closely as possible. Typical adjustments include modifications to system connectivity, operational controls, facility configurations, elevations, etc. Several indicators are utilized to determine if the model accurately simulates field conditions: water levels in storage tanks, the run times or flows for pumps and PRVs (where available), and recorded pressures from SCADA data. Calibration also acts as the "debugging" phase for the hydraulic model where any modeling discrepancies or data input errors are discovered and corrected.

The hydraulic model is validated during steady state and calibrated during extended period simulation:

- Steady State Validation: Simulating fire hydrant flow tests to match field results (January 11, 2013 to August 21, 2014)

- 24-hour Extended Period Simulation (EPS) Calibration: Modifying the model until it mimics the field operations on the day of calibration (July 24, 2014)

6.2.1 Steady State Validation

The objective of the steady state validation is to validate the assumed pipeline roughness coefficients (C-factors) in the hydraulic model and make modifications, where appropriate. This validation is typically performed by conducting fire hydrant tests at various locations throughout the distribution system. Each test consists of measuring the static pressure with the hydrant closed, opening a fire hydrant (indicated as flowing hydrant) and flowing the open hydrant until the residual pressure at an adjacent hydrant (indicated as the gauging hydrant) stabilizes, and measuring the residual pressure. The flow measured at the hydrant is then input to the hydraulic model as an additional demand and the pressures at the node representing the flowing hydrant location with and without this fire flow demand are then compared with the field results.

As a result of the California drought over the past three years, new initiatives to conserve water, and to avoid the public perception of “wasting” water during a hydrant test, fire hydrant tests are not performed. Instead, twelve hydrant tests performed by PWD predominately during the last year are chosen to validate the model. The chosen hydrant tests are the most recent available hydrant tests and include test results for all the major pressure zones in the PWD system, besides the 2850 Zone. The use of previous hydrant test results is not as preferred as hydrant tests performed this year because the system status and operating conditions when the test was conducted cannot be determined. For example, exact water levels and pump operations are unknown during the time the historical tests were conducted. Therefore, the pump and tank levels on the hydrant test dates may not represent the pump and tank levels in the model during the static validation.

The locations of the twelve fire hydrant tests are shown in **Figure 6-2**. **Table 6-2** presents information on hydrant location, hydrant number, static and residual pressure, and actual flow. The results of the fire flow test validation are also summarized in **Table 6-2**. The static and residual pressures in the field are compared with the residual and static pressures predicted with the hydraulic model.

As shown in **Table 6-2,** all of the model results are within 10 feet of head (4.5 psi) of the observed static field data as recommended by AWWA’s Computer Modeling Manual M32. The dynamic pressures are also mostly within the guidelines. While test location 10 falls outside the guideline in dynamic pressure comparison, it simulates a very similar drop indicating that the

Table 6-2
Steady State Model Comparison

Location Number	Zone	Date	Time	Address of gaging hydrant	Average Flow Rate Observed/ Modeled (gpm)	Calculated Flow at 20 PSI Residual at Gauging Hydrant (1) (gpm)	Static Pressure Observed (psi)	Static Pressure Simulated (psi)	Change in Simulated Static Pressure Over Observed	Residual Pressure Observed (psi)	Residual Pressure Simulated (psi)	Change in Simulated Residual Pressure Over Observed	Observed Pressure Drop (psi)	Simulated Pressure Drop (psi)	Change in Simulated Pressure Drop over Observed (psi)
1	3200	August 8, 2014	9:50 AM	Northwest Corner of Avenue R-12 and 7th Street West	1,267	2,799	103	103	0%	86	86	0%	17	17	-
2	2800	June 27, 2014	10:10 AM	North side of Palmdale Blvd +/-350' east of 30th Street East	1,113	5,620	71	70	2%	69	69	0%	2	1	1
3	3000	May 19, 2014	8:10 AM	North side of Pearblossom Highway +/-1065' west of 52nd Street East	1,547	9,661	98	100	-2%	96	98	-2%	2	2	-
4	3000	May 19, 2014	8:20 AM	Southwest corner of Pearblossom Highway and Fort Tejon Road	1,300	5,166	99	99	0%	94	94	0%	5	5	-
5	2800	November 14, 2013	9:30 AM	East side of Nova Avenue +/-115' north of Crater Way	1,061	4,564	57	57	0%	55	57	-3%	2	1	1
6	2800	November 14, 2013	9:08 AM	Northeast corner of Avenue R and 38th Street East	1,048	4,744	61	60	-%	59	59	0%	2	1	1
7	3000	October 21, 2013	9:45 AM	Southeast corner of Avenue T-4 and 52nd Street East	1,332	7,708	87	86	-%	85	83	2%	2	3	(1)
8	2800	October 16, 2013	2:45 PM	Southeast corner of Avenue Q-4 and 5th Street East	919	2,906	50	51	-2%	47	50	-6%	3	1	2
9	2800	March 8, 2013	2:10 PM	Westside of 47th St. East +/-1050' south of Palmdale Blvd.	1,138	5,153	61	59	3%	59	58	1%	2	1	1
10	2800	March 5, 2013	9:35 AM	Northeast corner of Avenue Q-6 and Sierra Highway	1,034	3,870	48	52	-7%	46	51	-10%	2	0	2
11	2800	March 5, 2013	9:40 AM	Northeast Corner of Avenue Q-6 and Sierra Highway	1,048	5,545	48	52	-7%	47	51	-8%	1	0	1
12	2950	January 11, 2013	10:15 AM	East side of Alton Drive +/-605' south of Spanish Broom Drive	1,256	2,971	76	77	-1%	66	73	-10%	10	4	6

1) The flow shown is the calculated flow at the gauging hydrant with a 20 PSI residual. Value is not used in calculations

Figure 6-2- Hydrant Test Locations

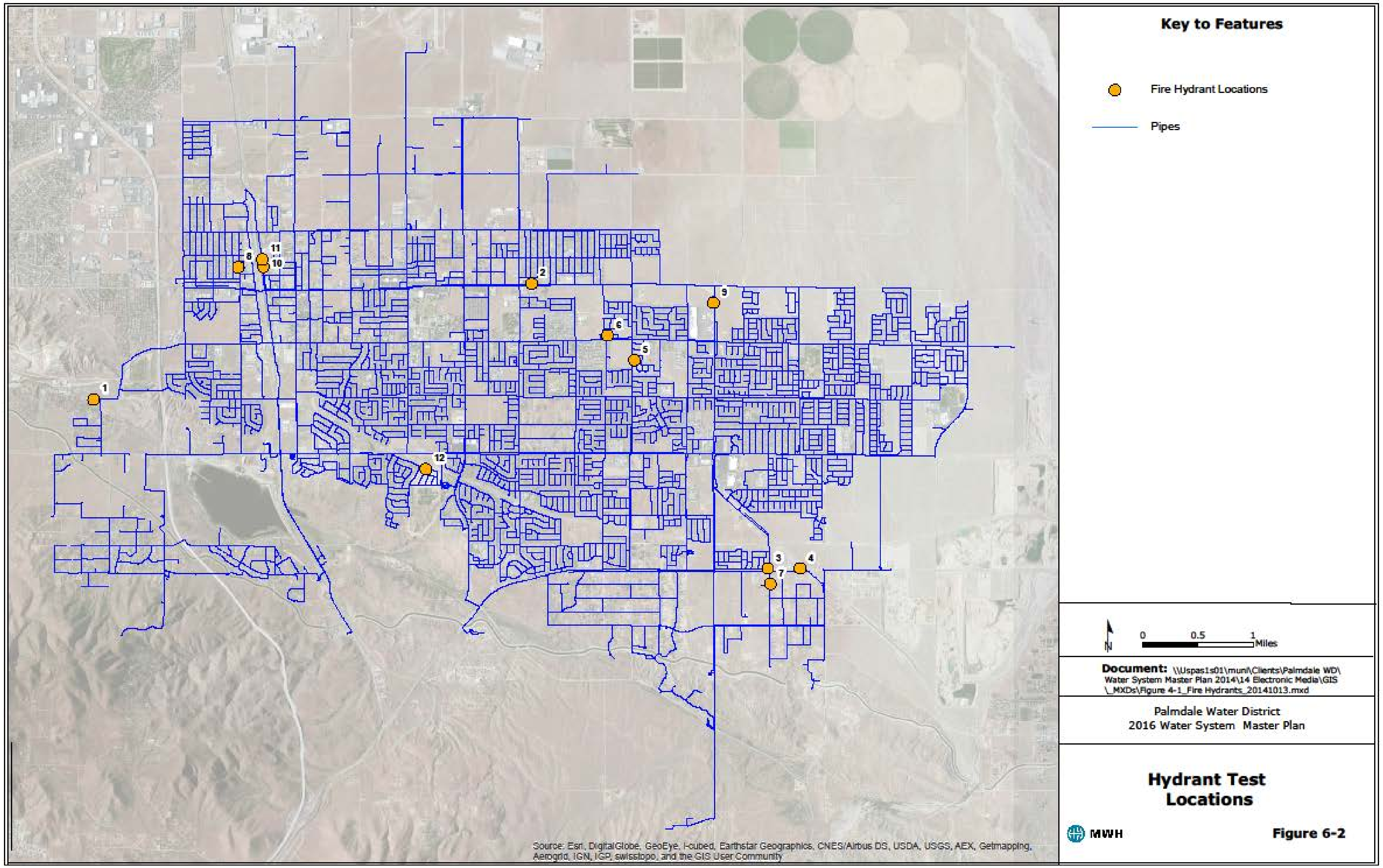
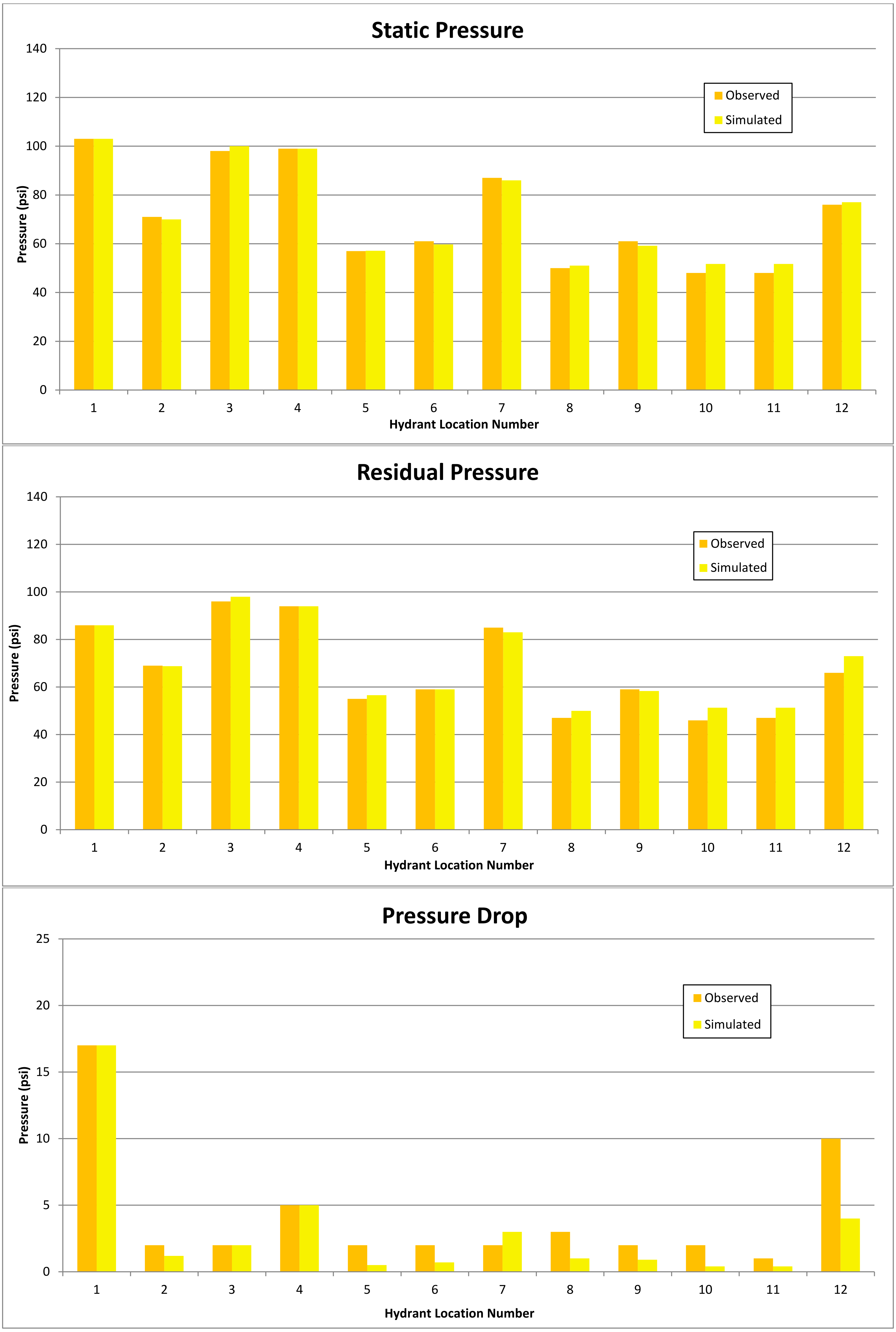


Figure 6-3
Hydrant Testing Pressure Comparisons



variation might just be due to tank level differences on the test day. Test location 12 in the 2950 zone is the only location that is slightly concerning. Because there are many PRV's leading from the 3000 zone to the 2950 zone, it is very possible that a PRV setting is different in the field than in the model. Without flows recorded at PRV stations, MWH recommends that during future fire flow tests in the 2950 zone, they also have staff record pressures at nearby PRV locations to ensure they are flowing correctly.

6.2.2 Extended Period Simulation

A model calibrated for a steady-state scenario provides an instantaneous snapshot of a water distribution system. As steady state modeling does not involve time-steps, the behavior of a water distribution system over time cannot be analyzed. An extended period simulation (EPS) model provides a better understanding of the operations of a water distribution system than a steady state model. The goal of the EPS calibration is to estimate the accuracy with which the model simulates the field operations over a 24-hour period. The EPS calibration is performed for the 24-hour period between midnight July 24, 2014 and midnight July 25, 2014, approximating operations on a peak summer day. The total water production on this day is calculated to be 18,600 gpm (26.8 MGD). This is equal to 1.43 times the Average Day Demand (ADD) for the 2011-2013 time period.

The model results are compared with the SCADA data to determine if the model reflects the actual system operating conditions over a 24-hour period. The modeled versus field data for the storage tanks, booster stations, several PRVs, and groundwater wells on calibration day are presented in **Appendix D**.

In order to achieve a balanced and calibrated model, the following adjustments are made in the model:

- Adjust facility controls for pumps based on observed tank level data - For example, based on discussions with PWD operations staff, the tank levels at which certain pumps turned ON had been adjusted from last year during the calibration day.

- Adjust pump curves of the Upper El Camino and Clearwell 2800 – Based on SCADA flow data, the booster pumps appear to be pumping approximately significantly lower than the pump curve would indicate. Under the calculated pump curves, flows are too high to match recorded flows or pressures are significantly impacted. With the adjusted pump curves, the flow results seem to mimic the data recorded on SCADA.

- Simulate a partially closed valve or other constriction between Walt Dahlitz Tank and Lower El Camino Tank to account for the tanks equilibrating in the model which was not observed in the SCADA data.

- PRV settings are too high in many instances. Because there is not any metering at most of the PRV locations, the settings are reduced to minimize flows and to simulate the lower pressures observed. This is a conservative measure to ensure deficiencies found in the system analysis can be viewed as actual deficiencies. Where setting change recommendations are used to address deficiencies, MWH will request further field analysis by PWD staff to gather additional pressure readings at PRV locations.

6.3 Calibration Conclusions

The American Water Works Association (AWWA) Manual of Water Supply Practices M32 provides guidelines for computer modeling of water distribution systems. These guidelines include Hydraulic Grade Line (HGL) predictions and water level fluctuation predictions. HGL predictions by the model should be within 5 to 10 feet of those recorded in the field which is equivalent of 2.2 to 4.3 psi. The tank water level fluctuations predicted by the model should be within 3 to 6 feet of those recorded in the field. The lower accuracy range in these guidelines can typically be applied to models used for design and operational evaluations while the higher accuracy guideline (4.3 psi) is typically applied to models used for long range or master planning.

Based on the above mentioned guidelines, a majority of the system is believed to be well calibrated for long term master planning purposes. The static validation met the guidelines for long range or master planning on by nearly every measurement, and the modeled results are considered acceptable since these are older tests and the operating conditions at the time of the tests could not be determined. While this model can be used for long term planning, it is important to understand the limitations of the model are due to the input data used to develop the model. The following list gives possible causes for the discrepancies between the model and field data.

- Temporal variation in demand between EPS and steady state calibration days. The diurnal curve created for the calibration day is also used to determine demand at each hour for the fire flow tests. However, customer demands change from day to day and hour to hour resulting in different diurnal curves on different days.
- Demand variance in different pressure zones. A lack of sufficient flow meter data for each pressure zone of the system results in the use of a generalized diurnal curve for the entire system. With individual pressure zone diurnal curves, a more accurate demand pattern can be simulated.
- Inaccuracies in elevation data. Elevations used throughout the system for junctions, pump stations, and valves are based on ground elevation taken at one third arc second resolution from the NED. Elevation above or below ground level for instrumentation or hydrants are not accounted for except at facilities as provided by PWD.
- Inaccuracies in pump curves: PWD has limited information on pump curves at some facilities; therefore, the model creates a generic pump curve based on a single operating point. This can drastically affect the flow versus head relationship for each pump station resulting in flow or head variances from field conditions.
- Unknown groundwater level: The groundwater elevations used throughout the system are based on the depth of water during the calibration month (July 2014). However, groundwater drawdown can vary depending on the number of wells pumping and the static groundwater level conditions. These factors introduce additional inaccuracies in the model.

Based on the findings from the steady state validation and the EPS calibration, the following items are recommended to improve and refine the predictive capability of the model in the future:

- Install flow meters at remaining booster stations and PRVs between zones that currently do not have flow meters. Flows at these meters should be relayed to PWD's SCADA system.
- Utilize manufacturer's pump curves rather than design point curves for the few pumps missing this data in the hydraulic model.
- Perform fire flow tests in in the area between the Clearwell tank and the Lower El Camino Tank in the 2950 Zone.
- Check metering equipment at the Clearwell boosters for accuracy of pressure and flow data reported to SCADA.
- When drought is less of a concern, perform fire flow tests in each zone in a one or two day period to conduct a more comprehensive static calibration when pump and tank status are being recorded.

SECTION 7 PLANNING CRITERIA

This section presents the design criteria and methodologies for analysis used to evaluate the existing distribution system and its facilities and to size future improvements.

7.1 Design Criteria

Planning criteria are established for the evaluation of Palmdale Water Districts (PWD) potable water system. Peaking factors for PWD's system are determined based on a review of daily production data for the years 2009 to 2013. The criteria are developed using the typical planning criteria used in the systems of similar water utilities, local codes, engineering judgment, and commonly accepted industry standards. The "industry standards" are typically ranges of values that are acceptable for the criteria in question and, therefore, are used more as a check to confirm that the values being developed are reasonable. The design criteria and analytical methodologies used to conduct this evaluation are presented in **Table 7-1**.

Table 7-1
Water System Evaluation Criteria

Description	Value	Units
Maximum Pressure	120	psi
Minimum Pressure		
Maximum Day	40	psi
Peak Hour	30	psi
Minimum Pressure with Fire Flow	20	psi
Maximum Pipeline Velocity (Existing Pipelines)		
Transmission Pipelines (10-inch dia. and greater)	8	fps
Distribution Pipelines (<10-inch dia.)	6	fps
Pump Stations	10	fps
Maximum Pipeline Velocity (Future Pipelines)		
Transmission Pipelines (10-inch dia. and greater)	6	fps
Fire Fighting Capabilities		
Parks (2 hrs)	1,250	gpm
Single Family Residential (1 du/acre or less, 2 hrs)	1,250	gpm
Single Family Residential (1-2 du/acre, 2 hrs)	1,250	gpm
Single Family Residential (greater than 2 du/acre, 2 hrs)	1,250	gpm
Medium Residential (2 hrs)	2,000	gpm
Multi-Family Residential (3 hrs)	3,000	gpm
Commercial (3 hrs)	3,000	gpm
Schools and Public Facilities (3 hrs)	3,000	gpm
Lockheed Martin (4 hrs)	3,600	gpm
Industrial (4 hrs)	4,000	gpm
Emergency Reservoir Storage Volume	100 % of MDD	MG
Operational Reservoir Storage Volume	25% of MDD	MG

Description	Value	Units
Fire Fighting	Highest fire flow requirement per zone under MDD	MG
Pump Efficiency Requirements	60%	
Supply Capacity		
Entire System	Provide MDD with largest well source out of service	
By Pressure Zone	Provide MDD with firm transfer/booster capacity between zones	
Tank Replenishment	Provide sufficient supply and transmission capacity to balance reservoirs in 24 hours	
System Reliability		
Pipe Breaks	Maintain Service with a single transmission pipeline out of service	
Single Largest Well Source Out of Service per Pressure Zone	Maintain service for 7 days with largest well source out of service	
Replenishing Empty Tanks	Replenish empty tanks in 3 days with total pumping capacity	

7.1.1 System Pressures

Minimum system pressures are evaluated under two different scenarios: Peak Hour Demand (PHD) and Maximum Day Demand (MDD) plus fire flow. The minimum pressure criterion for normal PHD conditions is 40 pounds per square inch (psi), while the minimum pressure criterion under MDD with fire flow conditions is 20 psi. The pressure analysis is limited to demand nodes, because only locations with service connections need to meet such pressure requirements. Lower pressures are acceptable for junctions at water system facilities and on transmission pipelines that have no service demands; however, no pressure shall be less than 5 psi except for short lengths near reservoir inlets and outlets where the water main is on premises owned, leased or controlled by the PWD.

7.1.2 Pipeline Velocities

Pipeline velocities are evaluated for the future system for three different conditions as listed in **Table 7-1**. The maximum velocity for distribution system pipelines is 6 feet per second (fps) provided that the system pressures are sufficient. This criterion is intended to minimize head loss. This criterion does not apply to flow in fire hydrant laterals. New distributions system pipelines (≤10-inch in diameter) within the PWD's system shall have a maximum design velocity of 6 fps under MDD conditions. The maximum velocity for transmission pipelines (> 10-inch in diameter), or suction pipelines at booster stations, should be 8-10 fps under MDD conditions based on trade-offs between pipeline cost and energy usage. The design velocity for transmission mains should consider energy requirements and pipeline length to determine the optimal diameter rather than use a fixed velocity criterion.

7.1.3 Storage

The total storage required for a water system is evaluated in three parts: 1) storage for operational use 2) storage for firefighting and 3) storage for emergencies. These three components are determined by pressure zone in order to evaluate the ability of the water system to meet the storage criteria on both an inter-zone basis as well as a system-wide basis. These three storage components are discussed in more detail below.

7.1.3.1 Operational Storage

Operational storage is defined as the quantity of water that is required to balance daily fluctuations in demand and water production. It is necessary to coordinate the water source production rates and the available storage capacity in a water system to provide a continuous treated water supply to the system. Water systems are usually designed to supply the average demand on the maximum day and use reservoir storage to supply water for peak hour flows that typically occur in the mornings and late afternoons. This operational storage is replenished during off-peak hours that typically occur during nighttime, when the demand is less. The American Water Works Association (AWWA) recommends that an operational supply volume ranging from one-quarter to one-third of the demand experienced during one maximum day. It is recommended that each pressure zone have an operational storage of at least 25 percent of MDD.

7.1.3.2 Fire Flow Storage and Criteria

The fire flow requirements for the various land use types are listed in **Table 7-1**. Fire flow storage is determined based on the highest fire flow requirement of each pressure zone multiplied by the corresponding duration. The fire flow duration is dependent on the fire flow criteria and is based on the LA County Regulation 8 Fire Flow requirements. For flows less than or equal to 2,500 gpm, the fire flow storage volume is based on a duration of 2 hours. Similarly, for flows of 4,000 gpm and greater, a duration of 4 hours is used.

For example, if the highest fire flow of a zone is 4,000 gpm for duration of 4 hours, the required fire flow storage for that zone is 0.96 million gallons (MG). For analysis purposes, it is assumed that there will only be one fire per pressure zone at any one time.

7.1.3.3 Emergency Storage

The volume of water that is needed during an emergency is usually based on the estimated amount of time expected to lapse before the emergency is corrected. Possible emergencies include earthquakes, water contamination, several simultaneous fires, unplanned electrical outages or pipeline ruptures or other unplanned events. The occurrence and magnitude of emergencies are difficult to predict; therefore, the emergency storage criterion is based on past experience and engineering judgment. Typically, emergency storage is set as a percentage of MDD. However, this percentage needs to be based on the water system layout and facilities. Water systems that have only once source of supply are more vulnerable in emergencies such as an earthquake or supply outage than water systems with a large number of groundwater wells that are located throughout the distribution system. For the purposes of the Water System Master Plan (WSMP), MWH has assumed that the emergency storage criterion for PWD system is 1.0 times MDD.

7.1.4 Supply Capacity

The water supply reliability is evaluated for the entire system and on a pressure zone basis using a spreadsheet model that calculates the water supply balance by pressure zone including zone transfers. The firm well capacity, all wells with the exception of the largest well, is used as the available groundwater supply for most scenarios. The system demands should be met under MDD conditions with the largest well source out of service. The hydraulic model is used to verify that 1) the system can move water between zones according to the required transfers calculated using the spreadsheet model, 2) system pressure criteria are met, 3) that transfer requirement are met using the firm capacity of booster station and 4) that all storage tanks replenish in a 24-hour period.

7.1.5 System Reliability

Four evaluation criteria are established for the system reliability evaluation. PWD should have adequate source water to:

- Maintain service with a single transmission pipeline out of service during MDD conditions
- Maintain service for 7 days with single largest well source out of service during MDD conditions
- Replenish empty tanks in three days with total pumping capacity of booster station

The intent of these reliability criteria is to identify storage needs during these emergencies to provide reliable service to the customers.

PWD's system is evaluated against these criteria and results are presented in the existing system evaluation section of this report.

SECTION 8 EXISTING SYSTEM EVALUATION

This section describes the evaluation of the existing water distribution system for Palmdale Water District (PWD). The system is first evaluated for hydraulic deficiencies in the distribution pipelines using the hydraulic model. Following the hydraulic evaluation, existing system storage analysis and existing system supply analysis ensure the reliability of the system. Existing system recommendations are made where hydraulic deficiencies are identified. Future system recommendations are made in **Section 9**.

Scenarios for fire flow analyses are not performed as part of this Water System Master Plan (WSMP) per the scope of work. The fire flow related recommendations from the previous master plan are included in this section for reference but were not re-evaluated by MWH.

The design criteria and analytical methodologies used to conduct the existing system evaluation are presented in detail in **Section 7** of this WSMP. Recommendations are made for each of these evaluations, which are combined in a summary of recommendations and proposed improvements at the end of this section.

8.1 Existing System Transmission Analyses

The distribution system transmission analyses consisted of identifying pressure and velocity deficiencies. Low-pressure deficiencies can lead to customer complaints, while high-pressure areas can lead to leaks and potential breaks in the distribution system. High velocity can cause leaks and excess headloss, which increases the required pump power and increases the pumping operational cost.

The PWD hydraulic model is used to evaluate system pressures and velocities for the following scenarios:

- Minimum Pressure: Meet Maximum Day Demand (MDD) while maintaining a minimum pressure of 40 pounds per square inch (psi) at all demand junctions and meet Peak Hour Demand (PHD) while maintaining a minimum pressure of 30 psi at all demand junctions.
- Maximum Pressure: Meet Minimum Day Demand (MinDD) while not exceeding a maximum pressure of 120 psi.
- Maximum Velocity: Meet MDD while maintaining pipeline velocity less than six feet per second (fps) for distribution pipelines (<10-inch dia.) and less than eight fps for transmission pipelines (10-inch dia. and greater).

8.1.1 Minimum Pressures during Maximum Day Demand (MDD)

For minimum pressure analysis, the model is run for 24 hour extended period simulation under MDD conditions using the diurnal curve developed during model calibration. This scenario provides the analysis of general system pressures on a maximum day and includes the pressures seen at the peak hour on the maximum day. As described earlier in this section, the minimum pressure criterion during MDD is 40 psi, and the minimum pressure criterion during PHD is 30 psi. This criterion does not apply to junctions on transmission mains or junctions at water facilities (such as reservoirs, wells, etc.) provided the minimum pressure at such locations exceed 5 psi (consistent with Division of Drinking Water regulations). The evaluation is performed for all of the roughly 17,800 junctions in the system, although not all of these junctions have their own demand. The hydraulic simulation identified 33 demand junctions with pressures below 40 psi. Minimum pressures at these 33 demand junctions varied between 27 and 38 psi. Thirty-one of the deficient junctions have a minimum pressure above 33 psi and only two fall below 30 psi on the maximum day. All demand junctions with pressures below 40 psi are shown in **Figure 8-1**.

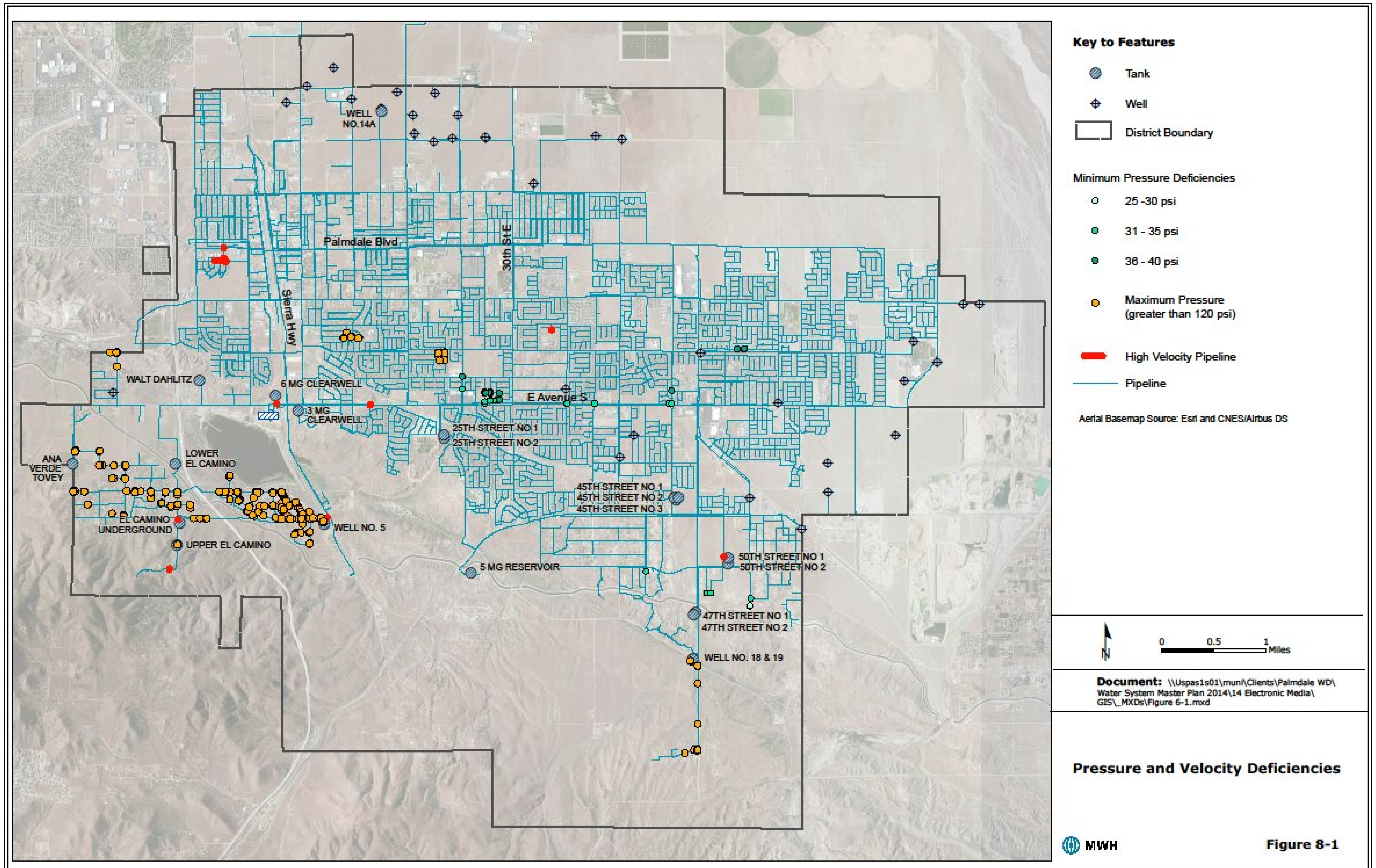
A majority of the junctions fall within two areas within the 2800 and 3000 pressure zones. In each of these areas, the existing pipeline diameters are large and often already contain loops. There are no pipelines causing unreasonable headloss for the area. The two junctions under 30 psi pressures are adjacent to each other and at an elevation that would provide a maximum pressure of 35 psi if the 3000 zone tanks were always full and there was no headloss in the system. Based on the elevations at the junctions and the tank elevations, there are not any reasonable recommendations to the existing system that will improve the pressures at these locations significantly enough to justify the cost of improvement. MWH recommends that the district staff compare customer complaints of low pressure with the map presented in **Figure 8-1**. If few complaints are received and reliable fire flows can be provided, no improvements need to be made.

8.1.2 Maximum Pressure during Minimum Daily Demand (MinDD)

The hydraulic model is also used to identify areas where the maximum pressure exceeds 120 psi. This evaluation is conducted under MinDD conditions. There are 331 demand junctions or approximately two percent of the system where the system pressures exceed 120 psi. High pressures at these demand junctions vary between 120 psi and 260 psi. These high-pressure areas are depicted along with the low-pressure junctions in **Figure 8-1**. High-pressures are mostly found in the lowest portions of the pressure zones where the static pressures increase due to lower ground elevations. High pressures can cause leaks in the distribution system as well as increased risk of pipe breaks.

These high-pressure areas can be remedied by creating a new pressure zone with a lower HGL than the HGL of the parent pressure zone. Based on discussions with the PWD’s Operations staff, these high pressures shown on **Figure 8-1** do not affect normal distribution system operations. Therefore, no changes to pressure zone boundaries are recommended. It is assumed that individual pressure regulator valves are installed in these areas to reduce pressures to 80 psi as required by the Uniform Plumbing Code. Future developments in these parts of the system should also include the installation of pressure regulators.

Figure 8-1
Existing System Pressure Deficiencies and high velocity pipelines



8.1.3 Maximum Velocity during MDD

For maximum velocity analysis, the hydraulic model is run in a 24 hour extended period simulation under MDD. High velocity pipelines in a pressurized system can cause water quality, maintenance, and efficiency issues. High velocity can scour pipe lining and cause leaking in valves and increases headloss, which requires more power for pumping and reduced pressures in the system.

The model shows that 43 pipe segments out of nearly 19,200 segments exceed the recommended maximum velocity. Most of these pipeline segments are very short segments that lead to or from pumping stations, PRVs, and tanks. An analysis of the pipelines near facilities and the few that are not located near facilities revealed that there is not significant headloss to require replacement in the near term. **Figure 8-1** shows the pipelines that exceed the maximum velocity recommendation in the system. These pipelines are important to document so that when pipelines are replaced at the end of design life or for system expansion, they are replaced with a larger pipeline. At this time, none of the high velocity pipelines should be replaced based on the existing system demands.

8.2 Existing System Storage Evaluation

The existing system storage evaluation compares the existing distribution system storage with the total required storage to evaluate if any deficiencies in storage exist. The existing system storage analyses are performed for the entire system and for each pressure zone. Storage criteria are discussed earlier in **Section 7**.

The existing distribution system contains 20 storage reservoirs with a total storage volume of approximately 49.8 million gallons (MG). However, the 6MG reservoir at the water treatment plant is not used in the storage evaluation since pumping is required for this tank to supply water to other zones. The 6MG reservoir cannot gravity supply any zones. Therefore, there is only 43.8 MG of storage volume assumed in the existing storage evaluation. The total required storage is a combination of three components:

1. Operational storage,
2. Fire flow storage, and
3. Emergency storage.

As mentioned earlier in **Section 7**, the operational storage criterion is set at 25 percent of MDD for the PWD system. Fire flow storage criterion is set to provide sufficient water for the highest fire flow requirement and fire duration of the zone evaluated. Emergency storage criterion is set at 100 percent of MDD. The total required storage is compared with the actual storage for the entire system and by pressure zone. **Table 8-1** shows a summary of the required and available storage volumes by pressure zone. **Table 8-1** indicates that PWD has a net surplus of approximately 1 MG in storage capacity for the existing system.

Table 8-1
Existing Potable Water System Storage Capacity Evaluation

Pressure Zone	Reservoirs	ADD of Zone (MGD)	MDD of Zone (MGD)	Fire Fighting Requirements		Fire Storage[1]	Operational Storage	Emergency Storage	Total Volume Required (MG) [2]	Existing Storage Tank Volume (MG)	Surplus/ Deficit Storage (MG)	Recommendation
				Fire Flow Required (gpm)	Fire Duration (hrs)	(MG)	25% MDD (MG)	100% MDD (MG)				
3600 [4]		0.02	0.04	1,250	2	0.15	0.01	0.04	0.20	0	**-0.20**	1.0 MG Storage Tank (ES-01)
3400W	Upper El Camino	0.13	0.23	1,250	2	0.15	0.06	0.23	0.44	0.30	**-0.14**	PRV from 3600
3400E and 3250	Well # 18 & 19	0.10	0.19	3,000	3	0.54	0.05	0.19	0.86	0.04	**-0.73**	3.1 MG Storage Tank in 3250 zone (ES-02)
3200	Well # 5, Ana Verde Tovey, and El Camino Underground	0.26	0.46	3,000	3	0.54	0.12	0.46	1.12	1.80	0.68	
3000	47th street and 5MG	1.87	3.36	3,000	3	0.54	0.84	3.36	4.74	10.00	5.26	
2950	Walt Dahlitz and Lower El Camino	4.40	7.92	4000	4	0.96	1.98	7.92	10.86	3.60	**-7.26**	4.2 MG Storage Tank (ES-03) and PRV from 3000 zone
2850	50th Street	3.32	5.98	4000	4	0.96	1.50	5.98	8.44	8.00	**-0.44**	PRV from 3000 zone
2800	45th and 25th street	8.62	15.52	4000	4	0.96	3.88	15.52	20.36	20.10	**-0.26**	PRV from 3000 zone
		18.72	**33.70**			**4.80**	**8.42**	**33.70**	**46.92**	**43.84** [3]	**-3.08**	

1) Fire Storage is calculated by multiplying the Fire Flow Required (gpm) by the Fire Duration (hrs)
2) Total Volume Required is the summation of the Fire Storage, Operational Storage, and Emergency Storage
3) 6 MG Clearwell is unable to provide emergency storage since without a pump they are unable to provide supply for a zone.
4) Pressure zone only includes the existing demands and does not include the anticipated Quail Valley development demands

A zone-by-zone comparison of available and required storage depicts a 5.2 MG surplus in the 3000 Zone. The 2950, 2850, and 2800 Zones each have deficiencies, and the combined deficiency between these three zones totals 8 MG, although the largest deficit is in the 2950 Zone with a deficit of 7.26 MG. Under emergency conditions, these deficits in the 2950, 2850, and 2800 Zones can be covered by the surplus in the 3000 Zone, since there are PRV connections between the 3000 Zone and the 2950, 2850, and 2800 Zone. The analysis does not include the wells in the system, which almost all of the wells are in these three zones and provide a redundancy.

The 3600 and 3400W Zones do not benefit by the excess water in the 3000 or 3200 Zones since 3600 and 3400W Zones are at a higher elevation than the 3000 and 3200 Zones. The current system requires an additional 0.2 MG storage tank in the 3600 Zone. However, the newly anticipated Quail Valley development (described in more detail in **Section 9**) will require an additional 0.67 MG of storage in the 3600W Zone, and therefore a 1.0 MG storage tank is recommended in the 3600 Zone. The 3400E and 3250 Zones also do not benefit by the excess water in the 3000 or 3200 Zone and require approximately 0.9 MG of additional storage to meet existing needs.

Recommendations from the existing system storage evaluation are summarized below:

- Construct 1.0 MG of new storage in the 3600 Zone with the Quail Valley development.
- Construct 3.1 MG of new storage south of Well 18&19 Reservoir in the 3250 Zone. Construct two 1.55 MG tanks in the 3250 Zone. Only 0.73 MG storage capacity is required in 2015. However, by 2030 the required storage capacity will be up to 3.1 MG and it would be wise to build a larger tank now so that as demand rises there is sufficient capacity to meet it.
- Construct a 4.2 MG storage tank in 2950 Zone. The full deficit does not need to be covered since there is additional storage in the 3000 Zone that can be provided to the 2950 Zone during emergencies through existing PRVs.

A detailed phasing plan for the storage improvements is presented in **Section 10**.

8.3 Existing System Supply Analysis

A discussion of PWD's existing system supply sources and their adequacy under existing demand conditions is presented.

8.3.1 System-wide Supply Evaluation

A water supply analysis is performed to determine whether available water production capacity is sufficient to meet MDD with the largest single source of supply out of service. Under MDD conditions, the system has an excess supply of 14 MGD when the largest well is out of service. This surplus provides reliability to PWD customers and provides operational flexibility within the system, resulting in economical operations of the water system. A surplus also allows for future growth within the system. **Table 8-2** shows results from the system-wide supply evaluation.

Table 8-2
Water Supply Analysis – Existing Conditions

Well Production (MGD)	Treatment Plant Production (MGD)	Maximum Day Demand (MGD)	Surplus/Deficit Supply (MGD)
15.8 (13 firm)	35	34	14

8.3.2 Inter-Zone Transfer Evaluation

In addition to evaluating the supply and demand as a system, it is important that each zone has sufficient supply capacity to meet MDD in that zone in addition to transferring the water needed to supply higher pressure zones. In this analysis, a firm pumping capacity (i.e., largest pump at each pumping station is out of service) is used which ensures redundancy in the system.

Total supply available for a pressure zone from wells and booster pumps is compared with the total demand for the pressure zone, assuming the largest well and the largest pump at each station is out of service. The total demand in the pressure zone consists of MDD for the zone evaluated plus any water leaving the pressure zone through PRVs or booster pumps. Water supply surplus/deficit for the pressure zone is determined by subtracting the total demand by the firm pumping capacity for the pressure zone.

For hydropneumatic zones, the evaluation criterion used is MDD plus fire flow with all the pump units available. This criterion accounts for the fact that there is no storage available in the hydropneumatic zone, and that the peak flows need to be supplied by the pumps. Therefore, water supply surplus/deficit for the pressure zone is determined by subtracting the total demand and the fire flow required by the total pumping and well capacity.

A positive zone balance implies that sufficient pumping capacity is available in the zone to meet system demands, whereas a negative zone balance implies that there is a deficit in the pumping capacity for that zone under the evaluation criteria. For pressure zones without any existing storage, the booster pumping capacity should be sufficient to meet MDD and provide fire-fighting relief in that zone. **Table 8-3** shows the results of this evaluation.

Overall, the booster stations that transfer water to zones with storage reservoirs are all sufficient to provide the required flows. The only recommendations are to ensure that the hydropneumatic zones are equipped with fire flow pumps to ensure the zones have sufficient protection under these emergency conditions.

Recommendations from the existing system supply evaluation are summarized below:

- Add an additional fire flow pump in the following booster stations: 3600 Booster, 5 MG Booster, V-5 Booster, Palmdale Hill Booster, and Hilltop Booster

A detailed phasing plan for the booster improvements is presented in **Section 10**.

Table 8-3
Existing Potable Water System Zone Booster Evaluation

Pressure Zone	Pump Station	In-Zone MDD (gpm)	Higher Zone MDD (gpm)	Total MDD (gpm) [1]	Fire Flow Required (gpm)[2]	Total Pumping and Well Capacity (gpm)	Firm Pumping Capacity (gpm)[3]	Surplus/Deficit (gpm)[4,5]	Recommendation
3600[6]	3600 Ft Booster	28		28	1,250	257	127	-1,151.0	None (If ES-01 is constructed)
3400W	Underground	161	28	189	1,250	1,002	352	163.2	
3400[6]	V-5 Booster	11	0	11	3,000	136	0	-3,011.4	Fire Pump (EB-01)
3250[6]	Palmdale Hill Booster and T-8 Booster	118	0	118	3,000	1,296	796	-2,321.9	Fire Pump (EB-02)
3250A[6]	5 MG	4	0	4	1,250	1,388	790	-463.9	Fire Pump (EB-04)
3250C[6]	Hilltop Booster	6	0	6	1,250	136	96	-1,159.8	Fire Pump (EB-03)
3200	Lower El Camino and Well 5 Booster	312	189	501	3,000	2,553	1,401	900.4	
3000	45th Street (3000), 25th Street, Well 20	2,332	139	2,471	3,000	8,896	5,778	3,307.1	
2950	Clearwell 2950, 3MG and wells	5,500	501	6,000	4,000	12,931	6,865	864.7	
2850	45th Street (2850) and Wells	4,153	0	4,153	4,000	10,379	6,991	2,837.6	
2800	Las Flores Canyon	10,776	12,625	23,440	4,000	35,982	24,152	751.6	

1) The “Total MDD” = “In-Zone MDD” + “Higher Zone MDD”, which is the flow required to meet the demand for that particular zone.
2) The “Fire Flow Required” is the highest fire flow requirement for that particular zone.
3) The “Firm Pumping Capacity” is the capacity of a pump station with the largest pump at each pumping station is out of service.
4) The “Surplus/Deficit” = “Firm Pumping Capacity” – “Total MDD” for pressure zones with existing storage.
5) The “Surplus/Deficit” = “Total Pumping and Well Capacity” – “Total MDD” – “Fire Flow Required” for pressure zones without existing storage.
6) Pressure zones without existing storage.

8.4 Fire Flow Analysis (excerpt from 2006 Master Plan)

As part of this WSMP, MWH was asked to not reevaluate the fire flow scenarios. The fire flow results from the previous master plan are presented below and incorporated into the model. The remainder of **Section 8.4** is an excerpt from the 2006 Palmdale Water District Water System Master Plan prepared by Carollo Engineers in 2007. Table and figure references have been changed to match this current WSMP. Fire flow projects area 2 and 3 have already been completed, and therefore were removed from this WSMP.

Fire flows were assigned based on land use. Land use information was obtained from the City and the County within the water system service area. Land use categories were assigned to junction nodes based on land use in the vicinity with the highest fire flow. For example, a junction node adjacent to single family residential, multifamily residential, commercial, and industrial land uses would be assigned industrial land use category because the fire flow demand is highest for this land use category.

After assigning land use categories to junction nodes in this mode, fire flow demands were applied to these nodes based on land use type and fire flow demands listed in **Table 7-1**. Each junction node was analyzed in the model to determine if it could deliver the assigned fire flow with a 20 psi residual pressure in the system. In some cases, larger fire flows may have been distributed to multiple hydrants to demonstrate compliance with the criteria. This approach is more representative to the method used by fire fighters in the field because hydrants can rarely supply more than 3,000 gpm from a single hydrant. The single node fire flow is used in hydraulic modeling to simplify the analysis while yielding conservative results.

Results of the fire flow analyses are summarized by area and shown on **Figure 8-2**. These improvements, though summarized in **Table 8-4**, are not recommended for construction until after a special study evaluates the actual land use intensities and determines their need.

8.4.1 Pressure Zone 2800

Pressure Zone 2800 is the oldest section of the District's water system. The average year of pipeline installation is about 1950, bringing this portion of the water system to over 50 years old. As is typical of older pipelines, there are a number of undersized pipes that may not meet the system demands with fire flow and provide a 20-psi residual pressure.

8.4.1.1 Fire Flow Area 1

Area 1 is bounded by 37th Street on the east, 32nd Street on the West, Avenue Q on the South, and Avenue P-8 on the north. The area north of Avenue Q is generally categorized with industrial land use and thus this area was analyzed with a fire flow demand of 5,000 gpm. The main bottleneck was observed on the 12-inch pipeline on Avenue P-8. A separate scenario was created for this fire flow and demands were distributed to three water model junctions.

8.4.1.2 Fire Flow Area 4

The area in the vicinity of Avenue Q-6 between 12th Street East and 15th Street East is categorized with commercial land use. A 3,500-gpm fire demand was analyzed in this area. On the existing 6-inch line, the model showed that less than 1,500-gpm of supply can be provided at the 20-psi residual pressure.

8.4.2 Pressure Zone 2950

8.4.2.1 Fire Flow Area 5

The majority of the land use in this zone is single-family residential land use, which requires a 1,250 gpm at the hydrant. This fire flow area lies on Fort Tejon Road and 52nd Street East. An 8-inch pipeline from the north, which feeds this area, is reduced to two 6-inch pipelines. The headloss created in these 6-inch pipelines was too high, thus could not meet the required residual pressure. Only 800 gpm of supply can be provided. A new 16-inch pipeline could connect to the existing 16-inch pipeline on Fort Tejon Road. With this 16-inch pipeline, replacing the existing 6-inch pipeline, adequate fire flow and pressure can be supplied.

8.4.2.2 Fire Flow Area 6

The land use of this area is also single family residential and it lies on Avenue S-10 between 40th Street East and 42nd Street East. A single 6-inch pipe is the main source for the fire flow to the pipe network in this area. Only 500 gpm of flow can be supplied at the required residual pressure. A 50 feet pipe connection at 40th Street East and Avenue S-10 should be considered to tie the 16-inch pipeline to the 6-inch pipeline. Adequate fire flow and pressure was simulated in a scenario with the proposed pipeline.

8.4.3 Pressure Zone 3400

8.4.3.1 Fire Flow Area 7

The land use in this zone is all single family residential, which has a 1,250-gpm fire flow requirement. The model results indicated that there is [sic] a fire flow deficiency near Barrel Spring Drive and Camares Drive. A fire flow of about 1,100 gpm was obtained from the analysis. A proposed 8-inch pipeline may be installed north of the Barrel Spring Dr. The pipeline is about 1,280 feet long and the model showed that this would mitigate the fire flow deficiency in this area.

Figure 8-2
Existing System Fire Flow Recommendations (2006 WSMP, Carollo)

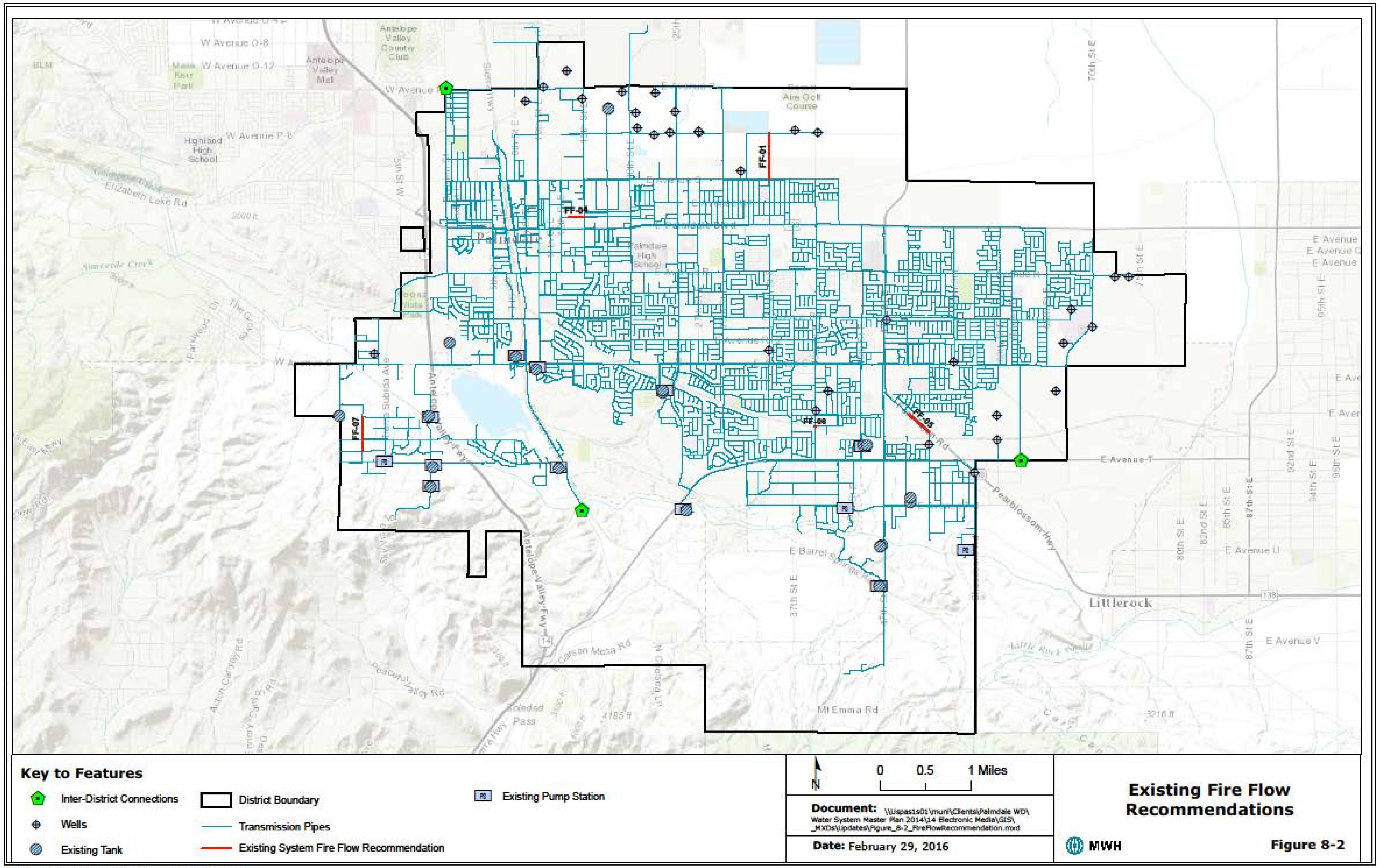


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Table 8-4
Tentative Improvements for Fire Flow Deficiencies (2006 WSMP, Carollo)

Pressure Zone	Fire Flow Area	Location	Deficient Model Nodes	Proposed Pipe(s)/Valve to Correct	Pipeline Diameters (in)	Pipeline Length (ft)	Proposed Facility [1]
2800	1	Avenue P-8 from 32nd St to 37th St	Nodes:25377, 23872, 23873, 25390, 25391	52140	12	600	New Pipe
				52141	12	380	New Pipe
				52142	12	645	New Pipe
				52143	12	680	New Pipe
				52147	12	370	New Pipe
	4	Avenue Q-6 between 12th Street East and 15th Street East	Nodes: 25011, 20436	51844	12	625	New Pipe
				54184	12	340	New Pipe
2950	5	52nd Street North and Fort Tejon Rd	Nodes: 16102, 14345	60049	16	1,570	New Pipe
	6	8" pipe on Avenue S-10 and 40th St East	Nodes: 12247	60051	8	48	New Pipe
3400	7	Camares Dr between Sierra Ancha Dr and Avenue S-14	Nodes: 14009, 14011	52332, 52259, 60048	8	1,400	New Pipe

1) Improvements are to be implemented only after a land use intensity analysis justifies their need.

8.5 Summary of Improvement Recommendations

Pressure and velocity deficiencies were evaluated for the distribution pipelines using the hydraulic model, and existing system storage analysis and existing system supply analysis were performed to determine deficiencies in storage and water supply between zones. Carollo Engineering in the 2006 WSMP performed fire flow analysis and recommendations. **Table 8-5** shows a summary of the deficiencies and existing system recommendations. The existing system storage and supply analysis resulted in recommendations to ensure capacity and supply of the system during emergencies.

Table 8-5
Summary of Existing System Improvement Recommendations

Existing System Evaluation	Deficiencies	Recommendations
Minimum Pressure under MDD and PHD	33 junctions are below 40 psi during MDD	If few complaints are received and reliable fire flows can be provided, no improvements need to be made.
Maximum Pressure under MinDD	331 junctions are above 120 psi during MinDD	Since the high pressures do not affect normal distribution system operations, no improvements need to be made.
Maximum Velocity under MDD	43 pipe segments exceed the maximum velocity of six fps for distribution pipelines and eight fps for transmission pipelines	Since there is no significant headloss to require replacement in the near term, no recommendations need to be made.
Existing System Storage	1.0 MG storage deficit in 3600, a 0.14 MG deficit in the 3400W Zone, a 7.26 MG storage deficit in 2950, and a 0.73 MG storage deficit in 3400E and 3250 Zone	Construct a 1.0 MG storage tank in the 3600 Zone, a 3.1 MG storage tank in the 3250 Zone, and a 4.2 MG storage tank in the 2950 Zone.
Existing System Supply	Water supply deficit in the 3400, 3250, 3250A, and 3250C Zones	Fire pumps are recommended for these four zones to provide water supply during emergency conditions, and these pumps will be used for future pumping capacity.
Existing System Fire Flow(1)	Seven areas of fire flow deficiency	Approximately 6,700 feet of new or replacement pipe recommended. Improvements are to be implemented only after a land use intensity analysis justifies their need.

1) Analysis performed by Carollo in 2006 WSMP

SECTION 9 FUTURE SYSTEM EVALUATION

This section describes the evaluation of the water distribution system under future demand conditions. Hydraulic deficiencies obtained through the model evaluation are identified and infrastructure improvements to address the deficiencies are recommended. The hydraulic model is used to create scenarios for 2030 and build-out. Transmission pipeline, booster pumping capacity, and storage recommendations are evaluated based on the criteria and demands described in **Section 3.** The recommended improvements discussed in this section are summarized in the Capital Improvement Plan described in **Section 10**. All recommendations to address existing system deficiencies presented in **Section 8** are implemented before performing future system analysis. This future system evaluation is based on the current production of the Palmdale Water District's (PWD's) Water Treatment Facility. Changes to infrastructure necessary to accommodate the proposed water bank are not included in this section.

9.1 Future System Supply Analysis

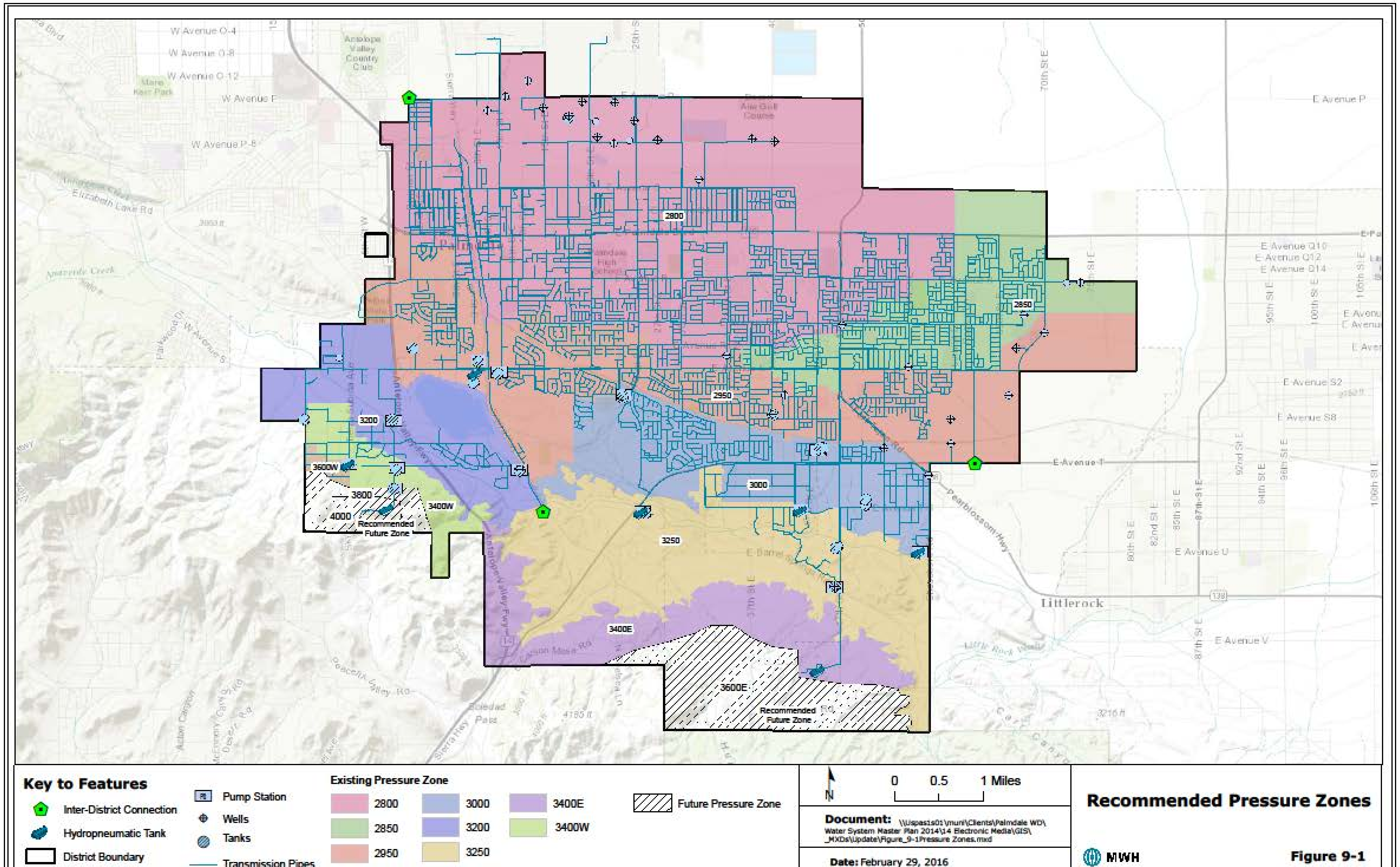
The existing water supplies for PWD consists of local surface water from Littlerock Creek Reservoir, imported surface water from the California State Water Project (SWP), and local groundwater pumped from PWD-owned wells in the Antelope Valley groundwater basin. Based on the future demand projections based on population that are presented in **Section 3**, the existing supplies should be sufficient through the 2030 demand horizon. While current supplies of potable water are expected to satisfy maximum daily demand, overall supply on a year-to-year basis must be planned for to prepare PWD for future dry years and possible cutbacks of available SWP water. Among other strategies, PWD is developing a groundwater banking program using recycled water and imported water to supplement its existing water supplies. This scheme is accounted for in the future system analysis presented in this section. An analysis of overall water supply and updated recommendations are presented in **Section 4** of this Master Plan update.

9.2 Future System Pressure Zones

As PWD's service area grows, it is important to have a pressure zone map based on topography to plan the best service options for new developments. In the existing system, pressures are planned within the range of 40 psi to 125 psi. As described in the Existing System Evaluation in **Section 8**, there are areas that fall outside of this range. Likewise, in future system zone delineation, there are some cases where pressures will be expected to fall outside the recommended boundaries to avoid very small PRV pressure zones or hydrostatic zones. Five pressure zones are added to the PWD system for the build-out scenario. **Figure 9-1** illustrates the new pressure zone configuration in the future system. These pressure zones are:

1. The 3400E Zone, located in the southeast end of the system and fed from the 3200 and 3250 Zone.
2. The 3600E Zone which is located in the far south of the system and is fed by 3400E Zone.
3. The 3800 pressure zone which is located in the south west portion of the system and fed by the 3600W Zone.

Figure 9-1
Future Pressure Zone Boundaries



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4. The 4000 Zone located in the south west portion of the system and fed by 3800 Zone.

In 2030, it is also assumed that the 3250 zone which is currently separated into three minor subzones (3250A, 3250B, and 3250C) will be combined into one 3250 zone. By 2030 it is assumed the distribution network will have grown and will be able to connect these three isolated zones.

9.3 Water Demand Projections

The PWD hydraulic model is used to analyze projected future conditions in the system. Two scenarios are analyzed in this master plan update to represent future conditions, the 2030 and build-out scenarios. For each of these scenarios, demands are developed as described in **Section 3** and assigned to their respective scenario in the model. Per discussion with PWD staff, the demands in the 2030 horizon are applied only to the existing zones but not including 3400W or 3600W. Demands for the build-out scenario are applied to all zones in the model, including the 3600E, 3800, and 4000 zones.

As described in **Section 3**, the demand for each vacant parcel is calculated using water duty factors and the parcel acreage. The 2030 demand scenario evaluates all vacant parcels located in the existing pressure zones as well as the 3400 and 3600W, but no parcels in the 3600E, 3800 and 4000 zones. At build-out, the demand will increase by 24,800 AFY for all vacant parcels from all zones. At build-out, the demand increase from all zones besides 3600E, 3800, and 4000 zones is roughly 21,430 AFY. However, to match the 2030 demand projections determined from the population analysis, only an additional 8,670 AFY of demand is added to the model in addition to the existing demands. The difference represents parcels that are not expected to develop until after 2030. However, because the specific parcels that will develop by 2030 are unknown, all vacant parcels in existing areas are considered when assigning future flows, but only a portion of the future demand of each vacant parcel is assigned to the model. The 2030 demand of each vacant parcel is determined by pro-rating the build-out demand of each vacant parcel based on the ratio of the 2030 additional demand to the additional demand at build-out (i.e. build-out parcel demand times 8,670 divided by 21,430). This results in 40 percent of the ultimate build out demand being applied for each parcel for 2030. The remaining demand (roughly 60 percent) generated from the vacant parcels based on land use was allocated during the build-out scenario.

The demands were generated for the Quail Valley development that will be implemented near-term. Quail Valley spans over three zones, the 3600W, 3400W, and 3200 zone. Irrigation demands were determined using the maximum allowed water allowance (MAWA) developed by landscape architects for the homeowners association (HOA) slopes, common amenity areas, and new recreational center. The demands from the 750 new houses were generated using equivalent dwelling units (EDUs), which associates an average demand use for each house. One EDU is equal to 500 gallons per day, and one single family house accounts for 0.8EDUs, which means each house is assumed to use 400 gallons per day. Since Quail Valley spans over multiple zones, the demands from the houses and irrigation were dispersed over the three zones based on the assumed geographic location of the demands.

Demands in the model are allocated to the closest pipeline for each parcel. For areas of new growth (i.e. expansions to the system) projected demands from new parcels are assigned to those new pipelines in the system as determined in the Draft 2006 Water System Master Plan. The process of how new pipelines were planned and added to, or updated in the model in the 2030 and build-out scenario are described in further detail in **Section 9.4**.

9.4 Future Distribution System Pipeline Analysis

The existing transmission system is updated to include the recommendations described in **Section 8** and analyzed using the future demands. The future PWD system includes growth in existing areas of the current system, as well as anticipated expansion of the system to currently unserved areas. As such, future transmission planned for the PWD system includes new or replacement pipelines in areas of current development, as well as new infrastructure in areas where there are no current transmission pipelines.

As part of the previous Draft 2006 Water System Master Plan, an expansion to the transmission system was developed for 2030 and build-out scenario. These expanded networks are applied in this current master plan wherever possible. MWH evaluated these areas to ensure the previously recommended pipelines were appropriately sized to convey flow based on the updated demands discussed in **Section 3**. However, alternative alignments to the previously recommended infrastructure are not considered unless specifically requested by PWD.

The future expanded systems (2030 and build-out) in the hydraulic model are representative of where streets have been planned and thus the most likely locations for future pipelines. The proposed network contained in the Draft 2006 Water System Master Plan had anticipated dates of completion associated with the pipelines, starting from 2010 through 2040. This same projected transmission network is used in the current master plan's 2030 and build-out scenarios as an approximation to where the future pipelines will be constructed. Pipelines delineated in the 2006 model to be constructed prior to 2030 within the currently served zones are activated in the 2030 scenario during the future system analysis. All the pipelines in the future zones and pipelines projected to be constructed after 2030 are assumed to be constructed by build-out and are activated in the model for the build-out analysis.

The pipelines already provided in the model as part of the future system were initially assigned diameters as part of the previous 2006 analysis. These diameters are retained as originally provided in the model. However, the pipeline diameters are adjusted if a pipeline was previously undersized. The pipelines in the model are evaluated for head loss using the previous diameter to determine if they needed to be resized. The future distribution analysis focused on determining which parts of the previous (2006) recommendation required updating based on the revised water demands, as well as ensuring system reliability.

In addition to the expanded network, pipeline recommendations from the Draft 2006 Water System Master Plan included in-fill pipelines in currently served areas of the system. These in-fill pipelines provide redundancy and eliminate bottlenecks in the existing system. These recommendations are also evaluated for proper sizing during the 2030 future evaluation, and adjustments to pipeline diameters are made based on this analysis. In addition, pipelines no longer needed given the current demands assigned to the model, are eliminated from the list of recommendations.

Table 9-1 summarizes the total length of updated distribution pipeline recommendation by scenario (2030 or build-out), diameter, and purpose (2030 expansion, fire flow recommendation, velocity-based recommendation, rezoning recommendation, or build-out recommendation). In addition, **Table 9-2** summarizes the length of pipeline for infill recommendations included in the original 2006 Water System Master Plan that have been removed from the current model as no longer required given the updated demands and criteria conditions. **Table 9-3** summarizes all transmission improvements associated with infrastructure projects, such as new tanks, wells, PRVs, or pumping stations; these are delineated as either pumping station specific projects, or other projects (wells, tanks, or PRVs). **Figure 9-2** shows a map displaying all pipeline recommendations by planning horizon. Due to the large amount of infrastructure recommended (roughly 194 miles in total), pipeline recommendations were not given specific project names in the model, and are instead summarized by diameter and purpose of improvement in the tables below.

Table 9-1
Future Transmission Recommendations

Purpose of Improvement	Diameter (in.)	Total Length of Pipeline Recommended (ft.)
2030 Planning Horizon		
Expansion	6	910
Expansion	8	617,490
Expansion	10	930
Expansion	12	65,770
Expansion	14	100
Expansion	16	31,630
Expansion	18	1,030
Expansion	20	34,560
Expansion	24	10,280
Rezoning	6	340
Rezoning	8	2,410
Rezoning	10	570
Rezoning	12	2,960
Velocity Deficiency	12	2,720
Velocity Deficiency	16	100
Velocity Deficiency	20	540
Velocity Deficiency	24	1,590
Total 2030 (feet)	-	**773,930**
Total 2030 (miles)	-	**146.6**
Build-Out Planning Horizon		
Expansion	8	125,280

Purpose of Improvement	Diameter (in.)	Total Length of Pipeline Recommended (ft.)
Expansion	12	68,250
Expansion	16	10,070
Expansion	18	3,520
Expansion	20	3,790
Expansion	24	200
Total Build-out (feet)	-	**211,110**
Total Build-out (miles)	-	**40.0**
Total		
Total (feet)	-	**985,040**
Total (miles)	-	**186.6**

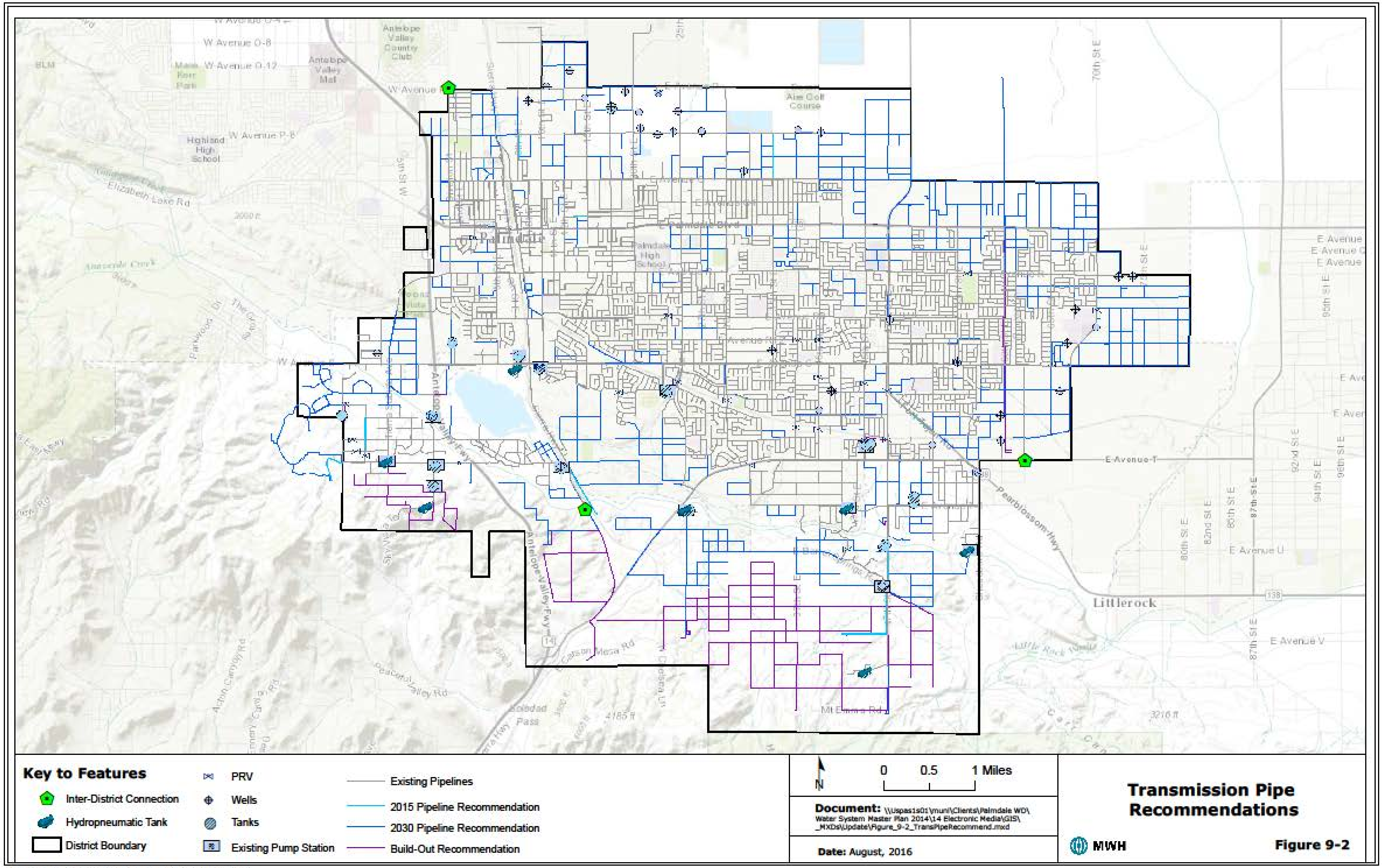
Table 9-2
2030 Infill Recommendations No Longer Required

Diameter (in.)	Total Length of Pipeline Recommended (ft.)
8	10,040
10	1,180
12	4,130
16	10,260
Total (feet)	**25,590**
Total (miles)	**4.8**

Table 9-3
Project-Based Transmission Recommendations

Purpose of Improvement	Diameter (in.)	Total Length of Pipeline Recommended (ft.)
2030 Planning Horizon		
Project	8	190
Project	30	280
Pump Station	8	240
Pump Station	12	1,290
Pump Station	16	860
Pump Station	20	22,860
Pump Station	24	3,780
Build-Out Planning Horizon		
Project	12	110
Project	16	170
Pump Station	8	1,320
Pump Station	16	500
Total		
Total (feet)	-	**31,600**
Total (miles)	-	**6.0**

\Figure 9-2
Future System Transmission Recommendations



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9.5 Future System Storage Evaluation

The storage and emergency supply analyses are performed for each pressure zone for the 2030 and build-out scenarios. Storage criteria are discussed in detail in **Section 7**. The total required storage is a combination of three components:

1. Operational storage,
2. Fire flow storage, and
3. Emergency storage.

The operational storage criterion is set at 25 percent of Maximum Day Demand (MDD) for the PWD system. Fire flow storage should provide sufficient water for the highest fire flow requirement of the zone evaluated. Emergency storage is set at 100 percent of MDD. The required storage is compared with the actual storage for the entire system and by pressure zone.

To analyze the required storage, a spreadsheet model is developed to analyze the storage on a zone by zone basis. The spreadsheet analyzes the ADD and MDD of each zone for the planning horizons of 2030 and build-out. Once the MDD of a zone is obtained, the operational storage, fire flow storage, and emergency storage are calculated and summed to equal the total storage required for a particular zone. The required storage is then compared with the existing storage in that zone to determine if the existing storage is sufficient or if additional storage is needed in the zone. A similar process is performed in **Section 8** of the report to analyze the existing storage deficiencies. The recommended storage improvements from the existing system evaluation are assumed to be constructed by 2030 and the storage improvements recommended for the 2030 planning horizon are assumed to be constructed in the build-out analysis.

A summary of the required and available storage volume by pressure zone for the 2030 and build-out scenarios are presented in **Table 9-4** and **Table 9-5**, respectively. PWD has a storage volume of 52.1 MG and a storage requirement of 64.3 MG in 2030, resulting in a net deficit of approximately 12.1 MG. At build-out, PWD has a storage volume of 66.6 MG and a storage requirement of 96.7 MG, resulting in a net deficit of approximately 30.1 MG. All storage recommendations to address these deficiencies are presented on **Figure 9-3** and listed in **Table 9-6**.

Table 9-4
Future System Storage Capacity Evaluation for 2030

Pressure Zone	Existing Reservoirs	ADD of Zone (mgd)(1)	ADD of Lower Zones (mgd)(1)	Total ADD (mgd)	MDD (mgd)	Fire Fighting Requirements (2)		Fire Storage (2)	Operational Storage (3)	Emergency Storage (4)	Total Volume Required (MG)	Existing Storage Tank Volume (MG)	Surplus Storage (MG) (5)	Recommendation
						Fire Flow Required (gpm)	Fire Duration (hrs)	(MG)	0.25 MDD (MG)	100% MDD				
3600W	Future Tank (ES-01)	0.25		0.25	0.45	1,250	2	0.15	0.11	0.45	0.72	1.00	0.28	None
3400W	Upper El Camino	0.38		0.38	0.68	1,250	2	0.15	0.17	0.68	0.99	0.30	-0.69	Construct 0.75 MG Tank (FS-05)
3400E		0.01		0.01	0.02	3,000	3	0.54	0.00	0.02	0.56	0.00	-0.56	Construct 2 MG Tank (FS-01)
3250(6)	Well No. 18 & 19 and 3250 Future Tank (ES-02)	1.15		1.15	2.07	3,000	3	0.54	0.52	2.07	3.12	3.14	0.02	None
3200	Ana Verde Tovey and Lower El Camino	0.73		0.73	1.31	3,000	3	0.54	0.33	1.31	2.18	1.80	-0.38	None - PRV from 3400W
3000	47th Street and 5 MG	2.16		2.16	3.88	3,000	3	0.54	0.97	3.88	5.39	10.00	4.61	None
2950	Well No. 5, Walt Dahlitz, Lower El Camino, and Future Tank (ES-03)	6.03		6.03	10.85	4,000	4	0.96	2.71	10.85	14.53	7.80	-6.73	Construct 5.7 MG Tank (FS-02) and PRV from 3000 Zone
2850	50th Street	3.86		3.86	6.94	4,000	4	0.96	1.74	6.94	9.64	8.00	-1.64	Construct 2.0 MG Tank (FS-03)
2800	45th and 25th Street	11.50		11.50	20.69	4,000	4	0.96	5.17	20.69	26.83	20.10	-6.73	Construct 4.0 MG Tank (FS-04) and PRV from 3000 Zone
		26.05		**26.05**	**46.89**			**5.64**	**11.72**	**46.89**	**64.26**	**52.14(7)**	**-12.12**	

1) Hydropnuematic and PRV zone demands are added to the larger gravity fed zones they are fed from
2) Fire flow based on highest estimated requirement per zone
3) Operational Storage equals 0.25 times MDD
4) Emergency Storage equals 1.0 times MDD
5) Surplus is positive and deficit is negative
6) 3250 Includes 3250A and 3250C
7) 6 MG Clearwell is unable to provide emergency storage since without a pump they are unable to provide supply for a zone.

Table 9-5
Future System Storage Capacity Evaluation for Build-Out

Pressure Zone	Existing Reservoirs	ADD of Zone (mgd)(1)	ADD of Lower Zones (mgd)(1)	Total ADD (mgd)	MDD (mgd)	Fire Fighting Requirements (2)		Fire Storage (2)	Operational Storage (3)	Emergency Storage (4)	Total Volume Required (MG)	Existing Storage Tank Volume (MG)	Surplus Storage (MG) (5)	Recommendation
						Fire Flow Required (gpm)	Fire Duration (hrs)	(MG)	0.25 MDD (MG)	100% MDD				
4000	None	0.21	0.24	0.46	0.83	1,250	2	0.15	0.21	0.83	1.18	0	-1.18	1.2 MG tank (FS-16)
3800	None	0.24		0.24	0.44									PRV from 4000
3600E	None	0.80		0.80	1.44	1,250	2	0.15	0.36	1.44	1.95	0	-1.95	2.0 MG tank (FS-06)
3600W	Future Tank (ES-01)	0.25		0.25	0.45	1,250	2	0.15	0.11	0.45	0.72	1	0.28	None
3400W	Upper El Camino and Future Tank (FS-05)	0.74		0.74	1.33	1,250	2	0.15	0.33	1.33	1.81	1.05	-0.76	0.75 MG tank (FS-07)
3400E	Future Tank (FS-01)	1.42		1.42	2.55	3,000	3	0.54	0.64	2.55	3.73	2.0	-1.73	1.8 MG tank (FS-08)
3250	Well No. 18 & 19 and 3250 Future Tank (ES-02)	2.71		2.71	4.87	3,000	3	0.54	1.22	4.87	6.63	3.14	-3.49	3.5 MG tank (FS-09)
3200	Ana Verde Tovey and Lower El Camino	1.20		1.20	2.17	3,000	3	0.54	0.54	2.17	3.25	1.8	-1.45	1.5 MG Tank (FS-10)
3000	47th Street and 5 MG	2.74		2.74	4.93	3,000	3	0.54	1.23	4.93	6.70	10.0	3.30	None
2950	Well no. 5, Walt Dahlitz and Lower El Camino, and Future Tank (ES-03) and (FS-02)	8.79		8.79	15.82	4,000	4	0.96	3.96	15.82	20.74	13.5	-7.24	7.3 MG Tank (FS-11)
2850	50th Street and Future Tank (FS-03)	4.92		4.92	8.85	4,000	4	0.96	2.21	8.85	12.02	8.0	-2.02	2.1 MG Tank (FS-12)
2800	45th Street, 25th Street, and Future Tank (FS-04)	16.43		16.43	29.58	4,000	4	0.96	7.40	29.58	37.94	24.1	-13.84	5.5 MG tank (FS-13), 6.0 MG tank (FS-14), and 2.4 MG tank (FS-15)
		40.46	**0.24**	**40.70**	**73.27**			**5.64**	**18.21**	**72.83**	**96.67**	**66.59(6)**	**-30.08**	

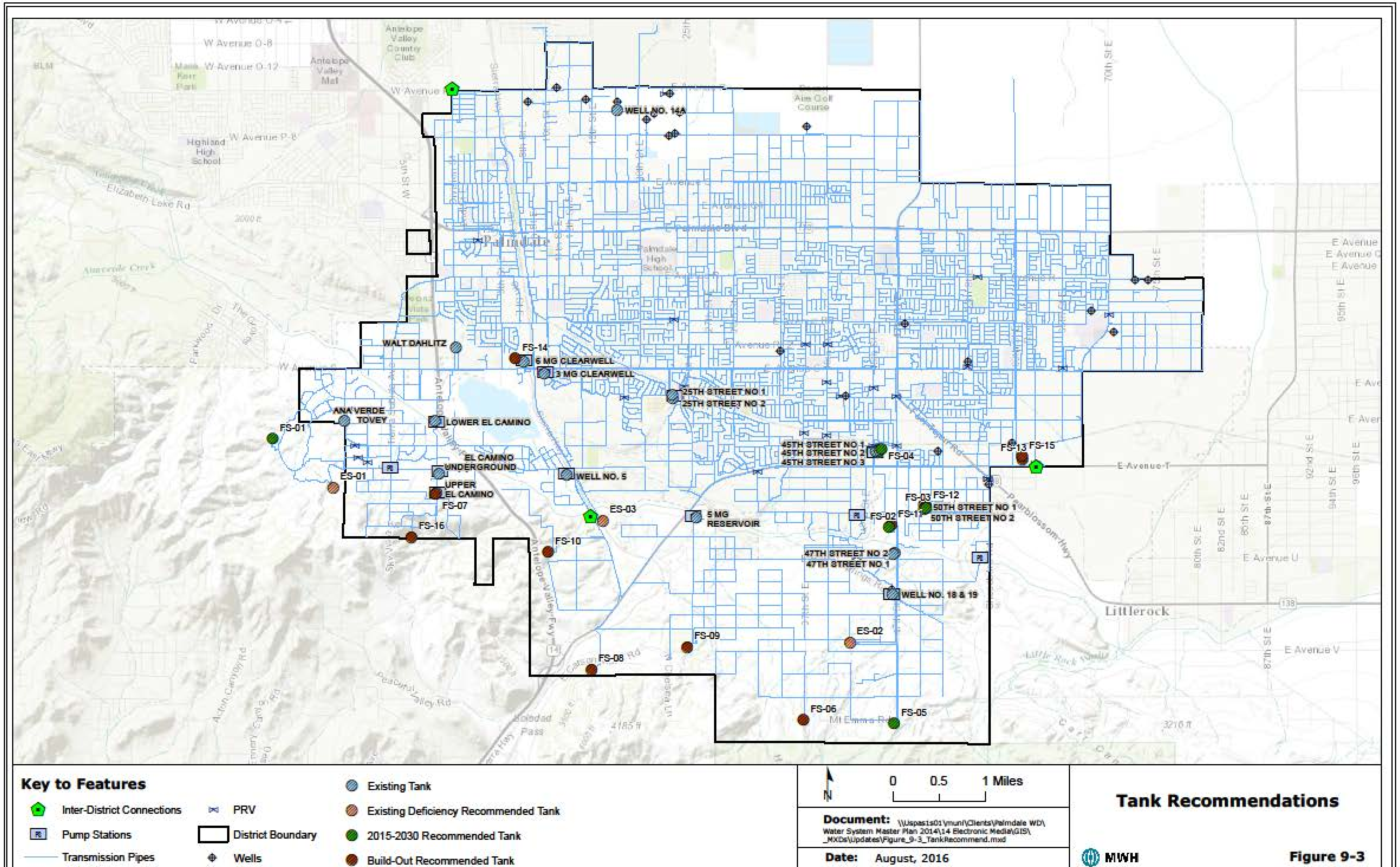
1) Hydropnuematic and PRV zone demands are added to the larger gravity fed zones they are fed from
2) Fire flow based on highest estimated requirement per zone
3) Operational Storage equals 0.25 times MDD
4) Emergency Storage equals 1.0 times MDD
5) Surplus is positive and deficit is negative
6) 6 MG Clearwell is unable to provide emergency storage since without a pump they are unable to provide supply for a zone.

Table 9-6
Future System Storage Recommendations

MAP ID	Location	Zone	Size (MG)	Phasing
FS-01	Quail Valley development	3400W	0.75	2020
FS-02	47th Street E south of E Avenue T-8	2950	5.7	2025
FS-03	East Avenue T-8 and 50 Street	2850	2.0	2030
FS-04	45 Street and Pearblossom Highway	2800	4.0	2030
FS-05	Mt. Emma Rd. and 47th Street E	3400E	2.0	2025
FS-06	East of Mt. Emma Rd.	3600E	2.0	Build-Out
FS-07	At existing Upper El Camino Tank	3400W	0.75	Build-Out
FS-08	E Carson Mesa Rd and N. Rough Rd	3400E	2.0	Build Out
FS-09	E Carson Mesa Rd and N Chelsea Ln	3250	3.5	Build Out
FS-10	East of CA-14 between Barrel Springs Rd. and Pear Blossom Hwy.	3200	1.5	Build-Out
FS-11	47th Street E south of E Avenue T-8	2950	7.3	Build-Out
FS-12	East Avenue T-8 and 50 Street	2850	2.1	Build-Out
FS-13	East Avenue T and 60 Street	2800	5.4	Build-Out
FS-14	At existing Water Treatment Plant	2800	6.0	Build-Out
FS-15	East Avenue T and 60 Street	2800	2.4	Build-Out
FS-16	Desert Springs Rd. and Tierra Subida Ave.	4000	1.2	Build-Out

Figure 9 3

Future System Storage Recommendations



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9.6 Future System Pumping Capacity

Similar to the evaluation of the existing system booster pumping capacity evaluation, it is important that each zone have sufficient pumping capacity to meet MDD in that zone while transferring the water needed to supply higher pressure zones for each demand horizon. In this analysis, a firm transfer capacity (i.e., largest pump at each pumping station is out of service) is used which ensures redundancy in the system.

The analysis is performed for each zone for the 2030 and build-out demand horizons, and is shown on **Table 9-7** and **Table 9-8**. Booster station recommendations based on the analysis performed for the 2030 and build-out demand horizons are presented in **Table 9-9** and on **Figure 9-4**. It is important to note that this storage analysis considers a 24-hour firm pumping capacity to meet demands and fire flow conditions and recommendations are sized based on a 24-hour firm capacity. Fire flow conditions are typically satisfied by storage tanks, and the ability to meet fire flow demands was calculated into the sizing of tanks as seen in **Table 9-4** and **Table 9-5** above. The recommended configuration at all pump stations is one duty pump plus one standby pump.

By 2030, a majority of the new demands were in the 2800, 2850, and 2950 Zone, with the most demand in the 2800 and 2950 Zone. The Quail Valley development will add demands to the 3200, 3400W, and 3600W Zones. The 2850 Zone has sufficient existing pumping so no more booster pumping is required by 2030. The 2950 Zone does not have sufficient pumping capacity to meet the 2030 demand, and therefore an additional pump at the existing Water Treatment Plant is required to meet these pumping demands. By 2030, the largest added demand will be in the 2800 Zone. However, no new pumping is required in the system since this large increase in demand will be supplied by the groundwater banking program. It is anticipated that the groundwater banking program will allow for an additional 12,000 gpm of total capacity, with a firm capacity of 9,000 gpm to be delivered to the 2800 Zone. The Quail Valley development will require additional pumping to the 3200, 3400W, and 3600W Zone.

At build-out, almost all zones are deficient in pumping. New pump stations are recommended for pumping into new zones. Additional pumps for existing zones were typically added at existing pump stations. However, in some cases new pump stations were created to diversify the pumping into a zone and provide redundancy to the system. New pump stations would have one duty pump plus one standby pump, so that the firm capacity of the pump station would be able to satisfy the pumping demand.

Table 9-7
Booster Station Capacity Evaluation for 2030

Pressure Zone	Pump Station	In-Zone MDD (gpm)	Higher Zone MDD (gpm)	Total MDD (gpm) [1]	Fire Flow Required (gpm)[2]	Total Pumping and Well Capacity (gpm)[3]	Firm Pumping Capacity (gpm)[3,4]	Surplus/ Deficit (gpm)[5]	Recommendation
3600W	3600 Ft Booster	316		316	1,250	257	127	-189	New pump at 3600 Ft. Booster (FB-01) (300 gpm)
3400W	Underground Booster	469	316	785	1,250	1,002	352	-433	New pump at Underground booster station (same size as existing pump (FB-02) (650 gpm))
3400E	V-5 Booster and Fire Pump (EB-01)	11		11	3,000	3,636	1,875	1,875	None
3250[6]	Palmdale Hill Booster and T-8 Boosters, 5 MG Booster, and Hilltop Booster and Fire Pumps (EB-02, EB-03, and EB-04)	1,436		1,436	3,000	7,820	2,820	1,384	None
3200	Lower El Camino and Well 5 Booster	911	785	1,696	3,000	2,553	1,401	-295	New Pump at Lower El Camino pump station (FB-03) (1,000 gpm)
3000	45th Street (3000), 25th Street, Well 20	2,695	1,446	4,142	3,000	8,896	5,778	1,636	None
2950	Clearwell 2950, 3MG and Wells	7,537	1,696	9,233	4,000	12,931	6,865	-2,368	New Pump at WTP (FB-04) (2,000 gpm)
2850	45th Street (2850) and Wells	4,821		4,821	4,000	10,379	6,991	2,170	None
2800	Las Flores Canyon	14,370	18,196	32,566	4,000	47,982	33,152	586	None
Entire System		**32,566**	**22,439**	**55,004**	**-**	**95,456**	**59,372**		

1) The “Total MDD” = “In-Zone MDD” + “Higher Zone MDD”, which is the flow required to meet the demand for that particular zone.
2) The “Fire Flow Required” is the highest fire flow requirement for that particular zone.
3) Total Pumping and Well Capacity and Firm Pumping Capacity includes any previous recommendations.
4) The “Firm Pumping Capacity” is the capacity of a pump station with the largest pump at each pumping station is out of service.
5) The “Surplus/Deficit” = “Firm Pumping Capacity” – “Total MDD” for pressure zones with existing storage.
6) Includes 3250A and 3250C

Table 9-8
Future Booster Station Capacity Evaluation for Build-Out

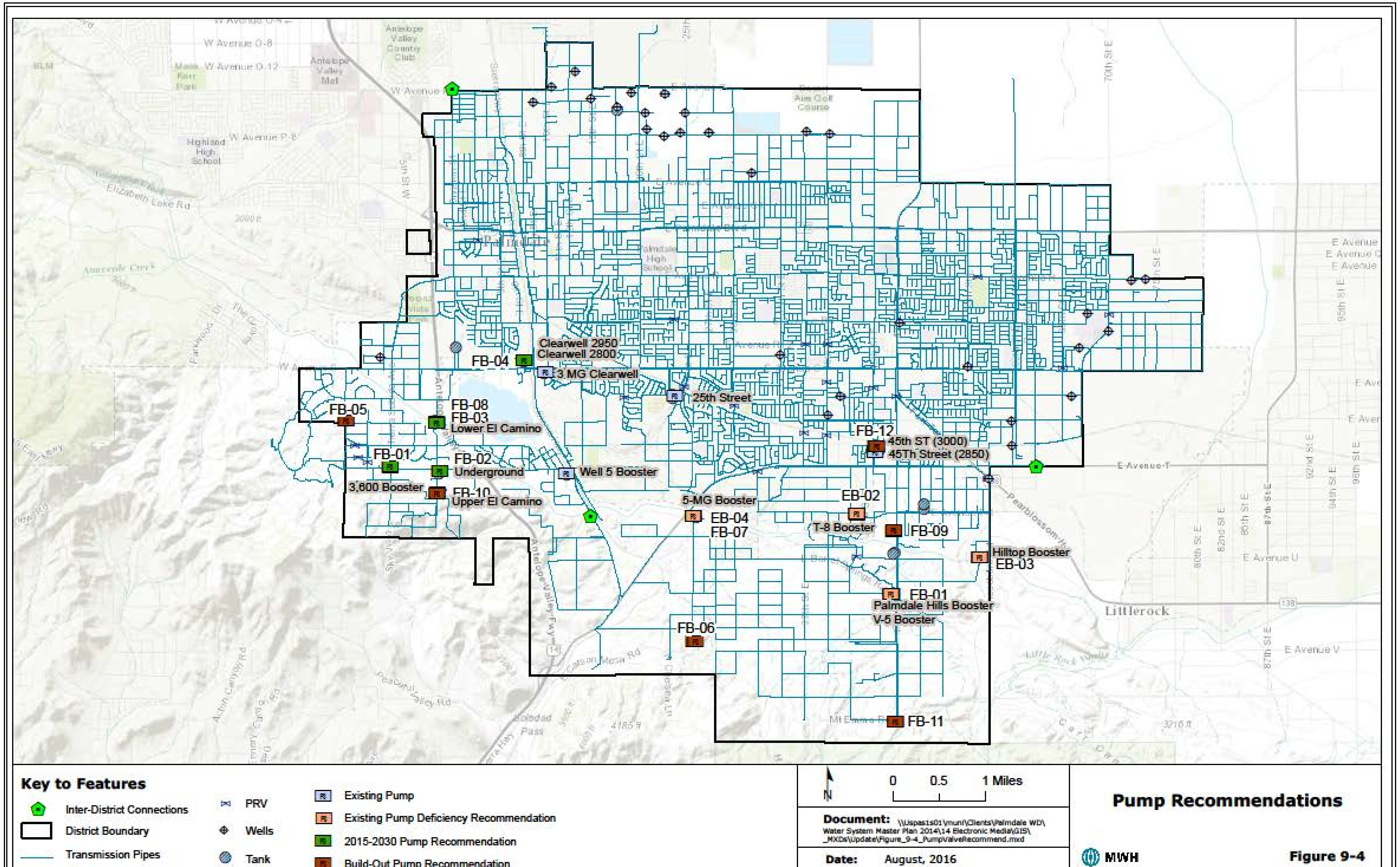
Pressure Zone	Pump Station	In-Zone MDD (gpm)	Higher Zone MDD (gpm)	Total MDD (gpm)(1)	Fire Flow Required (gpm)(2)	Total Pumping and Well Capacity (gpm)(3)	Firm Pumping Capacity (gpm)(3,4)	Surplus/ Deficit (gpm)(5)	Recommendation
4000	None	268	306.	574	1,250	0	0	-574	Two 600 gpm pumps (FB-10)
3800	PRV Zone	306	0	306					None
3600E	None	1,003		1,003	1,250	0	0	-1,003	Two 1,100 gpm Pumps (FB-11)
3600W	3600 Ft Booster	316		316	1,250	557	907	-59	None
3400W	Underground	924	890	1,814	1,250	1,652	1,002	-812	Two 900 gpm pump (FB-05)
3400E	V-5 Booster and Fire Pump (EB-01)	1,770	1,003	2,773	3,000	3,636	1,886	-887	Two 900 gpm pumps (FB-06)
3250(6)	Palmdale Hill Booster, T-8 Boosters, 5 MG Booster, Hilltop Booster, and Fire Pumps (EB-02, EB-03, and EB-05)	3,385	0	3,385	3,000	7,820	2,820	-565	700 gpm pump (FB-07)
3200	Lower El Camino and Well 5 Booster	1,504	1,814	3,319	3,000	3,553	2,401	-918	1,000 gpm pump (FB-08)
3000	45th Street (3000), 25th Street, Well 20	3,422	6,158	9,579	3,000	8,896	5,778	-3,801	Three 1,900 gpm pumps (FB-09)
2950	Clearwell 2950, 3MG, Wells, and Future Pump Station (FB-01)	10,988	3,319	14,306	4,000	14,931	8,865	-5,441	Four 1,800 gpm pumps (FB-12)
2850	45th Street (2850), and Wells	6,145	0	6,145	4,000	10,379	6,991	846	None
2800	Las Flores Canyon	20,543	30,030	50,573	4,000	65,482	49,652	-921	None
Entire System		**49,763**	**41,002**	**88,882**	**-**	**115,504**	**78,145**		

1) The "Total MDD" = "In-Zone MDD" + "Higher Zone MDD", which is the flow required to meet the demand for that particular zone.
2) The "Fire Flow Required" is the highest fire flow requirement for that particular zone.
3) Total Pumping and Well Capacity and Firm Pumping Capacity includes any previous recommendations.
4) The "Firm Pumping Capacity" is the capacity of a pump station with the largest pump at each pumping station is out of service.
5) The "Surplus/Deficit" = "Firm Pumping Capacity" – "Total MDD" for pressure zones with existing storage.
6) Includes 3250A and 3250C

Table 9-9
Future System Booster Recommendations

MAP ID	Suction Zone	Discharge Zone	Description / Location	TDH (feet)	Total Capacity (gpm)	Phase
FB-01	3400W	3600W	New pump at existing 3600 Ft Booster Station	200	300	2015
FB-02	3200	3400W	New 650 gpm pump at Underground PS	282	650	2015
FB-03	2950	3200	New Pump at Lower El Camino Pump Station	290	1,000	2025
FB-04	WTP	2950	New pump at existing 2950 Booster Station at WTP	181	2,000	2030
FB-05	3200	3400W	New booster pump station at Ana Verde Tovey Tank	230	1,800	Build-out
FB-06	3250	3400E	New pump station on Steven Ambers Way and E Carson Mesa Rd.	160	1,800	Build-out
FB-07	3000	3250	New pump at existing 5 MG Pump Station	270	700	Build-out
FB-08	2950	3200	New pump at Lower El Camino Pump Station	290	1,000	Build-out
FB-09	2950	3000	New booster pump station at E Avenue T-8 and 47 Street	60	5,700	Build-out
FB-10	3400W	4000	New booster pump station at Upper El Camino Tank	630	1,200	Build-out
FB-11	3400E	3600E	New pump station on Mt. Emma Rd and 47th Street	220	2,200	Build-out
FB-12	2800	2950	New pump station at 45th St. Existing Pump Station	200	7,200	Build-out

Figure 9-3
Future System Booster Station



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9.7 Wells and GroundWater Banking

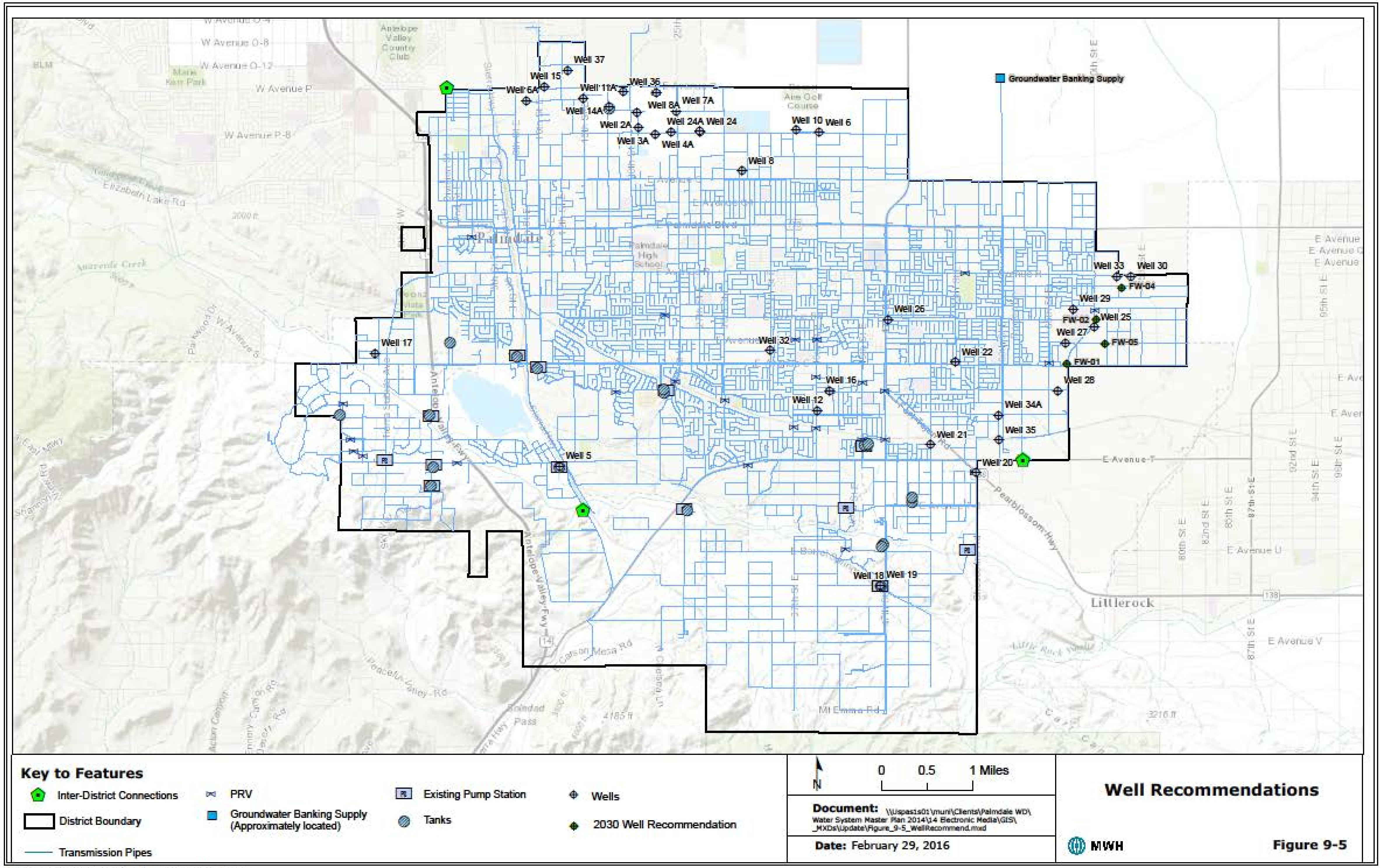
As part of the future system analysis, a total of four wells were recommended to be added to the system in the 2030 scenario to increase reliability of supply. These wells were selected based on the recommendations of the 2006 Water System Master Plan. In addition to the wells recommended in the 2030 scenario, PWD is planning on beginning a groundwater banking program. The groundwater banking program minimizes supply costs by prioritizing State Water Project water for the Water Treatment Plant up to the 25 percent target, with the rest of the water going to the water bank along with recycled water. The water banking wells will run continuously and will be pumped through a 30-inch diameter transmission line to the existing 20-inch pipeline at the corner of Palmdale Boulevard and 60th Street. The banking pump station will have three active 3,000 gpm, 400 horse power pumps with one standby pump (3+1 configuration). The banking program is described in detail in the Palmdale Regional Groundwater Recharge & Recovery Project Preliminary Design Report completed in November 2015.

The banking program provides an additional 12,000 gpm (9,000 gpm firm) of water banking north of the service area by 2030, with an additional 5,500 gpm planned for the build-out. **Table 9-10** below lists the wells and additional water banking recommended in the 2030 system; these wells are depicted on **Figure 9-5**. **Section 4** discusses the full water supply strategy for the PWD system in further detail.

Table 9-10
Additional Wells and Water Banking

Well	Project ID	Zone	Head (ft)	Capacity (gpm)	Phase
Well 28	FW-01	2950	406	512	2025
Well 27	FW-02	2950	448	483	2025
Well 34	FW-03	2950	450	500	2025
Well 36	FW-04	2850	455	2,150	2030
Well 37	FW-05	2950	520	1,000	2030
Water Banking	WATERBANK	2800		12,000 (9,000 Firm)	2030
Water Banking	WATERBANK	2800		17,500 (14,500 Firm)	Build-Out

Figure 9-4
Future System Well Recommendations



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SECTION 10 CAPITAL IMPROVEMENT PROGRAM

This section presents the recommended Capital Improvement Program (CIP) for Palmdale Water District (PWD) water distribution system through the year 2030. The recommended projects allow PWD to address existing system deficiencies, replace aging infrastructure, and provide the facilities necessary to meet future growth. The major categories of facilities associated with the water distribution system consist of distribution pipes, storage tanks, and pump stations.

10.1 Phasing

The phasing of system improvements is based upon the following considerations:

- Anticipated construction of future land developments,
- The need to meet existing system deficiencies,
- Improvement of the water system reliability,
- Replacement of aging assets, and
- Allocation of funding to obtain feasible annual CIP costs.

All projects developed during the existing and future system analysis, as well as during the facility assessment, are prioritized, and phased accordingly. Projects are categorized into 5-year planning horizons starting in year 2015 as follows: 2015-2020, 2021-2025, and 2026-2030.

Improvements to address existing system deficiencies that seriously affect the ability of PWD to provide a reliable water supply to its customers are the highest priority and are assigned to the 2015-2020 planning horizon. Improvements that address existing system deficiencies that are not considered critical are placed in a later phasing category. The prioritization of projects provides PWD with a practical and cost-balanced CIP that focuses on the most urgent projects first. The phasing of existing system projects is presented as a planning guideline and is subject to the availability of funds. The phasing of infrastructure that addresses future growth up to year 2030 is based on information provided by PWD and projected demands for each pressure zone. The actual timing of future facilities will be dependent upon the actual rate of growth and the timing of new developments expected in the service area.

10.2 Cost Estimating Basis

The opinions of probable construction costs are developed based on costs obtained from industry manufacturers and MWH's experience on similar water master planning projects. Some key cost assumptions are:

- All cost assumptions are based on **2015 U.S. Dollars** and are consistent with the American Association of Cost Engineers guidelines for developing reconnaissance-level estimates (Class 5)
- 20 percent of construction costs for contingency is included in the cost estimates
- 30 percent of construction cost for the engineering, administration, and legal costs is included in the cost estimates. The engineering, administration, and legal costs also include typical services such as inspection, materials testing and construction management.

- Escalation, Land acquisition, environmental documentation, permits and easements costs are not included.
- Additional assumptions are listed in **Table 10-6**.

Table 10-1 to **Table 10-6** below show the unit construction costs for different assets used for the CIP.

Table 10-1
Pipeline Cost (2015 Dollars)

Diameter (in)	Construction Cost ($/dia-in/ft.)	Construction Cost ($/linear-ft.)	30% Engineering, Legal & Admin ($/linear-ft.)	20% Contingency ($/linear-ft.)	Total Cost ($/linear-ft.)
8	$15.00	$120.00	$36.00	$24.00	$180.00
10	$15.00	$150.00	$45.00	$30.00	$230.00
12	$15.00	$180.00	$54.00	$36.00	$270.00
16	$15.00	$240.00	$72.00	$48.00	$360.00
18	$15.00	$270.00	$81.00	$54.00	$410.00
20	$15.00	$300.00	$90.00	$60.00	$450.00
24	$15.00	$360.00	$108.00	$72.00	$540.00
30	$15.00	$450.00	$135.00	$90.00	$680.00
36	$15.00	$540.00	$162.00	$108.00	$810.00
42	$15.00	$630.00	$189.00	$126.00	$950.00
48	$15.00	$720.00	$216.00	$144.00	$1,080.00

1) The cost estimates are Class 5 cost estimates for typical materials used in water distribution networks such as HDPE and steel.

Table 10-2
Storage Tank Cost (2015 Dollars)

Size Range (MG)	Construction Cost ($/gal)	30% Engineering, Legal & Admin ($/gal)	20% Contingency ($/gal)	Total Cost ($/gal)
0.1	$6.00	$1.80	$1.20	$9.00
0.2	$4.00	$1.20	$0.80	$6.00
0.3	$3.00	$0.90	$0.60	$4.50
0.5	$2.00	$0.60	$0.40	$3.00
1	$1.80	$0.54	$0.36	$2.70
2	$1.50	$0.45	$0.30	$2.25
3	$1.40	$0.42	$0.28	$2.10
4	$1.30	$0.39	$0.26	$1.95
5	$1.20	$0.36	$0.24	$1.80

1) Assumes Welded Steel on Grade for storage tanks costs

Table 10-3
New Pump Station Cost[1] (2015 Dollars)

Size (hp)	Construction Cost ($/hp)	30% Engineering, Legal & Admin ($/hp)	20% Contingency ($/hp)	Total Cost ($/hp)
10	$22,500	$6,750	$4,500	$33,750
25	$18,000	$5,400	$3,600	$27,000
50	$15,000	$4,500	$3,000	$22,500
75	$12,000	$3,600	$2,400	$18,000
100	$9,000	$2,700	$1,800	$13,500
150	$7,500	$2,250	$1,500	$11,250
200	$7,200	$2,160	$1,440	$10,800
250	$6,750	$2,025	$1,350	$10,125
300	$6,300	$1,890	$1,260	$9,450
400	$6,000	$1,800	$1,200	$9,000
500	$5,550	$1,665	$1,110	$8,325
600	$5,250	$1,575	$1,050	$7,875
750 and larger	$4,800	$1,440	$960	$7,200

1) Include pumps, motors, electrical, controls, building, etc.

Table 10-4
Pump & Motor Replacement Cost[1] (2015 Dollars)

Size (hp)	Construction Cost ($/hp)	30% Engineering, Legal & Admin ($/hp)	20% Contingency ($/hp)	Total Cost ($/hp)
10	$3,750	$1,125	$750	$5,630
25	$3,000	$900	$600	$4,500
50	$2,500	$750	$500	$3,750
75	$2,000	$600	$400	$3,000
100	$1,500	$450	$300	$2,250
150	$1,250	$375	$250	$1,880
200	$1,200	$360	$240	$1,800
250	$1,125	$338	$225	$1,690
300	$1,050	$315	$210	$1,580
400	$1,000	$300	$200	$1,500
500	$925	$278	$185	$1,390
600	$875	$263	$175	$1,310
750 and larger	$800	$240	$160	$1,200

1) Costs are for replacing a pump with the same sized pump. Costs include pump, and motors replacement.

Table 10-5
Pump Upsizing Cos (2015 Dollars)(1)

Size (hp)	Construction Cost ($/hp)	30% Engineering, Legal & Admin ($/hp)	20% Contingency ($/hp)	Total Cost ($/hp)
10	$11,250	$3,375	$2,250	$16,880
25	$9,000	$2,700	$1,800	$13,500
50	$7,500	$2,250	$1,500	$11,250
75	$6,000	$1,800	$1,200	$9,000
100	$4,500	$1,350	$900	$6,750
150	$3,750	$1,125	$750	$5,630
200	$3,600	$1,080	$720	$5,400
250	$3,375	$1,013	$675	$5,060
300	$3,150	$945	$630	$4,730
400	$3,000	$900	$600	$4,500
500	$2,775	$833	$555	$4,160
600	$2,625	$788	$525	$3,940
750 and larger	$2,400	$720	$480	$3,600

1) These costs are related to increasing an existing pump size to a new HP sized pump. These costs include pump, motor, electrical, and necessary piping. These costs do not include the cost of upgrading the building.

Table 10-6
Miscellaneous Costs and Assumptions (2015 Dollars)

Assumption	Unit Cost or Assumption
Well Equipping	$600,000
Well Drilling and Equipping (based on 1 MGD)	$1,200,000
Pump Efficiency	75%
Pump Motor Efficiency	80%

10.3 Recommended Capital Improvement Program

The CIP costs were developed using the unit costs from the tables above along with the required size and length of pipelines; volume of storage tanks; horsepower of pumps and pump stations; and size of other PWD assets as assessed during the system analyses. The CIP was created for assets required to meet existing hydraulic deficiencies and planned future growth within the defined planning horizons up until the year 2030. The majority of the existing system deficiencies identified in the system addressed fire flow deficiencies in the PWD system. The total projected cost to address the existing system deficiencies (storage facilities, pumps, and fire flow pipe improvements) is $22,850,000. Future assets required beyond 2030 and for build-out are not included in this CIP.

10.3.1 Age Based Capital Improvement Projects

Age based asset replacement was determined using the useful life method. The useful life method sets a typical "useful life" for an asset based on the asset's material type. Once the asset has surpassed its typical useful life, the asset is added to the CIP list for recommended replacement. **Table 10-7** summarizes the useful life assigned to the different facilities present in PWD's system. The useful life is determined based on MWH professional engineering judgment and California Public Utilities Commission guidelines. Pipeline sizes smaller than 8-inches that surpass their useful life shall be replaced with 8-inch pipelines to meet PWD future fire flow demands.

Table 10-8 is a summary of the age-based deficiencies by 2030. There were no storage tanks that reached their useful life prior to 2030, and less than one percent of the pipes reached their typical useful life before 2030. Approximately 8 percent of the pipes had unknown installation periods in the model, but since very few pipes reached their useful life by 2030, it is assumed these pipes had a useful life past 2030. The exact pump installation dates were unknown, so it was assumed that half the pumps will be replaced by the 2030 phase, and the cost is distributed over the three phasing horizons. Although no storage tanks need to be replaced before 2030, an analysis was done on the annual cost of replacing all facilities in the useful life period. The total cost of replacing all facilities of a particular asset was divided by the typical useful life of that asset. This analysis (shown in **Figure 10-1**) estimates the typical annual cost of replacement once a majority of the system has reached its useful life, although this will not happen until beyond 2030.

Table 10-7
Typical Useful Life of Assets

Asset	Typical Useful Life (Years)
Pipeline	75
Storage Tanks	75
Pumps and Accessories (electrical, I&C)	20
Pump Station Structure	75

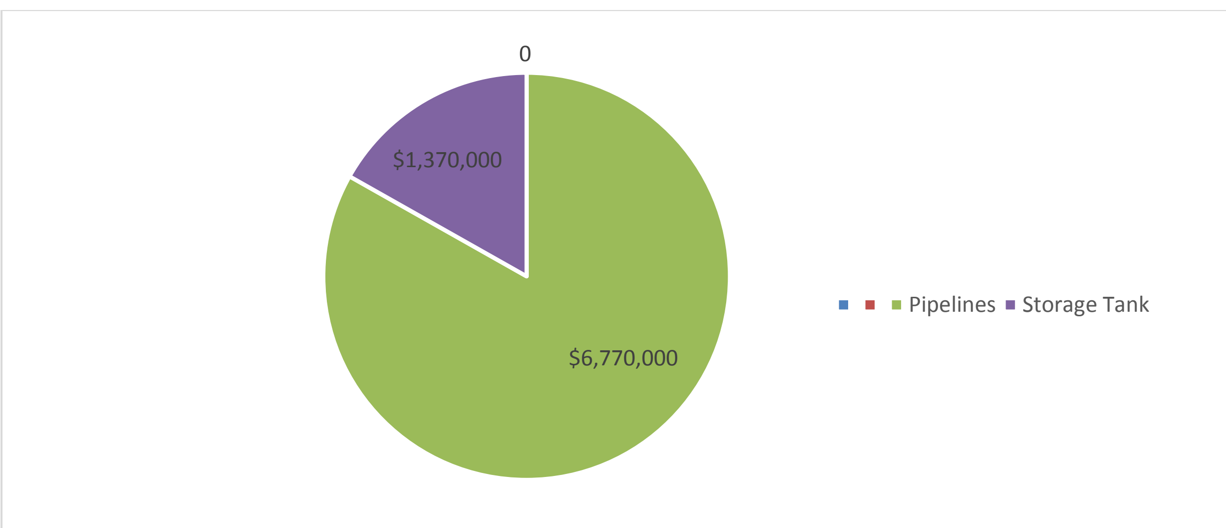

Figure 10-1
Foreshadow of Typical Annual Age-Based Replacement Costs

Table 10-8
Summary of Age Based Deficiencies (2015 Dollars)

Phase	Pipe Age Replacement[(1)]	Pumps Age Replacement[(2)]	Total
2015-2020	$-	$1,400,000	**$1,400,000**
2021-2025	$10,000	$1,400,000	**$1,410,000**
2026-2030	$330,000	$1,400,000	**$1,730,000**
TOTAL	**$340,000**	**$4,200,000**	**$4,540,000**

1) Assume that pipes with unknown installation periods will be replaced after 2030
2) Assume half the pumps are replaced by 2030, and the cost associated with pump replacement is distributed amongst the phasing horizons.

10.3.2 Capacity Based Capital Improvement Projects

The existing hydraulic deficiencies in PWD's distribution system that need to be addressed in the CIP are mentioned in the existing system evaluation section (**Section 8**). Pipelines need to provide fire flow requirements, meet water demands, and meet velocity and pressure criteria as defined in **Section 7**. Storage tanks need sufficient storage for fire protection, operational storage, and emergency storage, and booster pump stations need to supply Maximum Day Demand (MDD) conditions for different scenarios as mentioned in **Section 7**. The costs to meet these existing deficiencies are approximately $22.8 Million, and this is shown in **Figure 10-2**.

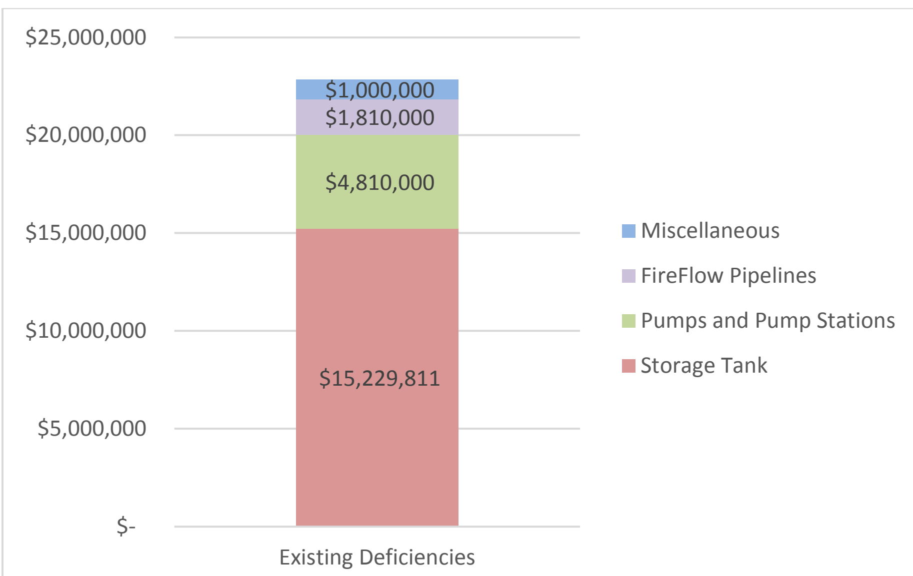

Figure 10-2
Total Cost of Existing System Deficiencies (2015 Dollars)

The existing deficiencies and future improvement projects for the CIP are phased over three planning horizons (2015-2020, 2021-2025, and 2026-2030). **Table 10-9** shows a summary of costs categorized into facility type (pipeline, storage, pump stations, etc.), as well as a total cost in each phase for the assets required to meet existing deficiencies and support future growth. A graphical representation of the CIP cost by type and phase is shown on **Figure 10-3**.

Table 10-9
Summary of Total Capital Improvement Program Costs by Project Type (2015 Dollars)

Phase	Pipelines[1]	Storage Tanks	Pumps[2]	Water Supply[3]	Miscellaneous[4]	Total
2015-2020	$56,966,800	$10,890,000	$5,040,000	$39,000,000	$1,000,000	$112,896,800
2021-2025	$55,166,800	$11,010,000	$4,420,000	$40,800,000	$1,000,000	$112,396,800
2026-2030	$55,486,800	$22,560,000	$2,260,000	$2,400,000	$13,000,000	$95,706,800
TOTAL	**$167,620,400**	**$44,460,000**	**$11,720,000**	**$82,200,000**	**$15,000,000**	**$321,000,400**

1) The pipelines category includes fire flow projects, age based pipeline improvements, and pipeline expansion projects
2) The pumps category includes deficiency projects and age based improvements
3) The future water supply category includes the Phase 1 Palmdale Regional Groundwater Recharge and Recovery Project and recommended wells in the PWD service area. The future supply does not include costs for expanding recycled water system or funds required for SWP leased water
4) Miscellaneous costs are estimated costs for facility assessment maintenance costs in **Appendix B** and increased staffing in the 2026-2030 phase.

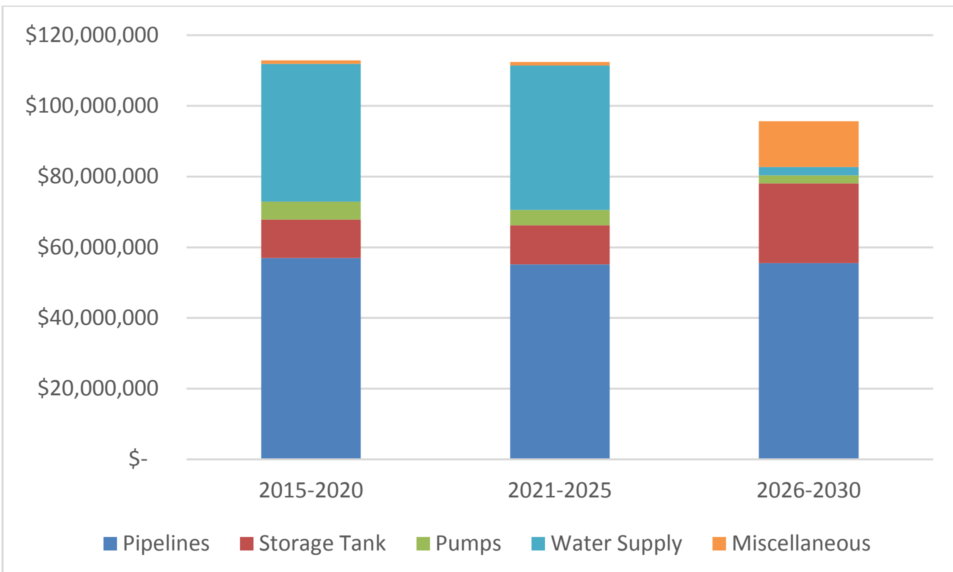

Figure 10-3
CIP Cost by Project Type and Phase (Planning Period 2015-2030) (2015 Dollars)

The pipeline expansion costs are estimated costs based on projected expansion by the 2007 master plan and adjusted in the 2015 master plan. The actual expansion in the PWD service area is based on a variety of factors, and therefore these estimated costs can be greatly affected by a change in the actual growth.

The deficiencies were determined for 2015, 2030, and build-out in **Section 8** and **Section 9**. However, the CIP gives five-year increments of projected projects. Therefore, the existing deficiencies were planned to be constructed from 2015-2020, and the projects determined for 2030 were broken into two segments, 2021-2025 and 2026-2030. The projects required for the Quail Valley development are in the 2015-2020 phase since these projects need to be constructed with the new development. The storage tank projects that were determined to have been constructed in 2021-2025 are projects in higher zones, since storage is more valuable in higher zones since it could supply the lower zones through PRVs in emergencies. The pipeline expansion costs determined for 2030 were distributed evenly between the three planning horizons, and these costs are assumed to be paid by future ratepayers since these pipe expansions are a result of increased consumption and population growth.

As mention in **Section 9**, the demands allocated to the model in 2030 did not include expansion in the higher zones (4000, 3800, 3600E, 3600W, or 3400W) besides demands for Quail Valley developments in the 3400W and 3600W Zone. If these zones have population and demand growth prior to 2030 and require pump stations and storage tanks, the projected CIP will be altered.

Table 10-10 summarizes the CIP costs by the ratepayer class (existing or future) expected to incur the costs of the improvement. Existing deficiencies are assumed to be paid by existing ratepayers. If an existing deficiency improvement is larger than the existing deficiency to address existing and future requirements, then the deficiency improvement cost is distributed to existing and future ratepayers based on the percentage of existing deficiency is required. Future wells and water supply projects are assumed to be split evenly by existing and future ratepayers. **Figure 10-4** summarizes the CIP costs by the ratepayer class (existing or future) expected to incur the costs.

Table 10-10
Summary of Capital Improvement Program Costs by Funder (2015 Dollars)

Phase	Existing Ratepayers	Future Ratepayers	Total
2015-2020	$15,010,000	$97,886,800	$112,896,800
2021-2025	$7,040,000	$105,356,800	$112,396,800
2026-2030	$9,440,000	$86,266,800	$95,706,800
TOTAL	**$31,490,000**	**$289,510,400**	**$321,000,400**

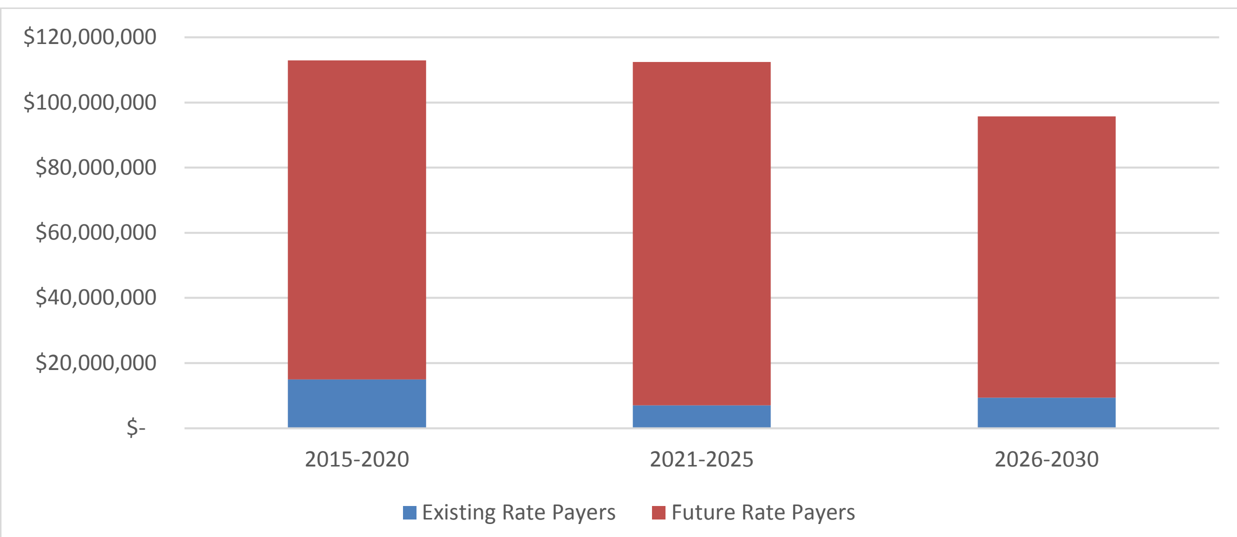

Figure 10-4
CIP Cost by Funder and Phase (2015 Dollars)

Recommended projects are given an alphanumeric project identification (ID) code in order to easily identify them in the model and separate improvements into distinct projects. The first letter of the project ID represents whether it is an existing system deficiency ("E") or a recommendation to address future growth ("F"). The second letter of the project ID represents the type of facility; "B" is a booster pump station improvement, "S" is a storage tank improvement, and "W" is a well project. The CIP does not include the wells required for the groundwater-banking program. Projects are presented below in **Table 10-11** through **Table 10-14**, with phasing and cost listed for each improvement. A project indicator is also included to show when these developments are required to be constructed. The project indicator is typically the number of equivalent dwelling units (EDUs) until a project is required. **Table 10-15** presents the fire flow projects with IDs and associated costs. Fire flow analysis was not conducted during the 2015 WSMP, and the necessity of these fire flow projects was not re-evaluated. It is assumed that these projects are still required since they were identified in 2007 as being fire flow deficient. Fire flow projects 2 and 3 are not mentioned since they have been completed since the 2007 WSMP**.** **Figure 10-5** and **Figure 10-6** presents the location of the CIP projects in the PWD system for the 2015 to 2030 horizons and the build-out horizon, respectively.

Table 10-11
CIP – Transmission Pipelines through 2030 (2015 Dollars)

(details of pipelines are presented in Appendix E)

Purpose of Improvement	Dia (in)	Length (ft.)	Cost
Expansion	6	810	$113,400
Expansion	8	617,480	$111,146,400
Expansion	10	930	$213,900
Expansion	12	62,610	$16,904,700
Expansion	14	100	$27,000
Expansion	16	34,630	$12,560,400
Expansion	18	1,020	$418,200
Expansion	20	34,630	$15,583,500
Expansion	24	10,350	$5,589,000
Expansion	30	880	$598,400
Expansion	36	159	$121,500
Expansion	42	190	$180,500
Rezoning	6	330	$46,200
Rezoning	8	2,410	$433,800
Rezoning	10	570	$131,100
Rezoning	12	2,960	$799,200
Velocity Deficiency	12	2,720	$734,400
Velocity Deficiency	16	100	$36,000
Velocity Deficiency	20	540	$243,000
Velocity Deficiency	24	1,580	$853,200
	Total	**775,250**	**$164,867,200**

Figure 10-5
Facility Improvement Year 2015-2030

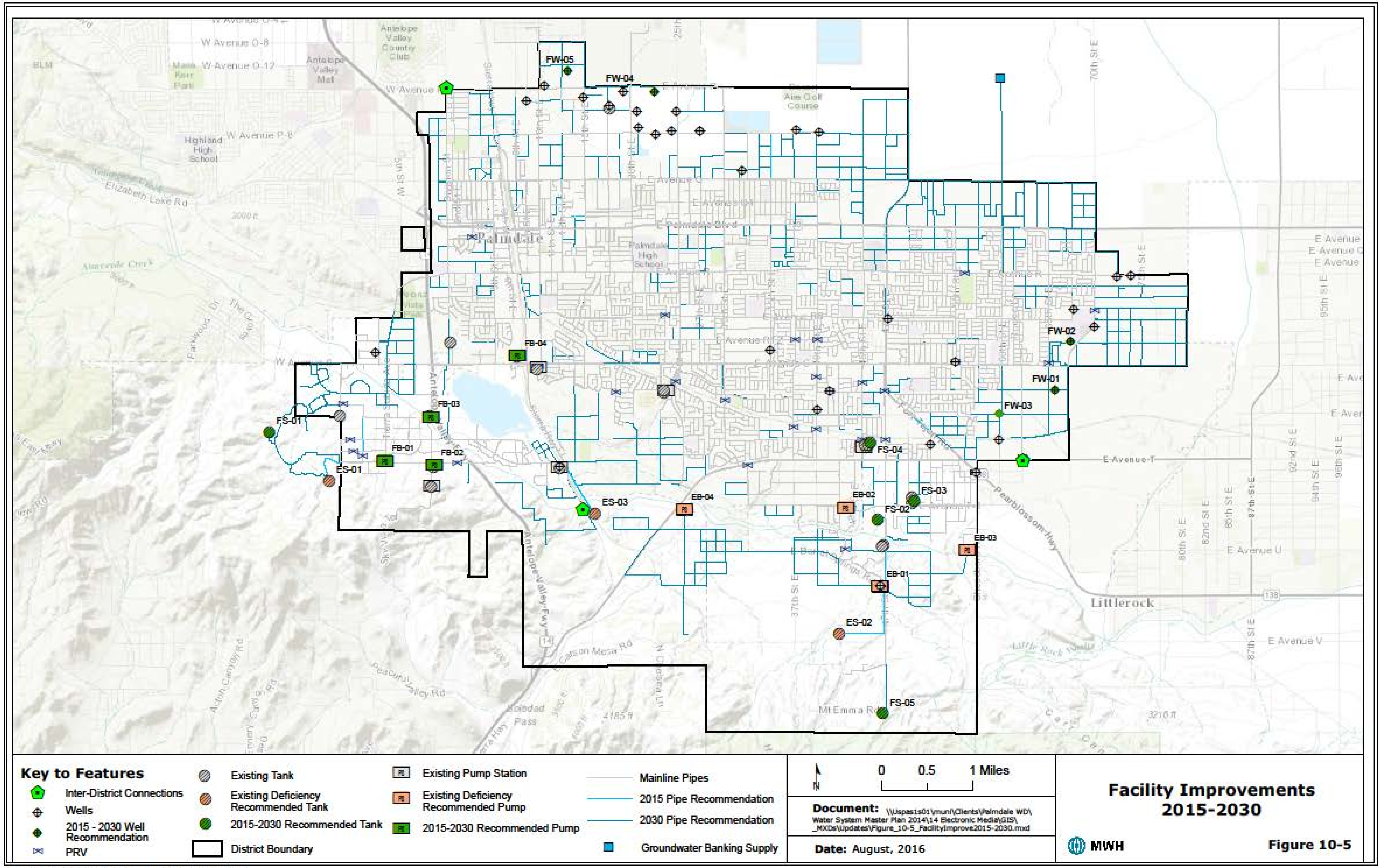

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Figure 10 6

Facility Improvements Year Build-Out

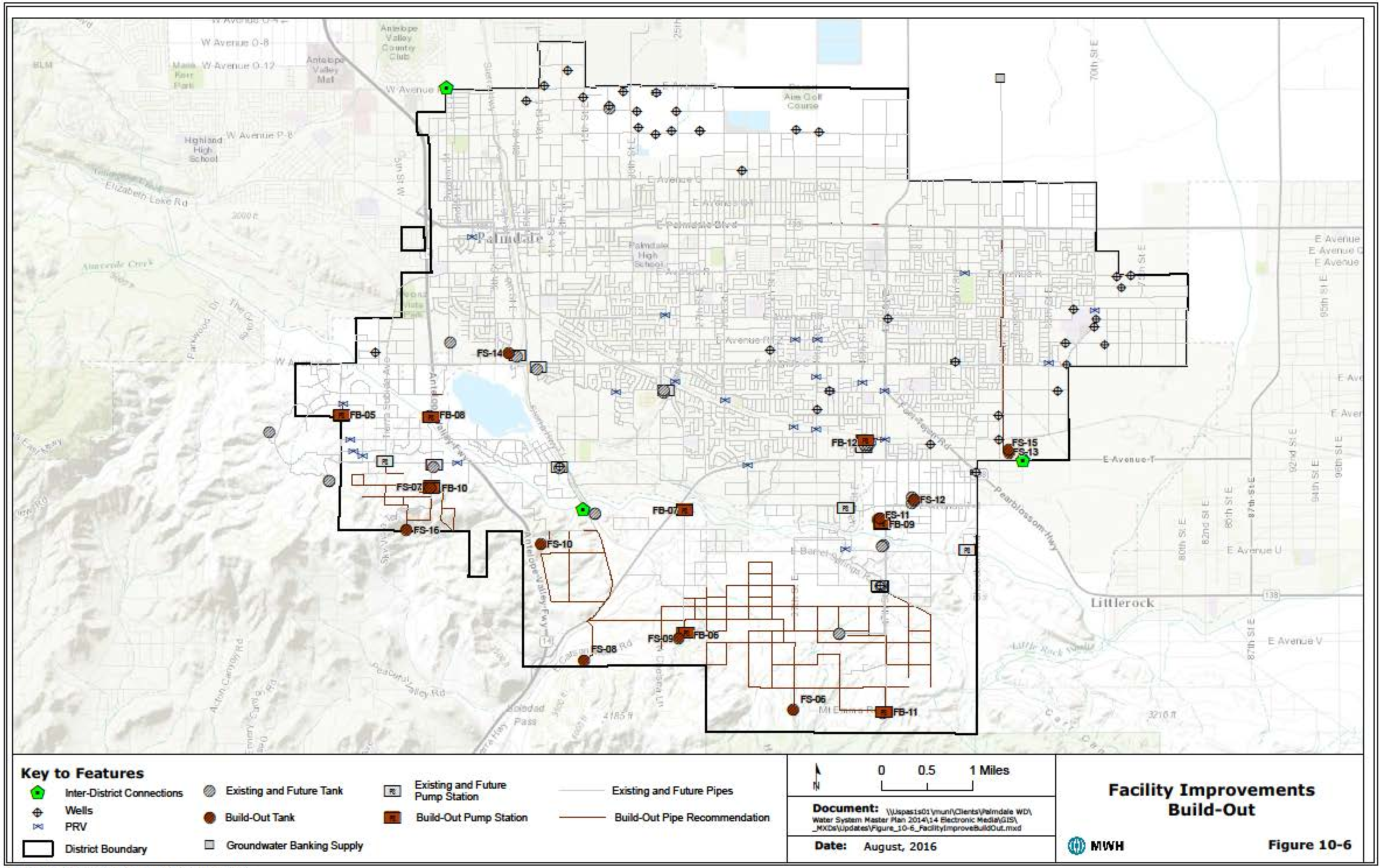

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Table 10-12 (data from Appendix E)
CIP – Booster Pump Stations (2015 Dollars)

MAP ID	Description and Purpose of Improvement	Project Indicator	TDH (feet)	Total Capacity (gpm)	Cost
Phase 2015-2020					
EB-01	Fire pumps at existing V-5 Pump Station. Required to meet fire flow requirements	Construct as soon as possible. Pump required to meet fire flow requirements in 3400E zone	350	3,500	$2,610,000
FB-01	New pump to 3600W zone at 3600 Ft Booster PS	Construct with new Quail Valley Development	200	300	$340,000
FB-02	New pump at Underground PS to 3400W zone	Construct with new Quail Valley Development	282	650	$690,000
Phase 2021-2025					
EB-02	Fire pumps at existing T-8 Pump Station. Required to meet fire flow requirements	Construct as soon as possible. Pump required to meet fire flow requirements in 3250 zone	105	3,500	$870,000
EB-03	Fire pumps at existing Hilltop Pump Station. Required to meet fire flow requirements	Construct as soon as possible. Pump required to meet fire flow requirements in 3250C zone	146	1,000	$690,000
EB-04	Fire pumps at existing 5 MG Booster Pump Station. Required to meet fire flow requirements	Construct as soon as possible. Pump required to meet fire flow requirements in 3250A zone	270	500	$640,000
Phase 2026-2030					
FB-03	New pump at Lower El Camino Pump Station	New pump after 2,592 EDUs(3) in the 3200, 3400W, or 3600W zone.	290	1,000	$820,000
FB-04	New pump at existing Clearwell 2950 booster PS at WTP to supply additional capacity to the 2950 zone.	Construct with first 2,490 EDUs in 2950, 3200, 3400W, and 3600W zone	181	2,000	$860,000
Build-Out					
FB-05(1)	New booster pump station at Ana Verde Tovey Tank	New pump station constructed with addition of 1,909 EDUs in the 3400W or 3600W zone.	230	900	$3,140,000
FB-06(1)	New pump station on Steven Ambers Way and E Carson Mesa Rd	Pump station constructed with addition of 5,400 EDUs in the 3400E or 3600E zone.	160	900	$2,730,000
FB-07	New pump at existing 5 MG Pump Station	New pump after 7,753 EDUs in the 3250, 3400E, or 3600E zone.	270	700	$720,000
FB-08	New pump at Lower El Camino Pump Station	New pump after 5,472 EDUs in the 3200, 3400W, or 3600W zone	290	1,000	$820,000
FB-09(1)	New booster pump station at E Avenue T-8 and 47 Street.	New pump station after 9,524 EDUs in the 3000, 3250, 3400E, or 3600E zone, and a new pumps after subsequent 3,744 EDUs.	60	3,800	$3,890,000
FB-10(1)	New booster PS at Upper El Camino tank to 4000 Zone	When developments are constructed in the 4000 zone	630	600	$3,580,000
FB-11(1)	New pump Station on Mt. Emma Rd and 47th Street.	When development are constructed in the 3600E zone	220	1,100	$2,750,000
FB-12(1)	New pump station at 45th St existing pump station site (2 pumps)	Pump station constructed with addition of 5,760 EDUs after FB-01 is constructed in 2950, 3200, 3400W, and 3600W zone, and the subsequent pump after another 5,760 EDUs	200	6,800	$6,820,000

1) New pump station
2) EB Existing Booster Pump Improvement, FB = Future Booster Pump Improvement
3) On equivalent dwelling unit (EDU) = 500 gallons per day.

Table 10-13 (data from Appendix E)
CIP – Storage Tanks (2015 Dollars)

MAP ID	Description and Purpose of Improvement	Indicator	Zone	Size (MG)	Cost
Phase 2015-2020					
ES-01	New tank at Quail Valley Development in 3600W zone	Construct with new Quail Valley development	3600W	1.0	$2,700,000
ES-03	New tank location near Sierra Hwy and Rae Street	Construct as soon as possible	2950	4.2	$8,190,000
FS-01	New tank at Quail Valley Development in 3400W zone	Construct with new Quail Valley development	3400W	0.75	$2,250,000
Phase 2021-2025					
ES-02	New tank location near 47th St and East Avenue V4 (South of E Barrel Springs Road)	Construct as soon as possible	3250	3.1	$6,510,000
FS-05	New tank location on Mt. Emma Rd. and 47th Street E	Construct with new developments in 3400E zone, 1 MG for every 2,000 EDUs	3400E	2	$4,500,000
Phase 2026-2030					
FS-02	New tank location on 47th Street E, South of E Avenue T-8	Construct as soon as possible after ES-03	2950	5.7	10,260,000
FS-03	New tank at existing 50th Street tank location	Construct after 4,040 EDUs in the 2850 zone	2850	2	$4,500,000
FS-04	New tank at existing 45th Street tank location	Construct after 9,160 EDUs in the 2800 zone	2800	4	$7,800,000
Build-out					
FS-06	New tank location on Mt. Emma Rd	Construct with new developments in the 3600E zone. 1 MG for every 2,000 EDUs	3600E	2	$4,500,000
FS-07	Additional tank located at Upper El Camino	Construct after 1,400 EDUs in 3400W zone	3400W	1	$2,700,000
FS-08	New tank location at E Carson Mesa Rd and N. Rough Rd	Construct after FS-01, 1 MG for every 2,000 EDUs	3400E	1.8	$4,860,000
FS-09	New tank location at E Carson Mesa Rd and N Chelsea Ln	Construct after ES-02 and 5,900 EDUs in 3250 zone.	3250	3.5	$7,350,000
FS-10	New tank location north of Rae St and close to the CA-14 N	Construct after 2,680 EDUs in the 3200 zone.	3200	1.1	$2,970,000
FS-11	New tank at 47St and E Avenue T-8	Construct after 11,160 EDUs in the 2950 zone.	2950	7.3	13,140,000
FS-12	New tank at existing 50th St tank location	Construct after 8,040 EDUs in the 2850 zone	2850	2.1	$4,730,000
FS-13	New tank location on E Avenue T and 60th Street.	Construct after 17,040 EDUs in the 2800 zone	2800	5.5	$9,900,000
FS-14	6 MG tank near existing 6 MG Clearwell	Construct after 28,040 EDUs in the 2800 zone	2800	6	10,800,000
FS-15	New tank at E Avenue T and 60th Street	Construct after 40,040 EDUs in the 2800 zone	2800	2.4	$5,400,000
FS-16	New tank location at Desert Spring Road and Tierra Subida Ave	Construct with new developments in the 4000 zone.	4000	1.2	$3,240,000

1) ES = Existing Storage Tanks, FS = Future Storage Tanks
2) One equivalent dwelling unit (EDU) = 500 gallons per day

Table 10-14 (data from Appendix E)
CIP – Wells (2015 Dollars)

MAP ID	Description and Purpose of Improvement	TDH (feet)	Total Capacity (gpm)	Cost
Phase 2021-2025				
FW-01	New well (Well 28) on 70th Street and E Avenue S requires equipping	406	512	$600,000
FW-02	New well (Well 27) on 70th Street north of Well 25 requires equipping	483	448	$600,000
FW-03	New well (Well 34) requires equipping	450	500	$600,000
Phase 2026-2030				
FW-04	New well (Well 36) near 375' S/O Ave P and 440' W/O 20th St E	455	2,150	$1,200,000
FW-05	New well (Well 37) near 1000' N/O Ave P and 1000' W/O 15th St E	520	1,000	$1,200,000

Table 10-15
CIP - Fire Flow (From 2007 Carollo Water System Master Plan) (2015 Dollars)

Fire Flow Area ID	Length of Pipe Replacement (ft.)	Cost ($)
Phase 2015-2020		
FF-01	2,675	$722,250
FF-04	965	$260,550
FF-05	1,570	$565,200
FF-06	48	$8,640
FF-07	1,400	$252,000

1) Fire Flow projects were developed by Carollo in 2007.

10.4 Costs Adjusted for Construction Cost Index

The costs shown in the previous tables are costs for 2015. Using the Construction Costs Index for Los Angeles from the Engineering News- Record, the 2015 costs were updated to July 2018. The results are presented in **Table 10-16**. Detailed supporting data are contained in both **Appendix E** – Capacity Based Capital Improvements and **Appendix F** – Allocation of Project Costs According to Zones which they Benefit,

Only pipelines of 16-inch diameter and greater and included in Table 10-16. Pipelines of diameter smaller than the 16-inch diameter are the responsibility of the Developer. Data from Appendix E is used to develop the data in Table 10-16.

The computation of Capital Impact Fees (CIF) is discussed in the following Chapter 11 – Capital Impact Fees and Financing Options. Data from Appendix F is used to develop the impact fees in Chapter 11.

Table 10-16 – Capital Improvement Program to Year 2030 (data from Appendix E)
Costs Adjusted for Construction Cost Index

2016 MASTER PLAN RECOMMENDED IMPROVEMENTS	July 2018 Costs	2015 Costs
Description (features required from 2015 to 2030)	ENR index July 2018	ENR index Dec 2015
	For Los Angeles	For Los Angeles
	11,985.50	11,117.28
A. Entire System		
1. Adjustments for CIF Collected from 2014 to July 2018		
2. Headquarters Building Expansion (21,000 square feet at $200 per square foot from R.S. Means)	$4,200,000	
3. Headquarters and other buildings remodeling to service growth in population	$2,000,000	
4. Littlerock Sediment Removal Grade Control (plus engineering and environmental)	$10,800,000	
5. Littlerock Sediment Removal EIS/EIR Preparation and Design (January 2015 to August 2018)	$1,010,057	
6. Engineering and Environmental for Water Master Plan (costs 2015 to 2018)	$345,407	
Sub-Total for Entire System	$18,355,464	
B. 2800 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$1,168,266	
2. New 4.0 MG storage tank at existing 45th Street Location (FS-04)	$8,409,152	$7,800,000
3. New fire flow deficiency pipe of 2,675 feet length (FF-01)	$778,655	$722,250
4. New fire flow deficiency pipe of 965 feet length (FF-04)	$280,898	$260,550
5. New well #36 near 375 feet S/O Ave P and 440 feet W/O 20th St. E. (FW-04)	$1,293,716	$1,200,000
6. New Well # 37 near 1000 feet N/O Ave P and 1000 feet W/O 15th St. E. (FW-05)	$1,293,716	$1,200,000
7. Expansion Pipeline of 850 linear feet of 16" diameter	$330,029	$306,122
8. Expansion Pipeline of 94 linear feet of 30" diameter	$69,103	$64,097
9. Velocity deficiency pipeline of 23 linear feet of 20" diameter	$11,246	$10,431
10. Velocity deficiency pipeline of 23 linear feet of 24" diameter	$787,376	$730,339
Sub-Total for 2800 zone	$12,085,624	$12,293,789

Table 10-16 – Capital Improvement Program to Year 2030 (data from Appendix E)
Costs Adjusted for Construction Cost Index

2016 MASTER PLAN RECOMMENDED IMPROVEMENTS	**July 2018 Costs**	**2015 Costs**
Description (features required from 2015 to 2030)	ENR index July 2018	ENR index Dec 2015
	For Los Angeles	For Los Angeles
	11,985.50	11,117.28
C. 2850 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	$0	
2. New 2.0 MG storage tank at existing 50th Street location (FS-03)	$4,851,434	$4,500,000
3. Expansion Pipeline of 2,702 linear feet of 16" diameter	$1,048,662	$972,698
Sub-Total for 2850 zone	$5,900,096	$5,472,698
2800 and 2850 Total	**$19,153,986**	**$17,766,487**
D. 2950 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$242,303	
2. New 4.2 MG storage tank near Sierra Highway and Rae Street (ES-03)	$8,829,610	$8,190,000
3. New 5.7 MG storage tank on 47th Street East, South of East Avenue T-8 (FS-02)	$11,061,269	$10,260,000
4. New pump at existing Clearwell 2950 booster pump station (FB-04)(serves multi-zone)	$927,163	$860,000
(note: construct FB-04 with first 2,490 EDU's in Zones 2950, 3200, 3400 W and 3600 W)		
5. New Well # 28 on 70th St. and East Avenue S requires equipping (FW-01)	$646,858	$600,000
6. New Well #27 on 70 St north of Well #25 requires equipping (FW-02)	$646,858	$600,000
7. New Well #34 requires equipping (FW-03)	$646,858	$600,000
8. New fire flow deficiency pipe 1,570 feet length (FF-05)	$609,340	$565,200
9. New fire flow deficiency pipe 48 feet length (FF-06)	$9,315	$8,640
10. Expansion Pipeline of 5,871 linear feet of 16" diameter	$2,278,519	$2,113,465
11. Expansion Pipeline of 1,024 linear feet of 18" diameter	$452,840	$420,037
12. Expansion Pipeline of 564 linear feet of 20" diameter	$273,482	$253,671
13. Expansion Pipeline of 25,465 linear feet of 20" diameter (serves multi-zones)	$12,354,044	$11,459,127
14. Expansion Pipeline of 3,585 linear feet of 24" diameter	$2,087,017	$1,935,835
15. Expanision Pipeline of 1,228 linear feet of 24" diameter (serves mulit-zones)	$715,148	$663,343
16. Expansion Pipeline of 150 linear feet of 36" diameter (serves multi-zones)	$130,989	$121,500
17. Expansion Pipeline of 87 linear feet of 42" diameter	$89,473	$82,992
18. Expansion Pipeline of 100 linear feet of 42" diameter (serves multi-zones)	$102,419	$95,000
19. Velocity deficiency pipeline of 96 linear feet of 16" diameter	$37,240	$34,542
20. Velocity deficiency pipeline of 516 linear feet of 20" diameter	$250,533	$232,385
21. Velocity deficiency pipeline of 231 linear feet of 24" diameter	$134,627	$124,875
Sub-Total for 2950 zone	$42,041,299	$39,220,612

Table 10-16 – Capital Improvement Program to Year 2030 (data from Appendix E)
Costs Adjusted for Construction Cost Index

2016 MASTER PLAN RECOMMENDED IMPROVEMENTS	July 2018 Costs	2015 Costs
Description (features required from 2015 to 2030)	ENR index July 2018	ENR index Dec 2015
	For Los Angeles	For Los Angeles
	11,985.50	11,117.28
E. 3000 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$19,884	
2. Expansion Pipeline of 3,462 linear feet of 20' diameter	$1,679,329	$1,557,680
3. Expansion Pipleline of 1,494 linear feet of 20" daimeter (serves multi-zones)	$724,984	$672,467
4. Expansion Pipeline of 120 linear feet of 24" diameter	$69,861	$64,800
5. Expansion Pipeline of 412 linear feet of 30" diameter	$302,069	$280,187
6. Expansion Pipeline of 370 linear feet of 30" diameter (serves multi-zones)	$271,029	$251,396
Sub-total for 3,000 zone	$3,027,388	$2,826,530
2950 and 3000 Total	**$45,330,874**	**$42,047,142**
F. 3200 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	$0	
2. New pump at Lower El Camino Pump Station (FB-03) (serves multi-zones)	$884,039	$820,000
(note construct FB-03 pump after 2,592 EDU's in Zones 3200, 3400 and 3600)		
3. Expansion Pipeline of 11.528 linear feet of 16" diameter	$4,474,206	$4,150,098
4. Expansion Pipeline of 33 linear feet of 20" diameter	$16,157	$14,987
5. Expansion Pipeline of 586 feet of 20" diameter (serves multi-zones)	$284,343	$263,745
6. Expansion Pipeline of 20 linear feet of 24" diameter	$11,591	$10,751
Sub-Total for 3200 zone	$5,670,336	$5,259,581

Table 10-16 – Capital Improvement Program to Year 2030 (data from Appendix E)
Costs Adjusted for Construction Cost Index

2016 MASTER PLAN RECOMMENDED IMPROVEMENTS	**July 2018 Costs**	**2015 Costs**
Description (features required from 2015 to 2030)	ENR index July 2018	ENR index Dec 2015
	For Los Angeles	For Los Angeles
	11,985.50	11,117.28
G. 3250 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	$0	
2. New 3.1 MG storage tank near 47th Street and East Avenue V4 (south of Barrel Springs Road) (ES-02)	$7,018,408	$6,510,000
3. Existing Fire pump deficiency at existing T-8 Pump Station 3250 Zone (EB-02)	$937,944	$870,000
4. Existing Fire pumps deficiency at existing Hilltop Pump Station 3250 C Zone (EB-03)	$743,887	$690,000
5. Existing Fire pump deficiency at existing 5 MG Booster pump station 3250 A Zone (EB-04)	$689,982	$640,000
6. Expansion Pipeline of 13,794 linear feet of 16" diameter	$5,353,662	$4,965,847
7. Expansion Pipeline of 5,394 linear feet of 24" diameter	$3,139,945	$2,912,490
Sub-Total for 3250 zone	$17,883,827	$16,588,337
3200 and 3250 Total	**$23,554,163**	**$21,847,918**
H. 3400 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$4,910	
2. New 0.75 MG storage tank Quail Valley Development (FS-01)	$2,425,717	$2,250,000
3. New 2.0 MG storage tank on Mt. Emma Road and 47th Street East (FS-05)	$4,851,434	$4,500,000
4. Existing fire pump deficiency at existing V-5 pump station 3400 E zone(EB-01)	$2,813,832	$2,610,000
5. New fire flow deficiency pipe 1,400 feet length (FF-07)	$271,680	$252,000
6. Expansion Pipeline of 143 linear feet of 16" diameter	$55,339	$51,330
7. Expansion Pipeline of 3,028 linear feet of 20" diameter	$1,468,971	$1,362,560
8. New pump at Underground Pump Station to 3400 Zone	$743,887	$690,000
Sub-Total for 3400 zone	$12,625,950	$11,715,890

Table 10-16 – Capital Improvement Program to Year 2030 (data from Appendix E) Costs Adjusted for Construction Cost Index

2016 MASTER PLAN RECOMMENDED IMPROVEMENTS	July 2018 Costs	2015 Costs
Description (features required from 2015 to 2030)	ENR index July 2018	ENR index Dec 2015
	For Los Angeles	For Los Angeles
	11,985.50	11,117.28
I. 3600 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$19,315	
2. New 1.0MG storage tank Quail Valley Development (ES-01)	$2,910,860	$2,700,000
3. New pump to 3600 W. Zone at Ft Booster pump station (FB-01)	$366,553	$340,000
Sub-Total for 3600 zone	$3,258,098	$3,040,000
3400 and 3600 plus	**$15,908,272**	**$14,755,890**
Total Future (10-year CIP)	**$122,302,760**	**$96,417,437**

Contents

SECTION 11 CAPITAL IMPACT FEES AND FINANCING OPTIONS

11.1 Introduction

This current Water Master Plan considers all facilities currently in-place and determines the additional facilities that will be needed to serve new customers to the year 2030. Costs for the capital facilities to meet additional demands have been developed, accounting for projections of growth in each of the service zones and the necessary improvements to service the growth.
More detailed background data used to develop the Capital Impact Fees (CIF) are contained in this Chapter 11, as well as Chapter 10 and Appendices E and F.

11.2 Existing (Approved) Capital Impact Fees

In order for the Palmdale Water District to continue approving the construction of new water service connections to the water system and committing to providing reliable water supply, the District established an equitable revenue source that would fund the development and/or acquisition of new water supplies to support new development. On October 23, 2013, the Palmdale Water District Board of Directors approved a resolution that modified the Capital Improvement Fees in place at that time and added a Water Supply Fee component. The Board of Directors carefully considered various options and after working closely with the Los Angeles/Ventura Chapter of the Building Industry Association, the Board adopted a resolution making the modifications to the Capital Impact Fees that woud became effective January 1, 2014. The following table displays the CIF that were in place in year 2014. CIF is from Appendix H of Article 10.07 Capital Impact Fee

Table 11-1
2014 Approved Capital Impact Fee per Service Zone

Single Family ($ per Equivalent Dwelling Unit (EDU))				Commercial and Industrial		
Zone	Infrastructure	Water Supply	Total	Infrastructure	Water Supply ($/AFY)	Total
2800’ & 2850’	$1,441	$7,288	$8,729	$1,441	$10,970	Based on EDU’s & AFY
2950’ & 3000’	$1,161	$7,349	$8,510	$1,161	$10,970	
3200 & 3250	$9,089	$7,041	$16,130	$9,089	$10,970	
3400 & 3600 plus	$12,274	$7,041	$19,315	$12,274	$10,970	

11.3 Demand and EDU's per Zone

The demands for the existing system (2014) and future horizons (2030 and build out) have been broken down by pressure zone and are detailed in Table 11-2. A factor of 500 gpd was used to convert the model demand to EDU's and the results are detailed in Table 11-3.

Table 11-2 Expected Growth in Demand per Zone

Zone	Total Expected Demands (gpm)			Difference in Demands gpm)	
	2014	**2030**	**Build Out**	**2030**	**Build Out**
2800	5,974	7,870	10,796	1,896	2,926
2835	0	0	3	0	3
2850	2,307	2,946	3,817	639	871
2950	3,067	3,957	6,224	890	2,267
3000	1,295	1,810	2,081	515	270
3200	170	701	1,100	531	399
3250	67	386	863	319	477
3400W	98	407	538	308	131
3400E	6	71	1,540	65	1,469
3600W	16	304	373	289	69
3600E	0	0	574	0	574
3800	0	0	170	0	170
4000	0	0	63	0	63
Total	13,000	18,452	28,141	5,452	9,689

Table 11-3 Expected EDU's Growth per Zone

Zone	Total Expected EDU'S			Difference in EDU'S	
	2014	**2030**	**Build Out**	**2030**	**Build Out**
2800	17,205	22,666	31,093	5,461	8,427
2835	0	0	8	0	8
2850	6,645	8,486	10,994	1,841	2,508
2950	8,833	11,396	17,925	2,563	6,529
3000	3,730	5,213	5,992	1,483	779
3200	489	2,018	3,168	1,529	1,150
3250	193	1,111	2,484	919	1,373
3400W	283	1,172	1,549	888	378
3400E	18	205	4,436	187	4,231
3600W	45	876	1,074	831	199
3600E	0	0	1,653	0	1,653
3800	0	0	490	0	490
4000	0	0	181	0	181
Total	**37,440**	**53,143**	**81,046**	**15,702**	**27,904**

11.4 Allocation of Costs to Service Zones

Using data from Appendix F – Allocation of Project Costs According to Zones Which They Benefit, costs for project features are listed according to the Zone that benefits from the Capital Improvement Feature. Using these costs and the EDU's from Table 11-3, the proposed Capital Impact Fees (CIF) are calculated. Table 11-4 contains the data used to directly calculate the proposed CIF. The 2015 costs in the Water Master Plan were indexed to July 2018 costs using the construction cost index for Los Angeles as presented in the Engineering News Record online service. The construction index factor for 2015 was 11,117.28. For July 2018 the construction cost index was 11,985.50. The ratio of 11,985.50 to 11,117.28 is 1.0781. The 2015 costs were multiplied by the factor of 1.0781 to update the costs to July 2018 costs. Future adjustments to the 2015 costs will be updated to future years using the construction cost index method.

Table 11 - 4 Cost Allocation According to Zones Which Receive Benefits
(Data obtained from Appendix F)

2016 MASTER PLAN RECOMMENDED IMPROVEMENTS **Description (features required from 2015 to 2030)**	**July 2018 Costs** ENR index July 2018 For Los Angeles 11,985.50	**2015 Costs** ENR index Dec 2015 For Los Angeles 11,117.28
A. Entire System		
1. Adjustments for CIF Collected from 2014 to July 2018	$0	
2. Headquaters Building Expansion (21,000 square feet at $200 per square foot from R.S. Means)	$4,200,000	
3. Headquarters and other buildings remodeling to service growth in population	$2,000,000	
4. Littlerock Sediment Removal Grade Control Constructon (plus environmental monitoring)	$10,800,000	
5. Littlerock Sediment Removal EIS/EIR Preparation and Design (January 2015 to August 2018)	$1,010,057	
6. Engineering and Environmental for Water Master Plan (Costs 2015 to 2018)	$345,407	
Sub-Total for Entire System	$18,355,464	
B. 2800 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$1,168,266	
2. New 4.0 MG storage tank at existing 45th Street Location (FS-04)	$8,409,152	$7,800,000
3. New fire flow deficiency pipe of 2,675 feet length (FF-01)	$778,655	$722,250
4. New fire flow deficiency pipe of 965 feet length (FF-04)	$280,898	$260,550
5. Allocation of costs for features serving multiple zones		
5a. New groundwater wells	$377,334	$350,000
5b. Pipelines of greater than 16-inch diameter	$1,197,753	$1,110,989
Sub-Total for 2800 zone	$9,875,526	$10,243,789
C. 2850 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	$0	
2. New 2.0 MG storage tank at existing 50th Street location (FS-03)	$4,851,434	$4,500,000
5. Allocation of costs for features serving multiple zones	$0	
5a. New groundwater wells	$377,334	$350,000
5b. Pipelines of greater than 16-inch diameter	$1,048,662	$972,698
Sub-Total for 2850 zone	$6,277,430	$5,822,698
2800 and 2850 Total	**$17,321,222**	**$16,066,487**

**Table 11 - 4 Cost Allocation According to Zones Which Receive Benefits
(Data obtained from Appendix F)**

2016 MASTER PLAN RECOMMENDED IMPROVEMENTS **Description (features required from 2015 to 2030)**	**July 2018 Costs** ENR index July 2018 For Los Angeles 11,985.50	**2015 Costs** ENR index Dec 2015 For Los Angeles 11,117.28
D. 2950 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$242,303	
2. New 4.2 MG storage tank near Sierra Highway and Rae Street (ES-03)	$8,829,610	$8,190,000
3. New 5.7 MG storage tank on 47th Street East, South of East Avenue T-8 (FS-02)	$11,061,269	$10,260,000
4. New fire flow deficiency pipe 1,570 feet length (FF-05)	$609,340	$565,200
5. New fire flow deficiency pipe 48 feet length (FF-06)	$9,315	$8,640
6. Alllocation of costs for features serving multiple zones		
6a. New groundwater wells	$377,334	$350,000
6b. Pipelines of greater than 16-inch diameter	$8,520,322	$7,903,117
6c. New pumps	$231,791	$215,000
Sub-Total for 2950 zone	$29,396,678	$27,491,957
E. 3000 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$19,884	
2. Allocation of costs for features serving multiple zones		
2a New groundwater wells	$377,334	350,000
2b. Pipelines of greather than 16-inch diameter	$4,967,849	$4,607,982
Sub-total for 3,000 zone	$5,325,299	$4,957,982
2950 and 3000 Total	**$34,984,164**	**$32,449,939**
F. 3200 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	$0	
2. Allocation of costs for features serving multiple zones		
2a. New groundwater wells	$377,334	$350,000
2b. Pipelines greater than 16-inch diameter	$4,501,954	$4,175,836
2c. New pumps	$526,470	$488,333
Sub-Total for 3200 zone	$5,405,758	$5,014,169
G. 3250 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	$0	
2. New 3.1 MG storage tank near 47th Street and East Avenue V4 (south of Barrel Springs Road) (ES-02)	$7,018,408	$6,510,000
3. Existing Fire pump deficiency at existing T-8 Pump Station 3250 Zone (EB-02)	$937,944	$870,000
4. Existing Fire pumps deficiency at existing Hilltop Pump Station 3250 C Zone (EB-03)	$743,887	$690,000
5. Existing Fire pump deficiency at existing 5 MG Booster pump station 3250 A Zone (EB-04)	$689,982	$640,000
6. Allocation of costs for features serving multiple zones		
6a. New groundwater wells	$377,334	$350,000
6b. Pipelines greater than 16-inch in diameter	$11,410,199	$10,583,653
Sub-Total for 3250 zone	$21,177,752	$19,643,653
3200 and 3250 Total	**$26,583,510**	**$24,657,822**

Table 11 - 4 Cost Allocation According to Zones Which Receive Benefits
(Data obtained from Appendix F)

2016 MASTER PLAN RECOMMENDED IMPROVEMENTS Description (features required from 2015 to 2030)	July 2018 Costs ENR index July 2018 For Los Angeles 11,985.50	2015 Costs ENR index Dec 2015 For Los Angeles 11,117.28
H. 3400 Zone		
1. Adjustments for CIF Collected from 2014 to July 2018	-$4,910	
2. New 0.75 MG storage tank Quail Valley Development (FS-01)	$2,425,717	$2,250,000
3. New 2.0 MG storage tank on Mt. Emma Road and 47th Street East (FS-05)	$4,851,434	$4,500,000
4. Existing fire pump deficiency at existing V-5 pump station 3400 E zone(EB-01)	$2,813,832	$2,610,000
5. New fire flow deficiency pipe 1,400 feet length (FF-07)	$271,680	$252,000
6. New pump at Underground Pump Station to 3400 Zone	$743,887	$690,000
7. Allocation of costs for features serving mulitple zones		
7a. New groundwater wells	$754,668	$700,000
7b. Pipelines greater than 16-inch in diameter	$4,440,900	$4,119,205
7c. New pumps	$526,471	$488,334
Sub-Total for 3400 zone	$16,823,679	$15,609,539
I. 3600 Zone and higher zones		
1. Adjustments for CIF Collected from 2014 to July 2018	-$19,315	
2. New 1.0MG storage tank Quail Valley Development (ES-01)	$2,910,860	$2,700,000
3. New pump to 3600 W. Zone at 3600 Ft. Booster Pump station	$366,553	$340,000
3. Allocation of costs for features serving multiple zones		
3a. New groundwater wells	$1,509,335	$1,400,000
3b. Pipelines greater than 16-inch in diameter	$2,916,592	$2,705,316
3c. New pumps	$526,471	$488,334
Sub-Total for 3600 zone	$8,210,496	$7,633,650
3400 and 3600 and higher zones	**$25,058,399**	**$23,243,189**
Total Future (10-year CIP)	**$122,302,760**	**$96,417,437**

11.5 Proposed Capital Impact Fees - Single Family Dwelling Unit

The infrastructure portion of the fees has been updated using this 2016 Water Master Plan. The water supply fees are still deemed appropriate but have been updated from 2014 using the Engineering-News Record construction cost index to July 2018. To be consistent with the development of the water supply fee, the adjacent zones are combined for computing the Capital Infrastructure Fee. See Table 11-4 for data where the costs for the two adjacent zones have been combined. Table 11-5 displays the proposed capital infrastructure component of the Capital Impact Fee.

Table 11-5 - 2018 Capital Infrastructure Fee			
Service/Benefit Zone	**CIF Required**	**Total Equiv. Units**	**CIF/Unit for Zone**
All Zones	18,355,464	15,702	1,169
2800'/2850'	17,321,222	7,302	2,372
2950'/3000'	34,984,164	4,046	8,647
3200'/3250'	26,583,510	2,448	10,859
3400'/3600+	25,058,399	1,906	13,147
Total	**122,302,760**	**15,702**	

To account for the capital infrastructure component of facilities that serve all zones it is necessary to add the cost of these features to other zones as presented in Table 11-6.

Table 11-6 - 2018 Capital Infrastructure Fee				
Service/Benefit Zone	**2800' & 2850'**	**2950' & 3000'**	**3200' & 3250'**	**3400' & 3600'+**
All Zones	$1,169	$1,169	$1,169	$1,169
2800'/2850'	$2,372			
2950'/3000'		$8,647		
3200'/3250'			$10,859	
3400'/3600'+				$13,147
Fee for Zone	**$3,541**	**$9,816**	**$12,028**	**$14,316**

The next step is to add together the infrastructure component and the water supply component to arrive at the proposed Capital Impact Fee. The 2014 water supply fee was indexed to July 2018 using the construction cost index for Los Angeles from the Engineering News Record online service. The construction cost index for December 2014 was 10,747.08. For July 2018 the construction cost index was 11,985.50. The ratio of 11,985.50 to 10,747.08 is 1.1152. The 2014 water supply component was multiplied by the factor of 1.1152 to update the water supply fee to July 2018 costs. The proposed 2018 Capital Impact Fee (CIF) is the combined cost of the infrastructure and water supply component as presented in Table 11-7.

Table 11-7 - Proposed 2018 Capital Impact Fee (CIF) (Single Family Dwelling Unit)				
	2800 & 2850	**2950 & 3000**	**3200 & 3250**	**3400 & 3600+**
Infrastructure	**$3,541**	**$9,816**	**$12,028**	**$14,316**
Water Supply	**$8,128**	**$8,196**	**$7,852**	**$7,852**
Total CIF	**$11,669**	**$18,012**	**$19,880**	**$22,168**

11.6 Capital Impact Fees – Commercial and Industrial

For commercial and industrial the same unit infrastructure costs computed for single family dwelling units is used. However, the water supply fee for commercial and industrial is different and higher because of the larger meters that serve these developments. The infrastructure costs from Table 11-7 are used while the 2014 water supply fee presented in Table 11-1 of 10,970 is index to July 2018. Results are presented in Table 11-8. Note that the Total Capital Impact Fee for commercial and industrial is contingent on the amount of water supply used.

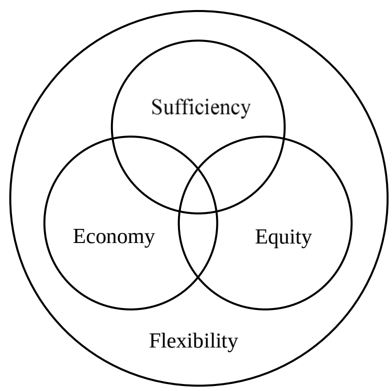
Table 11-8 - Proposed 2018 Capital Impact Fee (CIF) (Commercial and Industrial)

	2800 & 2850	2950 & 3000	3200 & 3250	3400 & 3600+
Infrastructure	**$3,541**	**$9,816**	**$12,028**	**$14,316**
Water Supply ($/AFY)	**$12,234**	**$12,234**	**$12,234**	**$12,234**
Total CIF	**Based on EDU's and AFY of Water**			

11.7 Finance Objectives

Successful financing of large capital programs depends on optimizing three overarching financial objectives:

- Produce capital in sufficient amounts when needed;
- Produce capital at lowest cost, and
- Produce capital with greatest equity among customers, including the principle that growth-pays-for-growth.



Financing Objectives

Because the Palmdale Water District (PWD) Water System Master Plan (WSMP) Capital Improvement Plan (CIP) will be implemented and refined over many years, the financial plan should be robust, yet flexible to accommodate changes in project timing, capital requirements, interest rates/inflation, system and constituency requirements or changes in law. While an in-depth detailed financial plan and analysis is beyond the scope of this Master Planning effort, this section is intended to present high-level issues and options for consideration and guidance.

11.8 Funding Sources

There are several possible funding sources available for the successful implementation of the PWD WSMP, including pay-as-you-go, Drinking Water State Revolving Fund Loan Program, general obligation bonds, revenue bonds, Certificates of Participation, commercial paper (short term notes), public-private-partnership (P3), developer impact or connection fees, and other state grants and loans. These sources are further described below.

11.8.1 Pay-As-You-Go

Pay-as-you-go funding requires that an agency (or group of agencies) generate and accumulate adequate capital reserves to fund capital improvements, usually through user rates. With sufficient planning, capital reserves can be built up over time to pay for future facility requirements by increasing user rates/fees prior to the need for capital facilities. These accumulated reserves can then fund capital facility costs in whole or in part. Using pay-as-you-go financing usually reduces the net overall costs of capital facilities to users by avoiding the costs associated with arranging financing (bond issue costs, legal and financial advisers, management fees, etc.) as well as interest payments on borrowed money.

Pay-as-you-go funding can lead to user fee inequities since customers today are paying the full costs for facilities that will provide benefits to future customers. Public approval of pay-as-you-go funding strategies can also be more difficult as user rates tend to be impacted more heavily in the early years of the planning period. Many agencies achieve a more equitable and palatable sharing of the cost burden by using other funding sources in addition to pay-as-you-go, to account for the differences in timing between reserve accumulation and capital facility spending requirements over time.

11.8.2 Drinking Water State Revolving Fund Loan Program

Through a jointly financed program between the federal EPA and the State of California, the Drinking Water State Revolving Fund (DWSRF) Loan Program can provide low interest loans to water utilities to help pay for improvements. Under the program, loans are issued for a period of up to 20 years at a fixed interest rate equal to 50 percent of the State’s average interest rate paid on general obligation bonds sold during the previous calendar year. Repayment under the program must begin within six months after completion of the project and loans are limited only by water system's ability to borrow. Previously overseen by the Department of Public Health, the DWSRF program was transferred to the State Water Resources Control Board (State Water Board) as of July 2014. The State Water Board’s Division of Financial Assistance (Division) administers the DWSRF Program

Generally, loans are limited to $20 million for any single project, with a cap of $30 million available to a single water utility in a single fiscal year. These amounts may be modified if it is determined that excess funds are available that cannot otherwise be obligated before the EPA obligation deadline.

Loans are granted competitively statewide based on a set of ranking criteria that give highest priority to projects that resolve deficiencies having direct health implications. Also high on the priority list are projects addressing insufficient water supply or water quality projects that address water outages. Significant priority is also given to disadvantaged communities. Funds are allocated to applicants based on the priority categories until all funds are obligated. Since the program began in May 1998 through March 30, 2010, California Department of Public Health (CDPH) has closed 207 loans totaling $895 million cumulatively (USEPA, 2010).

11.8.3 General Obligation Bonds

General Obligation (G.O.) bonds are backed by the full faith and credit of the issuer. As such, they also carry the pledge of the issuer to use its taxing authority to guarantee repayment of interest and principal. The issuer's general obligation pledge is usually regarded by both investors and ratings agencies as the highest form of security for bond issues.

Because G.O. bonds are viewed as having lower risk than other types of bonds, they are usually issued at lower interest rates, have fewer costs for marketing and issuance, and do not require as extensive restrictions, covenants, special reserves, and higher debt service coverage ratios typical of other types of bond issues. However, issuance of G.O. bonds requires electoral approval by two-thirds of the voters, and education campaigns can be very expensive.

The ultimate security for G.O. bonds is the pledge to impose a property tax to pay for debt service. G.O. bonds are typically issued by a single agency. Use of property taxes, assessed on the value of property, may also not fairly distribute the capital cost burden in alignment with the benefits received by the benefitting customers. If the agency is a general purpose government (City or County) having taxing authority, the agency could choose to fund the debt service payments from non-general fund (or enterprise) sources of revenue, such as water rates or from development impact fees. Use of development impact fees to pay some portion of debt service could provide a more equitable matching of benefits with costs, since debt service on projects that benefit primarily new customers would be paid from fees collected from those new customers.

G.O. bonds are attractive due to lower interest rates, fewer restrictions, greater market acceptance, and lower issuing costs. However, the difficulties in securing a two-thirds majority of the qualified electorate makes G.O. bonds less attractive than other alternatives, such as revenue bonds and certificates of participation for many agencies.

11.8.4 Revenue Bonds

Revenue bonds are long-term debt obligations for which a specific revenue stream of the issuer is pledged for repayment of principal and interest. Because revenue bonds are not secured by the taxing authority of the issuing agency, they are not perceived as being as secure as general obligation (G. O.) bonds. Since revenue bonds are perceived to have less security and are therefore considered riskier, they are typically sold at a slightly higher interest rate (frequently in the range of 0.5 percent to 1.0 percent higher) than G.O. bonds. The security pledged is that the agency will collect sufficient revenues to meet debt service obligations.

Typically, issuers provide the necessary assurances to bondholders that funds will be available to meet debt service requirements through two mechanisms. The first is provision of a debt service reserve fund or a surety. A restricted debt service reserve fund is usually established from the proceeds of the bond issue. The amount held in reserve in most cases is based on either the maximum debt service due in any one year during the term of the bonds or the average annual debt service over the term. The funds are deposited with a trustee to be available in the event the issuer is otherwise incapable of meeting its debt repayment obligations in any year. The issuer pledges that any funds withdrawn from the reserve will be replenished within a short period, usually within a year.

The second assurance made by the borrower is a pledge to maintain a specified minimum coverage ratio on its outstanding revenue bond debt. The coverage ratio is determined by dividing the net revenues of the borrower by the annual revenue bond debt service for the year, where net revenues are defined as gross revenues less operation and maintenance expenses. Coverage ratio requirements depend on the borrower and perceived risk and are usually within the range of 1.1X to 1.3X, meaning that net revenues have to be from 110 percent to 130 percent of the amount of revenue bond debt service. To the extent that the borrower can demonstrate achievement of coverage ratios higher than required, the marketability and interest rates on new issues may be more favorable.

Issuance of revenue bonds may be authorized pursuant to the provisions of the Revenue Bond Law of 1941. Specific authority to issue a specified amount in revenue bonds requires approval by a simple majority of voters casting ballots, and would typically be limited to a single agency seeking a revenue bond. To limit costs (and risks) associated with seeking approval through elections; authorization is typically sought for the maximum amount of bonds that will be needed over the planning period. Upon receiving authorization, the agency usually issues bonds periodically over the planning period as needed, up to the total authorized amount.

11.8.5 Certificates of Participation

Certificates of Participation (COPs) are a form of lease-purchase financing that have many of the same basic features of revenue bonds except they do not require an election. COPs represent participation in an installment purchase agreement through marketable notes, with ownership remaining with the agency. COPs typically involve four different parties — the public agency as the lessee, a private leasing company as the lessor, a bank as trustee and an underwriter who markets the certificates. Because there are more parties involved, the initial cost of issuance for the COP and level of administrative effort may be greater than for bond issues. Due to the widespread acceptance of COPs in financial markets, COPs are usually easier to issue than other forms of lease purchase financing, such as lease revenue bonds.

The certificates are usually issued in $5,000 denominations, with the revenue stream from lease payments as the source of payment to the certificate holders. From the standpoint of the agency as the lessee, any and all revenue sources can be applied to payment of the obligation, not just revenues from the projects financed, thereby providing more flexibility. Unlike revenue bonds, COPs do not require a vote of the electorate and sometimes have no bond reserve requirements, although establishing a reserve may enhance marketability.

While interest costs for COPs may be marginally higher than for revenue bonds, a COP transaction is a flexible, useful and well accepted form of financing that should be considered for financing of the Master Plan projects. COP transactions are typically limited to a single agency obtaining a COP for a single or detailed portfolio of projects.

11.8.6 Commercial Paper (Short Term Notes)

To smooth out capital spending patterns over time without the costs of frequent bond issues, many public agencies with sufficient revenue streams use short-term commercial paper debt to attenuate the peaks and valleys of capital expenses from year to year. Similar to bonds issued by public agencies, commercial paper instruments are typically tax-exempt debt, thus demanding a lower interest cost to the agency than would prevail if the commercial paper were taxable. Commercial paper is usually issued for terms ranging from as short as a few days to as long as a year depending on market conditions. As the paper matures, it is resold ("rolled over") at the then prevailing market rate. Consequently, the paper can in effect "float" over an extended time, being constantly renewed. The short-term rates paid on commercial paper are frequently much lower than those on longer term debt.

The primary advantage in using commercial paper is to provide interim funding of capital projects when revenues and reserves are insufficient to fund capital projects fully. In this scenario either (1) the total amount needed is too small to justify a bond issue or (2) the funds are not currently available, but will be building up in the immediate future to a level sufficient to repay the borrowing. Commercial paper funding can provide a "bridge" to smooth out the flow of funds. As with other forms of debt financing, there are costs associated with issuing commercial paper, often similar to those of issuing bonds. With commercial paper, however, there is often a requirement that a line of credit be established that will guarantee repayment of the commercial paper should it not be possible to roll the paper over at any given maturity date. The cost of the credit line is usually based on the full amount of commercial paper authorized, whether issued or not, so the total commercial paper authorization must be carefully determined to maximize the benefit while minimizing costs.

While the interest rate for a particular commercial paper issue is fixed until its maturity, the short maturities and frequent rollovers of the debt effectively make commercial paper much like a long-term variable rate bond. Consequently, there is some exposure to interest rate risk in using commercial paper as a funding mechanism. However, unless inflationary pressure is great, the risk is relatively low.

The strategy now being used by a number of water agencies is to issue commercial paper up to the authorized limit, then pay-off the outstanding commercial paper through a revenue bond issue. The water agency gets the benefit of low short-term interest rates while still being able to convert to long term fixed rates through the bond issue. This is an appropriate strategy during periods of time with stable interest rates, but not when interest rates are rising or expected to rise substantially. Commercial paper programs are typically limited to a single water agency, and the agency pursuing commercial paper will need to confer with their legal and financial advisors to determine if sufficient authorization currently exists to implement a commercial paper program.

11.8.7 Property Related Debt

For many years, California has allowed a form of financing where the properties that benefit from projects pay debt service in proportion to the benefit received. The California Streets and Highways Code allows bonds to be sold under the 1911 Improvement Act or 1913 Municipal

Improvement Act, under the procedure of the 1913 Act and the 1931 Majority Protest Act. Mello Roos Community Facilities District Act (1982) financing is another variation of this theme. Assessment financing, as the method is called, is useful for allocating shares of cost and debt service to properties within specific areas (called assessment districts) within which all of the financed project's benefit accrued. Assessment districts are typically used for defined geographic areas to finance specific projects which benefit the property's in that geographic area. Although assessment methods still are legal, the voting requirement of the Tax Payers' Right to Vote Act (Proposition 218) has generally made the procedure less attractive when numerous properties are involved.

11.8.8 Private Sector Equity

Some utilities find it convenient to enter into agreements with a private sector service provider to perform certain well-defined functions. The service provider provides the assets as well as human resources, materials, supplies and other costs of business and includes those costs in the amount charged to the utility. This procedure becomes, de facto, a financing technique for the utility in that the capital cost of the assets are financed by the private sector service provider since the assets are owned by it. The financing costs and interest rates are often more expensive than traditional public financing methods as the private equity firm's cost of capital is generally higher and there are income tax considerations. The specifics can depend much on the private equity firm's other portfolio assets, but this method can reduce the capital requirement to be financed by the utility and may offer greater flexibility and creativity than other financing options.

Specific projects for engaging a private sector equity participant have not been identified. Further, any cost savings associated with this approach might depend on the specific projects, so this approach is not considered further in this financing plan. Again, this method can be a valuable tool for application in certain situations and should be considered when appropriate.

11.8.9 Public-Private Partnership (P3)

Public-Private Partnerships (P3) are similar to Private Sector Equity financing. A P3 project has two large drivers: the first is that the utility does not incur any borrowing, and second is that the utility can rely on the expertise and efficiencies that the private sector can bring to a project. P3 financed projects are effective when the public sector will have difficulty accessing or accumulating necessary funds for large capital improvement projects. A P3 approach will provide both access to capital and a highly experienced and efficient private sector project development, finance, and delivery team that leverages local resources, businesses, and expertise.

P3 projects help the agency save time and money. P3s specify the allocation of risk, which creates incentives for the private team to deliver the project efficiently. Additionally, alignment of the schedule of major projects to other water supply projects and development in the area can streamline activities and delivery, expediting the realization of community, developer, and environmental benefits. A delay in addressing water supply needs in order to secure adequate public funding will likely result in inflated costs. Current lower material and commodity prices suggest expediting the project will result in a lower cost. Addressing the financing and construction of a project immediately with a P3 approach will unbind staff and resources for other projects and capital improvements. By dealing with these water supply infrastructure needs with outside funding, the utilities bonding capacity, bonding constraints, and ability to address other projects in the capital improvement plan will be less affected.

In addition, use of a P3 project delivery model allows risks to be allocated to the party most capable of managing them, which typically results in the transfer of a number of commercial risks from the public sponsor to the private partners. Therefore, P3 projects are effective for large risk projects, to defer the risk from the public agency to the private sector.

Generally, financing costs will be higher for P3 projects than traditional sources of funding due to high capital costs for the private sector. However, these high costs could be offset by the delivery efficiency and risk mitigation techniques of the private sector.

11.8.10 Integrated Regional Water Management Plan (IRWMP) Grants

California Department of Water Resources (DWR) has a number of Integrated Regional Water Management Plan (IRWM) grant program funding opportunities. Current IRWM grant programs include: planning, implementation, and stormwater flood management. DWR's IRWM Grant Programs are managed within DWR's Division of IRWM by the Financial Assistance Branch with assistance from the Regional Planning Branch and regional offices (IRWMP website). The funding provided under this program is through Proposition 50, Proposition 84, and Proposition 1E. The intent of these grants is to assist in developing regional projects benefitting multiple stakeholders. Thus, IRWMP grants are not considered a viable primary CIP funding strategy.

11.8.11 Federal Funding

Federal funding for recycled water projects is available through the U. S. Bureau of Reclamation, Title XVI Program. The Title XVI Program makes funds available to eligible projects (such as 1) design and construction of demonstration and permanent facilities to reclaim and reuse wastewater and 2) water reclamation and reuse of municipal, industrial, domestic and agricultural wastewater, and naturally impaired ground and surface waters) in the form of grants. The Program funds up to 25 percent of the total project cost.

U.S. Army Corp of Engineers (USACE) funding is available, for flood damage reduction, aquatic system restoration, and certain eligible municipal & industrial water supply projects. This funding is through USACE's Civil Works Program and projects under this program are financed upfront by the Federal government with 100 percent of the cost to be repaid with interest over a period of 30-50 years. USACE funding is also available to certain rural and small communities to fund water supply projects via USACE's Environmental Infrastructure authorizations. Projects covered under this program are typically design and construction of drinking water and wastewater infrastructure, surface water protection and development. Financing under the environmental infrastructure authorizations is typically 75 percent federal and 25 percent non-federal.

11.8.12 2014 Water Bond

On November 4, 2014 the California Proposition 1, Water Bond (2014) was passed and enacted the Water Quality, Supply, and Infrastructure Improvement Act of 2014. This Act authorizes $7.12 billion in general obligation bonds for state water supply infrastructure projects, including surface and groundwater storage, water supply management, water recycling and advanced water treatment technology, flood control, and ecosystem, watershed, and drinking water protection. PWD should explore the possibility of securing funding through this measure, but should not be considered a viable primary capital-funding source. Certain projects receiving Proposition 1 funds must provide matching funds from non-state sources in order to receive the bond funds.

Contents

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APPENDIX B FACILITY ASSESSMENT

1. Introduction

This section summarizes the physical condition of the District's water system facilities based on the information gathered from field visits, existing reports, and input from District staff. Criteria for anticipated useful life for the various facilities are established. Based on the useful life criteria, the remaining useful life for the District's facilities is estimated. Factors such as routine facility repair and maintenance are also considered while estimating the remaining useful life of the facilities. Based on the remaining useful life for the District's facilities, a facility replacement schedule is recommended. In addition, a spreadsheet summarizing inventory, condition, and the remaining useful life for each facility is presented. However, it should be noted that periodic maintenance and repairs might change the useful life of any facility as well as periodic inspection may better assist in determining the actual useful life of facilities. The replacement and rehabilitation shall be scheduled for facilities as they reach the end of their useful life.

2. Water System Overview

The Westlake District has approximately 25,000 service connections. The District's water system consists of 21 storage reservoirs, 17 booster pumping stations, 27 active groundwater wells, 14 pressure reducing stations, and approximately 414 miles of pipeline.

3. Wells, Facilities, and Reservoirs Assessment Methodologies

3.1 Well Facilities Condition Assessment Methodology

The information collected during the field visits conducted on July 22, 2014 is included at the end of this section. Based on the information gathered during the field visits and input from the District, a methodology was developed to assess the visually observed condition of the District's facilities.

The facilities will be ranked based on their visually observed condition as good, fair, poor, or very poor. A brief description of the parameters considered to assess the condition of the District's facilities is provided below: The term asset used in this ranking refers to either the pump or the storage reservoir.

Good Condition - The District's asset is considered to be in good condition if the asset is able to perform its intended function(s) with a desirable degree of efficiency without requiring additional repair or refurbishment other than routine maintenance. In addition, the asset does not have any visible exterior damage.

Fair Condition - The District's asset is considered to be in fair condition if the asset is able to perform its intended function(s) at a lower than desired efficiency while requiring minor repair or refurbishment in addition to routine maintenance. Alternatively, the asset has minor visible exterior damage.

Poor Condition - The District's asset is considered to be in poor condition if the asset is able to perform its intended function(s) but requires major repair or refurbishment to operate at a lower than desired efficiency which may not be cost-effective for the District. Alternatively, the asset has severe visible damage on its exterior.

Very Poor Condition - The District's asset is considered to be in very poor condition if the asset is unable to perform its intended function(s) and requires replacement to operate at a desired efficiency. In addition, the asset has severe visible damage on its exterior.

In addition to the visually observed condition, other data such as pump efficiency, and tank inspection reports will be used to evaluate the condition of the District's facilities.

3.1.1 Pump Efficiency

Pump efficiency is defined as the ratio of the output power to the input power, expressed as a percentage. Pump tests done at regular intervals can be used to identify declining trends in pump efficiency. Ideally, the booster pumps shall have an efficiency greater than fair operating range. If the efficiency of a pump drops below good range, then less than half of the input power is being delivered to the system. Such pumps should be considered as candidates for renovation or replacement.

3.1.2 Previous Maintenance Records

By reviewing maintenance records for pumps and identifying the frequency and the severity of the repairs, the remaining useful life of a pump can be forecasted. In addition, preventative maintenance action required to achieve the asset's average anticipated service life can be identified.

3.1.3 Vibration Analyzer Tests

The vibration analyzer tests can detect pump bearing and impeller wear in pumps with rolling contact bearings. Sensors are placed on the motor bearing housing and various places along the axle. In the vibration detection reports supplied by the District and performed by Southern California Edison (SCE), the vibration waveform and spectra are measured and compared. Abnormal vibration spectra are indicated with their possible causes. The results can also be compared with the design vibration limits included in the original specifications and tolerances of the equipment.

3.1.4 Periodic Motor Temperature Check

Monitoring motor temperature over time can help detect damage to the electrical motor winding or increased friction losses within the motor. Motors are generally rated at sea level at a temperature of 104 degrees Fahrenheit. Direct sunlight can increase motor temperature by as much as 20 degrees Fahrenheit. Motors that operate at lower voltages draw additional current in an attempt to operate at their rated horsepower. An increase in the motor temperature may subsequently damage the motor winding.

3.2 Reservoirs Condition Assessment Methodology

Storage tanks will be ranked based on their visually observed condition as good, fair, poor, or very poor. The parameters considered to assess the condition of the reservoirs is similar to those discussed previously for the Booster Stations.

3.2.1 Signs of Corrosion/Damage

Any visible form of corrosion or damage on the exterior of the tank walls requires immediate attention. The District's tanks were evaluated for any external signs of damage or corrosion. In addition, the tank walls may also be internally affected by the presence of hidden cracks. These cracks are detected by isolating the storage tank from the system and monitoring the water level in the tank. If the water level in the tank declines over time, it indicates the presence of internal cracks.

3.2.2 Tank Inspection Reports

The District inspects the condition of its storage tanks over a five-year cycle. The results of the inspection are documented and include repair and other budgetary recommendations. The report specifically assesses the exterior of the tank roof, the exterior of the tank shell, the interior of the tank, and the cathodic protection system.

3.2.3 Ultrasonic Testing

Ultrasonic testing is a non-destructive method of testing that can measure tank wall thickness and detect any form of interior damage within the tank walls. The extent of corrosion can be identified by comparing the actual tank wall thickness at the time of the test to the original wall thickness at the time of the construction of the tank.

4. Well Stations and Reservoirs Assessments and Recommendations:

Well No. 6:
Well No. 6 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2800 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a steel building. The roofing of the structure appeared to be is good condition.

The station is equipped with an onsite sodium hypochlorite generation system and a magnetic flow meter. Heat lamps have been placed inside the building due to poor insulation. Corrosion of the piping was noted both interior and exterior of the building. Operations staff noted that cold weather is also problematic due to worn and missing piping insulation and poor building insulation and lack of a permanent heating system.

Recommendations:

1. Provide a new coating system to the interior and exterior well piping and appurtenances
2. Replace piping insulation
3. Consider adding permanent heating system and building insulation

Well No. 15:
Well No. 15 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2800 Zone and is controlled by pressure at the station. The pump station site is gated and fenced, and contained within a masonry building.

A second wood-framed stucco building houses an unused chlorine gas facility. Chlorine gas piping was noted as needing a new coating to indicate chemical by color code. Portable space heaters are utilized during cold weather due to the poor insulation in the building.

Other equipment at the site includes:

- Diesel Power Generator (good condition)
- HVAC system (good condition)
- Propane Gas Tank (good condition)
- Sodium Hypochlorite Tank (good condition)
- Gas Chlorine system (Not used/out of service)
- Magnetic Flow Meter (good condition)
- Onsite Sodium Hypochlorite Generation System (good condition)

Pump discharge piping inside the building showed signs of coating peeling. The chlorine gas piping also showed signs of its color-coded paint peeling.

Recommendations:

1. Provide a new coating system to the interior and exterior well piping and appurtenances
2. Provide a new coating system to the chlorine piping
3. Replace missing insulation
4. Consider adding permanent heating system and building insulation

Well No. 11:
Well No. 11 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2800 Zone and is controlled by pressure at the station. The pump station site is gated and fenced.

The pump and well are located immediately outside a steel building housing an emergency power generator. The emergency generator building contains an HVAC system and this system is reported in good condition.

The pump discharge piping showed signs of coating peeling and corrosion consistent with long-term exposure to the elements.

A second wood-framed stucco building houses a chlorine generation facility. This facility was noted in good condition.

Recommendations:

1. Extend the building to fully enclose the vertical turbine pump
2. Provide a new coating system to the discharge piping and appurtenances
3. Provide a new coating system to the chlorine piping

Well No. 14 Tank & Booster:

This station serves the 2800 Zone 2800 and is controlled by pressure at the station. The pump station site is gated and fenced. Well No. 14 is equipped with a vertical turbine pump and operated by a variable-frequency drive. The well discharges to an uncoated bolted steel storage tank. The overflow piping from the tank is noted as heavily corroded.

A booster pump on the tank outlet transfers the water to the distribution system is located outside on a concrete pad and open to weathering. The booster pump along with its motor and appurtenances were evaluated as being in fair condition.

The well pump is located inside a masonry and wood building. One wall of the structure is removable to permit access/removal of the pumping equipment. Well discharge piping and control valve showed signs of coating deterioration. The well pump building was evaluated as being in fair condition. PLC screen number 4 was noted as requiring replacement. The HVAC system for the building was observed to be in good condition.

A second masonry building houses a sodium hypochlorite generation system. The control panel for the onsite sodium hypochlorite system was noted to be in need of replacement.

The District has plans to remove the storage tank and booster pump in 2 to 3 years and will reconfigure the piping to permit the well to pump directly into the distribution system.

Recommendations:

1. Replace control valve on the booster pump
2. Provide a protective shelter for the booster pump
3. Replace the tank's heavily corroded overflow pipe
4. Provide a new coating system to the well discharge piping and appurtenances

Well No. 23:

This station serves the 2800 Zone and is controlled by pressure at the station. The pump station site is gated and fenced. Well No. 23 is equipped with a vertical turbine pump and operated by a variable-frequency drive. The well is located in a small protective enclosure on a concrete pad without an HVAC system. The well was noted as being in good condition.

A steel building houses a decommissioned well and pump system. This structure also houses the flow measurement, electrical, and SCADA control systems. Flow from the well is monitored with a magnetic flow meter.

The well discharge piping and control valve showed signs of coating deterioration. The well pump building was evaluated as being in good condition. The HVAC system for the building was observed to be in good condition, although no cooling system is provided.

A second stucco frame building houses a sodium hypochlorite storage and metering system. The system was noted as being in good condition. The window on the structure showed signs of scratching and corrosion and the District has plans to make repairs.

Recommendations:

1. Provide a new coating system to the well discharge piping and appurtenances
2. Provide new coating to window frame and screens

Well No. 7:

Well No. 7 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2800 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a steel building. The door to the structure appeared to be heavily corroded is recommended for replacement.

The station is equipped with a sodium hypochlorite storage and metering system and a magnetic flow meter. Corrosion of the well discharge piping was noted and it is recommended a new protective coating system be applied.

Recommendations:

1. Replace the building entrance doorway
2. Provide a new coating system to the well discharge piping and appurtenances

Well No. 8:

Well No. 8 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2800 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a steel building.

The station is equipped with a sodium hypochlorite storage and metering system and a magnetic flow meter. The concrete pad supporting the sodium hypochlorite tank showed signs of cracking and requires structural reinforcement to prevent further deterioration. Corrosion of the well discharge piping was also noted.

Recommendations:

1. Provide structural reinforcement to the concrete pad supporting the sodium hypochlorite tank
2. Provide a new coating system to the well discharge piping and appurtenances

Well No. 2:

Well No. 2 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2800 Zone and is controlled by pressure at the station. The pump station site is gated and fenced, and contained within a masonry building. Discharge piping showed some signs of the coating peeling off and a new coating system is recommended.

The station is equipped with a sodium hypochlorite storage, a flow metering system, and an emergency power generator that operates on natural gas. The sodium hypochlorite building is using a portable fan to cool electrical equipment suggesting the HVAC system is inadequate to cool the equipment properly.

Recommendations:

1. It recommended to have the HVAC performance tested/checked/replaced
2. Provide a new coating system to the well discharge piping and appurtenances

Well No. 3:

Well No. 3 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2800 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a masonry building.

The station is equipped with a sodium hypochlorite storage and metering system and a power generator that operates on natural gas. A pair of centrifugal pumps are used for cooling. This system was noted as being in good condition.

The sodium hypochlorite building is using a portable fan to cool electrical equipment. This suggests the HVAC system is inadequate to cool the equipment properly. It is recommended to have the HVAC's performance tested.

Recommendations:

1. It recommended to have the HVAC performance tested/checked/replaced

Well No. 10:

Well No. 10 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2800 Zone and is controlled by pressure at the station.

The pump station site is gated, fenced, and contained within a steel building. The building is over 100 years old but noted to be in fair condition. The building's HVAC system was noted to be in good condition.

Portions of the site security fencing are missing due to theft and vandalism. The District also desires to install security cameras in the future to reduce damages and losses.

The station is equipped with a sodium hypochlorite storage and metering system and a magnetic flow meter. These systems were noted as being in good condition.

Corrosion of the well discharge piping was noted and in need of a new protective coating system.

Recommendations:

1. Provide a new coating system to the well discharge piping and appurtenances
2. Replace sections of missing security fencing
3. Consider additional security measures such as cameras and lighting to reduce vandalism

Well No.30:

Well No. 30 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2850 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a masonry building and appears to be in good condition. The building's HVAC system consists of a small fan on the roof and noted as being in fair condition.

The station is equipped with a sodium hypochlorite storage and metering system and a magnetic flow meter. These systems were noted as being in good condition.

Corrosion of the well discharge piping was noted and it is recommended a new protective coating system be applied.

Recommendations:

1. Provide a new coating system to the well discharge piping and appurtenances

Well No.33:

Well No. 33 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2850 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a masonry building and appears to be in good condition. The well itself is located outside the building and mounted on a concrete pad.

The station is equipped with a sodium hypochlorite storage and metering system and a magnetic flow meter. These systems were noted as being in good condition.

Signs of bullet strikes to control cabinets indicate vandalism is problematic at the site.

Recommendations:

1. Repair bullet strikes/vandalism damage
2. Consider additional security measures such as cameras and lighting to reduce vandalism

Well No.25:

Well No. 25 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2850 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a masonry building and appears to be in good condition. The building's HVAC system consists of a small fan on the roof and noted as being in good condition. Corrosion of the building's steel entrance door was noted.

The station is equipped with a sodium hypochlorite storage and metering system and a magnetic flow meter. These systems were noted as being in good condition.

Recommendations:

1. Provide a new coating system to the entrance door/replace door

Well No.29:

Well No. 29 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2850 Zones and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a masonry building and appears to be in good condition. The well itself is located outside the building and mounted on a concrete pad.

The station is equipped with a sodium hypochlorite generation system and storage as well as a magnetic flow meter. These systems were noted as being in good condition.

Recommendations:
No improvements are recommended

Well No.22:
Well No. 22 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2850 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a small wooden frame building and noted to require replacement. The building's HVAC system consists of a small fan on the roof and noted as being in good condition.

The station is equipped with a sodium hypochlorite storage and metering system noted as being in fair condition. A magnetic flow meter provides flow measurement and is in good condition.

Corrosion of the well discharge piping was noted and in need of a new protective coating system.

Recommendations:

1. Provide a new coating system to the well discharge piping and appurtenances

Well No.26:
Well No. 26 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2850 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a wood frame building and noted to be in good condition. The well itself is located outside the building and mounted on a concrete pad.

Operations stated the existing well motor is oversized and throttled in order to provide the pump flow required. This system requires detailed evaluation and possibly performance testing to determine the corrective action necessary to operate properly.

The station is equipped with a sodium hypochlorite generation system and storage as well as a magnetic flow meter. These systems were noted as being in good condition.

Corrosion of the well discharge piping and the steel window screens was noted and in need of a new protective coating system.

Recommendations:

1. Provide a new coating system to the window screens
2. Provide a new coating system to the well discharge piping and appurtenances
3. Perform a detailed hydraulic evaluation of the pumping system to eliminate throttling of the pump

Well No.21:
Well No. 21 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2950 Zone and is controlled by pressure at the station. The pump station site is gated and fenced, and contained within a wood frame building and noted to be in good condition. The well itself is located outside the building and mounted on a concrete pad.

The station is equipped with a sodium hypochlorite generation system and storage as well as a magnetic flow meter. These systems were noted as being in good condition.

Corrosion of the well discharge piping pipe supports, and the steel window screens was noted and in need of a new protective coating system.

Recommendations:

1. Provide a new coating system to the window screens
2. Provide a new coating system to the well discharge piping, supports, and appurtenances

Well No.35:

Well No. 35 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves the 2950 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a masonry building and noted to be in fair condition, showing some cracking and damage. The well itself is located outside the building and mounted on a concrete pad.

The station is equipped with a sodium hypochlorite generation system and storage as well as a magnetic flow meter. These systems were noted as being in good condition.

Corrosion of the well discharge piping was noted and in need of a new protective coating system.

Recommendations:

1. Provide a new coating system to the window screens
2. Provide a new coating system to the well discharge piping and appurtenances

Well No. 18 & Well No. 19:

Well No. 18 and Well No. 19 are equipped with vertical turbine pumps operated by variable-frequency drives. The wells are located out in the open on concrete pads and supply water to a ground storage reservoir and to the V-5 booster pump. Well No. 19 has been rehabilitated with a new pump and flow meter. Well No. 18 was noted with significant corrosion and operations stated the system is in need of rehabilitation in the same manner as was performed on Well No. 19.

Recommendations:

1. Provide rehabilitation of Well No. 18 as was performed on Well No. 19 to remove corrosion
2. Consider enclosing the pumps for protection from the elements

Well No. 18 & Well No. 19 Reservoir:

The Well No. 18 and Well No. 19 reservoir is a welded steel type tank and noted to be in good condition with minor corrosion to the overflow piping. This tank provides water to Zone 3200. The tank does not contain a level indicator and corrosion was noted on the over flow piping.

Recommendations:

1. Provide a level indicator
2. Provide a new coating system to the tank overflow piping and appurtenances

V-5 Booster Pump & Hydro Pneumatic Tank: The V-5 booster pump is a centrifugal type and noted to be in good condition. The system in enclosed in a wood frame building. Portable space heaters in the building suggest the HVAC system is not sufficient to provide heating requirements. A hydro pneumatic tank is combined with the booster pump to maintain pressure to Zone 3400.

Recommendations:

1. Perform an evaluation of the HVAC system for heating deficiencies

Palmdale Booster Pump & Hydro Pneumatic Tank:
The Palmdale centrifugal booster pump and hydro pneumatic tank serve Zone 3250. The equipment is mounted outside on concrete pads. This equipment was noted in good condition with no deficiencies.

Recommendations:

1. No improvements are recommended

Hilltop Booster & Hydro Pneumatic Tank:
The Hilltop Booster Pump is equipped with a centrifugal pump and hydro pneumatic tank. This station serves the 3200 Zone and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a wood frame building and noted to be in fair condition. Significant corrosion on the well discharge piping was noted.

The building does not provide a HVAC or emergency power systems. Electrical control panels are mounted on exterior walls with little protection from the elements.

Recommendations:

1. Provide a new coating system to the well discharge piping and appurtenances
2. Extend the building to enclose control panels

47th Street Reservoirs:
Three welded steel tanks are located at the fenced 47th Street facility. The tanks were noted to have received recent coatings and to be in good condition. The tanks contain a single inlet and outlet and an altitude valve for control.

Recommendations:

1. No improvements are recommended

50th Street Reservoirs:
Two, welded steel bolted tanks are located at the fenced 50th Street facility. The tanks and overall site were noted be in good condition. The tanks contain a single inlet and outlet and an altitude valve for control.

Recommendations:

1. No improvements are recommended

T-8 Booster Pump & Hydro Pneumatic Tank:
The station serves Zone 3200 and is equipped with three centrifugal booster pumps in conjunction with a hydro pneumatic tank. The facility also has an onsite sodium hypochlorite generation system, noted in good condition.

The centrifugal pumps showed a large amount of corrosion to the housing, mounting frame, and to the piping. The wood frame/stucco building housing the pumps showed a high degree of the paint coating peeling off and early stages of weather damage to the wood siding. Window screens on the building also show a high degree of corrosion.

The hydro pneumatic tank and site security were noted in good condition.

Recommendations:

1. Provide a new coating system to pump housings, mounting frames, piping and appurtenances
2. Provide a new coating system to wood frame building window screens and wood siding

Well No. 16:

Well No. 16 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves Zones 2950 and is controlled by pressure at the station. The pump station site is gated and fenced, and contained within a wood frame/stucco building and noted to be in good condition. The well itself is located outside the building. The facility also has an onsite sodium hypochlorite generation system that is in good condition.

A hydro pneumatic tank is located on site but is not operational. A small amount of corrosion was noted on the discharge piping of the well. Overall, the site is in good condition.

Recommendations:

1. Provide a new coating system to the well discharge piping and appurtenances

Well No. 32:

Well No. 32 is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves Zones 2800 and is controlled by pressure at the station. The pump station site is gated and fenced, and contained within a wood frame/stucco building and noted to be in good condition. Building window screens were noted in need of replacement.

The well itself is located outside the building and mounted on a concrete pad. The facility has onsite generation of sodium hypochlorite and flow metering systems in good condition.

Well 32 Recommendations:

1. Replace building window screens

45th Street Reservoirs:

This site contains three welded steel tanks, two 4 MG and one 3 MG capacities, that service Zone 2850. The tanks were noted in good condition and enclosed by a chain link fence for security. The tanks contained single inlet and outlets and level indicators.

Recommendations:

1. No improvements are recommended

46th Street Booster Pumps:

This facility consists of three centrifugal pumps servicing Zone 3000 and three centrifugal pumps servicing Zone 2850. Space for a future pump is provided. The pumps, piping and appurtenances where noted in good condition. The equipment is housed in a masonry building noted as being in good condition.

The facility has onsite generation of sodium hypochlorite and flow monitoring systems in good condition. The concrete pad supporting the hypochlorite tank was noted with minor cracking.

Recommendations:

1. No improvements are recommended

5M Booster Pumps & Hydro Pneumatic Tank:
The facility is secured with a chain link fence in good condition. The booster pumps do not have a building or shelter. The pumps are set on a steel frame on a concrete pad. The pumps have been wrapped in a thin plastic type sheeting for weather protection. Some corrosion of the discharge piping was noted. A small hydro pneumatic tank appeared to be in good condition.

Recommendations:

1. Provide a building or permanent shelter for the pumps
2. Provide a new coating system to pump piping and appurtenances

5M Reservoir:
The reservoir is a welded steel type construction and in good condition. Piping on the common inlet/outlet of the tank had a small amount of corrosion.

Recommendations:

1. Provide a new coating system to inlet/outlet piping and appurtenances

25th Street Pumps:
Three 100-HP and one 50-HP pumps are contained in a combination of steel and wood frame building. The building has a gravel floor and was noted as being in fair condition. The pumps indicated a significant amount of corrosion to the pump housing and discharge piping. A sodium hypochlorite system in good condition is located inside the pump building

A hydro pneumatic tank and air compressor were out of service. A 6-cylinder was noted as in operational condition.

25th Street Pumps Recommendations:

1. Provide a new coating system to the pump discharge piping and appurtenances

25th Street Reservoir:
The welded steel reservoir was noted to be in good condition. The tank contains a level indicator and a single inlet/outlet.

25th Street Reservoir Recommendations:

1. No improvements are recommended

3M Pumps:
The site is fenced and contains caged chickens belonging to the Antelope Valley Mosquito and Vector Control District. A 125-HP and a 75-HP pump are contained in a masonry building and were noted in good condition. Corrosion was found on both pumps at the mounting base, housing, and discharge piping.

3M Pumps Recommendations:

1. Provide a new coating system to inlet/outlet piping and appurtenances

3M Reservoir:

The welded steel tank was noted to be in good condition with no signs of corrosion. The tank contains a common inlet/outlet and a level indicator. A hydro pneumatic tank on site was out of service.

3M Reservoir Recommendations:

1. No improvements are recommended

Clearwells:

The clearwells supply water to Zones 2800 and 2950 with six pumps. Zone 2800 is served with two 200-HP pumps, a 100-HP pump, and a reserved space for one additional. Zone 2950 is served with two 250-HP pumps and a 150-HP pump. The pumps are contained in a masonry building and were noted to be well coated and in good condition. SCADA control provides as flow indicator on via a flow meter.

Emergency power is provided by a diesel generator. Staff noted that converting to natural gas for a generator's fuel source was desired.

Clearwells Recommendations:

1. No improvements are recommended
2. Consider converting emergency power generator from diesel to natural gas

Lower El Camino Pumps:

Two identical 75-HP pumps with mild corrosion are contained in a masonry building and located within a chain link fence with razor wire top. The pump room is designed with piping connections and a concrete support pedestal for a future third pump. Each pump has a designated flow meter that does not report to the SCADA system.

Lower El Camino Pumps Recommendations:

1. Provide a new coating system to the pumps discharge piping and appurtenances

Lower El Camino Reservoir

A chlorine residual analyzer and level indicator were noted in good working order. The tanks have seismic control on a combined inlet/outlet.

Lower El Camino Reservoir Recommendations:

1. No improvements are recommended

Tovey Reservoir:

The reservoir is enclosed with a chain link fence and has a level indicator. The steel tank recently received a new coating and was noted to be in good condition.

Tovey Reservoir Recommendations:

1. No improvements are recommended

3600 Pumps:

A wood frame building houses two 40-HP pumps with a combined flow meter. Staff noted the hydro pneumatic tank has recently been replaced. All systems were reported to be in good condition. The site secured with a chain link fence.

3600 Pumps Recommendations:

1. No improvements are recommended

Al's Hydro Pneumatic Tank:

This facility has a hydro pneumatic tank in good condition. It was noted the paint on the tank supports was peeling and required a new coating. A small 1-HP pump is also located at this site.

Al's Hydro Pneumatic Tank Recommendations:

1. Provide a new coating system hydro pneumatic tank supports

Upper El Camino/3900 Pumps:

This facility is equipped with a vertical turbine pump and operated by a variable-frequency drive. This station serves Zones 3600 and is controlled by pressure at the station. The pump station site is gated, fenced, and contained within a wood frame/stucco building and noted to be in good condition. A flow meter provide data to the SCADA system.

Upper El Camino/3900 Pumps Recommendations:

1. No improvements are recommended

Upper El Camino/3900Reservoir:

The welded steel tank with a level indicator was noted to be in good condition.

Upper El Camino/3900 Reservoir Recommendations:

1. No improvements are recommended

Under Ground Pumps/GAC Vessel:

This facility contains a granular activated carbon (GAC) in a pressure vessel as part of a program to reduce chlorinated byproducts. The facility also contains two pumps and an onsite sodium hypochlorite generation system located in a concrete block building. The site is fenced and all equipment was noted to be in good condition.

Under Ground Pumps/GAC Vessel Recommendations:

1. No improvements are recommended

Well No. 5 Pumps:

The four pumps at this facility are housed in a small wood frame building. The building shows significant signs of paint peeling, wood deterioration, and structural failures. Minor cracks in the foundation were also observed. Pump-3 was noted to have corrosion, while pump-5 has been removed and no longer in service.

Well No. 5 Pumps Recommendations:

1. Refurbish or replace the existing pump building
2. Provide a new coating system to the pumps discharge piping and appurtenances

Well No. 5 Reservoir:

This reservoir is configured with separate inlet and outlets and is monitored for chlorine residual by an analyzer. The tank ladder was noted as being unreachable and the level indicator broken. Signs of attempted gunshots on tank were observed.

Well No. 5 Reservoir Recommendations:

1. Repair ladder for access
2. Repair level indicator
3. Suggest increasing security measures (i.e. cameras, signs, security patrols)

Table 1 summarizes the well station and reservoir recommendations.

Table 1
Well Stations and Reservoirs Recommendations Summary

Facility Name	Overall Assessment	Recommendations
Well No 6	Fair	1. Provide a new coating system to the interior and exterior well piping and appurtenances 2. Replace piping insulation 3. Consider adding permanent heating system and building insulation
Well No. 15	Fair	1. Provide a new coating system to the interior and exterior well piping and appurtenances 2. Provide a new coating system to the chlorine piping 3. Replace piping insulation 4. Consider adding permanent heating system and building insulation
Well No. 11	Fair	1. It is recommended the steel building be extended to fully enclose the vertical turbine pump for better protection from the elements 2. Provide a new coating system to the interior and exterior piping and appurtenances 3. Provide a new coating system to the chlorine piping equipment
Well No. 14	Fair	1. Replace control valve on the booster pump 2. Provide a protective shelter for the booster pump 3. Replace the tank's heavily corroded overflow pipe 4. Provide a new coating system to the well discharge piping and appurtenances
Well No. 23	Good	1. Corrosion of the well discharge piping was noted and it is recommended a new protective coating system be applied. 2. Provide new coating to window structure.
Well No. 7	Fair	1. Replace the building entrance doorway 2. Provide a new coating system to the well discharge piping and appurtenances
Well No. 8	Fair	1. Provide structural reinforcement to the concrete pad supporting the sodium hypochlorite tank 2. Provide a new coating system to the well discharge piping and appurtenances
Well No. 2	Fair	1. It recommended to have the HVAC performance tested/checked/replaced 2. Provide a new coating system to the well discharge piping and appurtenances
Well No. 3	Good	1. It recommended to have the HVAC performance tested/checked/replaced
Well No. 10	Fair	1. Provide a new coating system to the well discharge piping and appurtenances 2. Replace sections of missing security fencing
Well No. 30	Good	1. Provide a new coating system to the well discharge piping and appurtenances
Well No. 33	Good	1. Recommend repairing bullet strikes/vandalism damage and increase security measures

Facility Name	Overall Assessment	Recommendations
Well No. 25	Good	1. Provide a new coating system to the entrance door/replace door
Well No. 29	Very Good	1. No improvements are recommended
Well No. 22	Good	1. Provide a new coating system to the well discharge piping and appurtenances
Well No. 26	Fair	1. Provide a new coating system to the window screens 2. Provide a new coating system to the well discharge piping and appurtenances 3. Perform a detailed hydraulic evaluation of the pumping system to eliminate throttling of the pump
Well No. 21	Fair	1. Provide a new coating system to the window screens 2. Provide a new coating system to the well discharge piping and appurtenances
Well No. 35	Fair	1. Provide a new coating system to the window screens 2. Provide a new coating system to the well discharge piping and appurtenances
Well No. 18 & Well No. 19	Fair	1. Provide rehabilitation of Well No. 18 as was performed on Well No. 19 to remove corrosion 2. Consider enclosing the pumps for protection from the elements
Well No. 18 and Well No. 19 Reservoir	Fair	1. Provide a level indicator 2. Provide a new coating system to the tank overflow piping and appurtenances
V-5 Booster Pump & Hydro Pneumatic Tank	Fair	1. Perform an evaluation of the HVAC system for heating deficiencies
Palmdale Booster Pump & Hydro Pneumatic Tank	Very Good	1. No improvements are recommended
Hilltop Booster & Hydro Pneumatic	Fair	1. Provide a new coating system to the well discharge piping and appurtenances 2. Extend the building to enclose control panel and piping
47th Street Reservoirs	Very Good	1. No improvements are recommended
50th Street Reservoirs	Very Good	1. No improvements are recommended
T-8 Booster Pump & Hydro Pneumatic Tank	Fair	1. Provide a new coating system to pump housings, mounting frames, piping and appurtenances 2. Provide a new coating system to wood frame building window screens and wood siding
Well No.16	Good	1. Provide a new coating system to the well discharge piping and appurtenances
Well No. 32	Good	1. Replace building window screens
45th Street Reservoirs	Very Good	1. No improvements are recommended
46th Street Booster Pumps	Very Good	1. No improvements are recommended
5M Booster Pumps & Hydro Pneumatic Tank	Fair	1. Provide a building or permanent shelter for the pumps 2. Provide a new coating system to pump piping and appurtenances
5M Reservoir	Good	1. Provide a new coating system to inlet/outlet piping and appurtenances
25th Street Pumps	Good	1. Provide a new coating system to the well discharge

Facility Name	Overall Assessment	Recommendations
		piping and appurtenances
25th Street Reservoir	Very Good	1. No improvements are recommended
3M Pumps	Good	1. Provide a new coating system to inlet/outlet piping and appurtenances
3M Reservoir	Very Good	1. No improvements are recommended
Clearwells	Very Good	1. No improvements are recommended 2. Consider converting emergency power generator from diesel to natural gas
Walt Dahilitz Reservoirs	Good	1. No improvements are recommended
Lower El Camino Pumps	Fair	1. Provide a new coating system to the pumps discharge piping and appurtenances
Lower El Camino Reservoir	Very Good	1. No improvements are recommended
Tovey Reservoir:	Very Good	1. No improvements are recommended
3600 Pumps	Very Good	1. No improvements are recommended
Al's Hydro Pneumatic Tank	Good	1. Provide a new coating system hydro pneumatic tank supports
Upper El Camino/3900	Very Good	1. No improvements are recommended
Upper El Camino/3900Reservoir	Very Good	1. No improvements are recommended
Under Ground Pumps/GAC Vessel	Very Good	1. No improvements are recommended
Well No. 5 Pumps	Fair	1. Refurbish or replace the existing pump building 2. Provide a new coating system to the pumps discharge piping and appurtenances
Well No. 5 Reservoir	Fair	1. Repair ladder for access 2. Repair level indicator 3. Suggest increasing security measures (i.e. cameras, signs, security patrols)

APPENDIX C WATER QUALITY REGULATIONS

Existing and future regulations may impact the Palmdale Water District's (District) water supply sources, treatment requirements, and system operations. The following section presents brief descriptions of the current and future drinking water regulations that are relevant to the District. Both the federal regulations, set by the U.S. Environmental Protection Agency (USEPA), and state regulations, set by the California State Resources Control Board's Division of Drinking Water Programs (DDW), are presented. Emphasis is placed on rules that have recently been promulgated. Regulatory information and framework contained in this document is current as of August 2015.

1. REGULATORY BACKGROUND

1.1 Federal Regulations

The Safe Drinking Water Act (SDWA) of 1974 established primary drinking water regulations designed to ensure the distribution of safe drinking water. These regulations were the first to be implemented at all public water systems (PWSs) in the United States (U.S.), covering both chemical and microbial contaminants. These regulations consisted of standards for 18 parameters, referred to as the National Interim Primary Drinking Water Regulations. They remained in place for over 10 years with minor revisions, including a revised fluoride standard, addition of a total trihalomethanes standard, and interim regulations for radionuclides in potable water.

In 1986, Congress passed widespread amendments to the SDWA, which significantly altered the rate at which the USEPA was to set drinking water standards. These amendments resulted in a three-fold increase in the number of contaminants regulated. In addition, at that time, the National Interim and revised Primary Drinking Water Regulations promulgated prior to 1986 were redefined as National Primary Drinking Water Regulations.

The 1996 amendments to the SDWA greatly enhanced the existing law by recognizing source water protection, operator training, funding for water system improvements, and public information as important components of safe drinking water. Among others, the 1996 amendments required the USEPA to develop rules to balance risks between microbial pathogens and disinfection by-products (DBP), named the Microbial/Disinfection By-Product (M/DBP) Rules. Several rules emerged from this requirement, including the Interim Enhanced Surface Water Treatment Rule, the Stage 1 and Stage 2 Disinfectants and Disinfection By-Products Rules, and the Long Term 1 and Long Term 2 Enhanced Surface Water Treatment Rules.

1.2 State Regulations

The SDWA gives the USEPA authority to delegate primary enforcement responsibilities, or primacy, to individual states. Within the state of California, the DDW was given authority to enforce drinking water regulations. The Safe Drinking Water and Toxic Enforcement Act (more commonly referred to as Proposition 65) was a voters' initiative passed in November 1986 and became effective on January 1, 1987. To maintain authority to enforce drinking water regulations under the SDWA, a state must adopt drinking water regulations at least as stringent as the federal standards. The California regulations are contained in Titles 17 and 22 of the California Code of Regulations (CCR), and are discussed below, as appropriate.

2. PRIMARY AND SECONDARY DRINKING WATER REGULATIONS

The National Primary Drinking Water Regulations (NPDWRs) are currently set for 92 contaminants, including turbidity, eight indicator microorganisms, four radionuclides, 19 inorganic contaminants, and 60 organic contaminants. Maximum Containment Levels (MCLs) and maximum contaminant level goals (MCLGs) have been set for 83 contaminants, and nine other contaminants have treatment technique requirements.

The DDW has established more stringent MCLs for some of these contaminants. In addition, the DDW has established MCLs for additional contaminants that are not regulated under the federal requirements. Considering that the DDW regulations are more stringent than the federal regulatory requirements, they take priority over the federal regulations. **Table 1** presents the federal and state MCLs for the contaminants listed in the NPDWR with effective dates when each MCL was adopted.

**Table 1 — Maximum Contaminant Levels and Regulation Dates for Drinking Water Contaminants
2015 Water System Master Plan Update
Palmdale Water District**

Contaminant	U.S. EPA		DDW	
	MCL (mg/L)	Date[a]	MCL (mg/L)	Effective Date
Inorganics				
Aluminum	0.05 to 0.2[b]	1/91	1 0.2[b]	2/25/89 9/8/94
Antimony	0.006	7/92	0.006	9/8/94
Arsenic	0.05 0.01	eff: 6/24/77 2001	0.05	77
Asbestos	7 MFL[c]	1/91	7 MFL[c]	9/8/94
Barium	1 2	eff: 6/24/77 1/91	1	77
Beryllium	0.004	7/92	0.004	9/8/94
Cadmium	0.010 0.005	eff: 6/24/77 1/91	0.010 0.005	77 9/8/94
Chromium	0.05 0.1	eff: 6/24/77 1/91	0.05	77
Copper	1.3[d]	6/91	1[b] 1.3[d]	77 12/11/95
Cyanide	0.2	7/92	0.2 0.15	9/8/94 6/12/03
Fluoride	4 2[b]	4/86 4/86	2	4/98
Hexavalent Chromium	-	-	0.010	7/1/14
Lead	0.05[e] 0.015[d]	eff: 6/24/77 6/91	0.05[e] 0.015[d]	77 12/11/95

Table 1	Maximum Contaminant Levels and Regulation Dates for Drinking Water Contaminants 2015 Water System Master Plan Update Palmdale Water District			
Contaminant	**U.S. EPA**		**DDW**	
	MCL (mg/L)	**Date[a]**	**MCL (mg/L)**	**Effective Date**
Mercury	0.002	eff: 6/24/77	0.002	77
Nickel	Remanded		0.1	9/8/94
Nitrate	(as N) 10	eff: 6/24/77	(as N03) 45	77
Nitrite (as N)	1	1/91	1	9/8/94
Total Nitrate/Nitrite (as N)	10	1/91	10	9/8/94
Perchlorate	-	-	0.006	10/18/07
Selenium	0.01 0.05	eff: 6/24/77 1/91	0.01 0.05	77 9/8/94
Thallium	0.002	7/92	0.002	9/8/94
Radionuclides				
Uranium	30 ug/L	12/7/00	20 pCi/L 20 pCi/L	1/1/89 6/11/06
Combined Radium - 226+228	5 pCi/L	eff: 6/24/77	5 pCi/L 5 pCi/L	77 6/11/06
Gross Alpha particle activity (excluding radon & uranium)	15 pCi/L	eff: 6/24/77	15 pCi/L 15 pCi/L	77 6/11/06
Gross Beta particle activity	4 millirem/yr	eff: 6/24/77	50 pCi/L[f] 4 millirem/yr	77 6/11/06
Strontium-90	8 pCi/L	eff: 6/24/77 now covered by Gross Beta	8 pCi/L[f] 8 pCi/L[f]	77 6/11/06
Tritium	20,000 pCi/L	eff: 6/24/77 now covered by Gross Beta	20,000 pCi/L[f] 20,000 pCi/L[f]	77 6/11/06
VOCS				
Benzene	0.005	6/87	0.001	2/25/89
Carbon Tetrachloride	0.005	6/87	0.0005	4/4/89
1,2-Dichlorobenzene	0.6	1/91	0.6	9/8/94
1,4-Dichlorobenzene	0.075	6/87	0.005	4/4/89
1,1-Dichloroethane	-	-	0.005	6/24/90
1,2-Dichloroethane	0.005	6/87	0.0005	4/4/89
1,1-Dichloroethylene	0.007	6/87	0.006	2/25/89
cis-1,2-Dichloroethylene	0.07	1/91	0.006	9/8/94

Table 1	Maximum Contaminant Levels and Regulation Dates for Drinking Water Contaminants 2015 Water System Master Plan Update Palmdale Water District			
Contaminant	**U.S. EPA**		**DDW**	
	MCL (mg/L)	**Date[a]**	**MCL (mg/L)**	**Effective Date**
trans-1,2-Dichloroethylene	0.1	1/91	0.01	9/8/94
Dichloromethane	0.005	7/92	0.005	9/8/94
1,3-Dichloropropene	-	-	0.0005	2/25/89
1,2-Dichloropropane	0.005	1/91	0.005	6/24/90
Ethylbenzene	0.7	1/91	0.68 0.7 0.3	2/25/89 9/8/94 9/8/94
Methyl-tert-butyl ether (MTBE)	-	-	0.005[b] 0.013	1/7/99 5/17/00
Monochlorobenzene	0.1	1/91	0.03 0.07	2/25/89 9/8/94
Styrene	0.1	1/91	0.1	9/8/94
1,1,2,2-Tetrachloroethane	-	-	0.001	2/25/89
Tetrachloroethylene	0.005	1/91	0.005	5/89
Toluene	1	1/91	0.15	9/8/94
1,2,4 Trichlorobenzene	0.07	7/92	0.07 0.005	9/8/94 6/12/03
1,1,1-Trichloroethane	0.200	6/87	0.200	2/25/89
1,1,2-Trichloroethane	0.005	7/92	0.032 0.005	4/4/89 9/8/94
Trichloroethylene	0.005	6/87	0.005	2/25/89
Trichlorofluoromethane	-	-	0.15	6/24/90
1,1,2-Trichloro-1,2,2-Trifluoroethane	-	-	1.2	6/24/90
Vinyl chloride	0.002	6/87	0.0005	4/4/89
Xylenes	10	1/91	1.750	2/25/89
SOCS				
Alachlor	0.002	1/91	0.002	9/8/94
Atrazine	0.003	1/91	0.003 0.001	4/5/89 6/12/03
Bentazon	-	-	0.018	4/4/89
Benzo(a) Pyrene	0.0002	7/92	0.0002	9/8/94
Carbofuran	0.04	1/91	0.018	6/24/90

Table 1	Maximum Contaminant Levels and Regulation Dates for Drinking Water Contaminants 2015 Water System Master Plan Update Palmdale Water District			
Contaminant	**U.S. EPA**		**DDW**	
	MCL (mg/L)	**Date[a]**	**MCL (mg/L)**	**Effective Date**
Chlordane	0.002	1/91	0.0001	6/24/90
Dalapon	0.2	7/92	0.2	9/8/94
Dibromochloropropane	0.0002	1/91	0.0001 0.0002	7/26/89 5/3/91
Di(2-ethylhexyl)adipate	0.4	7/92	0.4	9/8/94
Di(2-ethylhexyl)phthalate	0.006	7/92	0.004	6/24/90
2,4-D	0.1 0.07	eff: 6/24/77 1/91	0.1 0.07	77 9/8/94
Dinoseb	0.007	7/92	0.007	9/8/94
Diquat	0.02	7/92	0.02	9/8/94
Endothall	0.1	7/92	0.1	9/8/94
Endrin	0.0002 0.002	eff: 6/24/77 7/92	0.0002 0.002	77 9/8/94
Ethylene Dibromide	0.00005	1/91	0.00002 0.00005	2/25/89 9/8/94
Glyphosate	0.7	7/92	0.7	6/24/90
Heptachlor	0.0004	1/91	0.00001	6/24/90
Heptachlor Epoxide	0.0002	1/91	0.00001	6/24/90
Hexachlorobenzene	0.001	7/92	0.001	9/8/94
Hexachlorocyclopentadiene	0.05	7/92	0.05	9/8/94
Lindane	0.004 0.0002	eff: 6/24/77 1/91	0.004 0.0002	77 9/8/94
Methoxychlor	0.1 0.04	eff: 6/24/77 1/91	0.1 0.04 0.03	77 9/8/94 6/12/03
Molinate	-	-	0.02	4/4/89
Oxamyl	0.2	7/92	0.2 0.05	9/8/94 6/12/03
Pentachlorophenol	0.001	1/91	0.001	9/8/94
Picloram	0.5	7/92	0.5	9/8/94
Polychlorinated Biphenyls	0.0005	1/91	0.0005	9/8/94
Simazine	0.004	7/92	0.010 0.004	4/4/89 9/8/94

Table 1	Maximum Contaminant Levels and Regulation Dates for Drinking Water Contaminants 2015 Water System Master Plan Update Palmdale Water District			
Contaminant	U.S. EPA		DDW	
	MCL (mg/L)	Date[a]	MCL (mg/L)	Effective Date
Thiobencarb	-	-	0.07 0.001[b]	4/4/89 4/4/89
Toxaphene	0.005 0.003	eff: 6/24/77 1/91	0.005 0.003	77 9/8/94
2,3,7,8-TCDD (Dioxin)	$3x10^{-8}$	7/92	$3x10^{-8}$	9/8/94
2,4,5-TP (Silvex)	0.01 0.05	eff: 6/24/77 1/91	0.01 0.05	77 9/8/94
Disinfection Byproducts				
Total Trihalomethanes	0.100 0.080	11/29/79 eff: 11/29/83 eff: 1/1/02[g]	0.100 0.080	3/14/83 6/17/06
Haloacetic acids (five)	0.060	eff: 1/1/02[g]	0.060	6/17/06
Bromate	0.010	eff: 1/1/02[g]	0.010	6/17/06
Chlorite	1.0	eff: 1/1/02[g]	1.0	7/17/06
Treatment Technique				
Acrylamide	TT[h]	1/91	TT[h]	9/8/94
Epichlorohydrin	TT[h]	1/91	TT[h]	9/8/94

Notes

a. "eff." indicates the date the MCL took effect; any other date provided indicates when US EPA established (i.e., published) the MCL.
b. Secondary MCL.
c. MFL = million fibers per liter, with fiber length > 10 microns.
d. Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL.
e. The MCL for lead was rescinded with the adoption of the regulatory action level described in footnote d.
f. Gross beta MCL is 4 millirem/year annual dose equivalent to the total body or any internal organ; Sr-90 MCL = 4 millirem/year to bone marrow; tritium MCL = 4 millirem/year to total body
g. Effective for surface water systems serving more than 10,000 people; effective for all others 1/1/04.
h. TT = treatment technique, because an MCL is not feasible.

Federal secondary standards are recommended for 15 contaminants to ensure aesthetic quality of drinking water. Because the federal standards primarily address taste and odor, rather than health issues, they are often used only as a guideline. However, the DDW has adopted secondary standards within the Secondary Drinking Water Standards Rule (SDWSR) that are enforceable for 16 contaminants. The DDW uses a tiered approach to address violations of secondary standards, addressing violations that may pose health concerns before they address violations of aesthetic requirements. **Table 2** presents the federal and state secondary standards for the contaminants listed in the Secondary Drinking Water Standards.

Table 2 Contaminants and Secondary Standards Listed in the Secondary Drinking Water Standards
2015 Water System Master Plan Update
Palmdale Water District

Contaminant	Federal Secondary Standards	California Secondary Standards
Aluminum	0.05 to 2 mg/L	0.2 mg/L
Chloride	250 mg/L	250 mg/L (recommended) 500 mg/L (maximum) 600 mg/L (short-term limit)
Color	15 color units	15 color units
Copper	1 mg/L	1.0 mg/L
Corrosivity (aggressiveness index)	Non-corrosive	Non-corrosive
Fluoride	2 mgL	2.0 mg/L
Foaming Agents (MBAS)	0.5 mg/L	0.5 mg/L
Iron	0.3 mg/L	0.3 mg/L
Manganese	0.05 mg/L	0.05 mg/L
Methyl-tert-butyl ether (MTBE)	-	0.005 mg/l
Odor	3 threshold odor number	3 threshold odor number
pH	6.5 – 8.5	6.5 – 8.5
Silver	0.10 mg/L	0.10 mg/L
Sulfate	250 mg/L	250 mg/L (recommended) 500 mg/L (maximum) 600 mg/L (short-term limit)
Thiobencarb	-	0.001 mg/L
Total Dissolved Solids	500 mg/L	500 mg/L (recommended) 1,000 mg/L (maximum) 1,500 mg/L (short-term limit)
Turbidity	-	5 NTU
Zinc	5 mg/L	5 mg/L

2.2 MICROBIAL AND DISINFECTION BY-PRODUCT RULES

Since the promulgation of the SDWA in 1974, several rules have focused on public health protection by limiting the presence of microorganisms in drinking water. The 1996 amendments to the SDWA required the USEPA to develop additional rules to balance risks between microbial pathogens and DBPs. These rules are briefly summarized in this section.

2.2.1 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was promulgated by the USEPA on June 29, 1989, and became effective on December 31, 1990. For systems using surface water or groundwater under the direct influence of surface water for supply, the SWTR established MCLGs of zero for *Giardia lamblia*, viruses, and *Legionella*, and includes the following treatment technique requirements to reduce exposure to pathogenic microorganisms:

(1) filtration, unless specific avoidance criteria are met;
(2) maintenance of a disinfectant residual in the distribution system;
(3) removal and/or inactivation of 3-log (99.9 percent) of *Giardia lamblia* and 4-log (99.99 percent) of viruses;
(4) maximum allowable turbidity in the combined filter effluent (CFE) of 5 NTU and 95th percentile CFE turbidity of 0.3 NTU or less for plants using conventional treatment or direct filtration (with different standards for other filtration technologies); and
(5) watershed protection and source water quality requirements for unfiltered PWSs. The overall reduction of *Giardia* and viruses is to be achieved using a combination of physical removal by pretreatment and filtration, and inactivation by disinfection.

The California Surface Water Treatment (SWT) Regulations was adopted in 1991 and is contained in Title 22 of the CCR. The general requirements of the California SWT Regulations are similar to the federal requirements.

2.2.2 California *Cryptosporidium* Action Plan Guidance

In April 1995, the DDW issued the *Cryptosporidium* Action Plan to clarify requirements of the SWTR. The Plan includes the following provisions:

- Identify location, population, and measures in place to avoid runoff from cattle and/or sheep operations to limit *Cryptosporidium* from these sources.
- Obtain and use an approved Operations Plan for treatment processes, which needs to specify filter performance including turbidity removal.

2.2.3 Total Coliform Rule

The Total Coliform Rule (TCR) was promulgated in June 1989, and established an MCLG of zero for total and fecal coliforms, and an MCL based on the percentage of positive samples collected during a compliance period. The required number of samples to be collected in a month depends on the number of people served. For systems that collect 40 or more samples per month, including the District, who is required to collect more than 90 samples per month, the rule allows no more than 5 percent positive samples per month. If a system has greater than 5 percent total coliform-positive (TC-positive) samples in a month, then this is considered a monthly MCL violation, which needs to be reported to the DDW and to the public in a specific timeframe.All TC-positive samples must be analyzed for the presence of *Escherichia coli* (*E. coli*) or fecal coliforms. If two consecutive samples in the system are TC-positive and one is also fecal coliform or *E.coli* positive, then this is defined as an acute violation of the MCL; the system must notify the SWRCB and the public using mandatory language developed by the USEPA and collect repeat samples.

Secondary disinfection is required under the TCR in accordance with the following:

- A minimum disinfectant residual of 0.2 mg/L free chlorine or 0.5 mg/L chloramines measured as total chlorine must be present throughout the distribution system continually.
- A sample with heterotrophic plate counts (HPCs) less than 500 cfu/100 ml is assumed to carry the required minimum residual

2.2.4 Revised Total Coliform Rule (RTCR)

The USEPA published a Revised Total Coliform Rule (RTCR) on February 13, 2013. The RTCR established an MCLG of zero for *E. coli*, because *E. coli* is a more specific indicator of fecal contamination than total coliform. The "acute" total coliform MCL violation under the 1989 TCR has been maintained as the MCL for *E. coli* under the RTCR. A public water system in violation of the *E. coli* MCL must conduct an assessment and correct any defects.

The RTCR also eliminated the 1989 MCLG and MCL for total coliform and replaced them with a treatment technique for coliforms. A public water system that exceeds a specified frequency of total coliform occurrence must conduct an assessment to determine any sanitary defects and if found, correct them. The RTCR eliminates the requirement to notify the public in instances of total coliform presence. Instead, the RTCR requires that the public water system notify the public when an *E. coli* MCL violation occurs or when they fail to take the required assessment and corrective action.

Additionally, the RTCR establishes criteria for public water systems to qualify for reduced monitoring, in order to reduce burden and provide incentives for better system operation.

The USEPA is also considering a possible Distribution System Rule to address distribution system issues that have the potential to impact public health risk. Potential issues that are currently being examined include intrusion, cross-connection control, aging infrastructure and corrosion, permeation and leaching, nitrification, biofilms/growth, covered storage, decay in water quality over time, and new or repaired water mains.

2.2.5 Interim Enhanced Surface Water Treatment Rule

The Interim Enhanced Surface Water Treatment Rule (IESWTR) was promulgated by the USEPA in December 1998. This rule applies to systems serving 10,000 people or more, and that use surface water or groundwater under the direct influence of surface water. Key provisions established by the IESWTR include: (1) an MCLG of zero for *Cryptosporidium;* (2) *Cryptosporidium* removal requirements of 2-log (99 percent) for PWSs that filter; (3) more stringent CFE turbidity performance standards of 1.0 NTU as a maximum and 0.3 NTU or less at the 95th percentile monthly for treatment plants using conventional treatment or direct filtration; (4) requirements for individual filter turbidity monitoring; (5) disinfection benchmark provisions to assess the level of microbial protection that PWSs provide as they take steps to comply with DBP standards; (6) inclusion of *Cryptosporidium* in the definition of groundwater under the direct influence of surface water and in the watershed control requirements for unfiltered PWSs; (7) requirements for covers on new finished water storage facilities; and (8) sanitary surveys for all surface water systems regardless of size.

The DDW believes, based on its own experiences and understanding of treatment plant performance, that some changes to the federal IESWTR are prudent and would increase the level of protection from exposure to pathogens, especially *Cryptosporidium.* As such, the California IESWTR, effective January 14, 2008, established treatment techniques in lieu of set MCLs for turbidity, *Giardia,* viruses, HPCs, and *Legionella.* Among others, turbidity levels of individual and combined filter effluent samples are specified. Additionally, approved surface water suppliers that serve more than 10,000 people have specific treatment techniques in lieu of an MCL for *Cryptosporidium.*

2.2.6 Enhanced Surface Water Treatment Rules

The Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) was promulgated on January 14, 2002. This rule extended the requirements of the IESWTR to systems serving less than 10,000 people. Considering that the District serves more than 10,000 people, the LT1ESWTR does not apply to the District's system.

The Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) was promulgated by the USEPA on January 5, 2006. This rule applies to systems that use surface water or groundwater under the direct influence of surface water. The purpose of the LT2ESWTR is to reduce illnesses linked with *Cryptosporidium* and other disease-causing microorganisms in drinking water. The rule supplements existing regulations by targeting additional *Cryptosporidium* treatment requirements to higher risk systems. It requires filtered and unfiltered systems to conduct a 24-month monitoring of their source water for *Cryptosporidium*. Filtered systems must also record source water *E. coli* and turbidity levels. Results are used to classify systems into one of four "Bins," as presented in **Table 3**. Systems may also use previously collected data (i.e., grandfathered data) to determine their bin classification, instead of monitoring. Bin classification will then be used to determine if the system's source is vulnerable to contamination and require additional treatment. If additional treatment is required, systems can choose from an array of options listed in the "microbial toolbox." Disinfection profiling and benchmarking are also required from all systems that plan to make a significant change to their disinfection practices.

This rule also contains provisions to reduce risks from uncovered finished water reservoirs by covering such reservoirs and treating their discharge.

Table 3 — Bin Classification for Compliance With the LT2ESWTR, as Applicable to the Palmdale Water District (i.e., System That Practice Conventional Filtration)
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Cryptosporidium Concentration Additional *Cryptosporidium* (oocysts/L)	Bin Classification	Additional *Cryptosporidium* Treatment Required
<0.075	Bin 1	No additional treatment required
0.075 – 1.0	Bin 2	1 log
1.0 to <3.0	Bin 3	2 log
≥3.0	Bin 4	2.5 log

Considering that the District is on Schedule 1, the District will have to comply with the LT2ESWTR, according to the schedule presented below. It is our understanding that the District intends to grandfather its existing data. Our preliminary review of the District's data, presented below, suggests that you may be eligible to do so.

- July 1, 2006: Notify DDW that you intend to submit results for grandfathering data.
- December 1, 2006: Submit monitoring results for data that the District wants to have grandfathered.
- April 2009: Report initial bin classification to DDW for approval.
- March 31, 2012: Install and operate additional treatment in accordance with bin classification.
- January 1, 2015:Submit sampling schedule, including sampling dates and locations, for the second round of source water monitoring to DDW.
- April 1, 2015: Begin the second round of source water monitoring. Based on the results obtained, re-determine bin classification n and provide additional treatment for *Cryptosporidium*, if necessary.

Considering the timeliness of this Master Plan with regard to compliance with this new regulation, further information on the LT2ESWTR can be provided upon request.

2.2.7 California Enhanced Surface Water Treatment Rule

The DDW's LT1ESWTR and LT2ESWTR took effect on July 1, 2013. The DDW adopted the federal LT1ESWTR requirements provided they are no less stringent than existing state requirements. The DDW incorporated the federal LT2ESWTR by reference.

2.2.7.1 Stage 1 Disinfectants and Disinfection By-Products Rule

The Stage 1 Disinfectants and Disinfection By-Product Rule (Stage 1 DBPR) was finalized by the USEPA in December 1998. This rule was promulgated at the same time as the IESWTR to balance the risks between microbial pathogens and DBPs. The rule affects all PWSs (surface and groundwater) and became effective in January 2002 for systems serving more than 10,000 people. While disinfection is required for surface water systems to control microbial contaminants, the disinfectants can react with naturally occurring organic and inorganic matter in source water and distribution systems to form DBPs, some of which are of concern to human health. This rule was developed to increase control on the occurrence of DBPs. The rule established the following DBP MCLs:

- Trihalomethanes (THM4, sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane): 0.080 mg/L.
- Haloacetic acids (HAA5, sum of monochloro-, dichloro-, trichloro-, monobromo-, and dibromo-acetic acids): 0.060 mg/L.
- Bromate ion: 0.010 mg/L.
- Chlorite ion: 1.0 mg/L.

Compliance with the THM4 and HAA5 MCLs is based on the running annual average (RAA) of quarterly averages of all samples taken in the distribution system. Compliance with the bromate MCL is based on the RAA of monthly samples taken at the point of entry. Compliance with the chlorite MCL is based on the average of three samples taken in the distribution system (point of entry, average, and maximum residence time (MRT)) during routine monthly sampling, daily monitoring at the point of entry to the distribution system, and additional daily sampling when the point of entry chlorite exceeds 1.0 mg/L. Systems need to collect four samples per plant, per quarter; three samples at locations representative of average residence time and one location representative of MRT.

The Stage 1 DBPR also introduced maximum residual disinfectant levels (MRDLs) for the following disinfectants:

- Free chlorine: 4 mg/L as Cl_2 as RAA.
- Chloramines: 4 mg/L as Cl_2 (total chlorine) as RAA.
- Chlorine dioxide: 0.8 mg/L as individual measurement.

Samples need to be collected at the same locations and at the same time that TCR monitoring samples are taken.

The Stage 1 DBPR also requires surface water systems to implement a treatment technique (i.e., enhanced coagulation or enhanced softening) to reduce DBP precursors. The intent is that the reduction of DBP precursors will also minimize the formation of unknown and unregulated DBPs. Systems using surface water or groundwater under the direct influence of surface water and using conventional filtration are required to remove specified percentages of organic materials (measured as total organic carbon (TOC)) that may react with disinfectants to form DBPs, as indicated in Table 4.

Table 4 **Required Removal of TOC By Enhanced Coagulation and Enhanced Softening**
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Source Water TOC (mg/L C)	Source Water Alkalinity (mg/L $CaCO_3$)		
	0 -60	>60-120	>120
>2.0-4.0	35.0	25.0	15.0
>4.0-8.0	45.0	35.0	25.0
>8.0	50.0	40.0	30.0

2.2.8 California Stage 1 D/DBPR

The California Stage 1 D/DBPR became effective on June 17, 2006 and applies to community water systems and non-transient, non-community water systems that provide or treat water with a chemical disinfectant in any part of the treatment process. This rule also applies to transient, non-community water systems using chlorine dioxide as a disinfectant.

The rule states that starting January 1, 2002, water systems serving greater than 10,000 people needed to begin sampling according to their approved plan, which needed to address seasonal variations, if applicable. Water systems using disinfected groundwater need to sample annually. Depending on the results obtained from the initial sampling, monitoring reductions may be issued. Monitoring must be conducted in accordance with a DBP Monitoring Plan that is approved by the DDW. Water systems also need to sample for chlorine and chloramines residuals at the same time and locations as their bacteriological samples, and submit all residual monitoring results to the DDW.

The rule also establishes requirements for public notification in the event of a water quality or procedural failure, or acute risk.

2.2.9 Stage 2 Disinfectants and Disinfection By-Products Rule

The Stage 2 D/DBPR was promulgated by the USEPA on January 4, 2006, at the same time than the LT2ESWTR to ensure that protection against microbial contaminants is not compromised by the presence of potentially harmful DBPs. The Stage 2 D/DBPR applies to community and non-transient, non-community water systems that add and/or deliver water that is treated with a primary or residual disinfectant other than ultraviolet light. The key provisions of the Stage 2 D/DBPR consist of:

- An Initial Distribution System Evaluation (IDSE) to identify distribution system locations with high DBP concentrations. Further information is provided below.
- Site-specific locational running annual averages (LRAAs) instead of system-wide RAAs to calculate compliance data. LRAAs will strengthen public health protection by eliminating the potential for groups of customers to receive elevated levels of DBPs on a consistent basis.
- An operational evaluation of the distribution system.

The MCLs for THM4 and HAA5 remain unchanged from the Stage 1 D/DBPR at 0.080 and 0.060 mg/L, respectively, although they will now be calculated as LRAAs. The MCL for bromate and chlorite also remain unchanged at 0.010 mg/L as RAAs, and 1.0 mg/L as monthly average, respectively. The MRDLs for free chlorine, chloramines, and chlorine dioxide are also unchanged: 4.0 mg/L for free chlorine and chloramines as annual averages, and 0.8 mg/L for chlorine dioxide as daily samples.

The operational evaluation level provides an early warning of possible future MCL violations and allows systems to take proactive actions to remain in compliance. A system that exceeds an operational evaluation level is required to review their operational practices and submit a report to the DDW. The report must identify actions that may be undertaken to mitigate future high DBP levels, particularly those that may jeopardize their compliance with the DBP MCLs.

Initial Distribution System Evaluation: The IDSE is the first step in Stage 2 DBPR compliance. It intends to identify sampling locations for Stage 2 D/DBPR compliance monitoring that represent distribution system sites with high THM and HM levels. Systems need to develop an IDSE Plan, collect data on DBP levels throughout their distribution system, evaluate these data to determine sampling locations with high DBP concentrations, and compile this information into a report for submission to the DDW. All systems must prepare Stage 2 D/DBPR compliance monitoring recommendations, including revised sampling sites and schedule.

Because the District serves more than 500 people and has THM4 and HAA5 concentrations greater than 0.040 and 0.030 mg/L, respectively, three options are available to the District to conduct the lDSE:

- Standard Monitoring Program (SMP), which involves a 1-year distribution system monitoring effort to determine locations that routinely show high THM4 and HAA5 concentrations.
- System-Specific Study (SSS), if the District has:
    - Sufficient historical THM4 and HAA5 data that encompass a wide range of sampling sites representative of the entire distribution system.
    - A well-calibrated distribution system model ran in extended period simulation to determine water age and conduct at least one round of THM4 and HAA5 samplings.

The DDW implemented the federal Stage 2 D/DBPR by reference.

2.2.10 Filter Backwash Recycling Rule

The Filter Backwash Recycling Rule (FBRR) was published in the Federal Register on June 8, 2001, and applies to all PWSs that recycle backwash water, regardless of size. Recycling spent filter backwash water can affect treated water quality by returning high concentrations of pathogens and other contaminants to the head of the plant. Recycling can also introduce already-formed DBPs to upstream processes when chlorination is practiced prior to filtration, which is the case at the District. In addition, spent filter backwash water recycling can affect treatment performance by surging solids loading to upstream processes and increasing demand for coagulant chemicals. The purpose of the FBRR is to control the re-entry of pathogens and other contaminants into the drinking water treatment process and minimize their effects on treatment and finished water quality.

The FBRR requires that recycled filter backwash water, sludge thickener supernatant, and liquids from dewatering processes be returned to a location where all processes of a system's conventional or direct filtration, including coagulation, flocculation, sedimentation, and conventional filtration, are employed. Considering that WTP filter backwash water goes to an on-site equalization basin from where it is pumped to Palmdale Lake before being treated again, the District meets this requirement. The FBRR also requires that systems notify the State in writing that they recycle filter backwash water. Systems must also collect and maintain specific information (e.g., recycle flows and frequency, duration of filter backwash, filter run length, etc.) for review by the state. Finally, the FBRR requires that certain conventional public water systems that practice direct recycling to perform a one-month, one-time recycling self-assessment.

The California version of the FBRR is included in the DDWs proposed IESWTR described above. The DDW has not introduced significant changes from the federal FBRR.

2.2.11 Groundwater Rule

The Groundwater Rule (GWR) was proposed by the USEPA on May 10, 2000, and the final rule was published in the Federal Register on November 08, 2006 and compliance was required by December 1, 2009. The purpose of the rule is to provide for increased protection against microbial pathogens in PWSs that use groundwater sources or system that mixes surface and groundwater, if the groundwater is added directly to the distribution system and provided to consumers without treatment. The USEPA is particularly concerned about groundwater systems that are susceptible to fecal contamination. The rule contains the following major components:

- Periodic on-site inspections of groundwater systems requiring evaluations of eight key areas (system sanitary survey) and identification of significant deficiencies.
- Source water monitoring to test for the presence of fecal indicators (*E. coli*, enterococci, or coliphage) in the groundwater sample. There are two monitoring provisions:
  - Triggered monitoring for systems that do not provide 4-log treatment and have a total-coliform positive sample under the TCR.
    - Assessment monitoring – State has the option to require systems to conduct source water assessment monitoring to help identify high-risk systems, at any time.

- Requirements for correction of significant deficiencies or positive microbial samples indicating fecal contamination. Options for corrective actions include: correct the significant deficiency, eliminate the source of contamination, provide an alternate source of water, and provide treatment that achieves at 4-log inactivation or removal of viruses.
- Compliance monitoring to ensure that treatment technology installed reliably achieves 4-log (99.99 percent) inactivation or removal of viruses.

2.3 OTHER REGULATED CONTAMINANTS

2.3.1 Lead and Copper Rule

The federal Lead and Copper Rule was finalized in June 1991. In lieu of MCLs, this rule establishes an action level for lead of 0.015 mg/L and for copper of 1.3 mg/L, and MCLGs of 0 mg/L for lead and 1.3 mg/L for copper. An exceedance of the action level is not a violation, but triggers additional action including water quality parameter monitoring, corrosion control treatment, source water monitoring/treatment, public education, and lead service line replacement.

On January 12, 2000, the USEPA made minor changes to the Lead and Copper Rule (also known as the Lead and Copper Rule Minor Revisions, (LCRMR)) to streamline requirements, promote consistent national implementation, and in many cases, reduce the burden on water systems. The LCRMR does not change the action levels or the rule's basic requirements to optimize corrosion control. The modified rule addresses seven broad categories:

1. Demonstration of optimal corrosion control.
2. Lead service line replacement requirements.
3. Public education requirements.
4. Monitoring requirements.
5. Analytical methods.
6. Reporting and record-keeping requirements.
7. Special primacy considerations.

The DDW adopted the federal LCRMR in October 2003. The action levels defined by the DDW are identical to those defined in the federal rule. There are minor differences between the state and federal rules, most of which address clarification on items not clearly defined in the federal rule, such as timeframes and requirements to determine sampling sites.

2.3.2 Arsenic Rule

In January 2001, the USEPA promulgated a new standard that requires PWSs to reduce arsenic levels in drinking water. The final rule became effective in February 2002. Systems were required to comply with the standard by January 2006. The arsenic rule applies to all community water systems and non-transient, non-community water systems regardless of size. The rule not only establishes an MCL for arsenic (0.010 mg/L), based on RAAs of quarterly results and an MCLG for arsenic (zero), but also lists feasible technologies and affordable technologies for small systems that can be used to comply with the MCL. However, systems are not required to use the listed technologies in order to meet the MCL.
California published a revised arsenic MCL of 0.010 mg/L, which became effective on November 28, 2008.

2.3.3 Radionuclide Rule

On December 7, 2000, the USEPA announced updated standards for radionuclides. This rule became effective on December 8, 2003. All community water systems are required to meet the MCLs, presented in Table 1, and requirements for monitoring and reporting. Non-transient, non-community water systems are not regulated at this time. All systems must complete initial monitoring and phase in the monitoring requirements between December 8, 2003 and the next Standardized Monitoring Framework Period, which is December 30, 2007. Initially, utilities undergo four consecutive quarters of monitoring for gross alpha, combined radium-225/-228, and uranium. Only systems considered "vulnerable" are required to monitor for gross beta (quarterly samples), tritium, and strontium-90 (annual samples). The initial monitoring will determine if a system will have to perform reduced or increased monitoring.

The California Radionuclide Rule took effect on June 11, 2006. The DDW adopted the same MCLs as proposed by the USEPA as shown in Table 1; except for uranium (DDW adopted 20 pCi/L, which is equivalent to 30 µg/L). In addition, the DDW requires non-transient, non-community water systems to monitor for radionuclides, except for radium 228, and comply with the MCLs.

2.3.4 Radon Rule

According to the USEPA, breathing radon in the indoor air of homes is the primary public health risk from radon, contributing to about 20,000 lung cancer deaths each year in the U.S. Radon is the second leading cause of lung cancer in the U.S. The USEPA estimates that radon in drinking water causes about 168 cancer deaths per year, 89 percent from lung cancer caused by breathing radon released from water, and 11 percent from stomach cancer caused by drinking water containing radon.

To address this issue, the USEPA proposed the Radon Rule in November 1999. The proposed rule would apply to all community water systems that use groundwater or mixed ground and surface water. The rule proposes an MCLG, an MCL, an alternative maximum contaminant level (AMCL), and requirements for multimedia mitigation (MMM) program plans to address radon in indoor air. The proposed MCLG for radon in drinking water is zero. The proposed regulation provides two options for the MCL. The proposed MCL is 300 pCi/L and the proposed AMCL is 4,000 pCi/L. The drinking water standard that would apply for a system depends on whether or not the state or community water system develops a MMM program. If a MMM program plan is developed by either the state or the community water system, the maximum level of radon allowed would be 4,000 pCi/L. If a MMM program plan is not developed, then the MCL of 300 pCi/L would apply.

The proposed regulation identifies four criteria that MMM program plans would be required to meet to be approved by the USEPA:

- Public involvement in the development of the MMM plan.
- Quantitative goals for reducing radon in existing and new homes.
- Strategies for achieving these quantitative goals.
- A plan for tracking and reporting results.

The proposal also includes monitoring, reporting, public notification, consumer confidence report requirements, proposed best available technologies, and analytical methods.

2.3.5 Perchlorate MCLs

In February 2011, the EPA decided to regulate perchlorate under the Safe Drinking Water Act (SDWA) and initiated a process to develop a national primary drinking water regulation (NPDWR) for perchlorate. However, until the NPDWR is finalized, there are not yet currently any requirements on public water systems. A final regulation is projected to be published in March 2017.

The DDW established a 6 µg/L MCL for perchlorate on October 18, 2007. The DDW also requires all community and non-transient-non-community water systems to monitor their data to determine compliance with the perchlorate MCL.

2.3.6 California Chromium-6 Standard

Chromium-6 monitoring is currently included in the 50 µg/L MCL for total chromium as part of the NPDWR. However, recent events, during the 1999 through 2001 period, prompted by concerns about chromium-6's potential health effects, resulted in a requirement for DDW to adopt an MCL that is specific for chromium-6. The DDW established a 10 µg/L MCL based on RAA of quarterly results for Chromium-6 on July 1, 2014.

2.3.7 California Fluoride Regulations

The California SDWA, which was established by the DDW in January 2000, addresses drinking water regulations for fluoride. For PWSs that are fluoridated, the current regulations establish an optimal fluoride level control range based on the annual average air temperature. Fluoride concentrations must be measured daily, and a system is out of compliance if more than 20 percent of the samples collected in a month are outside of the control range. The current MCL established by the DDW for fluoride is 2.0 mg/L. Note that this is more stringent than the federal primary drinking water standard (4.0 mg/L), and that this establishes the maximum allowable level of fluoride in drinking water, not the recommended dose for dental health benefits.

In 1995, the California legislature passed a bill requiring all water agencies to fluoridate their water supplies if money was provided to the agencies to do so. To date, this money has not been provided to the District, and the District has not been adding fluoride to the water supply. Due to the absence of state funding, the District is not required to fluoridate, and therefore is not out-of-compliance by not fluoridating at this point.

In 2015, the U.S. Public Health Service (PHS) updated its optimal fluoride dose recommendation. The PHS now recommends that community water systems add fluoride to achieve an optimal fluoride concentration of 0.7 mg/L. This concentration corresponds with the existing California Water Fluoridation Standards control range of 0.6 mg/L to 1.2 mg/L. The DDW will be developing amendments to the California Code of Regulations and individual public water supply permits to reference the PHS' recommended concentration of 0.7 mg/L.

2.4 UNREGULATED CONTAMINANTS

The following rules address contaminants that are not currently regulated, but are being considered for future regulations and may require monitoring and notification of the public if they are detected:

- Unregulated Contaminant Monitoring Rules.
- Contaminant Candidate List.
- California Notification Levels.

2.4.1 Unregulated Contaminant Monitoring Rules

The USEPA uses the Unregulated Contaminant Monitoring (UCM) program to collect data for contaminants suspected to be present in drinking water but that do not have health-based standards set under the SDWA. The unregulated contaminants are shown in **Table 5**. Every five years, the USEPA reviews the list of contaminants, which is largely based on the Contaminant Candidate List (CCL). The SDWA Amendments of 1996 provide for monitoring of no more than 30 contaminants per 5-year cycle.

The history of the UCM program includes:

- UCM Rounds 1 and 2 (1988 through 1997): State drinking water programs managed the original program and required PWSs serving more than 500 people to monitor contaminants. During Round 1, 62 (then) unregulated contaminants were monitored, whereas 48 (then) contaminants were monitored during Round 2.
- Unregulated Contaminant Monitoring Rule 1 (UCMR 1, 2001 through 2005): The SDWA Amendments of 1996 redesigned the UCM program to incorporate a two-tiered monitoring approach for 26 contaminants. The proposed contaminants are separated in two lists:
  - **Assessment Monitoring (for List 1 contaminants)** was conducted with analytical methods in common use by drinking water laboratories. Assessment Monitoring was required for 12 List 1 contaminants by PWSs serving more than 10,000 people, and 800 representative PWSs serving 10,000 or fewer people. Monitoring was conducted during a 12-month period between 2001 and 2003.
  - **Screening Survey Monitoring (for List 2 contaminants)** was conducted with analytical methods that are more specialized and not in common use. Screening Survey Monitoring was conducted for 14 List 2 contaminants (13 organic chemicals and one microorganism) at 300 randomly selected large and small PWSs.
- Unregulated Contaminant Monitoring Rule 2 (UCMR 2, 2008 through 2010): The second monitoring cycle (UCMR2) required monitoring for 25 contaminants. As with UCMR1, UCMR 2 included both Assessment Monitoring and Screening Survey Monitoring.
  - Assessment Monitoring was required for 11 List 1 contaminants by PWSs serving more than 10,000 people, and 800 representative PWSs serving 10,000 or fewer people. Monitoring was required during a 12-month period between January 2008 and December 2010.
  - Screening Survey monitoring was required for 15 List 2 contaminants by all PWSs serving more than 100,000 people, 320 representative PWSs serving 10,001 to 100,000 people, and 480 representative PWSs serving 10,000 or fewer people. Monitoring was required during a 12-month period between January 2008 and December 2010.

The contaminants proposed under the UCMR 2 were determined as follows. The USEPA reviewed contaminants that had been targeted through existing prioritization processes, including previous UCMR "reserved" contaminants (i.e., those contaminants for which analytical methods were not yet available), and the CCL. Additional contaminants were identified based on current research on occurrence and health effects risk factors, as well as availability of analytical methods. The list of proposed contaminants is shown in **Table 6**.

Table 5	Unregulated Contaminants Monitored under UCMR1 2015 Water System Master Plan Update Palmdale Water District
Assessment Monitoring (List 1)	**Screening Survey (List 2)**
2,4-dinitrotoluene	1,2-diphenylhydrazine
2,6-dinitrotoluene	2-methyl-phenol
Acetochlor	2,4-dichlorophenol
DCPA mono-acid degradate	2,4-dinitrophenol
DCPA di-acid degradate	2,4,6-trichlorophenol
4,4'-DDE	Diazinon
EPTC	Disulfoton
Molinate	Diuron
MTBE	Fonofos
Nitrobenzene	Linuron
Perchlorate	Nitrobenzene
Terbacil	Prometon
	Terbufos
	Aeromonas 1

Table 6	Unregulated Contaminants Monitored under UCMR2 2015 Water System Master Plan Update Palmdale Water District
Assessment Monitoring (List 1)	**Screening Survey (List 2)**
Insecticides	*Parent Acetanilides*
Dimethoate	Acetochlor
Terbufos sulfone	Alachlor
	Metolachlor
Flame Retardants	
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	*Acetanilide Degradates*
2,2',4,4',5-pentabromod iphenyl ether (BDE-99)	Acetochlor ESA
2,2',4,4',5,5'-hexabromobiphenyl (HBB)	Acetochlor OA
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	Alachlor ESA
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	Alachlor OA
	Metolachlor ESA
Explosives	Metolachlor OA
1,3-dinitrobenzene	
2,4,6-trinitrotoluene (TNT}	*Nitrosamines*
Hexahydro-1,3, 5-trinitro-1,3,5-triazine (RDX)	N-nitroso-diethylami ne (NDEA)
	N-nitroso-dimethylamine (NDMA)
	N-nitroso-di-n-butylamine (NDBA)
	N-nitroso-di-n-propylami ne (NDPA)
	N-nitroso-methylethylamine (NMEA)
	N-nitroso-pyrroli dine (NPYR)

- Unregulated Contaminant Monitoring Rule 3 (UCMR 3, 2012-2016): UCMR3 requires monitoring for 30 contaminants, as shown in **Table 7**. As with the previous rules, UCMR3 includes Assessment Monitoring and Screening Survey Monitoring. However, UCMR3 also introduces Pre-Screen Testing for List 3 contaminants.
    - Assessment Monitoring is required for 21 List 1 contaminants by PWSs serving more than 10,000 people, and 800 representative PWSs serving 10,000 or fewer people. Monitoring is required during a 12-month period between January 2013 and December 2015.
    - Screening Survey monitoring is required for seven List 2 contaminants by all PWSs serving more than 100,000 people, 320 representative PWSs serving 10,001 to 100,000 people, and 480 representative PWSs serving 10,000 or fewer people. Monitoring is required during a 12-month period between January 2013 and December 2015.
    - Pre-Screen Testing uses newer technologies not as commonly used by drinking water laboratories. UCMR requires Pre-Screen Testing for two List 3 viruses by 800 representative PWSs that serve less than 1,000 people and do not disinfect. The PWSs have wells in areas of karst or fractured bedrock. Monitoring is required during a 12-month period between January 2013 and December 2015.

Table 7 — Unregulated Contaminants Monitored under UCMR3
2015 Water System Master Plan Update
Palmdale Water District

Assessment Monitoring (List 1)	Screening Survey (List 2)	Pre-Screening Testing (List 3)
VOCs	*Hormones*	*Viruses*
1,2,3-trichloropropane	17-β-estradiol	enteroviruses
1,3-butadiene	17-α-ethynylestradiol (ethinyl estradiol)	noroviruses
chloromethane (methyl chloride)	16-α-hydroxyestradiol (estriol)	
1,1-dichloroethane	equilin	
bromomethane (methyl bromide)	estrone	
Chlorodifluoromethane (HCFC-22)	testosterone	
bromochloromethane (halon 1011)	4-androstene-3,17-dione	
SOCs		
1,4-dioxane		
Metals		
vanadium		
molybdenum		
cobalt		
strontium		
chromium[1]		
chromium-6		
Oxyhalide Anion		
Chlorate		
Perfluorinated Compounds		
perfluorooctanesulfonic acid (PFOS)		
perfluorooctanoic acid (PFOA)		
perfluorononanoic acid (PFNA)		
perfluorohexanesulfonic acid (PFHxS)		
perfluoroheptanoic acid (PFHpA)		
perfluorobutanesulfonic acid (PFBS)		

2.5 California Unregulated Chemicals Requiring Monitoring

In the Title 22 regulations, the DDW includes a list of chemicals that are not regulated and do not have MCLs, but require monitoring. This requirement was effective January 3, 2001, but since then has been repealed as of October 18, 2007. Monitoring for all chemicals was to have been completed by December 31, 2003, except for chromium-6, which was to have been completed by December 31, 2002. **Table 8** lists the detection limit for reporting (DLR) purposes.

Monitoring requirements for chemicals that have been carried over from the previous list (perchlorate, 1,2,3-trichloropropane, dichlorodifluoromethane, ETBE, and TAME) can generally be satisfied by grandfathering data. However, new sources that are vulnerable, and sources that are newly designated as vulnerable to any of these, must be monitored. It may be possible to grandfathering data for the new chemicals as well, if the samples were collected after January 1, 1998.

Table 8 Unregulated Chemicals Requiring Monitoring (repealed October 18, 2007)
2015 Water System Master Plan Update
Palmdale Water District

Chemical	DLR (µg/L)
Boron	100
Chromium VI	1
Perchlorate*	4
Vanadium	3
Dichlorofluoromethane	0.5
Ethyl tertiary butyl ether (ETBE)	3
Tertiary amyl methyl ether (TAME)	3
Tertiary butyl alcohol (TBA)	2
1, 2, 3-Trichloropropane	-

*Note: Perchlorate is now a regulated contaminant

2.5.1 Contaminant Candidate List

The 1996 amendments to the SDWA require the USEPA to establish a list of contaminants that aid in priority setting for the District's drinking water program. The Contaminant Candidate List (CCL) consists of contaminants that are known or anticipated to occur in public water systems, but are not currently subject to EPA drinking water regulations. The USEPA conducts research on health, analytical methods, treatment technologies, effectiveness, costs, and occurrence for drinking water contaminants on the CCL.

The first CCL was finalized in March 1998 and included 50 chemicals and 10 microbial contaminants. In July 2003, the USEPA determined that nine of these contaminants (manganese, sodium, sulfate, aldrin, dieldrin, metribuzin, hexachlorobutadiene, naphthalene, and Acanthamoeba) did not require regulation. In February 2005, the USEPA decided to carry over the remaining 51 contaminants as the CCL 2 and continue to collect data on these contaminants with the goal of making a regulatory determination in 2006.

The list was further updated and published as the CCL3 on October 8, 2009. The CCL3 was developed using an improved process that built on previous CCLs as well as expert input from the National Academy of Sciences' National Research Council (NAS) and the National Drinking Water Advisory Council (NDWAC). The EPA used a four-step process to establish the final CCL3 list. The steps included:

1. Broadly identifying 7,500 potential drinking water contaminants
2. Further applying screening criteria to identify 600 contaminants (the Preliminary CCL) that should be further evaluated based on potential for occurrence in public water and the potential for public health concern.
3. Selecting 116 contaminants from the PCCL based on more detailed evaluation of occurrence, health effects, and expert input.
4. Incorporating information from the public, expert input, and expert review.

The final CCL3 includes 104 chemical contaminants and 12 microbiological contaminants. These contaminants are presented in the **Table 9**.

Table 9	**Federal Contaminants Regulated Under the CCL3 Water System Master Plan Update Palmdale Water District**
Microbial Contaminant Candidates	**Chemical Contaminant Candidates**
Adenovirus	1,1,1,2-Tetrachloroethane
Caliciviruses	1,1-Dichloroethane
Campylobacter jejuni	1,2,3-Trichloropropane
Enterovirus	1,3-Butadiene
Escherichia coli (0157)	1,3-Dinitrobenzene
Helicobacter pylori	1,4-Dioxane
Hepatitis A virus	17alpha-estradiol
Legionella pneumophila	1-Butanol
Mycobacterium avium	2-Methoxyethanol
Naegleria fowleri	2-Propen-1-ol
Salmonella enterica	3-Hydroxycarbofuran
Shigella sonnei	4,4'-Methylenedianiline
	Acephate
	Acetaldehyde
	Acetamide
	Acetochlor
	Acetochlor ethanesulfonic acid (ESA)
	Acetochlor oxanilic acid (OA)
	Acrolein
	Alachlor ethanesulfonic acid (ESA)
	Alachlor oxanilic acid (OA)
	alpha-Hexachlorocyclohexane
	Aniline
	Bensulide
	Benzyl chloride
	Butylated hydroxyanisole
	Captan
	Chlorate
	Chloromethane (Methyl chloride)
	Clethodim
	Cobalt
	Cumene hydroperoxide
	Cyanotoxins (3)*
	Dicrotophos

Table 9	Federal Contaminants Regulated Under the CCL3 Water System Master Plan Update Palmdale Water District
Microbial Contaminant Candidates	**Chemical Contaminant Candidates**
	Dimethipin
	Dimethoate
	Disulfoton
	Diuron
	equilenin
	equilin
	Erythromycin
	Estradiol (17-beta estradiol)
	estriol
	estrone
	Ethinyl Estradiol (17-alpha ethynyl estradiol)
	Ethoprop
	Ethylene glycol
	Ethylene oxide
	Ethylene thiourea
	Fenamiphos
	Formaldehyde
	Germanium
	Halon 1011 (bromochloromethane)
	HCFC-22
	Hexane
	Hydrazine
	Mestranol
	Methamidophos
	Methanol
	Methyl bromide (Bromomethane)
	Methyl tert-butyl ether
	Metolachlor
	Metolachlor ethanesulfonic acid (ESA)
	Metolachlor oxanilic acid (OA)
	Molinate
	Molybdenum
	Nitrobenzene
	Nitroglycerin
	N-Methyl-2-pyrrolidone
	N-nitrosodiethylamine (NDEA)
	N-nitrosodimethylamine (NDMA)
	N-nitroso-di-n-propylamine (NDPA)
	N-Nitrosodiphenylamine
	N-nitrosopyrrolidine (NPYR)
	Norethindrone (19-Norethisterone)
	n-Propylbenzene
	o-Toluidine
	Oxirane, methyl-
	Oxydemeton-methyl
	Oxyfluorfen

Table 9	Federal Contaminants Regulated Under the CCL3 Water System Master Plan Update Palmdale Water District
Microbial Contaminant Candidates	**Chemical Contaminant Candidates**
	Perchlorate
	Perfluorooctane sulfonic acid (PFOS)
	Perfluorooctanoic acid (PFOA)
	Permethrin
	Profenofos
	Quinoline
	RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)
	sec-Butylbenzene
	Strontium
	Tebuconazole
	Tebufenozide
	Tellurium
	Terbufos
	Terbufos sulfone
	Thiodicarb
	Thiophanate-methyl
	Toluene diisocyanate
	Tribufos
	Triethylamine
	Triphenyltin hydroxide (TPTH)
	Urethane
	Vanadium
	Vinclozolin
	Ziram

The EPA published a draft CCL4 on February 4, 2015, which includes 100 chemical contaminants and 12 microbial contaminants. CCL4 proposes to add two new contaminants (manganese and nonylphenol) and remove six contaminants from the list. Perchlorate will be removed on CCL4 because of the 2011 EPA determination to establish a NPDWR for perchlorate under the SDWA. 1,3-dinitrobenzene, dimethoate, terbufos, terbufos sulfone, and strontium will be removed on CCL4 as a result of the preliminary third Regulatory Determination (RD3). As of October 2014, the RD3 proposed to regulate strontium and to not regulate 1,3-dinitrobenzene, dimethoate, terbufos, terbufos sulfone.

The state of California does not have the equivalent of the CCL at the state level.

2.5.2 California Notification Levels

The DDW has established notification levels (previously known as "action levels" through 2004) for chemicals in drinking water that lack current MCLs. Notification levels are advisory levels and not enforceable standards. However, if a chemical is detected above its notification level, certain requirements and recommendations apply, such as notification of the local governing body, consumer notification, and/or source removal. If the contaminant concentration exceeds the "response level," which is considerably higher than the notification level (10 to 100 times higher, depending on whether the contaminant exhibits cancer risks or non-cancer toxicological endpoints), DDW recommends that the water source be discontinued.

Of the 93 chemicals for which notification levels have been established thus far; 39 now have MCLs. Of the remaining 55 chemicals, 30 are chemicals with current notification levels and response levels (**Table 10**), and 24 are chemicals with archived advisory levels (**Table 11**).

Table 10 DDW Drinking Water Notification Levels and Response Levels
2015 Water System Master Plan Update
Palmdale Water District

	Chemical	Notification Level (mg/L)	Response Level (mg/L)
1	Boron(2)	1	10 times the NL
2	n-Butylbenzene	0.26	10 times the NL
3	sec-Butylbenzene	0.26	10 times the NL
4	tert-Butylbenzene	0.26	10 times the NL
5	Carbon disulfide	0.16	10 times the NL
6	Chlorate(2)	*0.8	10 times the NL
7	2-Chlorotoluene	0.14	10 times the NL
8	4-Chlorotoluene	0.14	10 times the NL
9	Dichlorodifluoromethane (Freon 12)(2)	1	10 times the NL
10	1,4-Dioxane<(2)	0.003	35 times the NL
11	Ethylene glycol	14	10 times the NL
12	Formaldehyde(2)	0.1	10 times the NL
13	HMX	0.35	10 times the NL
14	Isopropylbenzene(2)	0.77	10 times the NL
15	Manganese(2)	0.5	10 times the NL
16	Methyl isobutyl ketone (MIBK)(2)	0.12	10 times the NL
17	Naphthalene	0.017	10 times the NL
18	N-Nitrosodiethyamine (NDEA)	0.00001	10 times the NL
19	N-Nitrosodimethylamine (NDMA)(2)	0.00001	30 times the NL
20	N-Nitrosodi-n-propylamine (NDPA)	0.00001	50 times the NL
21	Perchlorate(2)	0.006	10 times the NL
22	Propachlor(2)	0.09	10 times the NL
23	n-Propylbenzene	0.26	10 times the NL
24	RDX	0.0003	100 times the NL
25	Tertiary butyl alcohol (TBA)(2)	0.012	100 times the NL
26	1,2,3-Trichloropropane (1,2,3-TCP)(2)	0.000005	100 times the NL
27	1,2,4-Trimethylbenzene(2)	0.33	10 times the NL
28	1,3,5-Trimethylbenzene(2)	0.33	10 times the NL
29	2,4,6-Trinitrotoluene (TNT)	0.001	100 times the NL
30	Vanadium(2)	0.05	10 times the NL

Notes

1. Notes include toxicological endpoint, references, history, and other information (see page 6)

Table 11	Archived Advisory Levels 2015 Water System Master Plan Update Palmdale Water District	
	Chemical	**Notification Level (milligrams per liter)**
1	Aldicarb	0.007
2	Aldin	0.000002
3	Baygon	0.03
4	a-Benzene Hexachloride	0.000015
5	b-Benzene Hexachloride	0.000025
6	Captan	0.0015
7	Carbaryl	0.7
8	Chloropicrin	0.056
9	Chlorpropham (CIPC)	1.2
10	1,3,-Dichlorobenzene	0.6
11	Dieldrin	0.00002
12	Dimethoate	0.001
13	2,4-Dimethylphenol	0.1
14	Diphenamide	0.2
15	Ethion	0.004
16	Malathion	0.16
17	N-methyl dithiocarbamate (Metam sodium)	0.02
18	Methylisothiocyanate	0.05
19	Methyl parathion	0.002
20	Parathion	0.04
21	Pentachloronitrobenzene	0.02
22	Phenol	4.2
23	2,3,5,6-Tetrachloroterephthalate	3.5
24	Trithion	0.007

Note

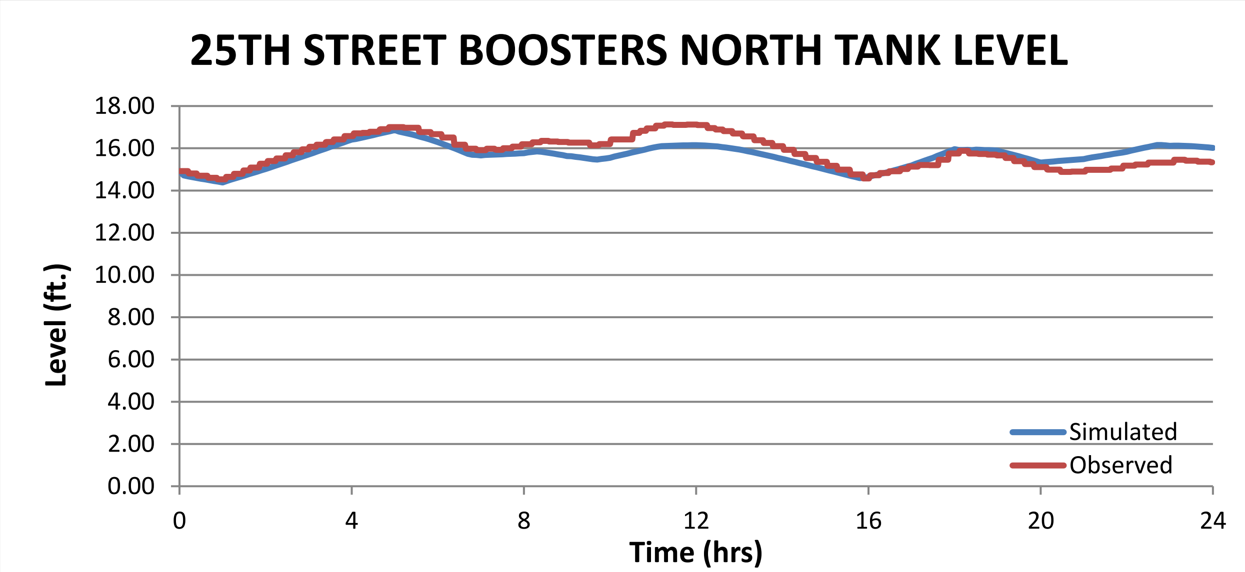
1. Include toxicological endpoint references, history, and other information, and are presented on the next page of this document. If the archived action level was updated to reflect a more recent risk assessment, that is indicated in the Notes.

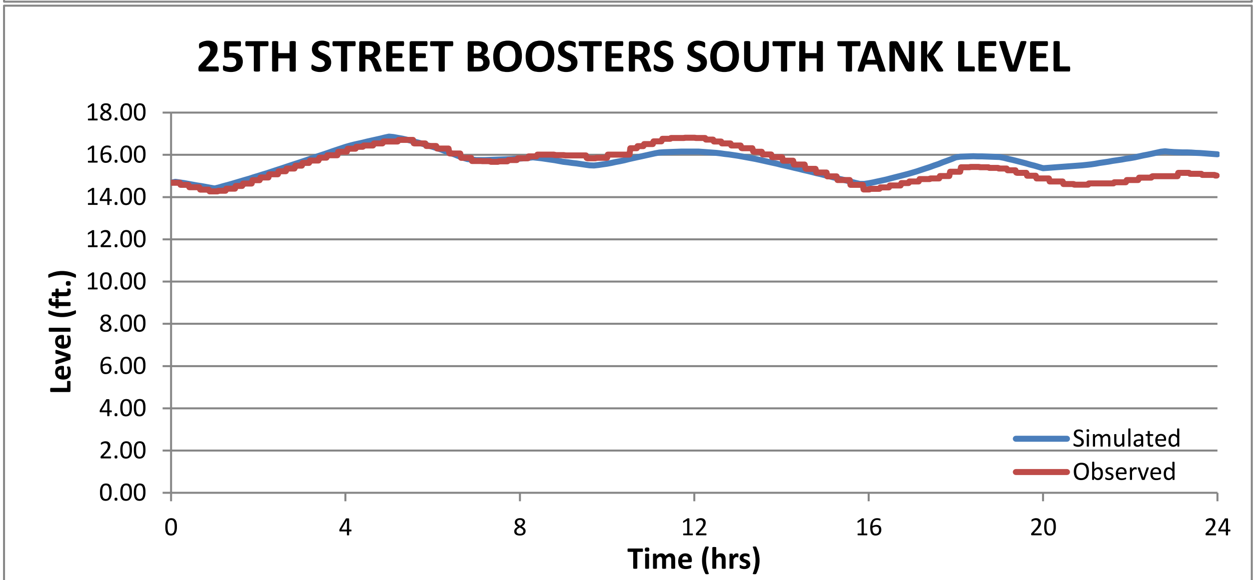
Appendix D Calibration Graphs

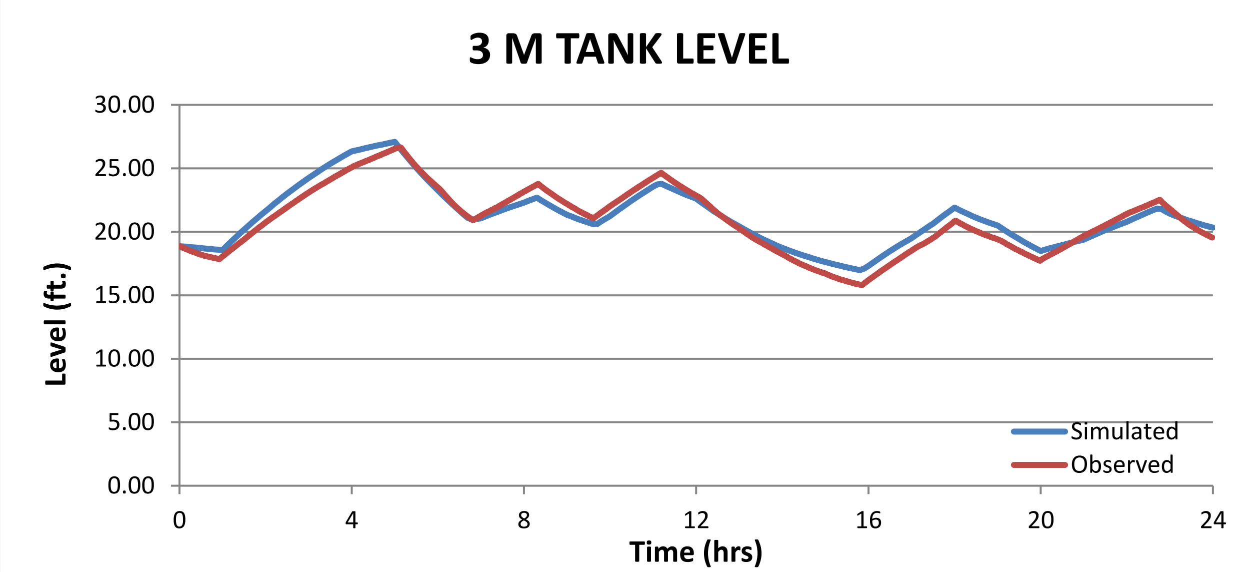
EPS Calibration:

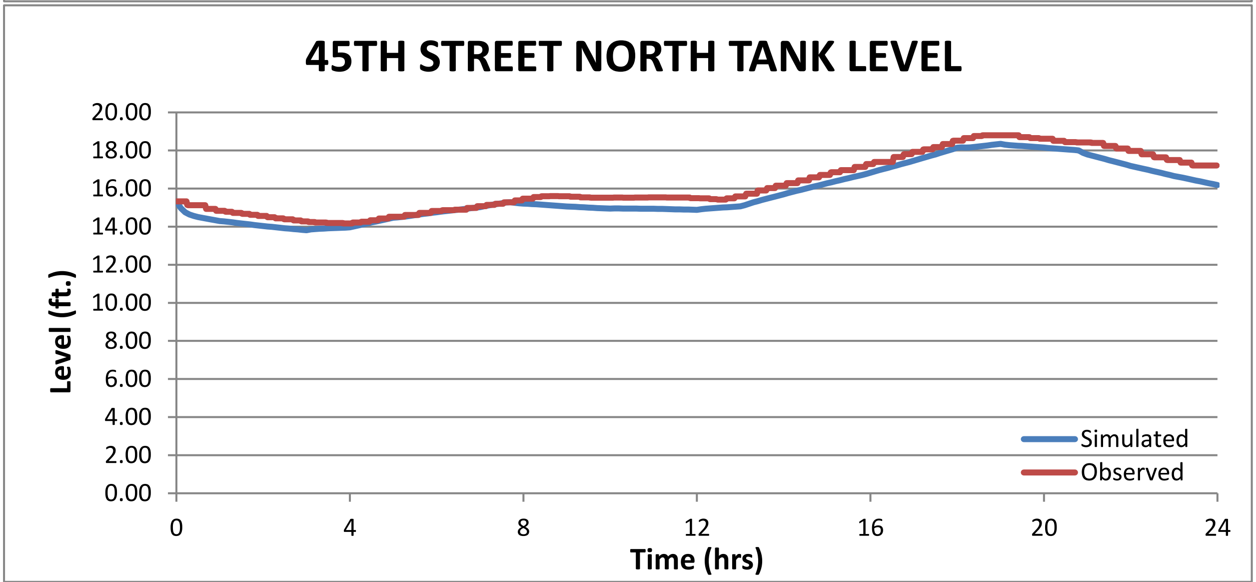
Below are the comparison between the model and the SCADA data for July 24, 2014, which was a high production day in the system. The blue "simulated" line is the model output, and the red "observed" line is the SCADA data from July 24, 2014.

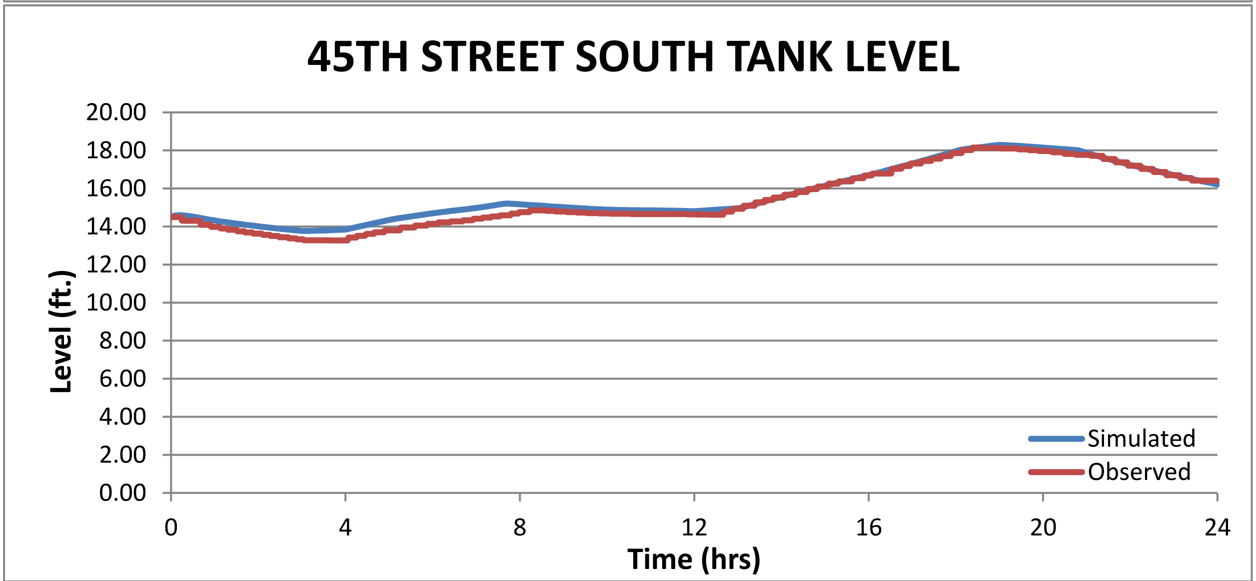
Tank Levels

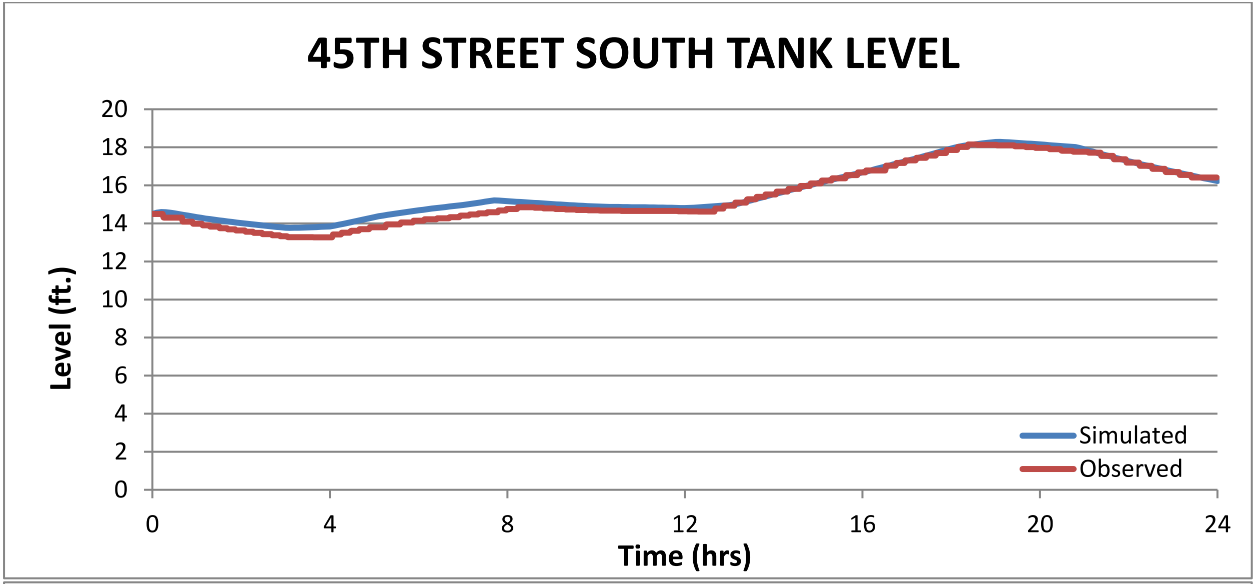


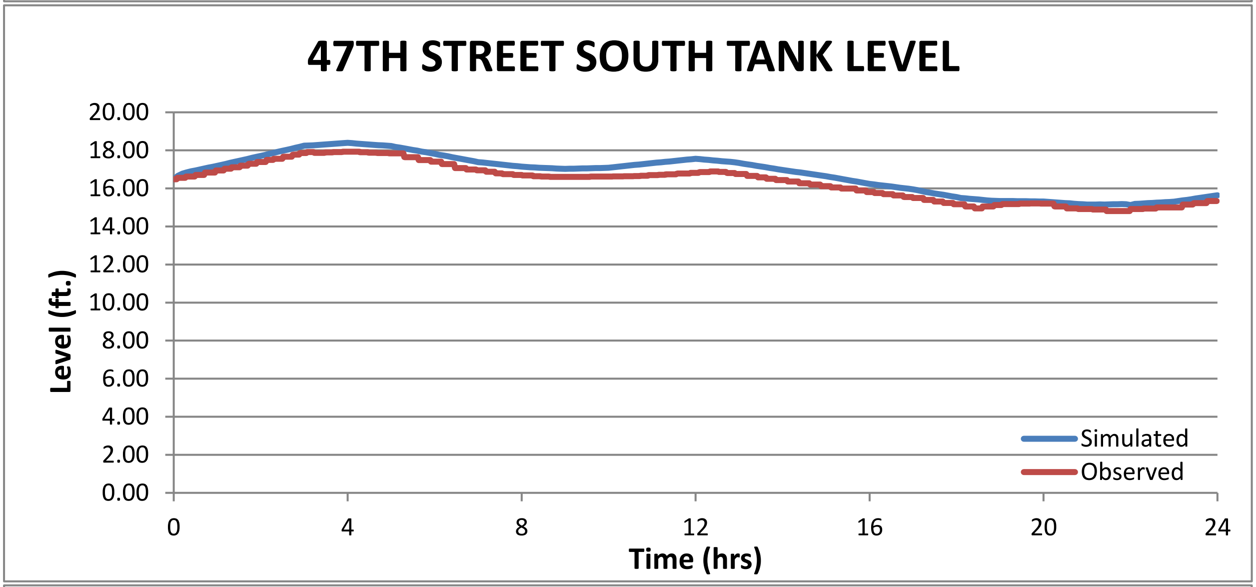


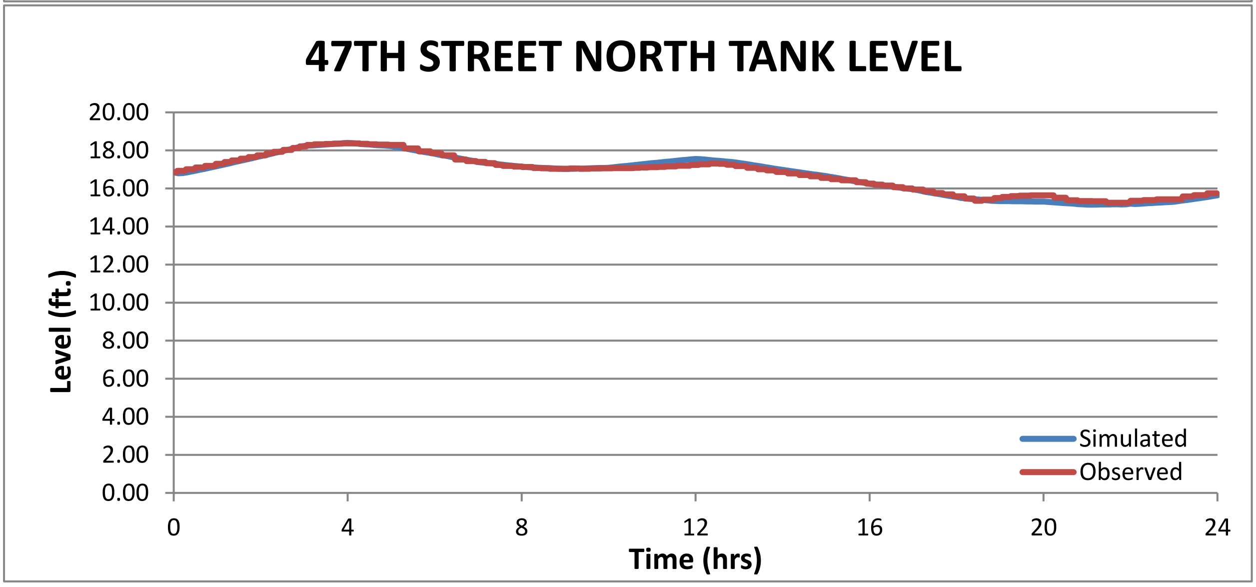

3 M TANK LEVEL
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Level (ft.)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

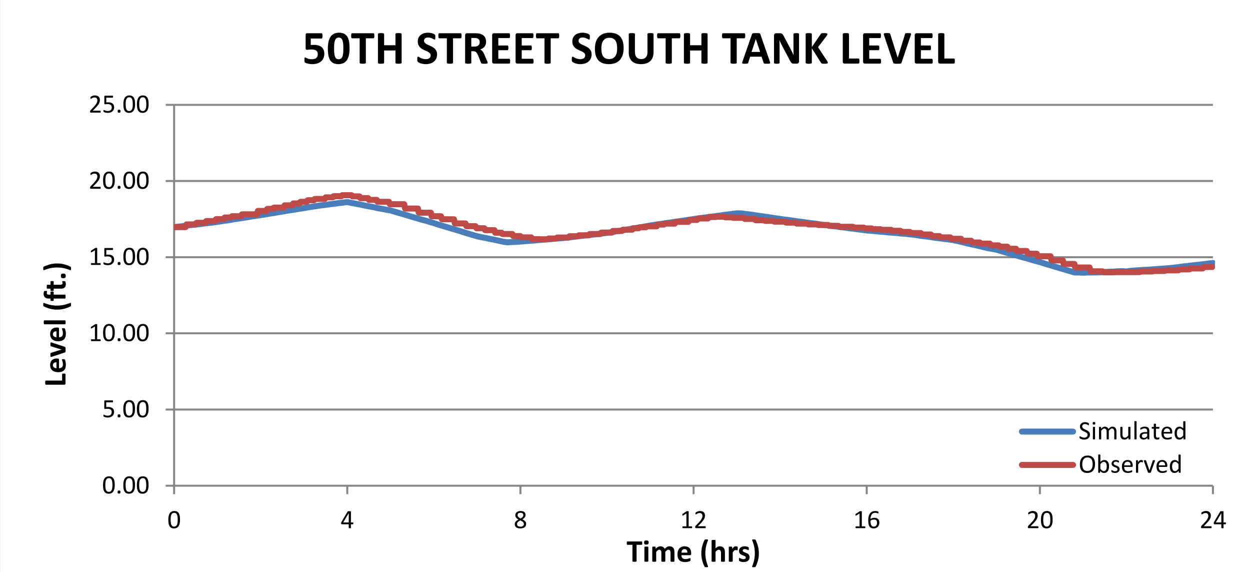

45TH STREET NORTH TANK LEVEL
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Level (ft.)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

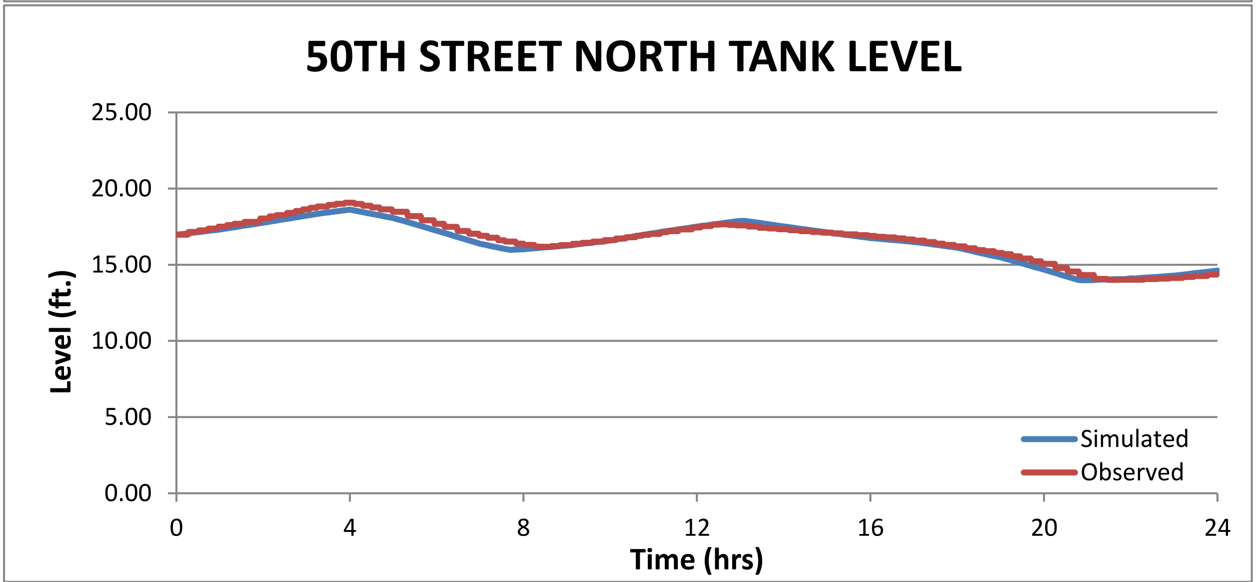

45TH STREET SOUTH TANK LEVEL
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Level (ft.)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

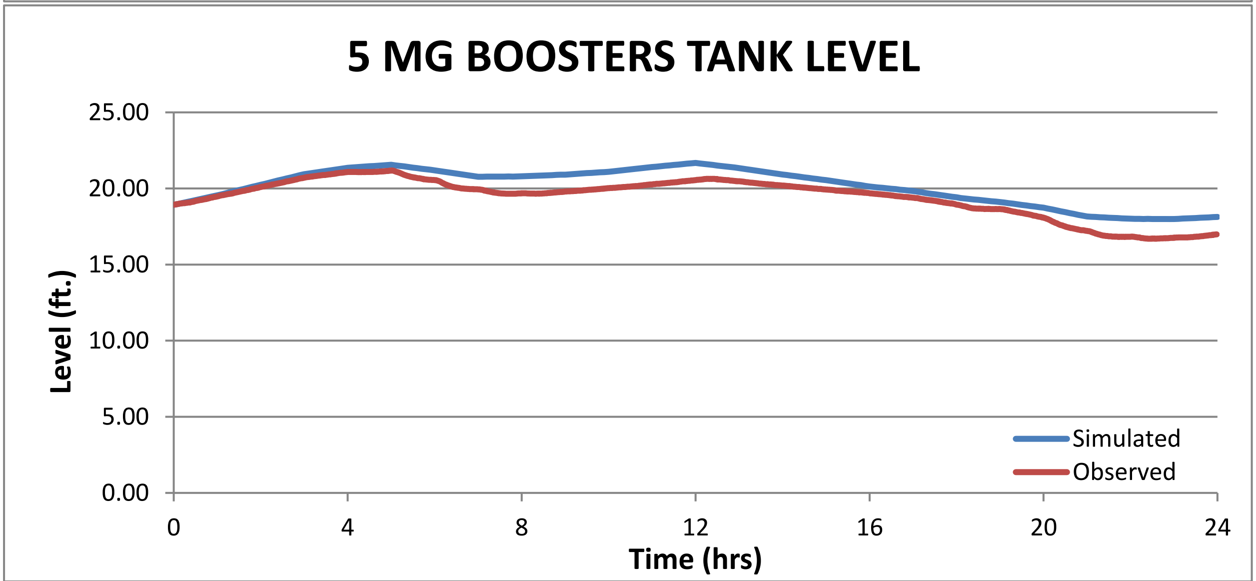

45TH STREET SOUTH TANK LEVEL
Level (ft.)
20
18
16
14
12
10
8
6
4
2
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

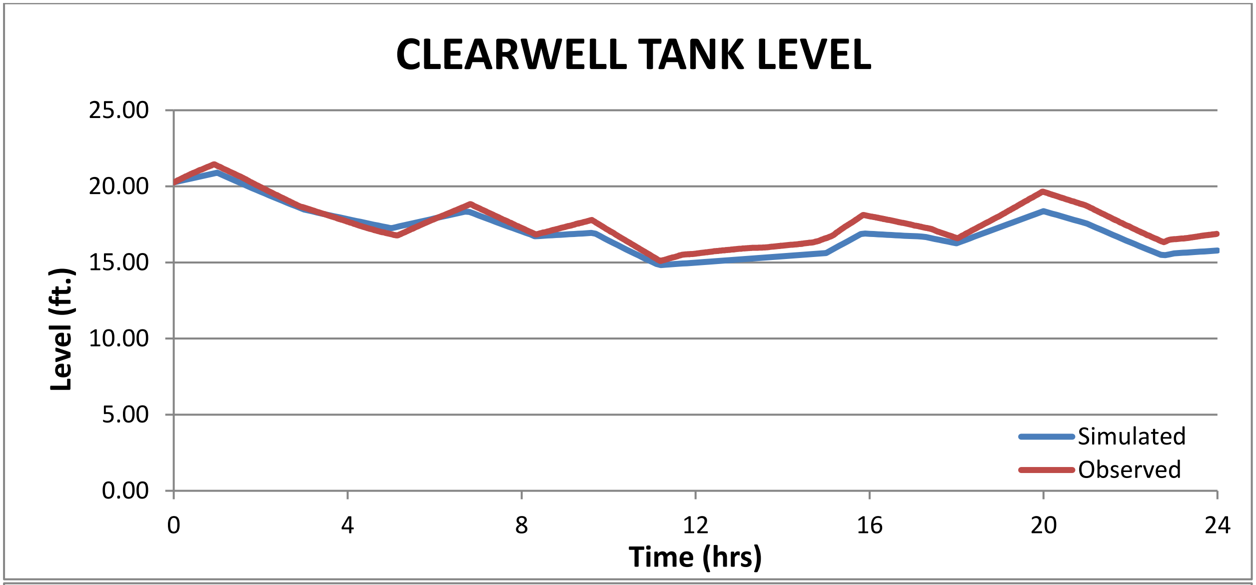

47TH STREET SOUTH TANK LEVEL
Level (ft.)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

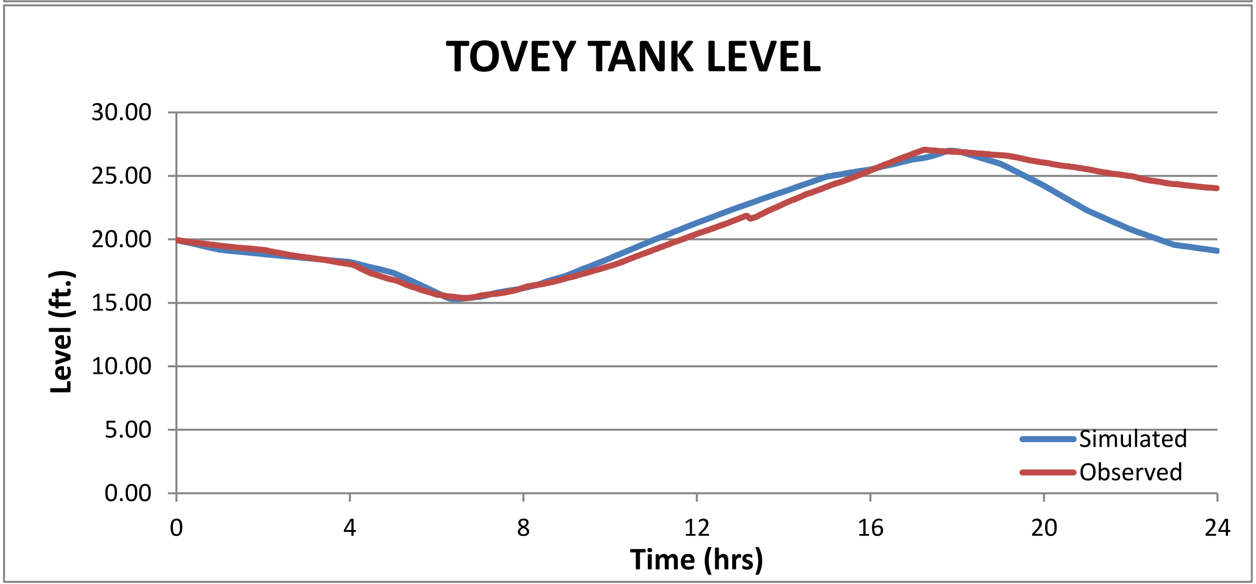

47TH STREET NORTH TANK LEVEL
Level (ft.)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

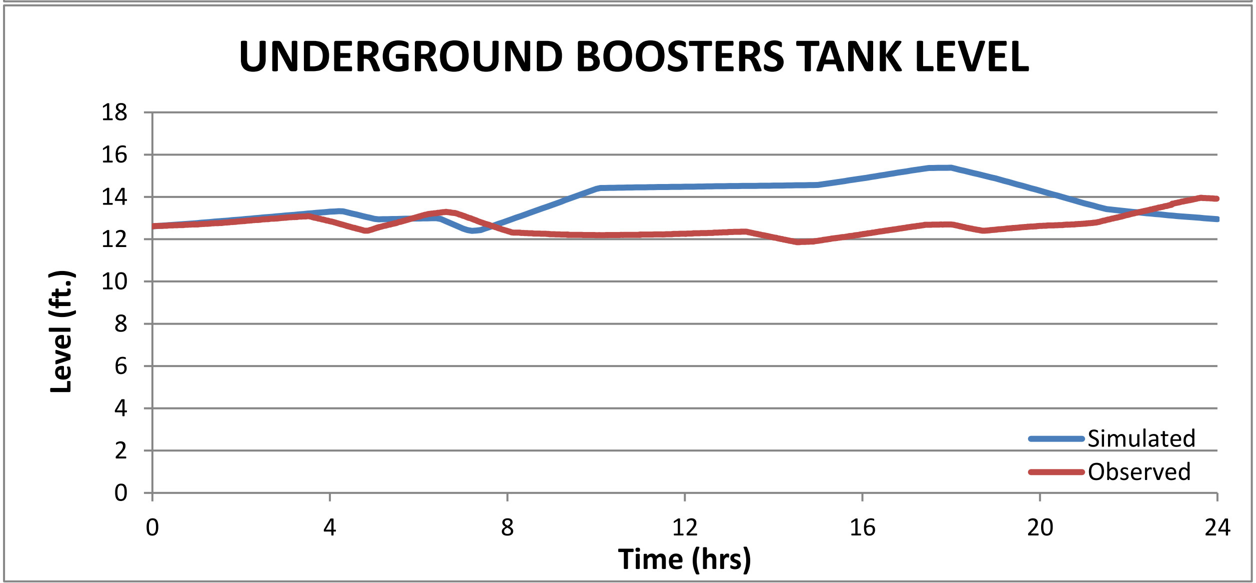

50TH STREET SOUTH TANK LEVEL
25.00
20.00
15.00
10.00
5.00
0.00
Level (ft.)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

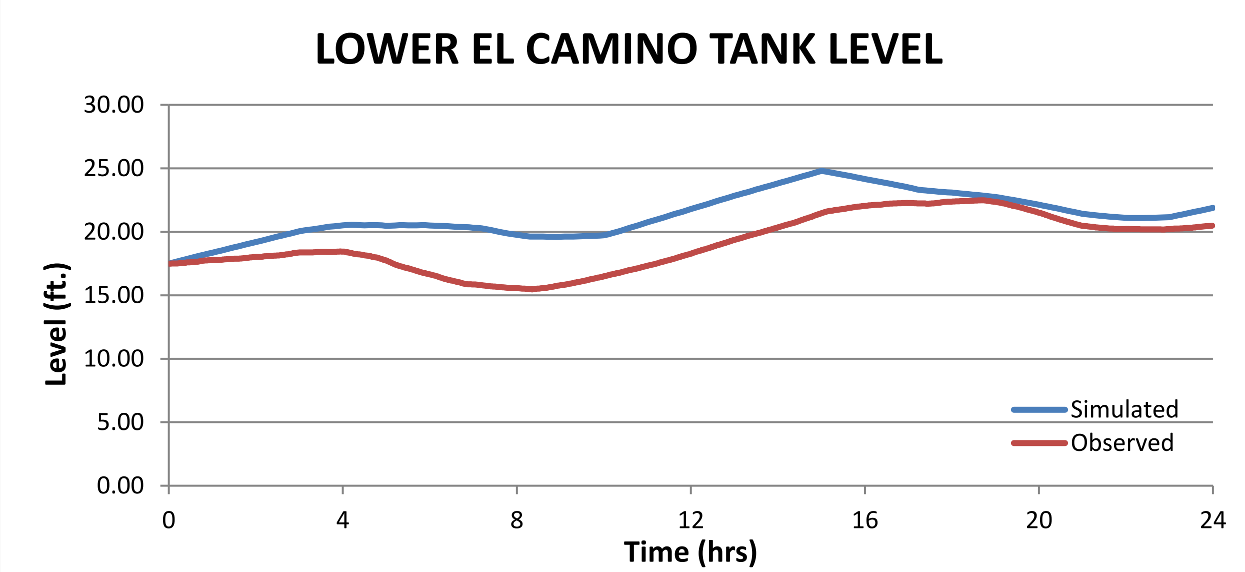

50TH STREET NORTH TANK LEVEL
25.00
20.00
15.00
10.00
5.00
0.00
Level (ft.)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

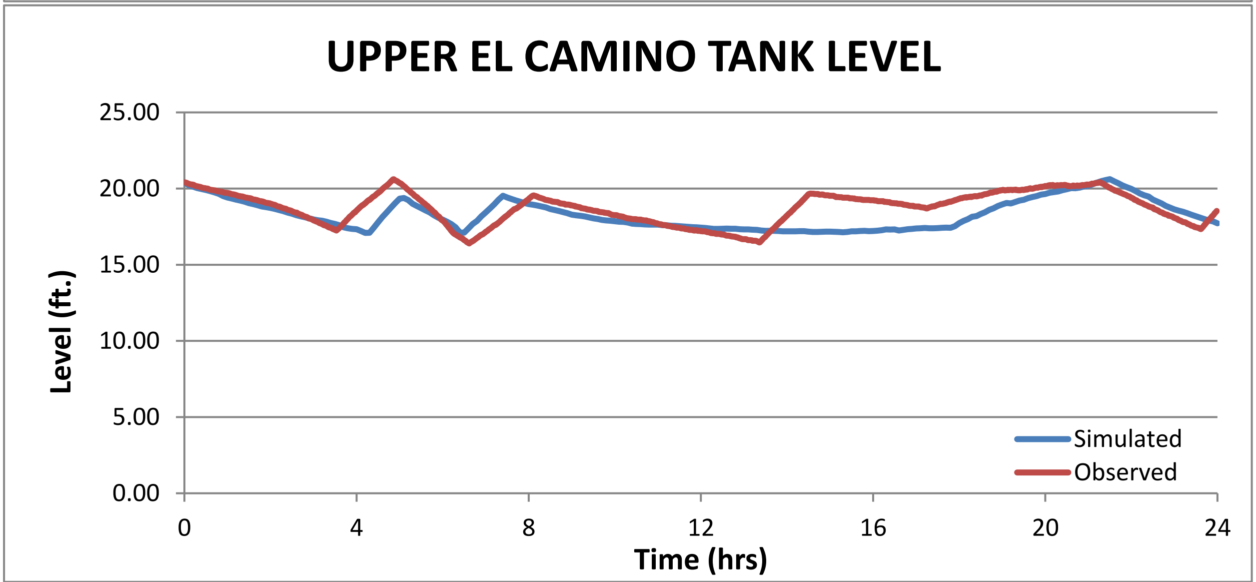

5 MG BOOSTERS TANK LEVEL
25.00
20.00
15.00
10.00
5.00
0.00
Level (ft.)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

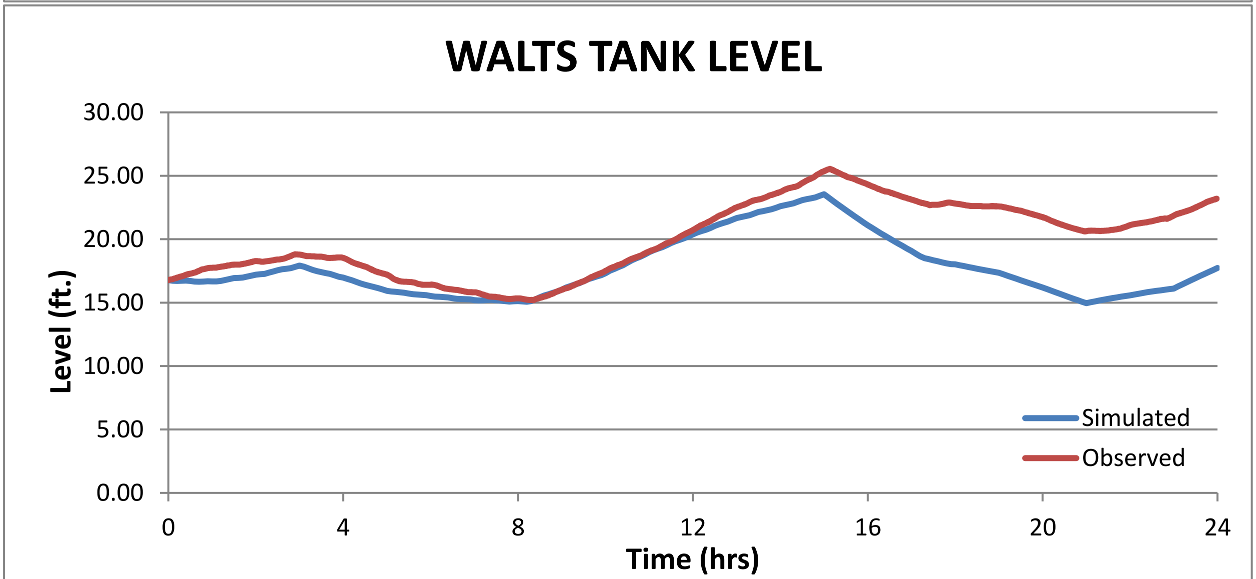

CLEARWELL TANK LEVEL
Level (ft.)
25.00
20.00
15.00
10.00
5.00
0.00
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

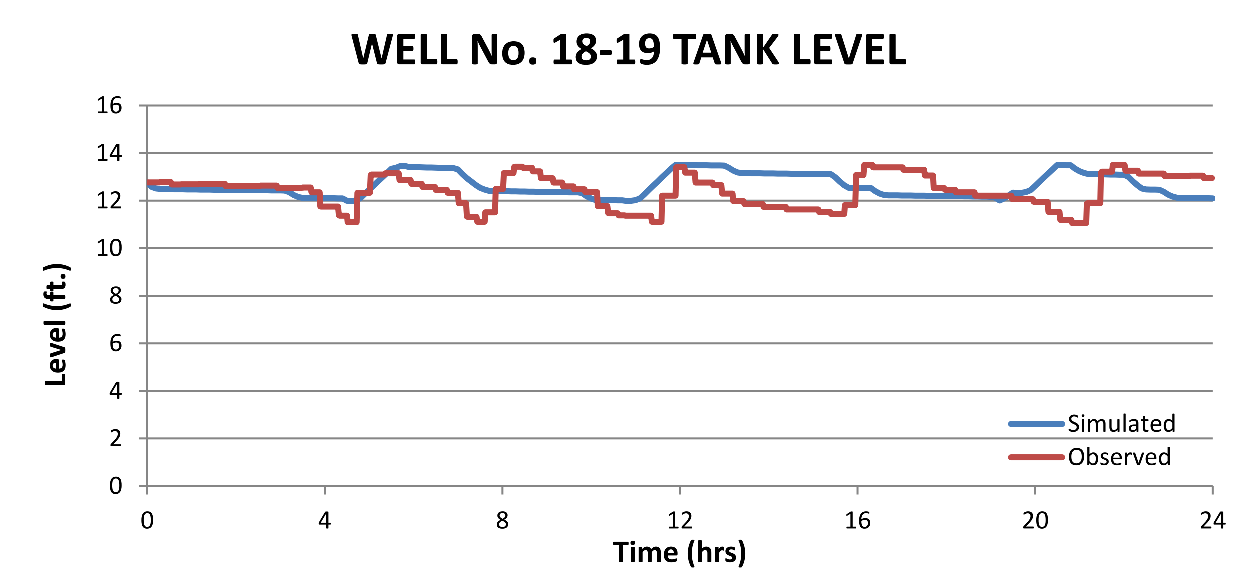

TOVEY TANK LEVEL
Level (ft.)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

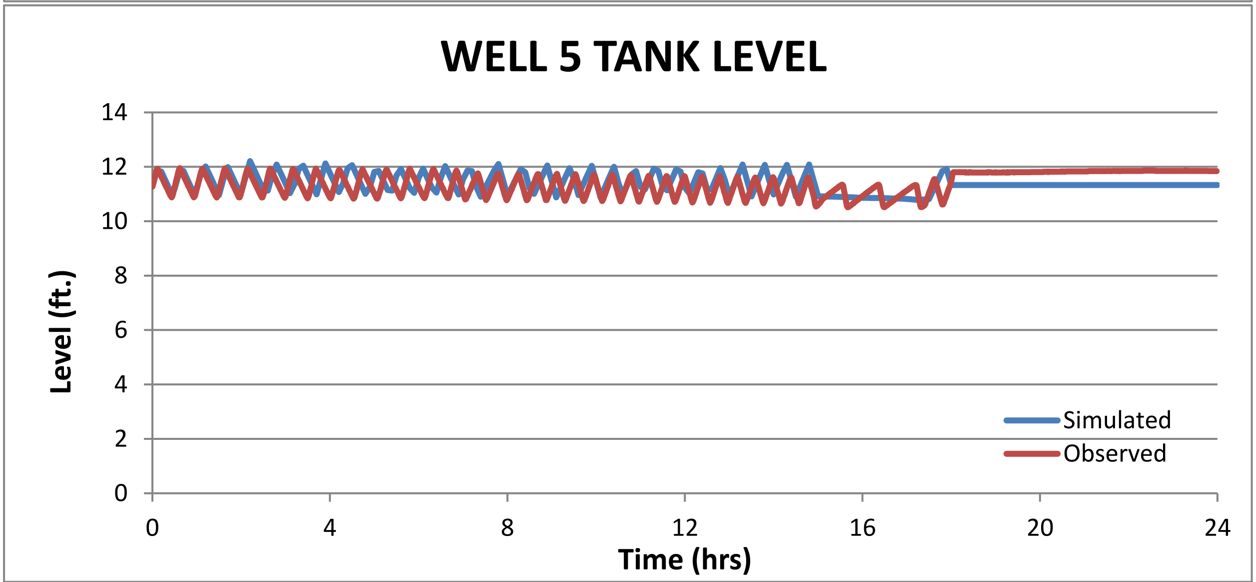

UNDERGROUND BOOSTERS TANK LEVEL
Level (ft.)
18
16
14
12
10
8
6
4
2
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed


LOWER EL CAMINO TANK LEVEL
Level (ft.)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

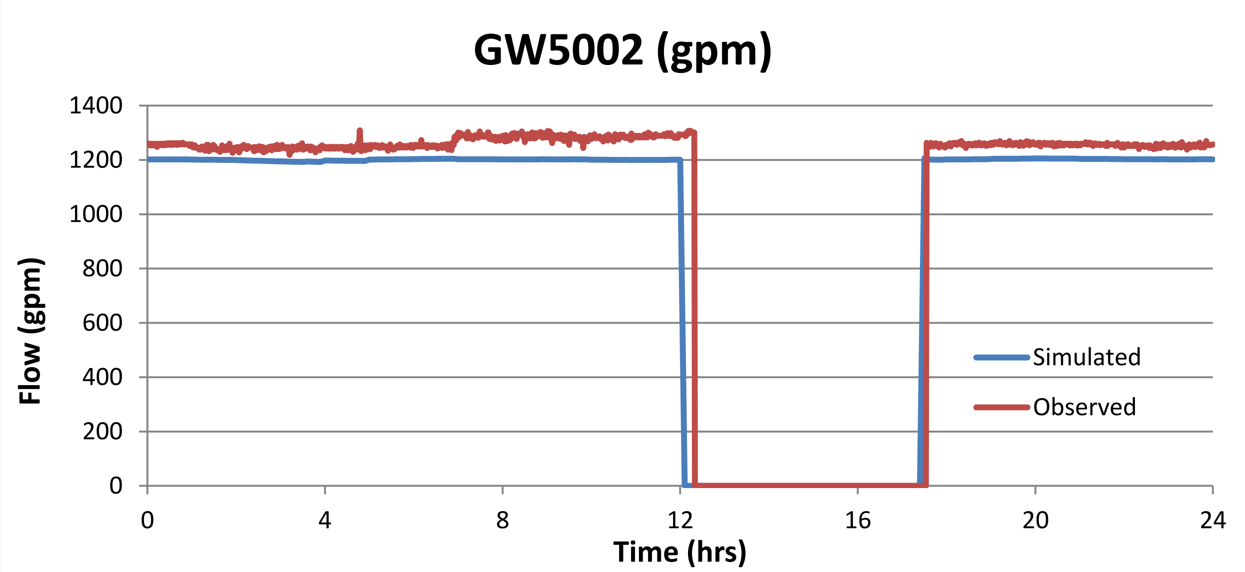

UPPER EL CAMINO TANK LEVEL
Level (ft.)
25.00
20.00
15.00
10.00
5.00
0.00
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

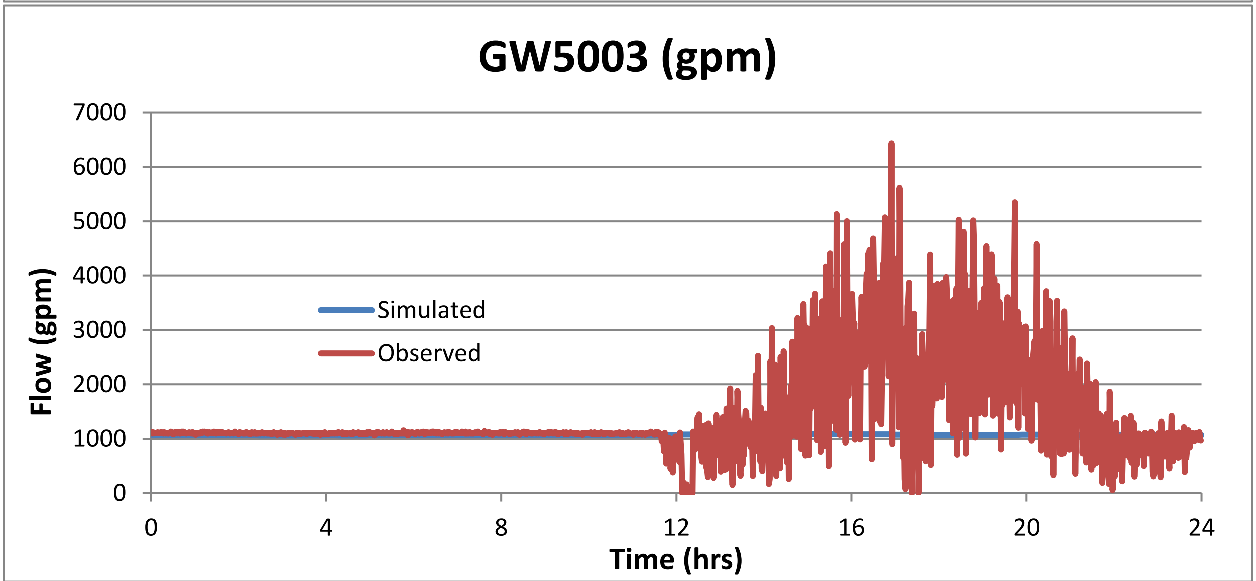

WALTS TANK LEVEL
Level (ft.)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

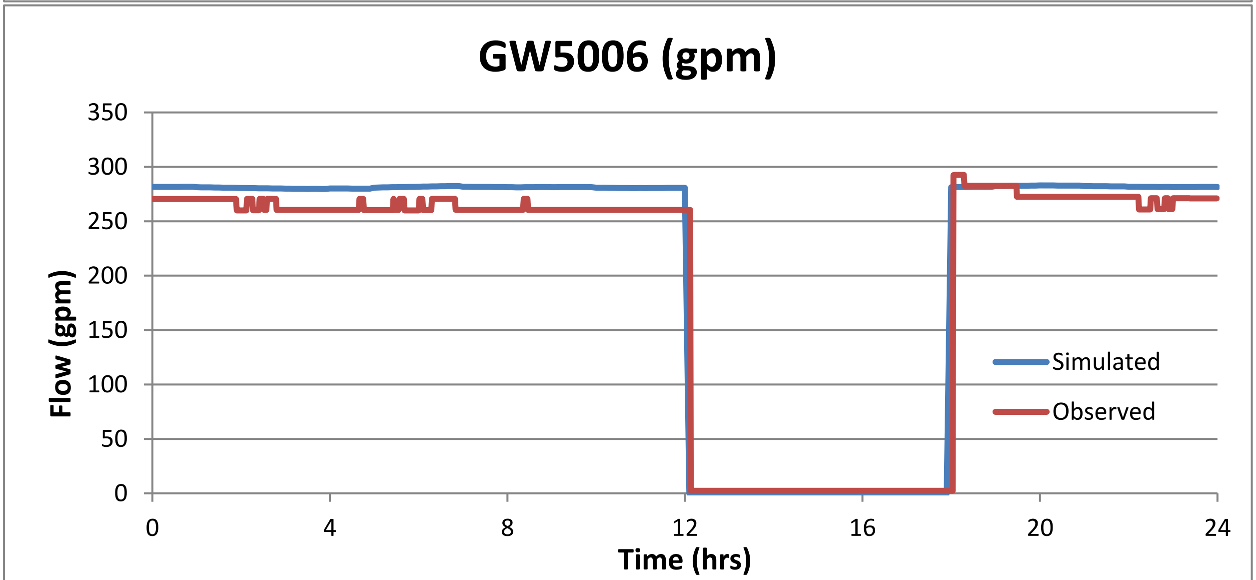

WELL No. 18-19 TANK LEVEL
16
14
12
10
8
6
4
2
0
Level (ft.)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

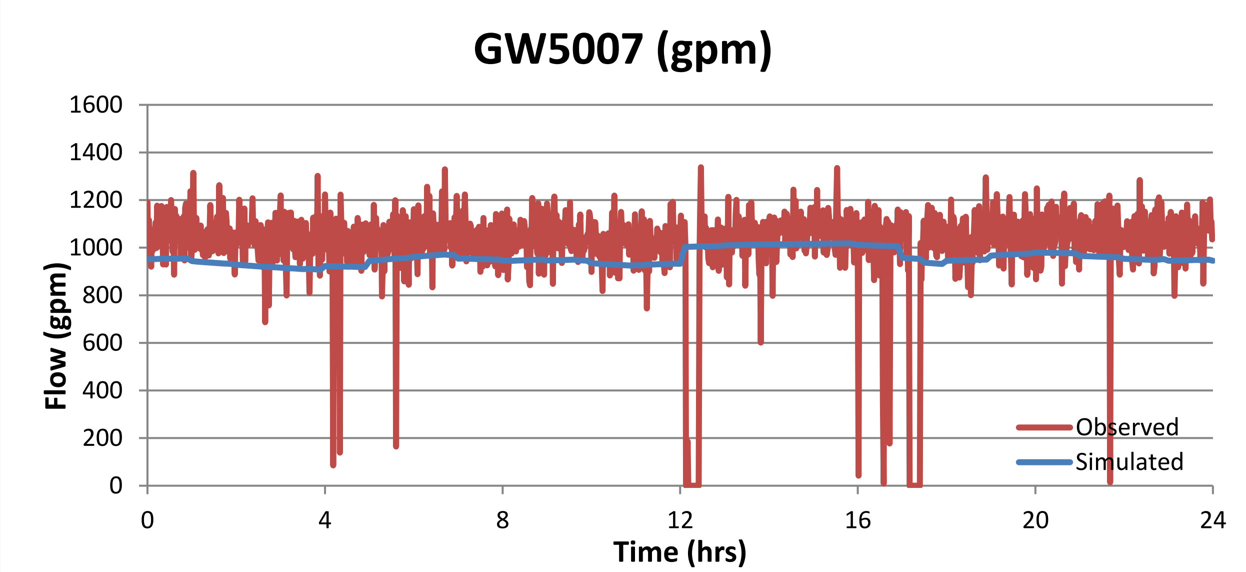

WELL 5 TANK LEVEL
14
12
10
8
6
4
2
0
Level (ft.)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

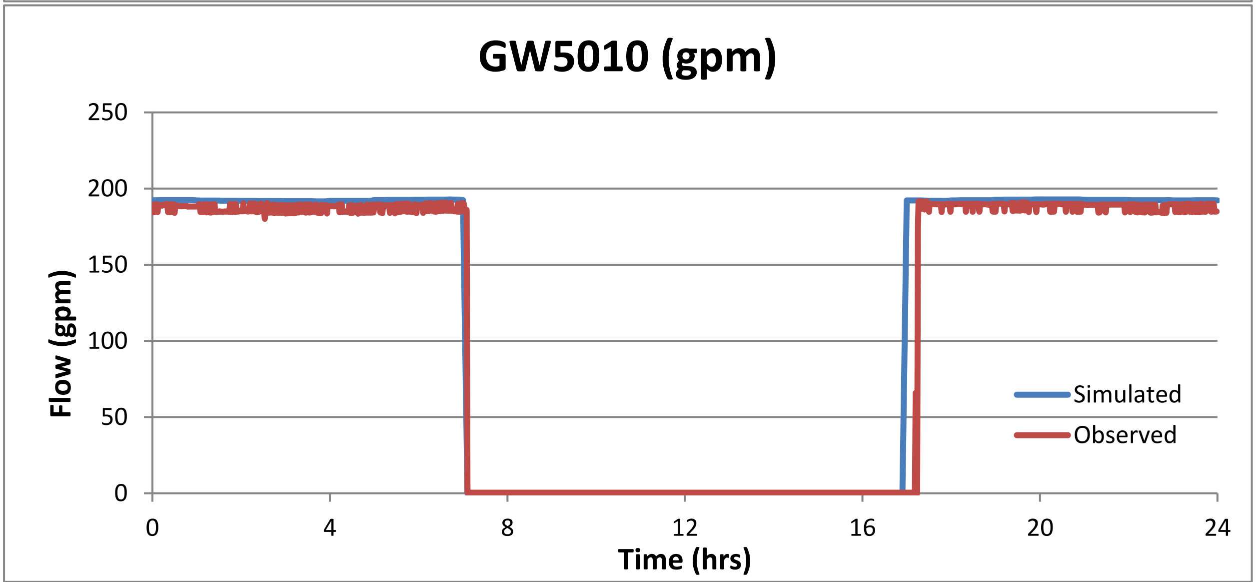
Well and Booster Pump Flows

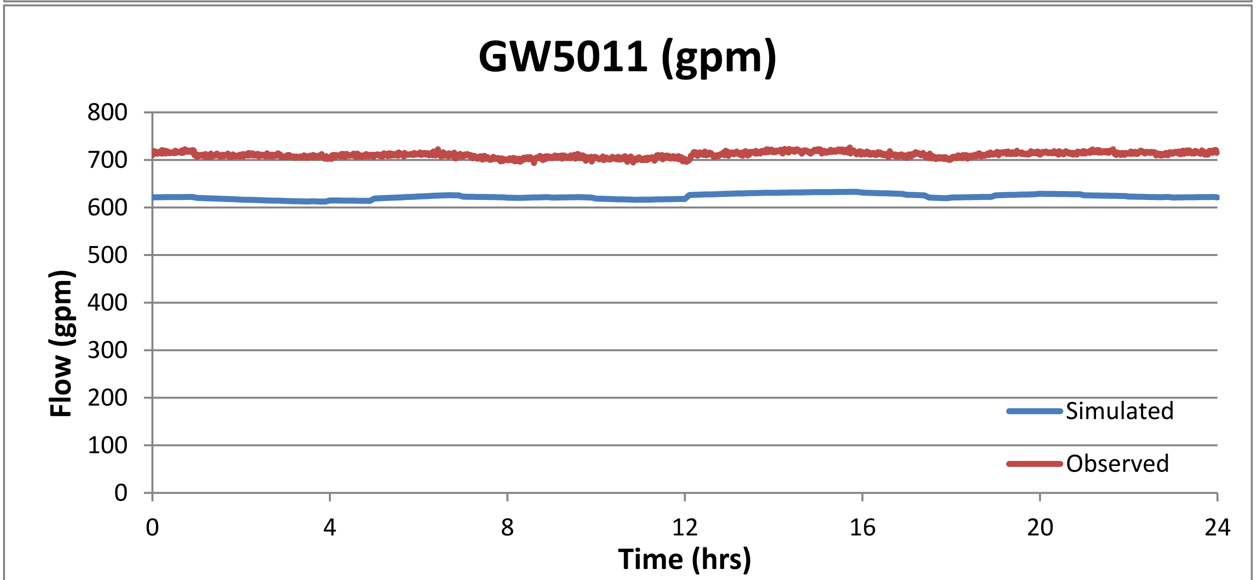


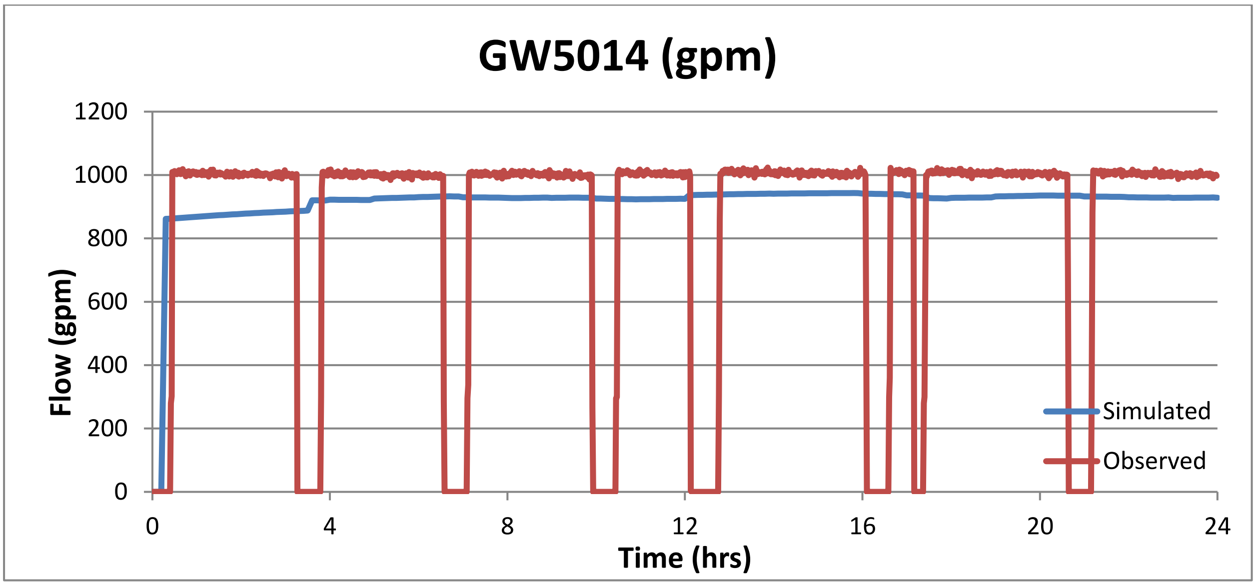


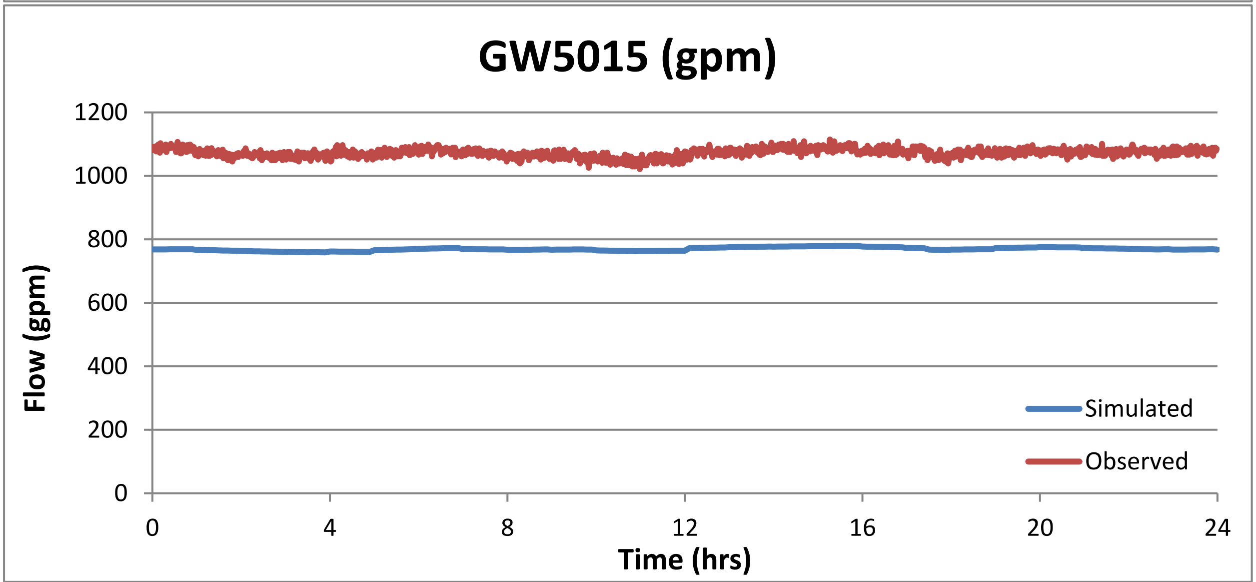


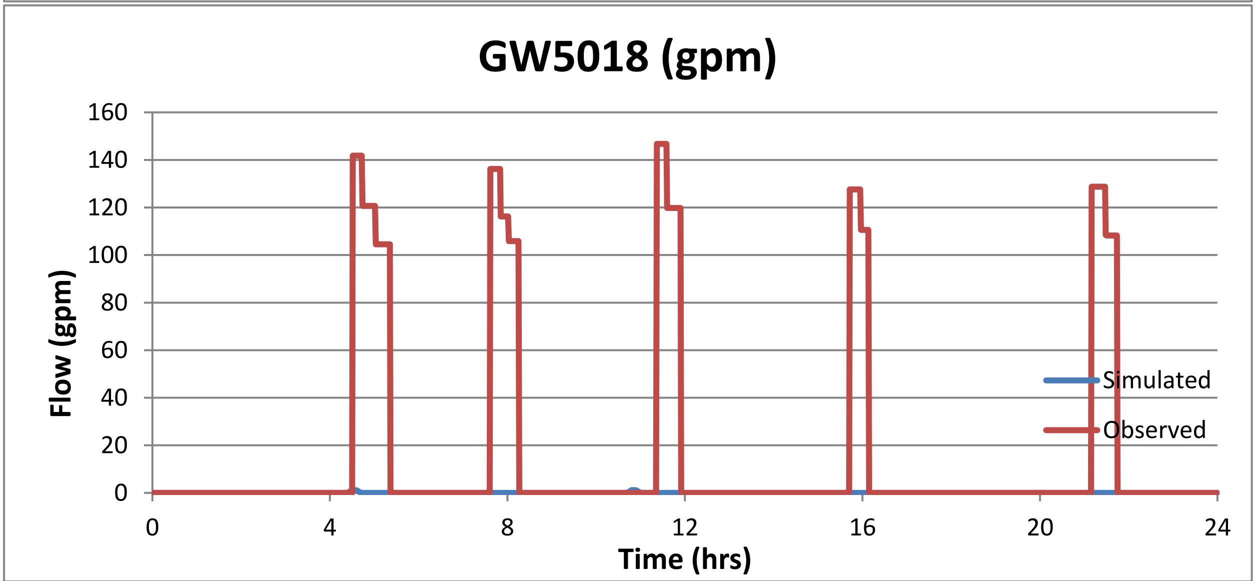

GW5007 (gpm)
Flow (gpm)
0
200
400
600
800
1000
1200
1400
1600
0
4
8
12
16
20
24
Time (hrs)
Observed
Simulated

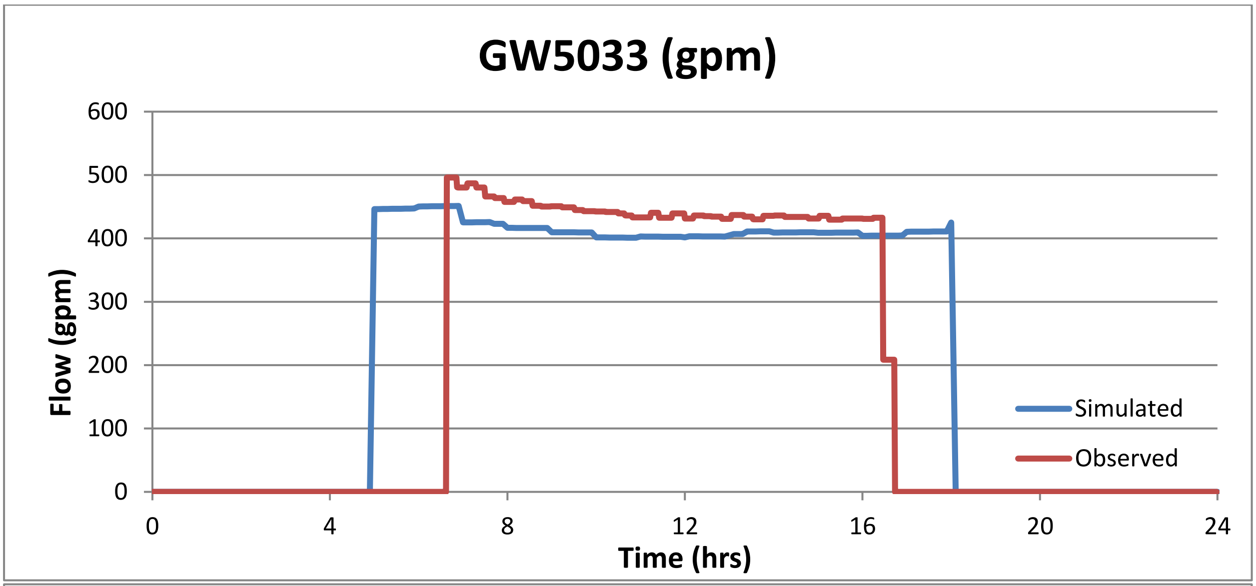

GW5010 (gpm)
Flow (gpm)
0
50
100
150
200
250
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

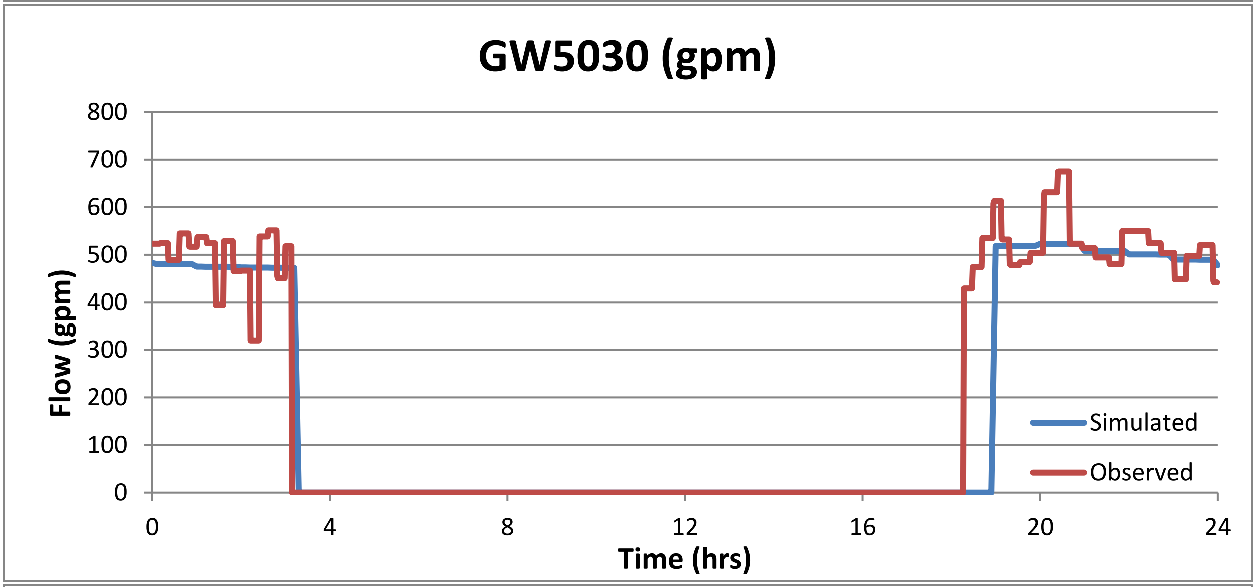

GW5011 (gpm)
Flow (gpm)
0
100
200
300
400
500
600
700
800
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

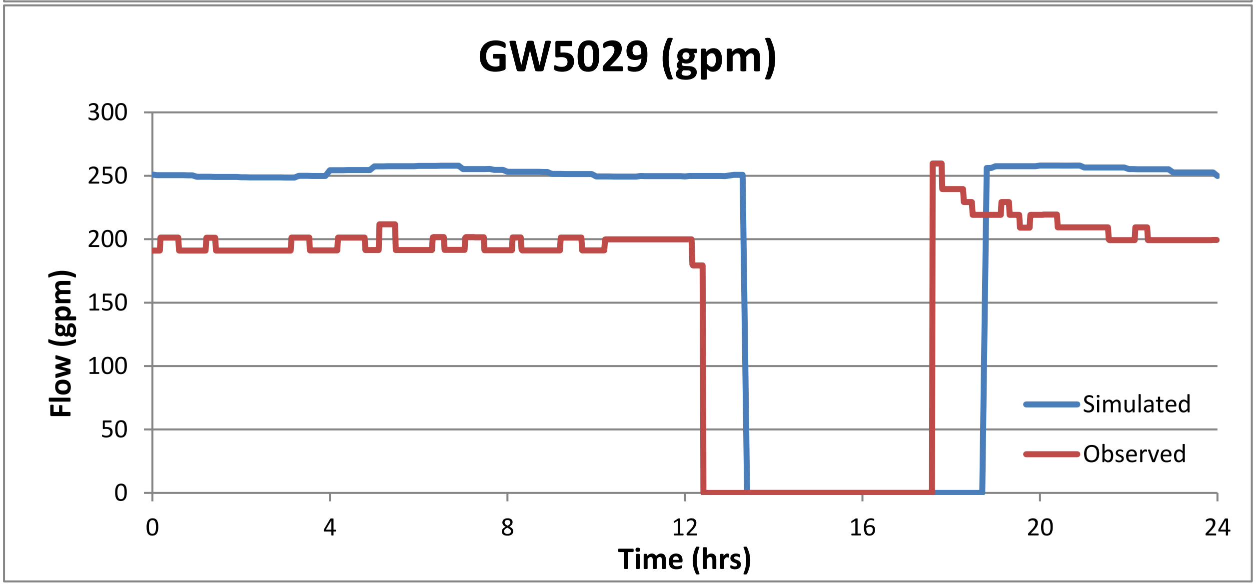

GW5014 (gpm)
Flow (gpm)
1200
1000
800
600
400
200
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

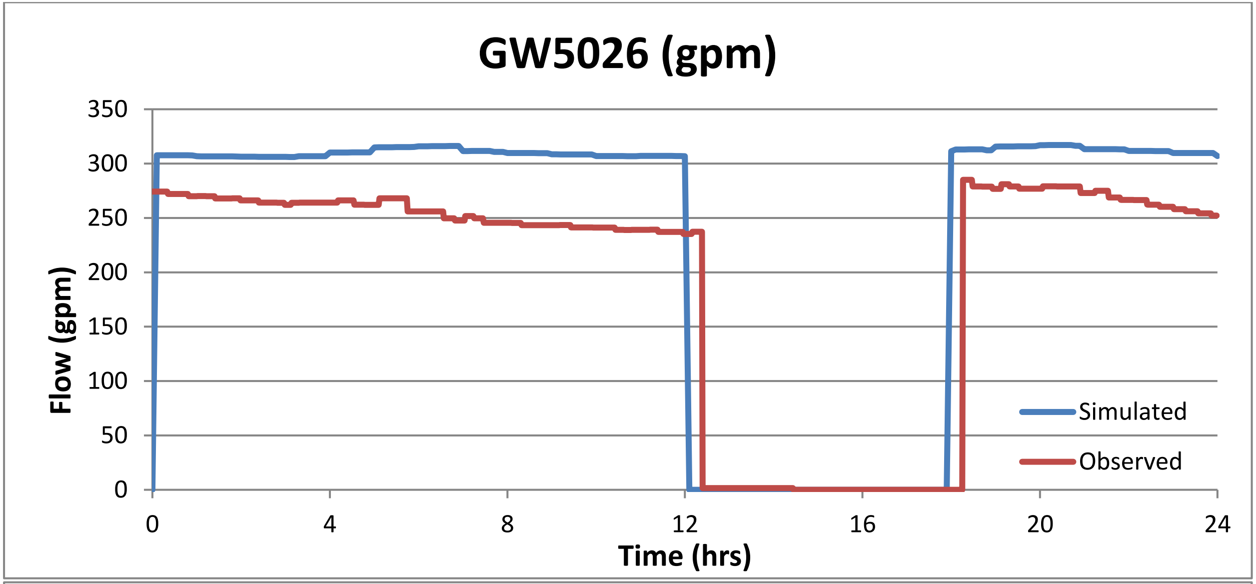

GW5015 (gpm)
Flow (gpm)
1200
1000
800
600
400
200
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

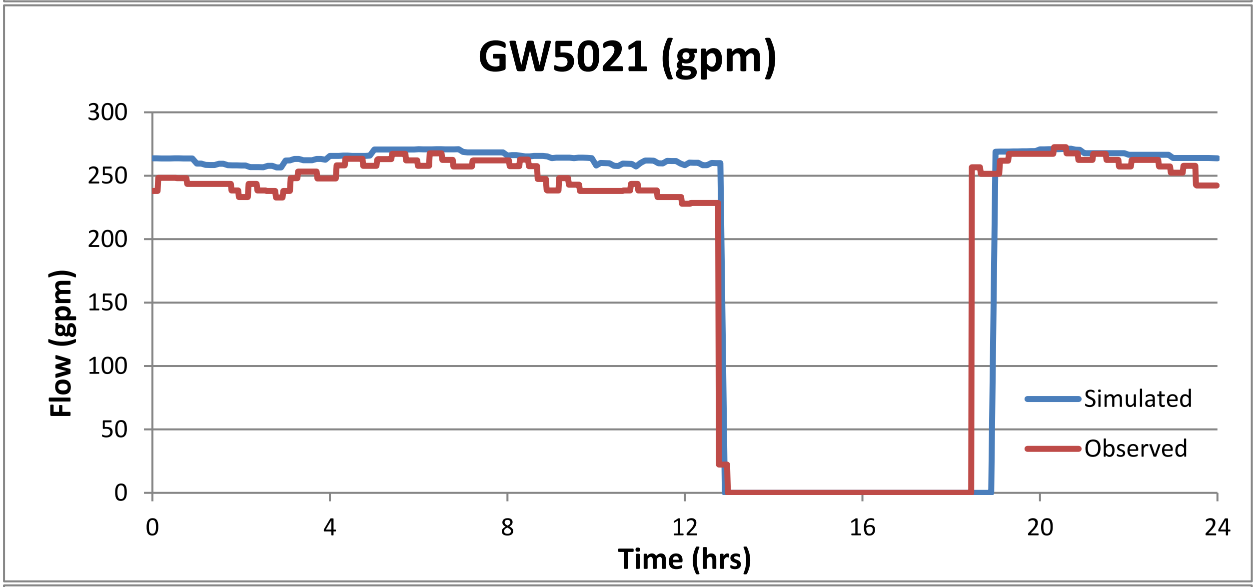

GW5018 (gpm)
Flow (gpm)
160
140
120
100
80
60
40
20
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

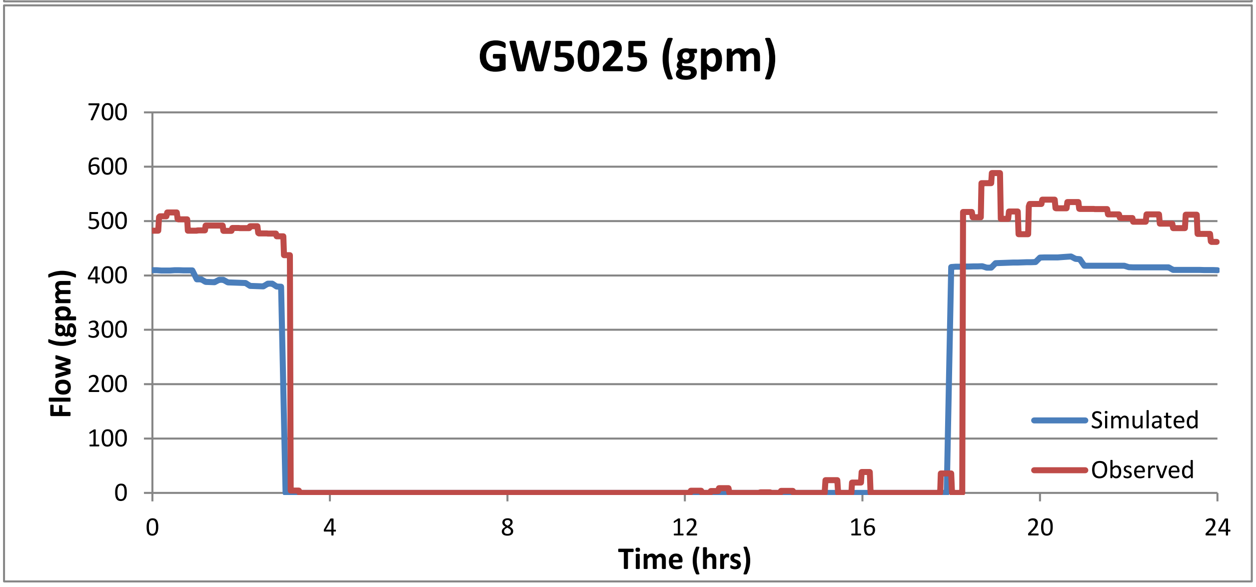

GW5033 (gpm)
Flow (gpm)
600
500
400
300
200
100
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

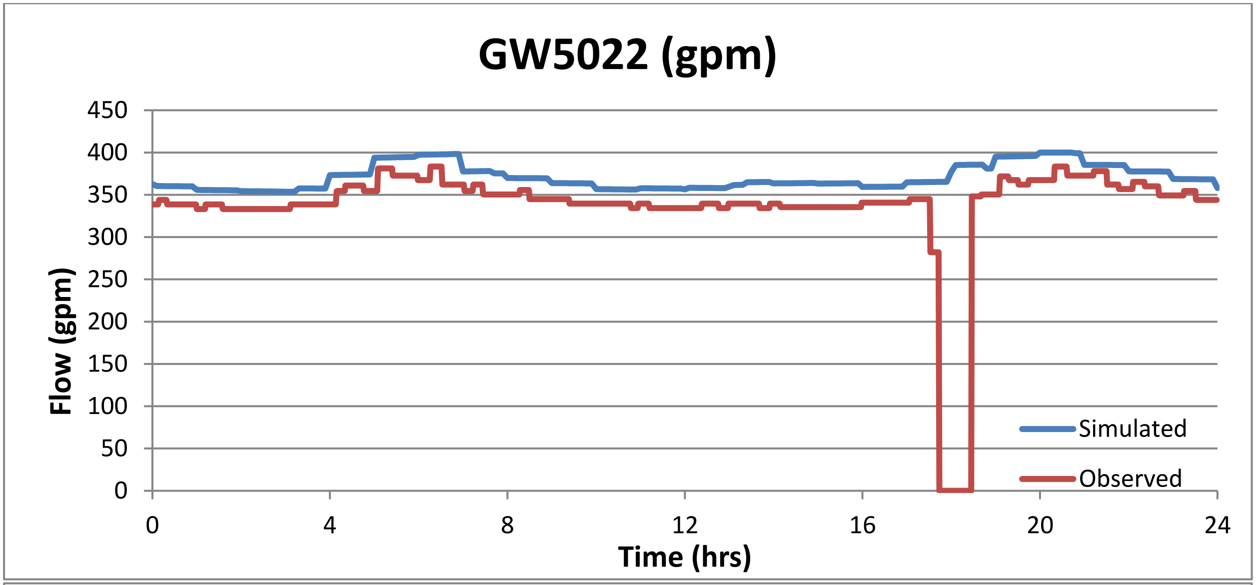

GW5030 (gpm)
Flow (gpm)
800
700
600
500
400
300
200
100
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

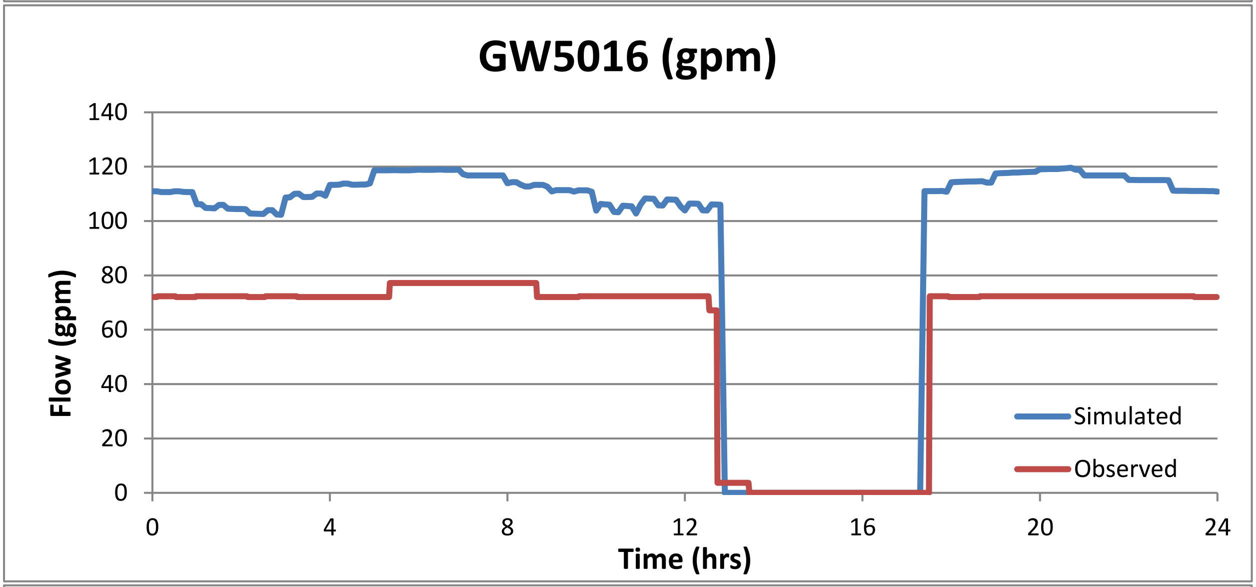

GW5029 (gpm)
Flow (gpm)
300
250
200
150
100
50
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

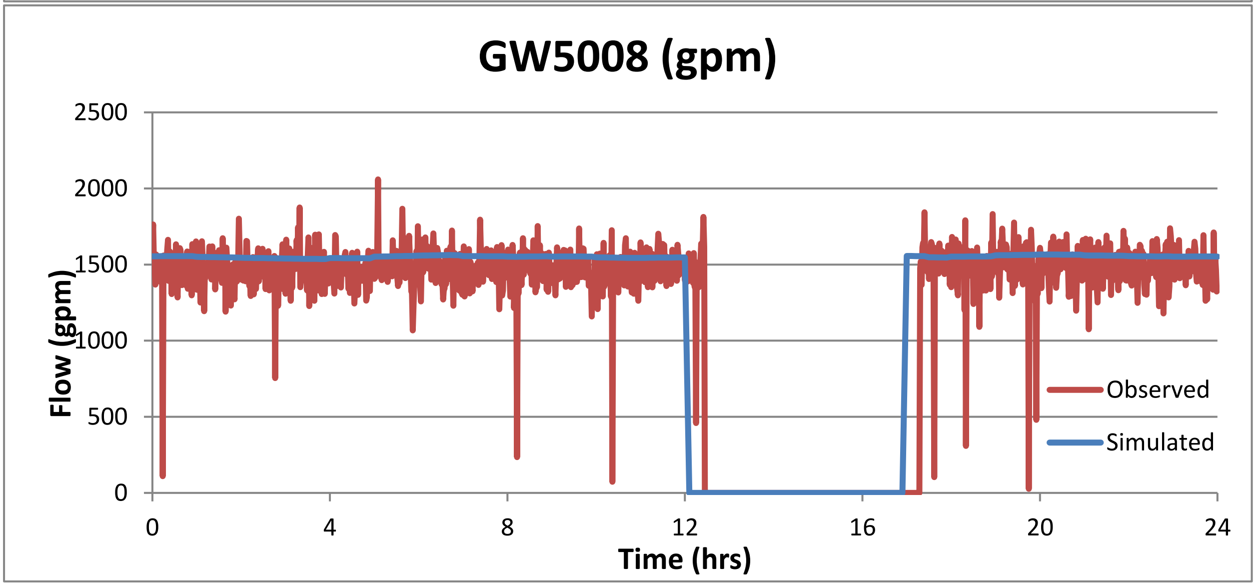

GW5026 (gpm)
Flow (gpm)
350
300
250
200
150
100
50
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

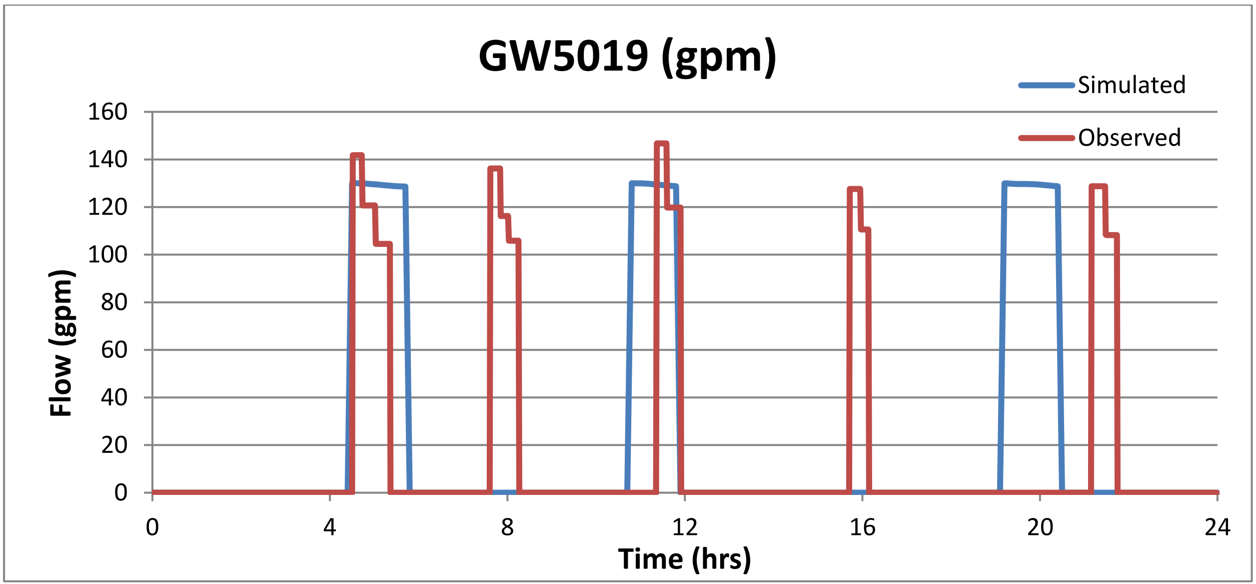

GW5021 (gpm)
Flow (gpm)
300
250
200
150
100
50
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

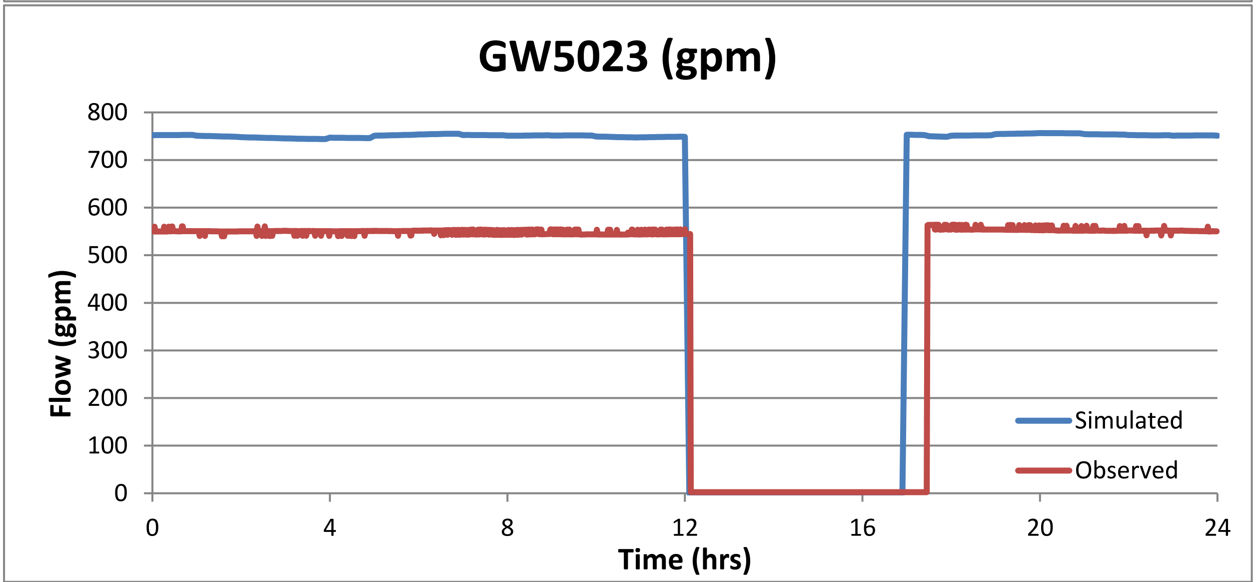

GW5025 (gpm)
Flow (gpm)
700
600
500
400
300
200
100
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

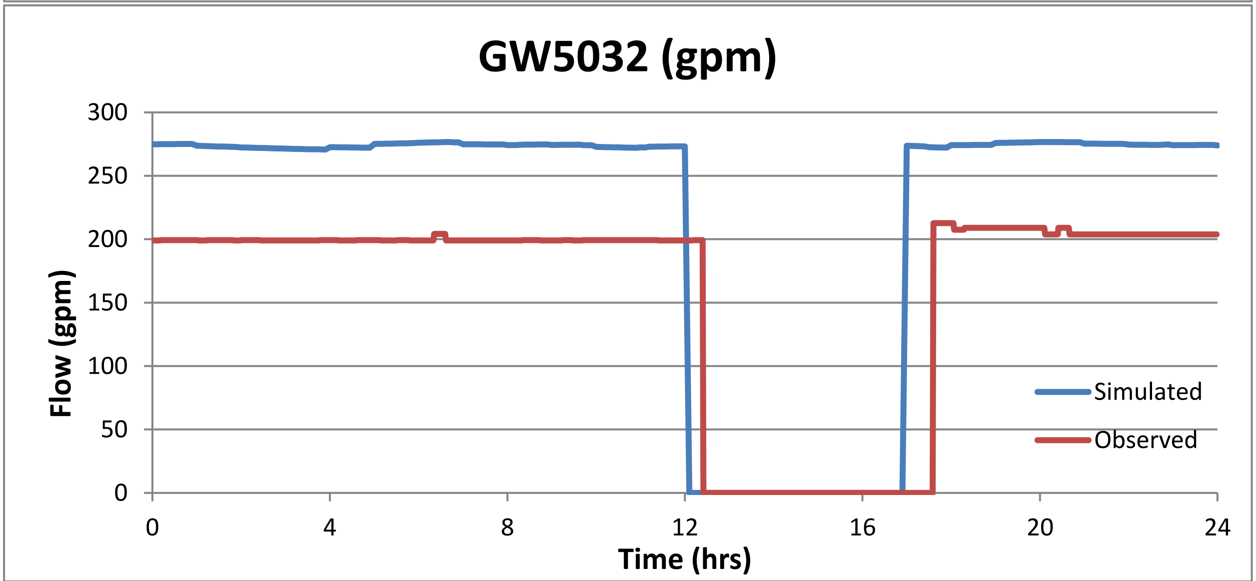

GW5022 (gpm)
Flow (gpm)
Time (hrs)
Simulated
Observed
450
400
350
300
250
200
150
100
50
0
0
4
8
12
16
20
24

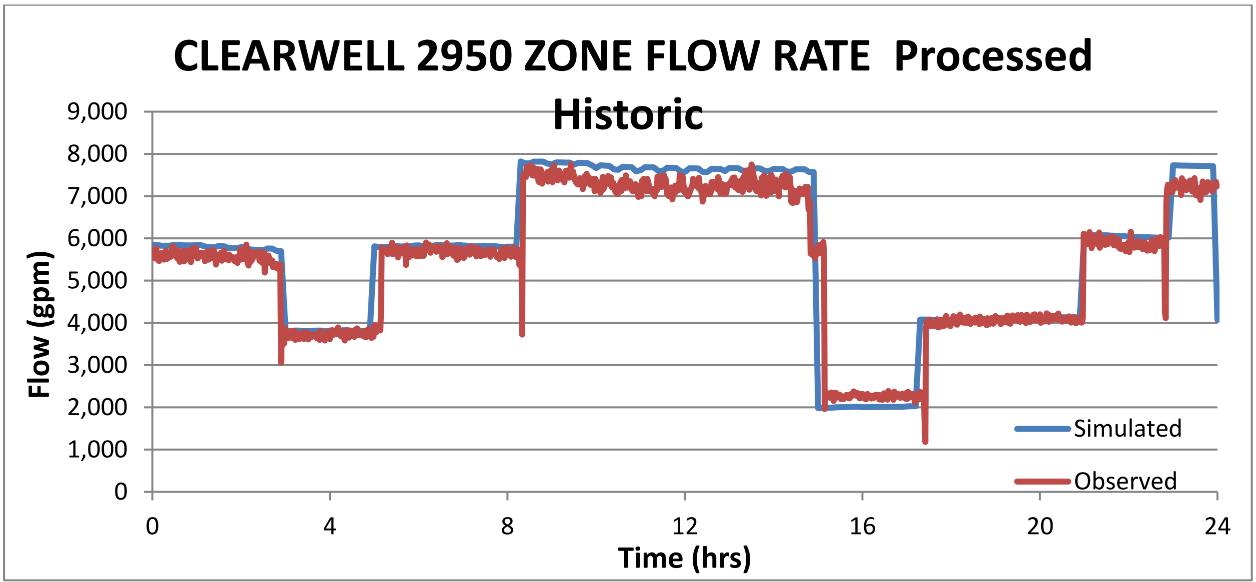

GW5016 (gpm)
Flow (gpm)
Time (hrs)
Simulated
Observed
140
120
100
80
60
40
20
0
0
4
8
12
16
20
24

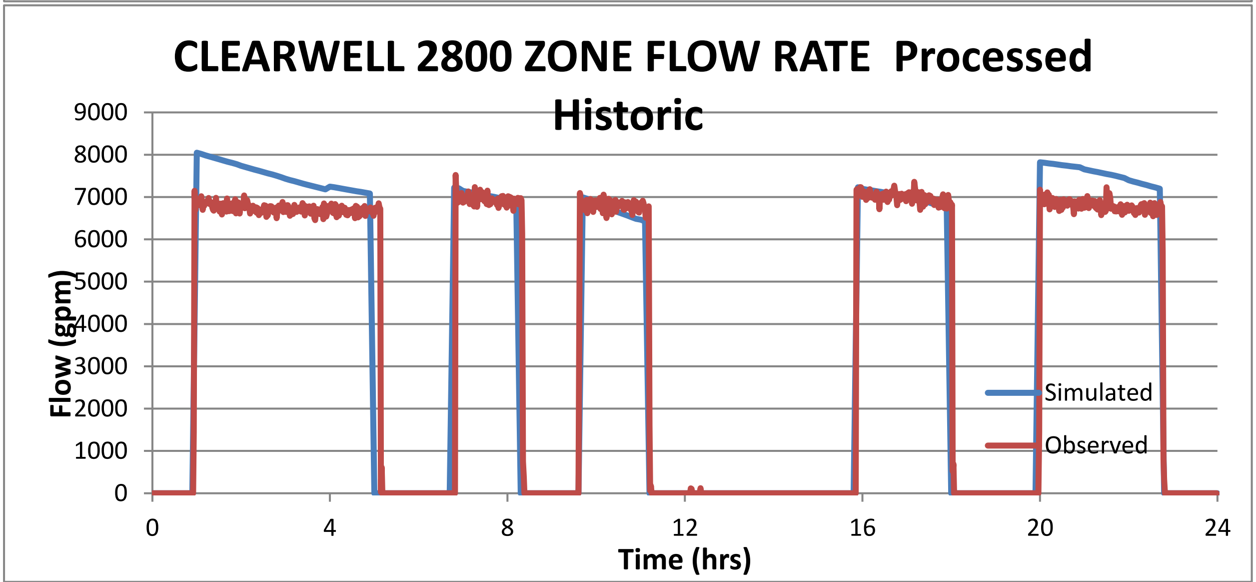

GW5008 (gpm)
Flow (gpm)
Time (hrs)
Observed
Simulated
2500
2000
1500
1000
500
0
0
4
8
12
16
20
24

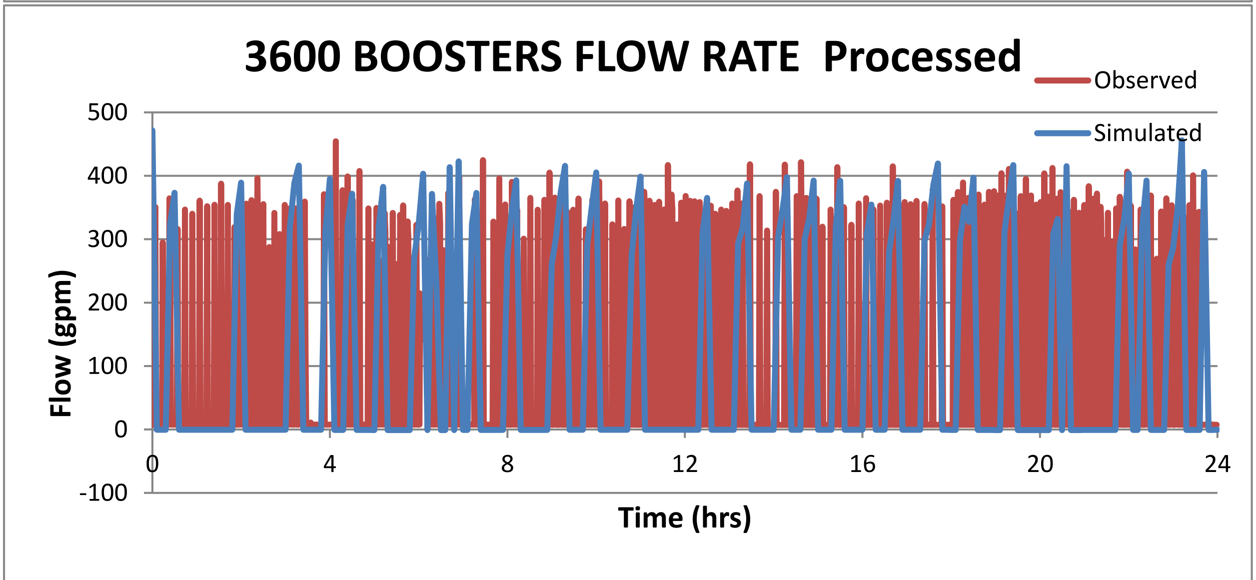

GW5019 (gpm)
Simulated
Observed
Flow (gpm)
160
140
120
100
80
60
40
20
0
0
4
8
12
16
20
24
Time (hrs)

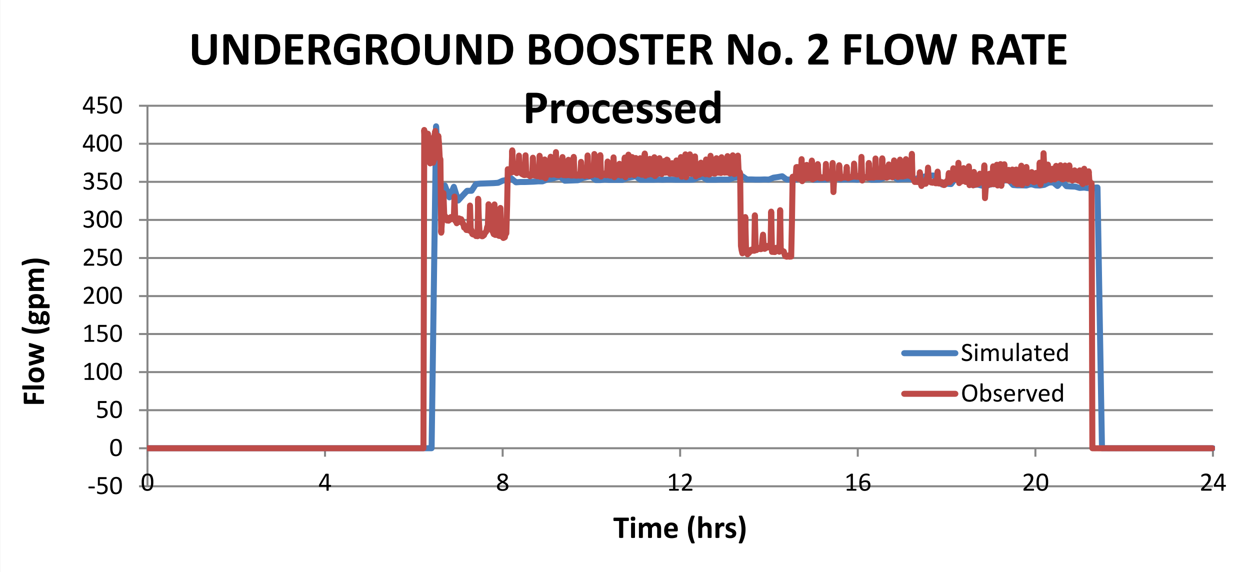

GW5023 (gpm)
Flow (gpm)
800
700
600
500
400
300
200
100
0
Simulated
Observed
0
4
8
12
16
20
24
Time (hrs)

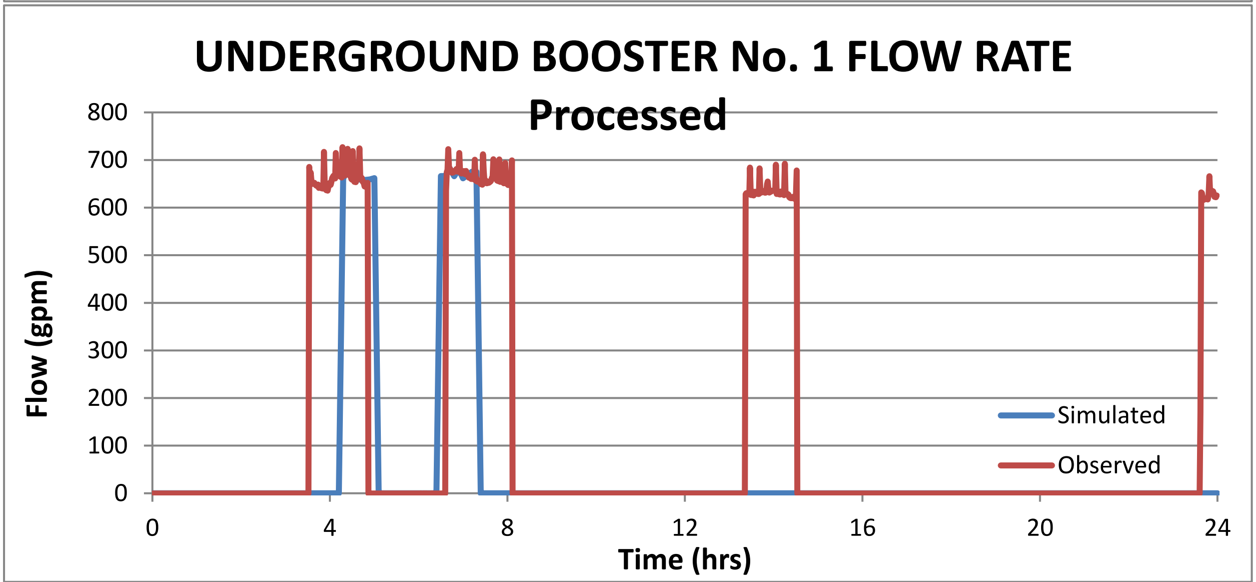

GW5032 (gpm)
Flow (gpm)
300
250
200
150
100
50
0
Simulated
Observed
0
4
8
12
16
20
24
Time (hrs)

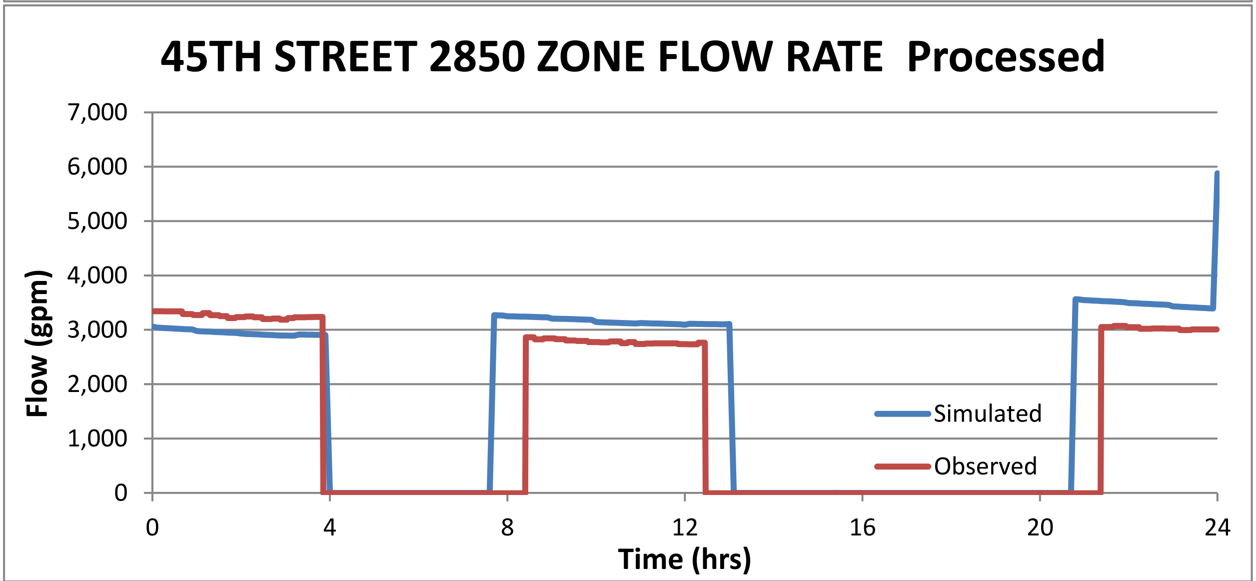

CLEARWELL 2950 ZONE FLOW RATE Processed Historic
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Flow (gpm)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

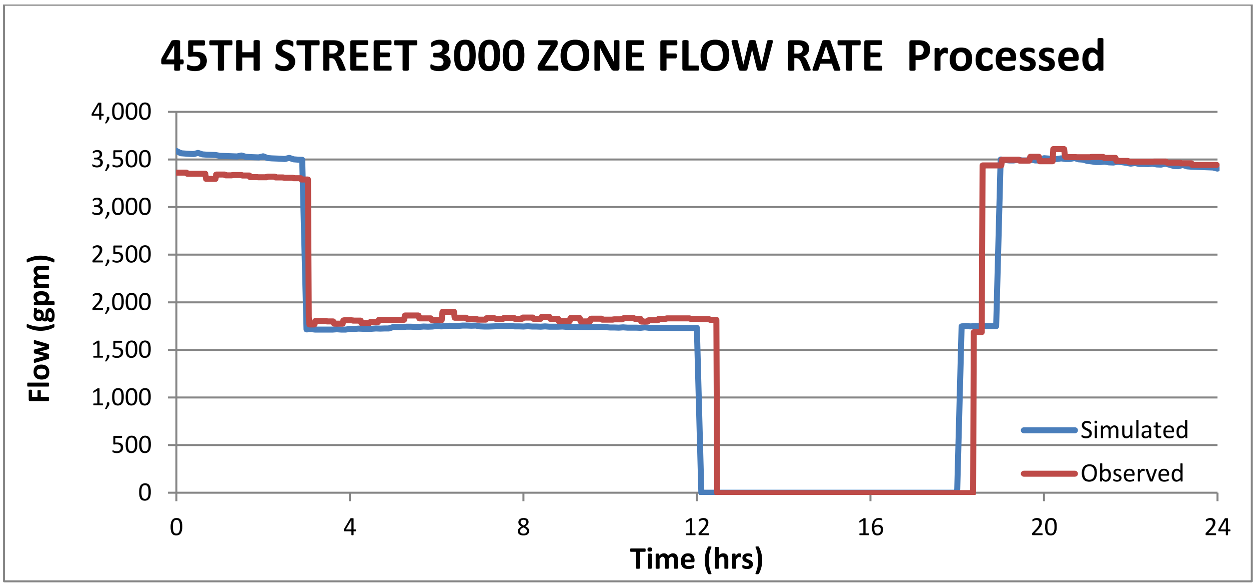

CLEARWELL 2800 ZONE FLOW RATE Processed Historic
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Flow (gpm)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed


3600 BOOSTERS FLOW RATE Processed
Observed
Simulated
500
400
300
200
100
0
-100
Flow (gpm)
0
4
8
12
16
20
24
Time (hrs)

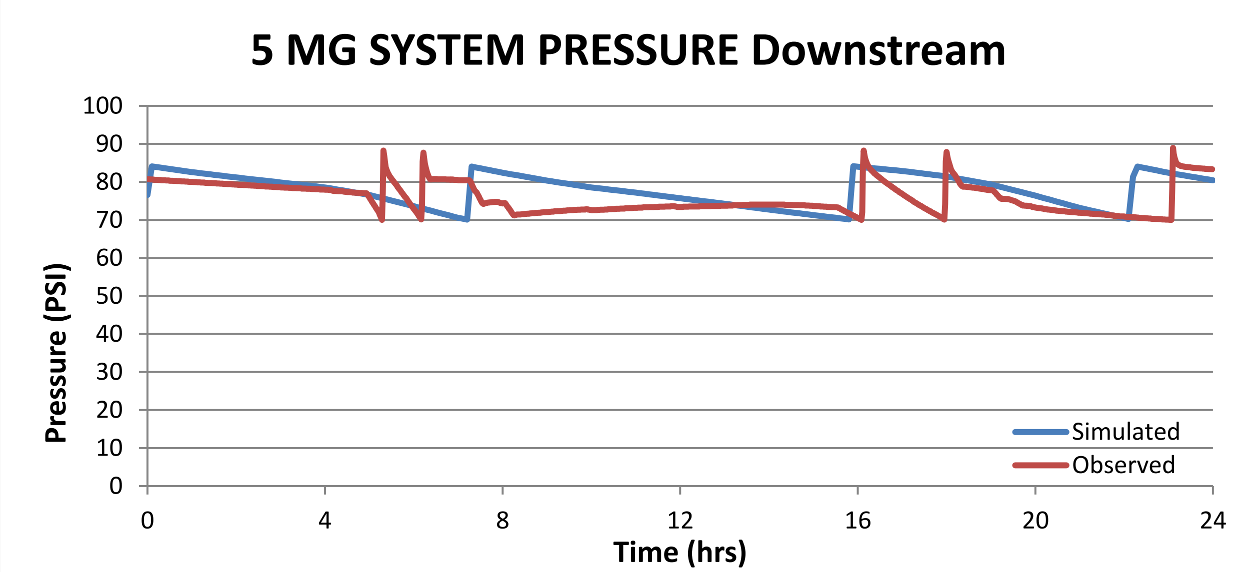

UNDERGROUND BOOSTER No. 2 FLOW RATE Processed
450
400
350
300
250
200
150
100
50
0
-50
Flow (gpm)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

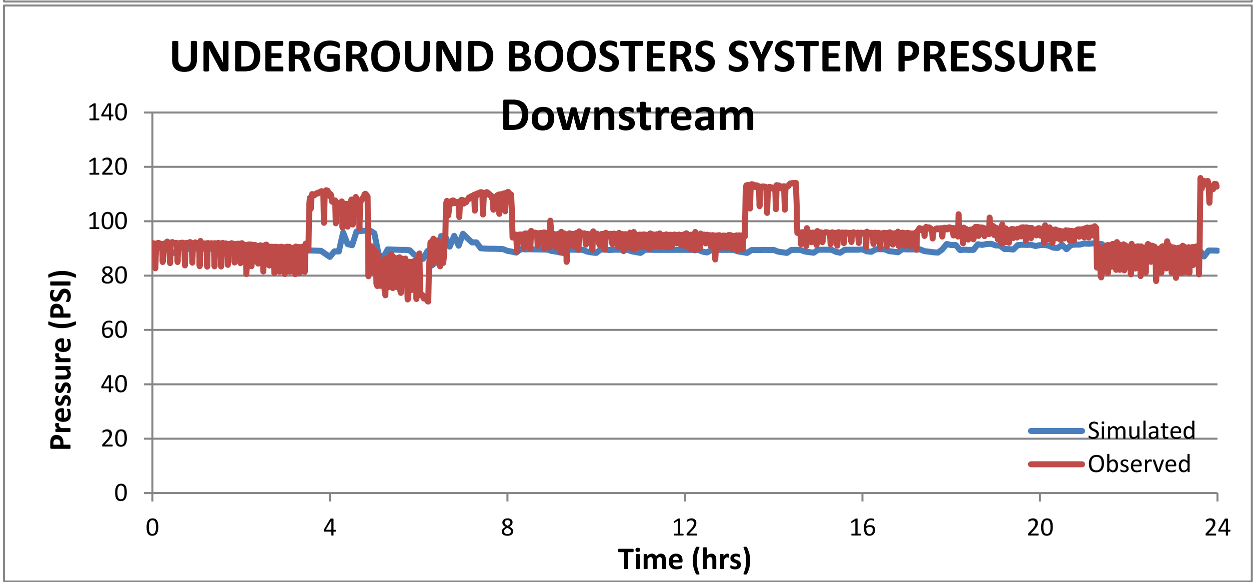

UNDERGROUND BOOSTER No. 1 FLOW RATE Processed
800
700
600
500
400
300
200
100
0
Flow (gpm)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

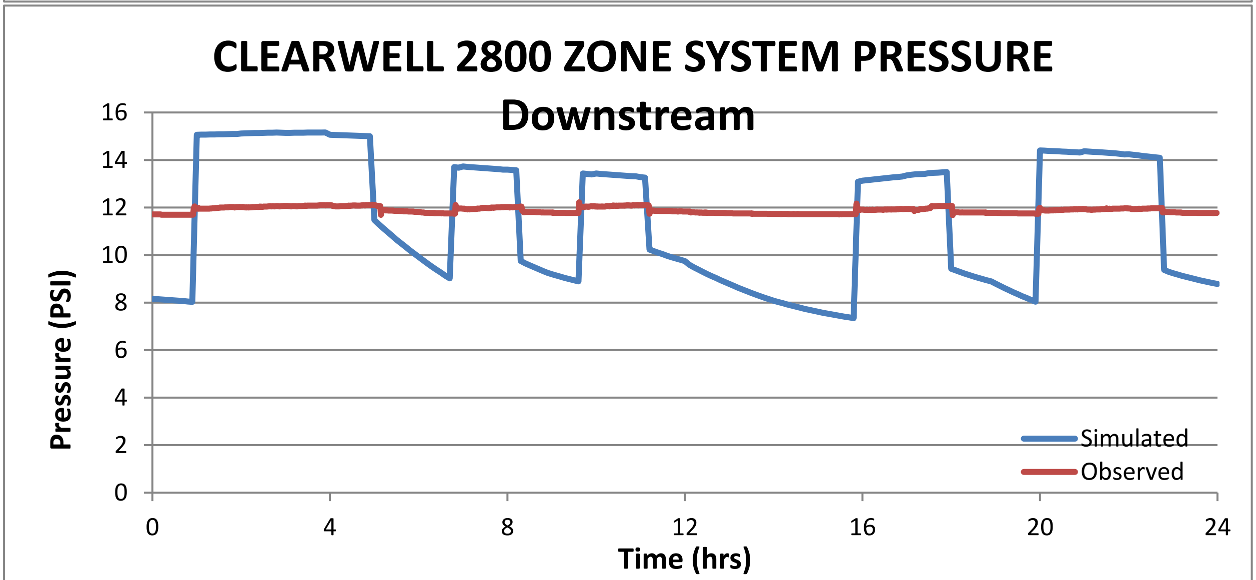

45TH STREET 2850 ZONE FLOW RATE Processed
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Flow (gpm)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

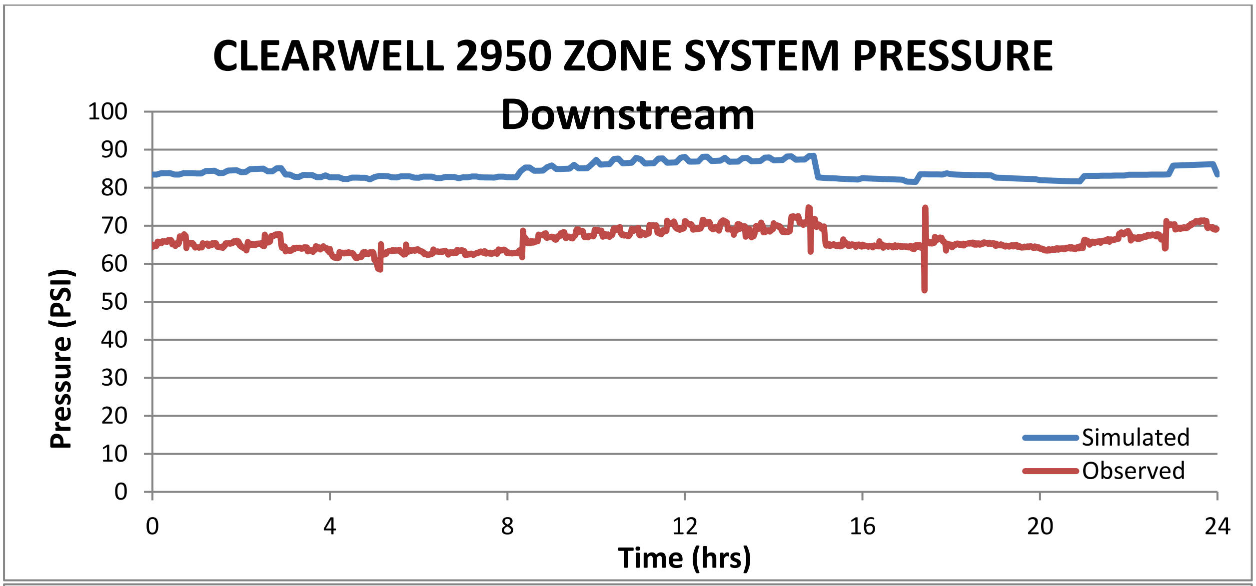

45TH STREET 3000 ZONE FLOW RATE Processed
Flow (gpm)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

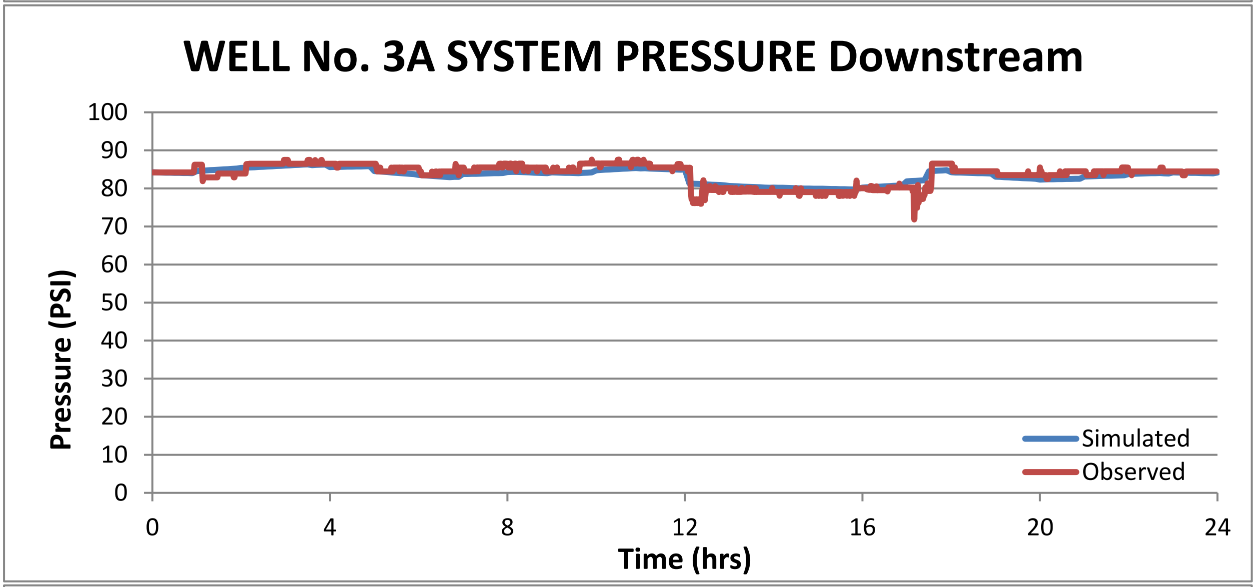
Pressure Levels

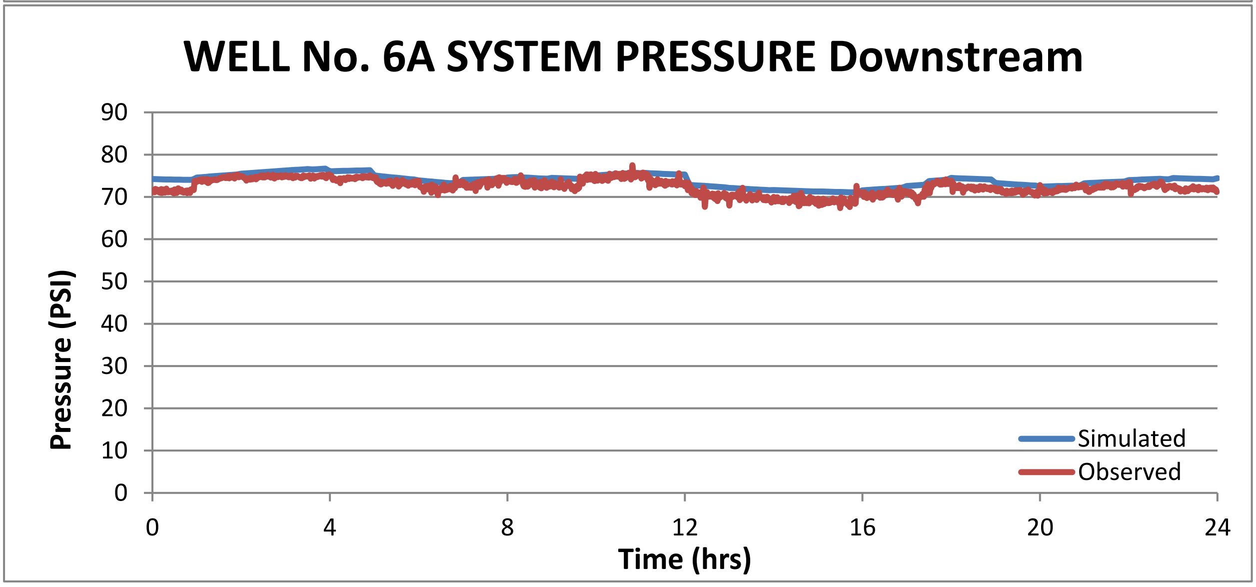


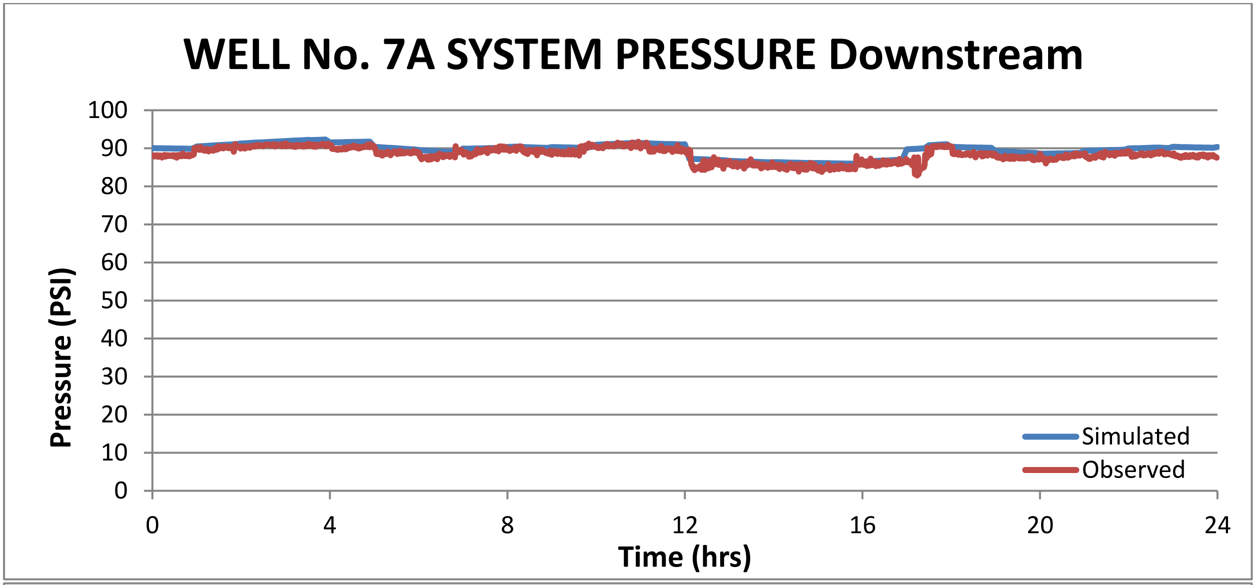


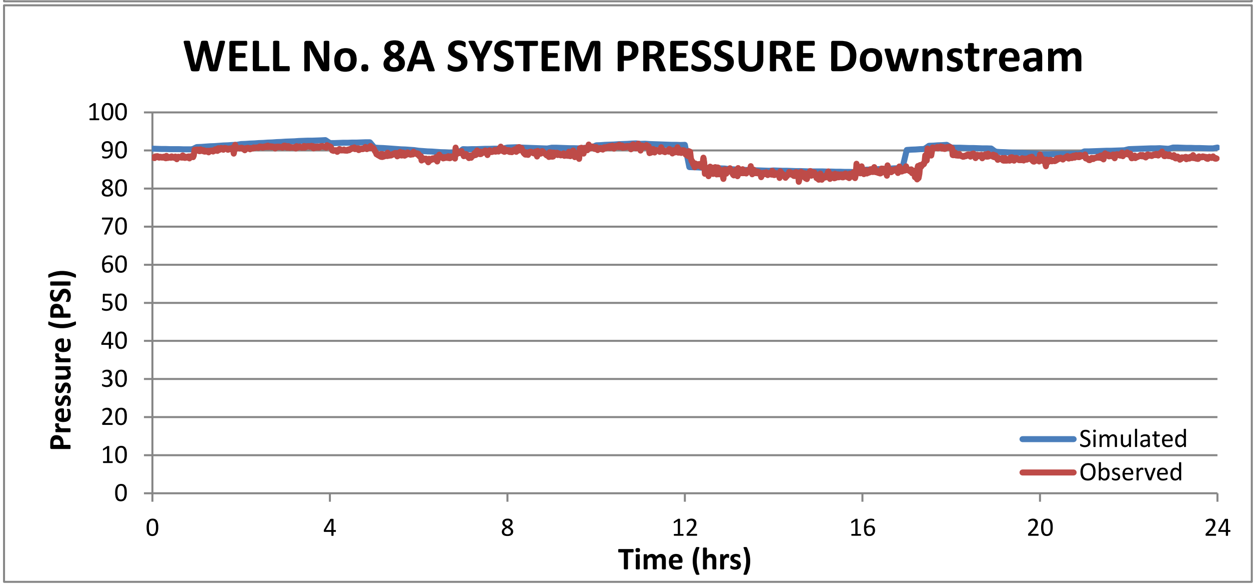


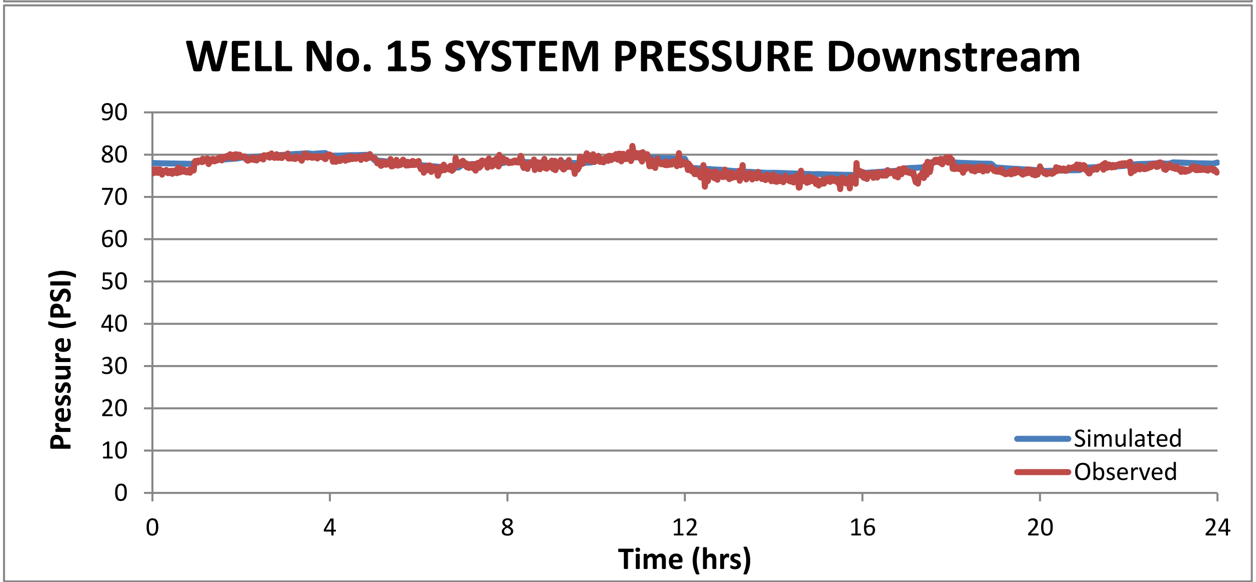

CLEARWELL 2950 ZONE SYSTEM PRESSURE Downstream
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

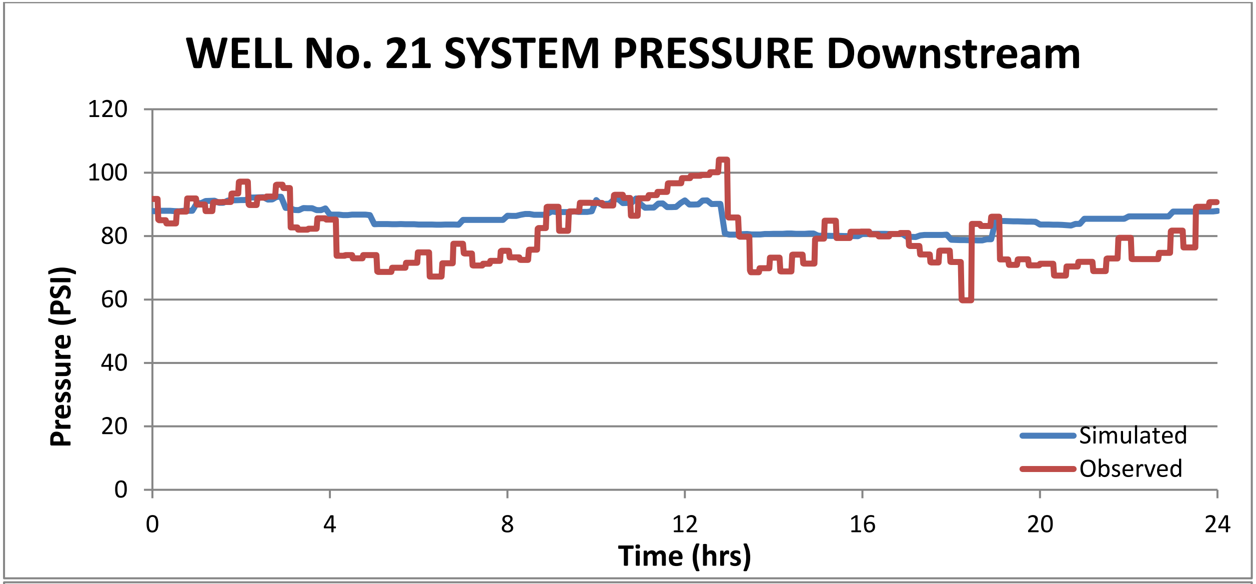

WELL No. 3A SYSTEM PRESSURE Downstream
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

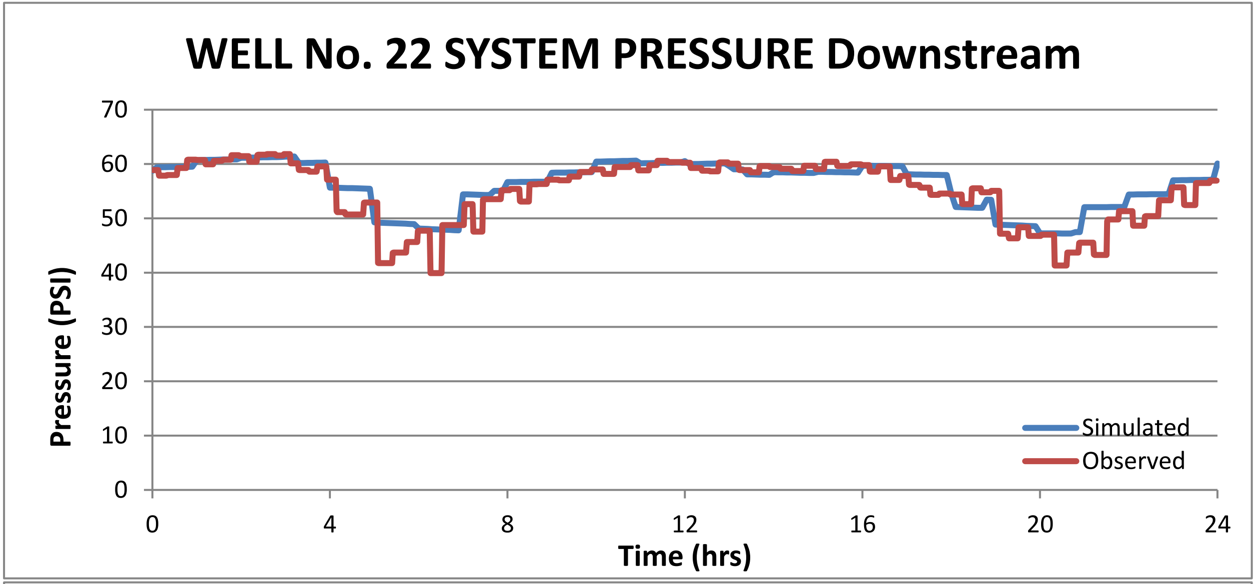

WELL No. 6A SYSTEM PRESSURE Downstream
Pressure (PSI)
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

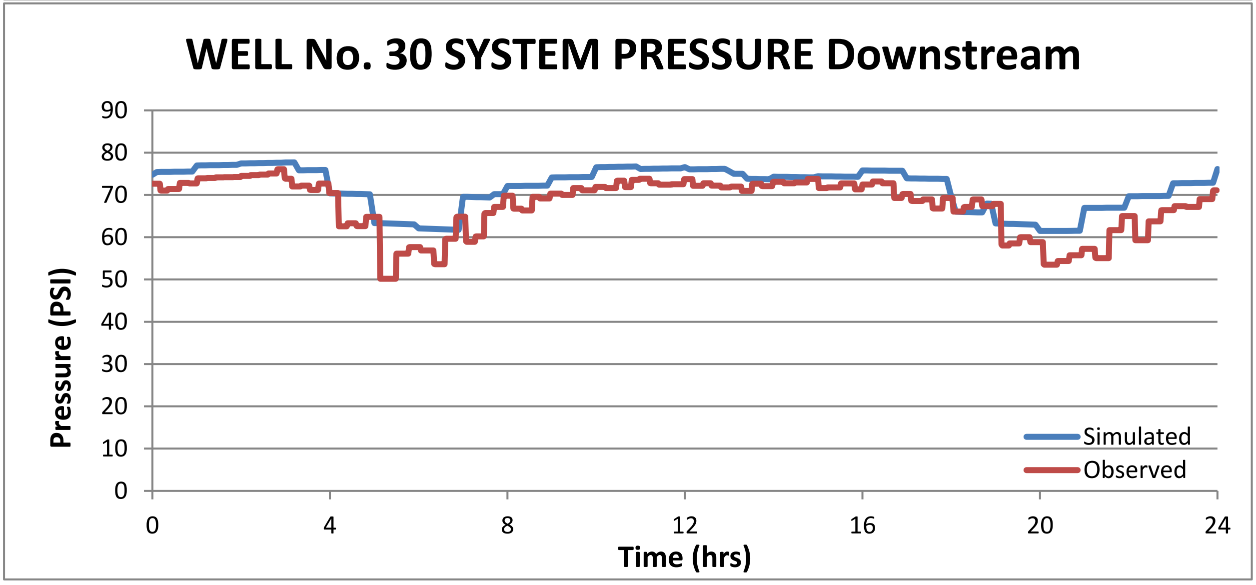

WELL No. 7A SYSTEM PRESSURE Downstream
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

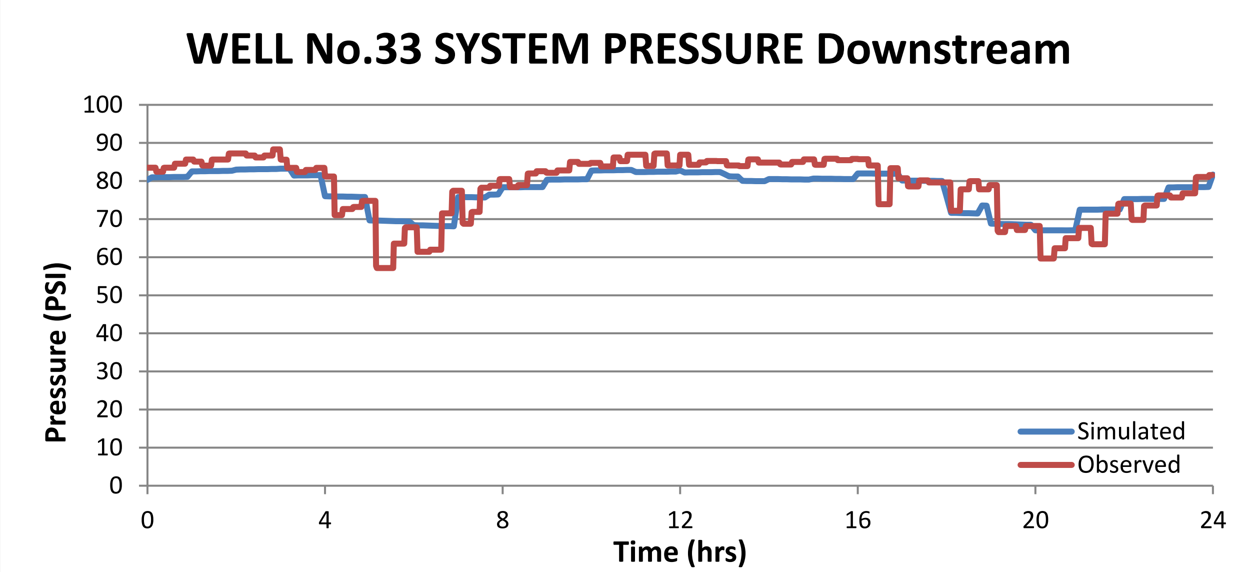

WELL No. 8A SYSTEM PRESSURE Downstream
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

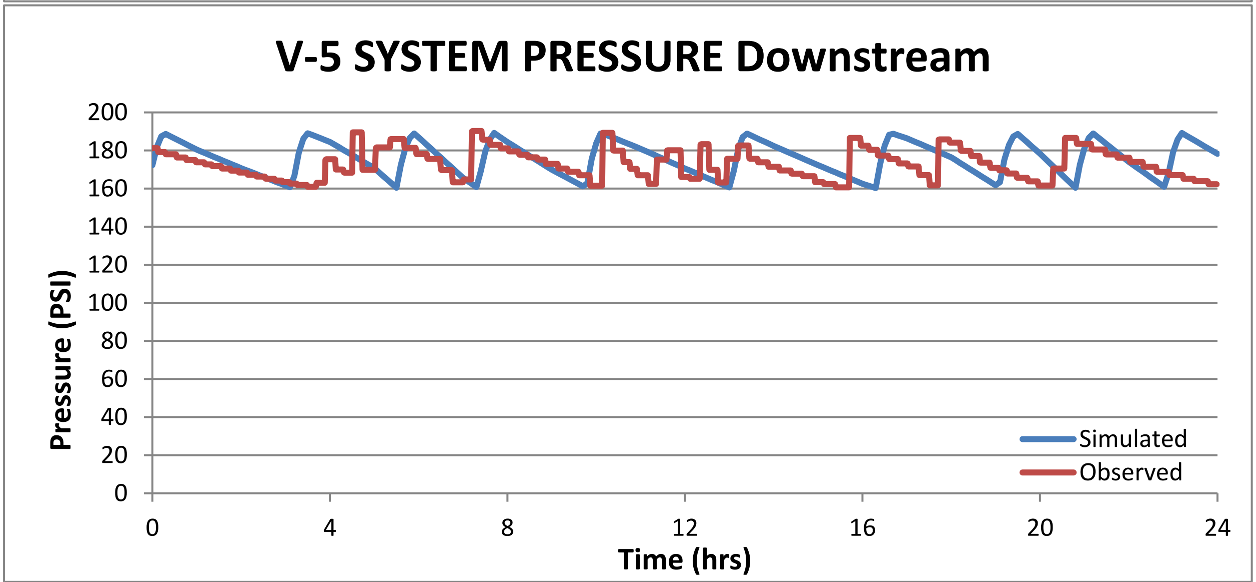

WELL No. 15 SYSTEM PRESSURE Downstream
Pressure (PSI)
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

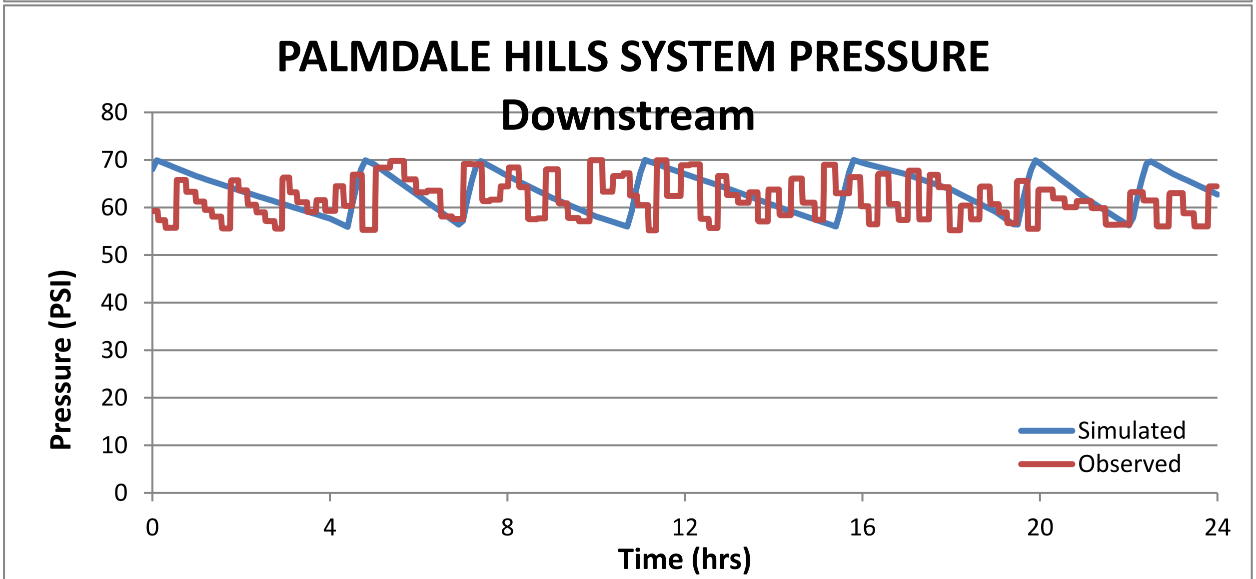

WELL No. 21 SYSTEM PRESSURE Downstream
Pressure (PSI)
120
100
80
60
40
20
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

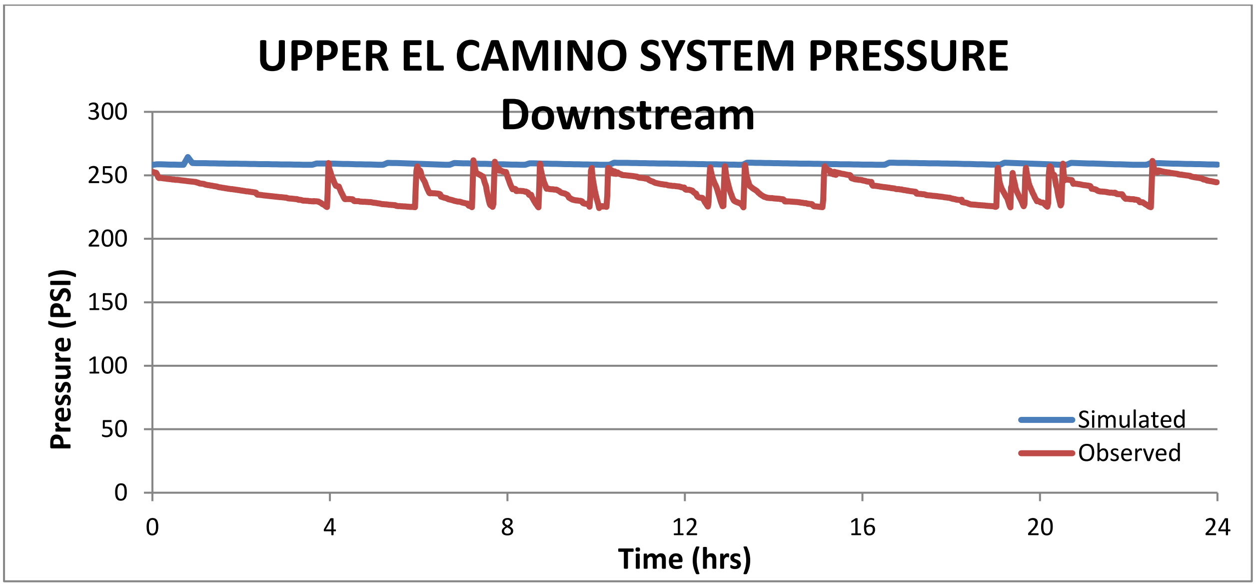

WELL No. 22 SYSTEM PRESSURE Downstream
Pressure (PSI)
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

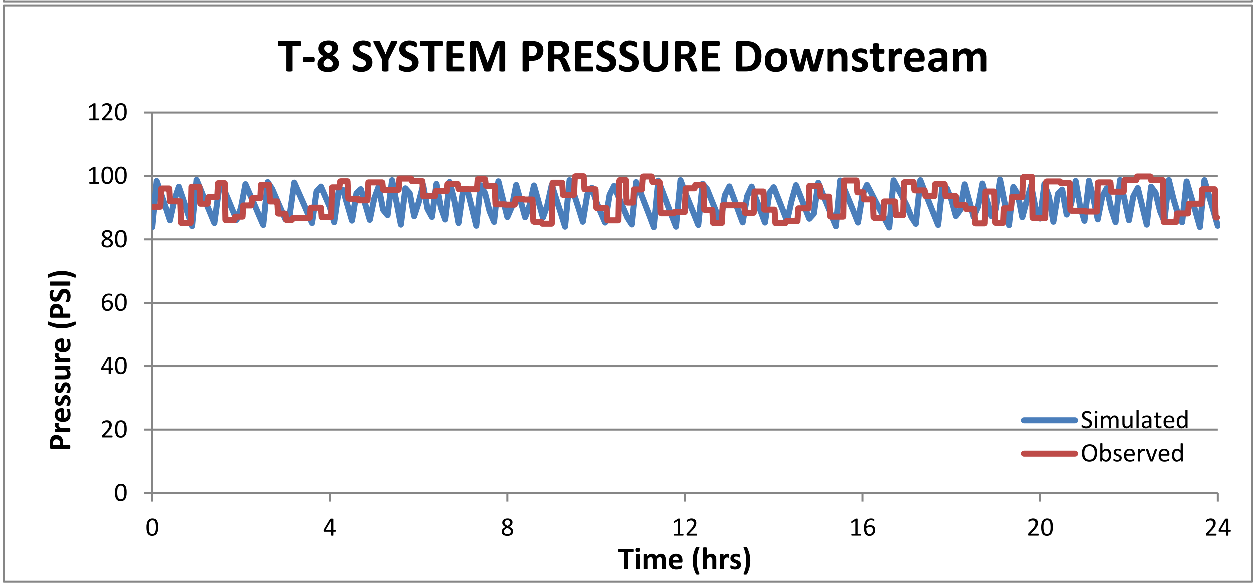

WELL No. 30 SYSTEM PRESSURE Downstream
Pressure (PSI)
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

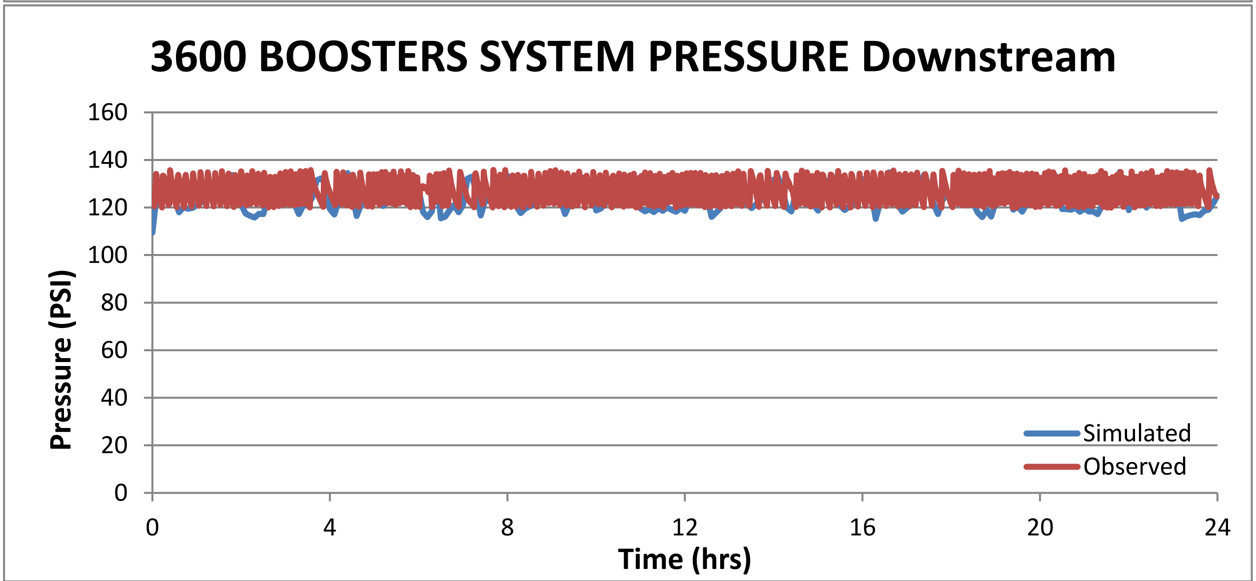

WELL No.33 SYSTEM PRESSURE Downstream
100
90
80
70
60
50
40
30
20
10
0
Pressure (PSI)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

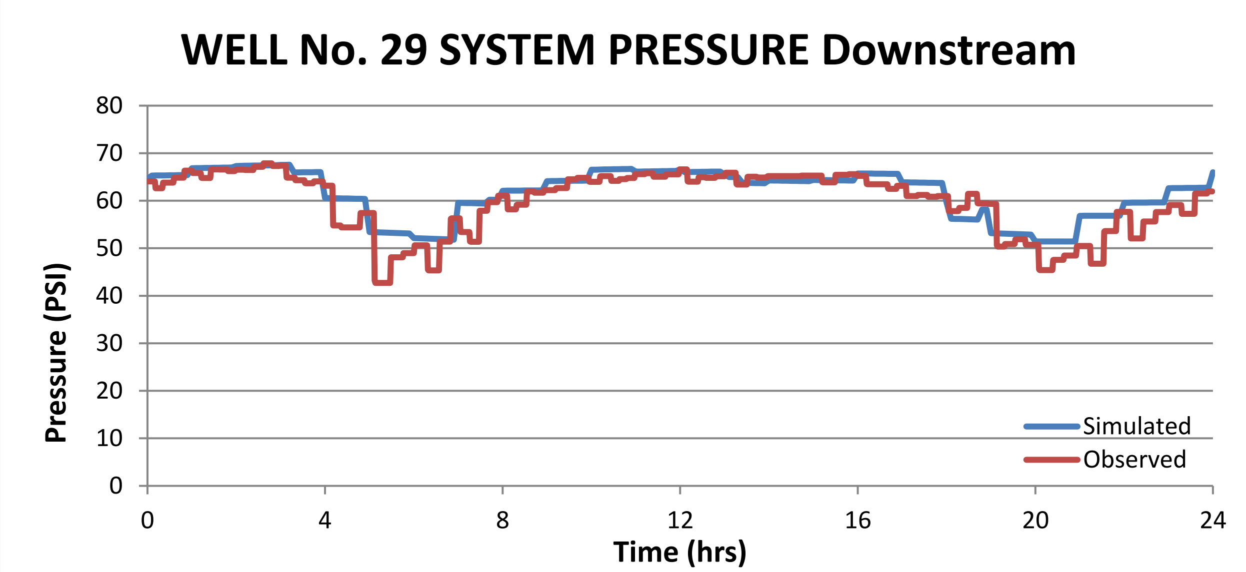

V-5 SYSTEM PRESSURE Downstream
200
180
160
140
120
100
80
60
40
20
0
Pressure (PSI)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

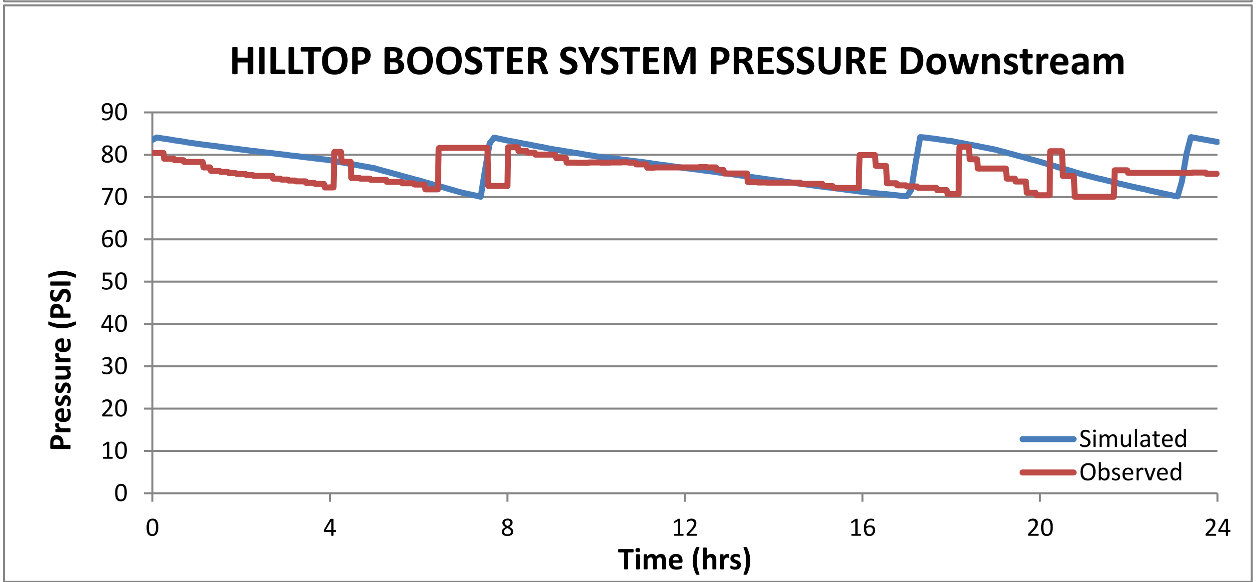

PALMDALE HILLS SYSTEM PRESSURE Downstream
80
70
60
50
40
30
20
10
0
Pressure (PSI)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed


UPPER EL CAMINO SYSTEM PRESSURE Downstream
300
250
200
150
100
50
0
Pressure (PSI)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed


T-8 SYSTEM PRESSURE Downstream
120
100
80
60
40
20
0
Pressure (PSI)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed


3600 BOOSTERS SYSTEM PRESSURE Downstream
160
140
120
100
80
60
40
20
0
Pressure (PSI)
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed


WELL No. 29 SYSTEM PRESSURE Downstream
Pressure (PSI)
0
10
20
30
40
50
60
70
80
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed


HILLTOP BOOSTER SYSTEM PRESSURE Downstream
Pressure (PSI)
0
10
20
30
40
50
60
70
80
90
0
4
8
12
16
20
24
Time (hrs)
Simulated
Observed

APPENDIX E: CAPACITY BASED CAPITAL IMPROVEMENTS

E.1 Pipeline Projects by Zone

This section details the length of pipeline broken down over the twelve pressure zones and categorized by the purpose of improvement. Pipelines are categorized by zone based on total length in feet for each diameter size, and then subsequently categorized by cost based on the pipeline cost tables shown previously in Chapter 10. Multizone pipelines were categorized by zone based on total length and cost. Other tables were created to determine cost allocation by zone. To determine cost allocation by zone it was assumed that each zone that the pipeline passed through would benefit from the pipeline itself, as well as any higher HGL zones. Therefore, the costs were evenly distributed across all the zones of benefit.

Calculations are presented in the following Tables.

- Table E-1 - 2030 Pipeline Expansion (linear feet)
- Table E-2 – 2030 Pipeline Expansion (2015 costs)
- Table E-3 - 2030 Pipeline Rezoning (linear feet)
- Table E-4 – 2030 Pipeline Rezoning (2015 costs)
- Table E-5 - 2030 Pipeline Velocity Deficiency (linear feet)
- Table E-6 - 2030 Pipeline Velocity Deficiency (2015 costs)
- Table E-7 - 2030 Multiple Zone Pipelines (linear feet)
- Table E-8 - 2030 Multiple Zone Pipelines (2015 costs)
- Table E-9 - 2030 Multiple Zone Pipeline Identified in Table E-8 Costs Spread Over Zones
- Table E-10- Build Out Pipelines (linear feet)
- Table E-11- Build Out Pipeline (2015 costs)

E.2 Project Triggers Signifying When a Capital Improvement Features is to be Constructed

As part of this exercise, the projects were assigned project trigger, dependencies, EDU's and an approximate demand trigger. This should allow PWD to allocate funding and costs as development occurs and demand milestones are met. This complete categorization has been provided in the following Tables.

Table E-12 - Booster Pumps
Table E-13 - Storage Tanks
Table E-14 – Groundwater Wells

Table E-1: 2030 Pipeline Expansion Projects by Zone (linear feet)

Zone	6”	8”	10”	12”	14”	16”	18”	20”	24”	30”	36”	42”	Total feet
2800	790	252,752		5,435		850				94			259,921
2850		73,457		411		2,702							76,570
2950		136,058		19,500	50	5,871	1,024	564	3,585			87	166,739
3000		37,888		394				3,462	120	412			42,276
3200		55,960		10,750	50	11,528		33	20				78,341
3250	22	61,365	930	26,125		13,794			5,394				107,629
3400W													0
3400E						143		3,028					3,170
3600W													0
3600E													0
3800													0
4000													0
Total	**812**	**617,480**	**930**	**62,614**	**100**	**34,888**	**1,024**	**7,086**	**9,118**	**506**	**0**	**87**	**734,647**

Table E-2: 2030 Pipeline Expansion Projects by Zone (2015 Dollars)

Zone	6”	8”	10”	12”	14”	16”	18”	20”	24”	30”	36”	42”	Total
2800	$110,600	$45,495,366		$1,467,325		$306,122				$64,097			$47,443,510
2850		$13,222,261		$111,094		$972,698							$14,306,054
2950		$24,490,509		$5,264,981	$13,500	$2,113,465	$420,037	$253,671	$1,935,835			$82,992	$34,574,990
3000		$6,819,904		$106,310				$1,557,680	$64,800	$280,187			$8,828,880
3200		$10,072,760		$2,902,484	$13,500	$4,150,098		$14,987	$10,751				$17,164,579
3250	$3,080	$11,045,661	$213,843	$7,053,647		$4,965,847			$2,912,490				$26,194,568
3400W													$0
3400E						$51,330		$1,362,560					$1,413,890
3600W													$0
3600E													$0
3800													$0
4000													$0
Total	**$113,680**	**$111,146,461**	**$213,843**	**$16,905,841**	**$27,000**	**$12,559,561**	**$420,037**	**$3,188,897**	**$4,923,877**	**$344,284**	**$0**	**$82,992**	**$149,926,472**

Table E-3: 2030 Pipeline Rezoning Projects by Zone (linear feet)

Zone	6”	8”	10”	12”	14”	16”	18”	20”	24”	30”	36”	42”	Total
2800		105		127									232
2850													0
2950	334	2,303	567	2,831									6,034
3000													0
3200													0
3250													0
3400W													0
3400E													0
3600W													0
3600E													0
3800													0
4000													0
Total	**334**	**2,409**	**567**	**2,957**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6,266**

Table E-4: 2030 Pipeline Rezoning Projects by Zone (2015 Dollars)

Zone	6”	8”	10”	12”	14”	16”	18”	20”	24”	30”	36”	42”	Total
2800		$18,969		$34,196									$53,165
2850													$0
2950	$46,701	$414,585	$130,332	$764,318									$1,355,936
3000													$0
3200													$0
3250													$0
3400W													$0
3400E													$0
3600W													$0
3600E													$0
3800													$0
4000													$0
Total	**$46,701**	**$433,554**	**$130,332**	**$798,514**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$1,409,100**

Table E-4: 2030 Pipeline Velocity Deficiency Projects by Zone (linear feet)

Zone	6”	8”	10”	12”	14”	16”	18”	20”	24”	30”	36”	42”	Total
2800				1,385				23	1,352				2,760
2850													0
2950						96		516	231				844
3000													0
3200				1,335									1,335
3250													0
3400W													0
3400E													0
3600W													0
3600E													0
3800													0
4000													0
Total	**0**	**0**	**0**	**2,720**	**0**	**96**	**0**	**540**	**1,584**	**0**	**0**	**0**	**4,939**

Table E-5: 2030 Pipeline Velocity Deficiency Projects by Zone (2015 Dollars)

Zone	6”	8”	10”	12”	14”	16”	18”	20”	24”	30”	36”	42”	Total
2800				$373,880				$10,431	$730,339				$1,114,650
2850													$0
2950						$34,542		$232,385	$124,875				$391,802
3000													$0
3200				$360,420									$360,420
3250													$0
3400W													$0
3400E													$0
3600W													$0
3600E													$0
3800													$0
4000													$0
Total	**$0**	**$0**	**$0**	**$734,300**	**$0**	**$34,542**	**$0**	**$242,816**	**$855,214**	**$0**	**$0**	**$0**	**$1,866,872**

Table E-6: 2030 Pipeline Multi-zone Projects by Zone (linear feet)

Zone	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	42"	Total
2800													0
2850													0
2950								25,465	1,228	0	150	100	26,943
3000								1,494		370			1,864
3200													0
3250								586					586
3400W													0
3400E													0
3600W													0
3600E													0
3800													0
4000													0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**27,545**	**1,228**	**370**	**150**	**100**	**29,393**

Table E-7: 2030 Pipeline Multi-zone Projects by Zone (2015 Dollars)

Zone	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	42"	Total
2800													$0
2850													$0
2950								$11,459,127	$663,343	$0	$121,500	$95,000	$12,338,970
3000								$672,467		$251,396			$923,863
3200													$0
3250								$263,745					$263,745
3400W													$0
3400E													$0
3600W													$0
3600E													$0
3800													$0
4000													$0
Total	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$12,395,338**	**$663,343**	**$251,396**	**$121,500**	**$95,000**	**$13,526,577**

Table E-8: 2030 Pipeline Multi-zone Projects by Zone (2015 Dollars)

(Note: These are the costs in Table E-8 that are spread over zones which they benefit)

Zone	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	42"	Total
2800													$0
2850													$0
2950								$2,479,068	$132,669	$50,279	$24,300	$19,000	$2,705,315
3000								$2,479,068	$132,669	$50,279	$24,300	$19,000	$2,705,315
3200													$0
3250								$2,479,068	$132,669	$50,279	$24,300	$19,000	$2,705,315
3400W													$0
3400E								$2,479,068	$132,669	$50,279	$24,300	$19,000	$2,705,315
3600W													$0
3600E								$2,479,068	$132,669	$50,279	$24,300	$19,000	$2,705,315
3800													$0
4000													$0
Total	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$12,395,338**	**$663,343**	**$251,396**	**$121,500**	**$95,000**	**$13,526,577**

Table E-9: 2030 Pipeline Build Out Projects by Zone (linear feet)

Zone	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	42"	Total
2800													0
2850													0
2950		686				3,056		34					3,776
3000						25			200	50	150	208	634
3200		1,240		168		289							1,698
3250						581							581
3400W		8,833		819									9,652
3400E		61,901		42,647		6,109	3,518	3,753					117,929
3600W		10,288											10,288
3600E		28,518		14,521		188							43,226
3800		9,212		3,676									12,888
4000		4,594		6,418									11,011
Total	**0**	**125,272**	**0**	**68,249**	**0**	**10,248**	**3,518**	**3,787**	**200**	**50**	**150**	**208**	**211,683**

Table E-10: 2030 Pipeline Build Out Projects by Zone (2015 Dollars)

Zone	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"	36"	42"	Total
2800													$0
2850													$0
2950		$123,440				$1,100,322		$15,260					$1,239,022
3000						$9,176			$108,000	$34,000	$121,500	$197,629	$470,305
3200		$223,267		$45,492		$104,069							$372,828
3250						$209,066							$209,066
3400W		$1,589,945		$221,181									$1,811,127
3400E		$11,142,202		$11,514,809		$2,199,250	$1,442,470	$1,688,855					$27,987,585
3600W		$1,851,801											$1,851,801
3600E		$5,133,243		$3,920,613		$67,566							$9,121,422
3800		$1,658,171		$992,433									$2,650,605
4000		$826,835		$1,732,810									$2,559,645
Total	**$0**	**$22,548,904**	**$0**	**$18,427,339**	**$0**	**$3,689,450**	**$1,442,470**	**$1,704,114**	**$108,000**	**$34,000**	**$121,500**	**$197,629**	**$48,273,406**

Table E-11: Booster Pump Stations

Project Number	Completion Year	Type	CIP Summary	Description	Pressure Zone	Justification	Project Trigger	Dependencies	CIP/ Development	EDU's	Demand (MGD)	Cost (2015)
EB-01	2015 - 2020	Pump	Fire pumps at existing V-5 Pump Station. Required to meet fire flow requirements.	New 3,500 gpm fireflow pump with total design head of 350 ft.	3400E	Unable to meet current fireflow requirements	None	None	CIP	N/A	0.00	$2,610,000
FB-01	2015 - 2020	Pump	New pump to 3600W zone at 3600 Ft Booster PS.	New 300 gpm booster pump with total design head of 200 ft.	3600W	To support the growth in pressure zone 3600W	Construct with new Quail Valley Development	None	Development		0.00	$340,000
FB-02	2015 - 2020	Pump	New pump at Underground PS to 3400W zone	New 650 gpm booster pump with total design head of 282 ft.	3400W	To support the growth in pressure zone 3600W	Construct with new Quail Valley Development	None	Development		0.00	$690,000
EB-02	2021 - 2025	Pump	Fire pumps at existing T-8 Pump Station. Required to meet fire flow requirements.	New 3,500 gpm fireflow pump with total design head of 105 ft.	3250	Unable to meet current fireflow requirements	None	None	CIP	N/A	0.00	$870,000
EB-03	2021 - 2025	Pump	Fire pumps at existing Hilltop Pump Station. Required to meet fire flow requirements	New 1,000 gpm fireflow pump with total design head of 146 ft.	3250C	Unable to meet current fireflow requirements	None	None	CIP	N/A	0.00	$690,000
EB-04	2021 - 2025	Pump	Fire pumps at existing 5 MG Booster Pump Station. Required to meet fire flow requirements	New 500 gpm fireflow pump with total design head of 270 ft.	3250A	Unable to meet current fireflow requirements	None	None	CIP	N/A	0.00	$640,000
FB-03	2026 - 2030	Pump	New pump at Lower El Camino Pump Station	New 1,000 gpm booster pump with total design head of 290 ft.	3200 3400W 3600W	To support the projected growth in pressure zone 3200, 3400W and 3600W	New demand exceeds 2,592 EDU (1.3 MGD) in 3200, 3400W or 3600W.	None	Development	2,592	1.30	$820,000
FB-04	2026 - 2030	Pump	New pump at existing Clearwell 2950 booster PS at WTP to supply additional capacity to the 2950 zone.	New 2,000 gpm booster pump with total design head of 181 ft.	2950 3200 3400W 3600W	To support the projected growth in pressure zone 2950, 3200, 3400W and 3600W	New demand exceeds 2,400 EDU (1.20 MGD) in 2950, 3200, 3400W or 3600W.	None	Development	2,400	1.20	$860,000
FB-05	Build Out	Pump	New booster pump station at Ana Verde Tovey Tank	New 900 gpm booster pump with total design head of 230 ft.	3400W 3600W	To support the projected growth in pressure zone 3400W and 3600W	Additional 2,400 EDU (0.95 MGD) in 2950, 3200, 3400W or 3600W.	None	Development	1,909	0.95	$3,140,000
FB-06	Build Out	Pump	New pump station on Steven Ambers Way and E Carson Mesa Rd.	New 900 gpm booster pump with total design head of 160 ft.	3400E 3600E	To support the projected growth in pressure zone 3400E and 3600E.	Additional 5,400 EDU (2.70 MGD) in either 3400E or 3600E.	None	Development	5,400	2.70	$2,730,000
FB-07	Build Out	Pump	New pump at existing 5 MG Pump Station.	New 700 gpm booster pump with total design head of 270 ft.	3250 3400E 3600E	To support the projected growth in pressure zone 3250, 3400E and 3600E.	Additional 7,753 EDU (3.88 MGD) in 3250,	None	Development	7,753	3.88	$720,000

Project Number	Completion Year	Type	CIP Summary	Description	Pressure Zone	Justification	Project Trigger	Dependencies	CIP/ Development	EDU's	Demand (MGD)	Cost (2015)
							3400E or 3600E.					
FB-08	Build Out	Pump	New pump at Lower El Camino Pump Station.	New 1,000 gpm booster pump with total design head of 290 ft.	3200 3400W 3600W	To support the projected growth in pressure zone 3200, 3400W and 3600W	Additional 5,472 EDU (2.74 MGD) in 3250, 3400E or 3600E.	None	Development	5,472	2.74	$820,000
FB-09	Build Out	Pump	New booster pump station at E Avenue T-8 and 47 Street.	Three new 1,900 gpm booster pump with total design head of 60 ft.	3000 3250 3400E 3600E	To support the projected growth in pressure zone 3000, 3250, 3400E, 3600E.	Additional either 9,524 EDU (4.76 MGD) in 3200, 3400W, or 3600W for the first two pumps. Additional either 3,744 EDU (1.87 MGD) in 3200, 3400W or 3600W for the third pump.	None	Development	13,268	6.63	$3,890,000
FB-10	Build Out	Pump	New booster PS at Upper El Camino tank to 4000 Zone.	Three new 600 gpm booster pump with total design head of 630 ft.	4000	To support the projected growth in pressure zone 4000.	Development begins for the 4000 pressure zone.	None	Development	880	0.44	$3,580,000
FB-11	Build Out	Pump	New pump Station on Mt. Emma Rd and 47th Street.	New 1,100 gpm booster pump with total design head of 220 ft.	3600E	To support the projected growth in pressure zone 3600E.	Start of development in 3600E.	None	Development		0.00	$2,750,000
FB-12	Build Out	Pump	New pump station at 45th St existing pump station site (2 pumps).	Four new 1,800 gpm booster pump with total design head of 220 ft.	2950 3200 3400W 3600W	To support the projected growth in pressure zone 2950, 3200, 3400W and 3600W	Additional 5,760 EDU (2.88 MGD) in 2950, 3200, 3400W or 3600W for the first two pump. Additional 5,760 EDU (2.88 MGD) in 3200, 3400W, or 3600W for the second two pumps.	FB-01	Development	11,520	5.76	$6,820,000
Total												**$31,970,000**

Table 12: Storage Tanks

Project Number	Completion Year	Type	CIP Summary	Description	Pressure Zone	Justification	Project Trigger	Dependencies	CIP/ Development	EDU's	Demand (MGD)	Cost (2015)
ES-01	2015 - 2020	Storage	New tank at Quail Valley Development in 3600W zone	Pressure Zone 3600W Reservoir (1.00 MG).	3600W	To support the projected growth in pressure zone 3600W	Construct with new Quail Valley development	None	Development		0.00	$2,700,000
ES-03	2015 - 2020	Storage	New tank location near Sierra Hwy and Rae Street	Pressure Zone 2950 Reservoir (4.20 MG).	2950	To support the projected growth in pressure zone 2950	Construct as soon as possible	None	Development		0.00	$8,190,000
FS-01	2015 - 2020	Storage	New tank at Quail Valley Development in 3400W zone	Pressure Zone 3400W Reservoir (0.75 MG).	3400W	To support the projected growth in pressure zone 3400W	Construct with new Quail Valley development	None	Development		0.00	$2,250,000
ES-02	2021 - 2025	Storage	New tank location near 47th St and East Avenue V4 (South of E Barrel Springs Road)	Pressure Zone 3250 Reservoir (3.10 MG).	3250	To support the projected growth in pressure zone 3250	Construct as soon as possible	None	Development		0.00	$6,510,000
FS-05	2021 - 2025	Storage	New tank location on Mt. Emma Rd. and 47th Street E	Pressure Zone 3400E Reservoir (2.00 MG).	3400E	To support the projected growth in pressure zone 3400E	Construct the first 1.0 MG reservoir with new developments in the 3600E zone. Second 1.0 MG reservoir after an additional 2,000 EDUs	None	Development	4,000	2.00	$4,500,000
FS-02	2026 - 2030	Storage	New tank location on 47th Street E, South of E Avenue T-8	Pressure Zone 2950 Reservoir (5.70 MG).	2950	To support the projected growth in pressure zone 2950	Construct as soon as possible after ES-03.	ES-03	Development		0.00	$10,260,000
FS-03	2026 - 2030	Storage	New tank at existing 50th Street tank location	Pressure Zone 2850 Reservoir (2.00 MG).	2850	To support the projected growth in pressure zone 2850	Construct after 4,040 EDUs in the 2850 zone	None	Development	4,040	2.02	$4,500,000
FS-04	2026 - 2030	Storage	New tank at existing 45th Street tank location	Pressure Zone 2800 Reservoir (4.00 MG).	2800	To support the projected growth in pressure zone 2800	Construct after 9,160 EDUs in the 2800 zone	None	Development	9,160	4.58	$7,800,000
FS-06	Build Out	Storage	New tank location on Mt. Emma Rd	Pressure Zone 3600E Reservoir (2.00 MG).	3600E	To support the projected growth in pressure zone 3600E	Construct the first 1.0 MG reservoir with new developments in the 3600E zone. Second 1.0 MG reservoir after an additional 2,000 EDUs	None	Development	4,000	2.00	$4,500,000
FS-07	Build Out	Storage	Additional tank located at Upper El Camino	Pressure Zone 3400W Reservoir (1.00 MG).	3400W 3800	To support the projected growth in pressure zone 3400W	Construct after 1,400 EDUs in 3400W zone	None	Development	1,400	0.70	$2,700,000

Project Number	Completion Year	Type	CIP Summary	Description	Pressure Zone	Justification	Project Trigger	Dependencies	CIP/ Development	EDU's	Demand (MGD)	Cost (2015)
FS-08	Build Out	Storage	New tank location at E Carson Mesa Rd and N. Rough Rd	Pressure Zone 3400E Reservoir (1.80 MG).	3400E	To support the projected growth in pressure zone 3400E	Construct the first 1.0 MG reservoir when new development in 3600E reach 4,000 EDU's. Second 1.0 MG reservoir after EDU's in pressure zone 3600E reach 6,000 EDUs.	FS-01	Development	4,000	2.00	$4,860,000
FS-09	Build Out	Storage	New tank location at E Carson Mesa Rd and N Chelsea Ln	Pressure Zone 3250 Reservoir (3.50 MG).	3250	To support the projected growth in pressure zone 3250	Construct after ES-02 and 5,900 EDUs in 3250 zone.	ES-02	Development	5,900	2.95	$7,350,000
FS-10	Build Out	Storage	New tank location north of Rae St and close to the CA-14 N	Pressure Zone 3200 Reservoir (1.10 MG).	3200	To support the projected growth in pressure zone 3200	Construct after 2,680 EDUs in the 3200 zone.	None	Development	2,680	1.34	$2,970,000
FS-11	Build Out	Storage	New tank at 47St and E Avenue T-8	Pressure Zone 2950 Reservoir (7.30 MG).	2950	To support the projected growth in pressure zone 2950	Construct after 11,160 EDUs in the 2950 zone.	None	Development	11,160	5.58	$13,140,000
FS-12	Build Out	Storage	New tank at existing 50th St tank location	Pressure Zone 2850 Reservoir (2.10 MG).	2850	To support the projected growth in pressure zone 2850	Construct after 8,040 EDUs (4.02 MGD) in the 2850 zone	None	Development	8,040	4.02	$4,730,000
FS-13	Build Out	Storage	New tank location on E Avenue T and 60th Street.	Pressure Zone 2800 Reservoir (5.50 MG).	2800	To support the projected growth in pressure zone 2800	Construct after 17,040 EDUs (8.52 MGD) in the 2800 zone	None	Development	17,040	8.52	$9,900,000
FS-14	Build Out	Storage	6 MG tank near existing 6 MG Clearwell	Pressure Zone 2800 Reservoir (6.00 MG).	2800	To support the projected growth in pressure zone 2800	Construct after 28,040 EDUs (14.02 MGD) in the 2800 zone	None	Development	28,040	14.02	$10,800,000
FS-15	Build Out	Storage	New tank at E Avenue T and 60th Street	Pressure Zone 2800 Reservoir (2.40 MG).	2800	To support the projected growth in pressure zone 2800	Construct after 40,040 EDUs (20.02 MGD) in the 2800 zone.	None	Development	40,040	20.02	$5,400,000
FS-16	Build Out	Storage	New tank location at Desert Spring Road and Tierra Subida Ave	Pressure Zone 4000 Reservoir (1.20 MG).	4000	To support the projected growth in pressure zone 4000	Construct with new developments in the 4000 zone.	None	Development		0.00	$3,240,000
Total												**$116,300,000**

Table E-14: Wells

Project Number	Completion Year	Type	CIP Summary	Description	Pressure Zone	Justification	Project Trigger	Dependencies	CIP/ Development	EDU's	Demand (MGD)	Cost (2015)
FW-01	2021-2025	Wells	New well (Well 28) on 70th Street and E Avenue S requires equipping	New 512 gpm capacity well at a depth of 406 ft.	All	Demand exceeds supply from current wells.	Demand exceeds supply from current wells.		CIP	N/A	0.00	$600,000
FW-02	2021-2025	Wells	New well (Well 27) on 70th Street north of Well 25 requires equipping	New 448 gpm capacity well at a depth of 483 ft.	All	Demand exceeds supply from current wells.	Demand exceeds supply from Well 28.	FW-01	CIP	N/A	0.00	$600,000
FW-03	2021-2025	Wells	New well (Well 34) requires equipping	New 500 gpm capacity well at a depth of 451 ft.	All	Demand exceeds supply from current wells.	Demand exceeds supply from Well 34.	FW-02	CIP	N/A	0.00	$600,000
FW-04	2026-2030	Wells	New well (Well 36) near 375' S/O Ave P and 440' W/O 20th St E	New 2,150 gpm capacity well at a depth of 455 ft.	All	Demand exceeds supply from current wells.	Demand exceeds supply from Well 36.	FW-03	CIP	N/A	0.00	$1,200,000
FW-05	2026-2030	Wells	New well (Well 37) near 1000' N/O Ave P and 1000' W/O 15th St E	New 1,000 gpm capacity well at a depth of 520 ft.	All	Demand exceeds supply from current wells.	Demand exceeds supply from Well 37.	FW-04	CIP	N/A	0.00	$1,200,000
Total												**$4,200,000**

APPENDIX F – ALLOCATION OF PROJECT COSTS ACCORDING TO ZONES WHICH THEY BENEFIT

F-1 Pipeline Projects by Zone

The pipeline projects, which were outlined in Appendix E for transmission pipelines have been broken down on a relative cost benefit per zone. This means that pipes, which were originally assigned to a single zone, now have their cost associated to the multiple zones they benefit. Table F-1 and Table F-2 represent the total allocation of pipeline cost to the pressure zone in which the benefit is realized for 2030 and build out, respectively.

- Table F-1 – Pipeline Costs to year 2030 (2015 Costs)
- Table F-2 – Pipeline Costs to Build Out (2015 Costs)

F-2 Capacity Based Projects by Zone

The capital improvement projects, which were outlined in **Table F-3, Table F-4**, **Table F-5 and F-6** have been subsequently broken down on a relative cost benefit per pressure zone. They cover new pump stations, wells, storage tanks and fire flow pump stations by zone and four planning horizons:

- Table F-3 - Capacity Based Capital Improvement (years 2015 to 2020) (2015 Costs)
- Table F-4 – Capacity Based Capital Improvement (years 2021 to 2025) (2015 Costs)
- Table F-5 – Capacity Based Capital Improvement (years 2026 to 2030) (2015 Costs)
- Table F-6 – Capacity Based Capital Improvement (Buildout) (2015 Costs)

Table F-1: Total Pipeline Projects Cost by Pressure Zone: 2030 (2015 Costs)

Zone	6”	8”	10”	12”	14”	16”	18”	20”	24”	30”	36”	42”	Total
2800	$110,600	$45,514,335		$1,875,400		$306,122		$10,431	$730,339	$64,097			$48,611,325
2850		$13,222,261		$111,094		$972,698							$14,306,054
2950	$46,701	$24,905,093	$130,332	$6,029,299	$13,500	$2,148,007	$420,037	$2,965,123	$2,193,379	$50,279	$24,300	$101,992	$39,028,043
3000		$6,819,904		$106,310				$4,036,747	$197,469	$330,466	$24,300	$19,000	$11,534,196
3200		$10,072,760		$3,262,904	$13,500	$4,150,098		$14,987	$10,751	$0	$0	$0	$17,525,000
3250	$3,080	$11,045,661	$213,843	$7,053,647	$0	$4,965,847		$2,479,068	$3,045,159	$50,279	$24,300	$19,000	$28,899,883
3400W													
3400E						$51,330		$3,841,627	$132,669	$50,279	$24,300	$19,000	$4,119,205
3600W													
3600E								$2,479,068	$132,669	$50,279	$24,300	$19,000	$2,705,315
3800													
4000													
Total	**$160,381**	**$111,580,014**	**$344,174**	**$18,438,655**	**$27,000**	**$12,594,103**	**$420,037**	**$15,827,050**	**$6,442,434**	**$595,680**	**$121,500**	**$177,992**	**$166,729,021**

Table F-2: Total Pipeline Projects Cost by Pressure Zone: Build Out (2015 Costs)

Zone	6”	8”	10”	12”	14”	16”	18”	20”	24”	30”	36”	42”	Total
2800													
2850													
2950		$123,440				$1,100,322		$15,260					$1,239,022
3000						$9,176			$108,000	$34,000	$121,500	$197,629	$470,305
3200		$223,267		$45,492		$104,069							$372,828
3250						$209,066							$209,066
3400W		$1,589,945		$221,181									$1,811,127
3400E		$11,142,202		$11,514,809		$2,199,250	$1,442,470	$1,688,855					$27,987,585
3600W		$1,851,801											$1,851,801
3600E		$5,133,243		$3,920,613		$67,566							$9,121,422
3800		$1,658,171		$992,433									$2,650,605
4000		$826,835		$1,732,810									$2,559,645
Total	**$0**	**$22,548,904**	**$0**	**$18,427,339**	**$0**	**$3,689,450**	**$1,442,470**	**$1,704,114**	**$108,000**	**$34,000**	**$121,500**	**$197,629**	**$48,273,406**

Table F-3: Capacity Based Capital Improvements by Pressure Zone: 2015 – 2020 (2015 Costs)

Project Number	Type	CIP Summary	Zone												Total
			2800	2850	2950	3000	3200	3250	3400W	3400E	3600W	3600E	3800	4000	
FF-01	Fire flow	Fire flow deficiency in pressure zone 2800.	$722,250												$722,250
FF-04	Fire flow	Fire flow deficiency in pressure zone 2800.	$260,550												$260,550
FF-05	Fire flow	Fire flow deficiency in pressure zone 2950.			$565,200										$565,200
FF-06	Fire flow	Fire flow deficiency in pressure zone 2950.			$8,640										$8,640
FF-07	Fire flow	Fire flow deficiency in pressure zone 3400W.							$252,000						$252,000
EB-01	Pump	Fire pumps at existing V-5 Pump Station. Required to meet fire flow requirements.								$2,610,000					$2,610,000
FB-01	Pump	New pump to 3600W zone at 3600 Ft Booster PS.									$340,000				$340,000
FB-02	Pump	New pump at Underground PS to 3400W zone.								$690,000					$690,000
ES-01	Storage	New tank at Quail Valley Development in 3600W zone.									$2,700,000				$2,700,000
ES-03	Storage	New tank location near Sierra Hwy and Rae Street			$8,190,000										$8,190,000
FS-01	Storage	New tank at Quail Valley Development in 3400W zone.							$2,250,000						$2,250,000
Total			**$982,800**	**$0**	**$8,763,840**	**$0**	**$0**	**$0**	**$2,502,000**	**$3,300,000**	**$3,040,000**	**$0**	**$0**	**$0**	**$18,588,640**

Table F-4: Capacity Based Capital Improvements by Pressure Zone: 2021 – 2025 (2015 Costs)

Project Number	Type	CIP Summary	Zone												Total
			2800	2850	2950	3000	3200	3250	3400W	3400E	3600W	3600E	3800	4000	
EB-02	Pump	Fire pumps at existing T-8 Pump Station. Required to meet fire flow requirements.						$870,000							$870,000
EB-03	Pump	Fire pumps at existing Hilltop Pump Station. Required to meet fire flow requirements						$690,000							$690,000
EB-04	Pump	Fire pumps at existing 5 MG Booster Pump Station. Required to meet fire flow requirements						$640,000							$640,000
FW-01	Wells	New well (Well 28) on 70th Street and E Avenue S requires equipping	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$600,000
FW-02	Wells	New well (Well 27) on 70th Street north of Well 25 requires equipping	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$600,000
FW-03	Wells	New well (Well 34) requires equipping	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$600,000
ES-02	Storage	New tank location near 47th St and East Avenue V4 (South of E Barrel Springs Road)						$6,510,000							$6,510,000
FS-05	Storage	New tank location on Mt. Emma Rd. and 47th Street E								$4,500,000					$4,500,000
Total			**$150,000**	**$150,000**	**$150,000**	**$150,000**	**$150,000**	**$8,860,000**	**$150,000**	**$4,650,000**	**$150,000**	**$150,000**	**$150,000**	**$150,000**	**$15,010,000**

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Table F-5: Capacity Based Capital Improvements by Pressure Zone: 2026 – 2030 (2015 Costs)

Project Number	Type	CIP Summary	Zone												Total
			2800	2850	2950	3000	3200	3250	3400W	3400E	3600W	3600E	3800	4000	
FB-03	Pump	New pump at Lower El Camino Pump Station					$273,333		$273,333		$273,333				$820,000
FB-04	Pump	New pump at existing Clearwell 2950 booster PS at WTP to supply additional capacity to the 2950 zone.			$215,000		$215,000		$215,000		$215,000				$860,000
FW-04	Wells	New well (Well 36) near E Avenue R and between 70th Street and 75th Street	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$1,200,000
FW-05	Wells	New well (Well 37) near 70th Street and East Avenue S	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$1,200,000
FS-02	Storage	New tank location on 47th Street E, South of E Avenue T-8			$10,260,000										$10,260,000
FS-03	Storage	New tank at existing 50th Street tank location		$4,500,000											$4,500,000
FS-04	Storage	New tank at existing 45th Street tank location	$7,800,000												$7,800,000
Total			**$8,000,000**	**$4,700,000**	**$10,675,000**	**$200,000**	**$688,333**	**$200,000**	**$688,333**	**$200,000**	**$688,333**	**$200,000**	**$200,000**	**$200,000**	**$26,639,999**
														ROUNDED UP	**$26,640,000**

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Table F-6: Capacity Based Capital Improvements by Pressure Zone: Build Out (2015 Costs)

Project Number	Type	CIP Summary	Zone												Total
			2800	**2850**	**2950**	**3000**	**3200**	**3250**	**3400W**	**3400E**	**3600W**	**3600E**	**3800**	**4000**	
FB-05	Pump	New booster pump station at Ana Verde Tovey Tank							$1,570,000		$1,570,000				$3,140,000
FB-06	Pump	New pump station on Steven Ambers Way and E Carson Mesa Rd.								$1,365,000		$1,365,000			$2,730,000
FB-07	Pump	New pump at existing 5 MG Pump Station.						$240,000		$240,000		$240,000			$720,000
FB-08	Pump	New pump at Lower El Camino Pump Station.					$273,333		$273,333		$273,333				$820,000
FB-09	Pump	New booster pump station at E Avenue T-8 and 47 Street.				$972,500		$972,500		$972,500		$972,500			$3,890,000
FB-10	Pump	New booster PS at Upper El Camino tank to 4000 Zone.												$3,580,000	$3,580,000
FB-11	Pump	New pump Station on Mt. Emma Rd and 47th Street.										$2,750,000			$2,750,000
FB-12	Pump	New pump station at 45th St existing pump station site (2 pumps).			$1,705,000		$1,705,000		$1,705,000		$1,705,000				$6,820,000
FS-06	Storage	New tank location on Mt. Emma Rd										$4,500,000			$4,500,000
FS-07	Storage	Additional tank located at Upper El Camino									$1,350,000		$1,350,000		$2,700,000
FS-08	Storage	New tank location at E Carson Mesa Rd and N. Rough Rd										$4,860,000			$4,860,000
FS-09	Storage	New tank location at E Carson Mesa Rd and N Chelsea Ln						$7,350,000							$7,350,000
FS-10	Storage	New tank location north of Rae St and close to the CA-14 N							$2,970,000						$2,970,000
FS-11	Storage	New tank at 47St and E Avenue T-8			$13,140,000										$13,140,000
FS-12	Storage	New tank at existing 50th St tank location		$4,730,000											$4,730,000
FS-13	Storage	New tank location on E Avenue T and 60th Street.	$9,900,000												$9,900,000
FS-14	Storage	6 MG tank near existing 6 MG Clearwell	$10,800,000												$10,800,000
FS-15	Storage	New tank at E Avenue T and 60th Street	$5,400,000												$5,400,000
FS-16	Storage	New tank location at Desert Spring Road and Tierra Subida Ave												$3,240,000	$3,240,000
Total			**$26,100,000**	**$4,730,000**	**$14,845,000**	**$972,500**	**$1,978,333**	**$8,562,500**	**$6,518,333**	**$2,577,500**	**$4,898,333**	**$14,687,500**	**$1,350,000**	**$6,820,000**	**$94,039,999**
														ROUNDED UP	**$94,040,000**