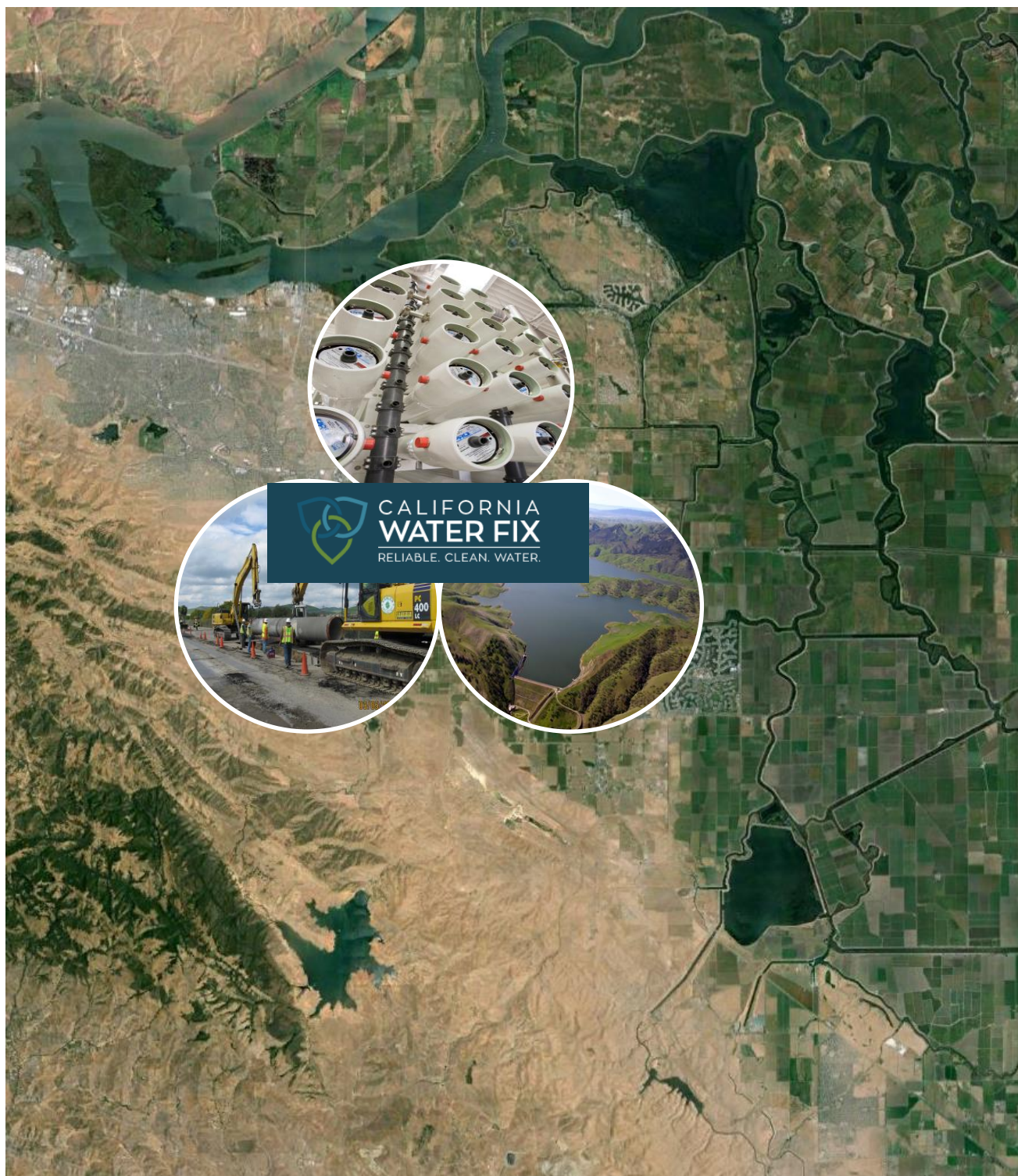


Water Supply Evaluation Update



Water Supply Alternatives for the Livermore-Amador Valley

February 2016



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Table of Contents

EXECUTIVE SUMMARY	1
1.0 PURPOSE & OBJECTIVES	9
2.0 DESCRIPTION OF ZONE 7 WATER AGENCY AND ITS SERVICE AREA	10
2.1 ZONE 7 WATER AGENCY: HISTORY AND PRIMARY FUNCTION	10
2.2 SERVICE AREA.....	12
2.3 EXISTING WATER USE SECTORS	13
2.4 POPULATION GROWTH.....	14
2.5 CLIMATE	15
3.0 HISTORICAL AND PROJECTED WATER DEMANDS.....	16
3.1 HISTORICAL WATER DEMANDS SERVED BY ZONE 7	16
3.3 PROJECTED WATER DEMANDS	20
4.0 Existing Water Supplies and Assumptions	28
4.1 STATE WATER PROJECT.....	28
4.2 BYRON BETHANY IRRIGATION DISTRICT	36
4.3 LOCAL RUNOFF - ARROYO VALLE	36
5.0 Existing Water Storage Facilities and Updated Assumptions.....	38
5.1 LOCAL STORAGE: LAKE DEL VALLE	38
5.2 LOCAL STORAGE: GROUNDWATER BASIN AND RECHARGE FACILITIES.....	39
5.3 LOCAL STORAGE: CHAIN OF LAKES – LAKE I AND COPE LAKE	43
5.4 KERN COUNTY GROUNDWATER BANKING PROGRAMS	44
6.0 CLIMATE CHANGE AND DISRUPTIONS IN THE DELTA	46
6.1 INCLUSION OF POTENTIAL LOCAL CLIMATE CHANGE	46
6.2 INCLUSION OF EXTENDED DISRUPTIONS IN THE DELTA.....	49
7.0 POTENTIAL FUTURE WATER SUPPLY OPTIONS.....	51
7.1 CALIFORNIA WATERFIX (FORMERLY BDCP/DELTA FIX)	51
7.2 PURIFIED RECYCLED WATER OPTIONS.....	52
7.3 DESALINATION	58

8.0	POTENTIAL RISK REDUCTION FACILITIES.....	62
8.1	RELIABILITY INTERTIE	62
8.2	CHAIN OF LAKES PIPELINE.....	63
8.3	LOS VAQUEROS EMERGENCY/DROUGHT STORAGE	64
8.4	WELL MASTER PLAN WELLS	66
9.0	PORTFOLIOS USED TO EVALUATE ZONE 7’S WATER SUPPLY SYSTEM	68
9.1	CURRENT PLAN	68
9.2	DESALINATION ONLY (PORTFOLIO A)	70
9.3	PURIFIED RECYCLED WATER ONLY (PORTFOLIO B)	71
9.4	DESALINATION PLUS PURIFIED RECYCLED WATER (PORTFOLIO C)	73
10.0	ANALYSIS USED IN THIS UPDATE: MORE CONSERVATIVE AND EXPANDED	75
10.1	SCENARIOS USED IN THE WSE UPDATE	75
10.2	METRICS USED FOR THIS WSE Update	76
11.0	FINDINGS FROM ANALYZING THE PORTFOLIOS	78
11.1	AVERAGE RELIABILITY	78
11.2.	RARE EXTREME SHORTAGES	79
11.3.	MINIMUM M&I SUPPLY DURING RARE EVENTS.....	80
11.4.	AVERAGE GROUNDWATER STORAGE	81
11.5	LOCAL CONTROL	82
11.6	DIVERSIFICATION	83
11.7	ENERGY USE	84
11.8	COSTS	85
11.9	COMPARISON OF THE BENEFITS PROVIDED BY EACH PORTFOLIO	86

List of Figures

FIGURE ES-1	Updated Projected Water Demands	2
FIGURE ES-2	Scenarios Used for Portfolios Analysis	5
FIGURE 2-1	Location of Service Area and Major Streams and Arroyos	13
FIGURE 2-2	Historical and Projected Populations within Zone 7's Service Area	14
FIGURE 2-3	Climate Data for the Zone 7 Service Area	15
FIGURE 3-1	Comparison of Historical Municipal and Industrial (M&I) Per Capita Demand to Rainfall	20
FIGURE 3-2	Historical Zone 7 Retail Customer Demand, acre-feet	23
FIGURE 3-3	Historical Zone 7 Untreated Water Demand	24
FIGURE 3-4	Historical Zone 7 Unaccounted for Water	26
FIGURE 3-5	Projected Water Demands Used for the WSE Update	27
FIGURE 4-1	DWR's Historical Table A Percentage Allocations to Zone 7	30
FIGURE 4-2	Historical Total Inflows into Lake Del Valle from Arroyo Valle	37
FIGURE 5-1	Artificial Recharge, Pumping, and Net Cumulative Impacts to Operational Storage from Water Year 1974 to 2014	41
FIGURE 5-2	Main Basin Ground Water Storage	42
FIGURE 5-3	Configuration of the Chain of Lake and Timing	43
FIGURE 6-1	Map Showing 12 km x 12 km in Cal-Adapt.org Centered over Zone 7's Service Area	47
FIGURE 6-2	Local Climate Model Results Obtained from Cal-Adapt.org	48
FIGURE 6-3	Local Rainfall Assumptions used for this 2015 Update	49
FIGURE 7-1	Promising Indirect Purified Recycled Water Concepts Identified by HDR	54
FIGURE 7-2	Regional Desalination Concepts	60

FIGURE 8-1	Proposed Chain of Lakes Pipeline	64
FIGURE 8-2	Storage in Los Vaqueros	65
FIGURE 9-1	Projected Percentage Average Water Supply Mix for the Current Plan	69
FIGURE 9-2	Projected Percentage Average Water Supply Mix for Portfolio A	70
FIGURE 9-3	Projected Percentage Average Water Supply Mix for Portfolio B	72
FIGURE 9-4	Projected Percentage Average Water Supply Mix for Portfolio C	74
FIGURE 10-1	Scenarios Used for Portfolio Analysis	75
FIGURE 11-1	Outcome of Portfolio Analysis for Average Reliability	79
FIGURE 11-2	Outcome of Portfolio Analysis for Rare Extreme Shortages	80
FIGURE 11-3	Outcome of Portfolio Analysis for Extreme Minimum Supply	81
FIGURE 11-4	Outcome of Portfolio Analysis for Average Groundwater Storage	82
FIGURE 11-5	Outcome of Portfolio Analysis for Local Control	83
FIGURE 11-6	Outcome of Portfolio Analysis for Diversification	84
FIGURE 11-7	Outcome of Portfolio Analysis for Energy Use	85
FIGURE 11-8	Outcome of Portfolio Analysis for Amortized Costs	86

List of Tables

TABLE ES-1	Summary of Water Supply Options Used	3
TABLE ES-2	Summary of Facilities or Programs Used	4
TABLE ES-3	Programs and Projects Included in Each Portfolio	4
TABLE ES-4	Core Mission Metrics Used to Evaluate Portfolios	6
TABLE ES-5	Lower Priority Metrics Used to Evaluate Portfolios	6
TABLE ES-6	Summary of Benefits Provided by Each Portfolio	7
TABLE 3-1	Historical Water Demand in the Zone 7 Service Area, acre-feet	18
TABLE 3-2	Historical M&I Per Capita Water Demands in the Zone Service Area	19
TABLE 3-3	Projected Treated Water Demands from Retailers, acre-feet	22
TABLE 3-4	Projected Demands from Zone 7's Untreated Water Customers	25
TABLE 4-1	Previous Projected SWP Allocations from DWR Used by Zone 7	32
TABLE 4-2	Scenarios from DWR's Delivery Capability Report	33
TABLE 4-3	Conservative SWP Allocations Used in this WSE	34
TABLE 5-1	Revised Assumptions for Groundwater Banking Programs Located in Kern County	45
TABLE 7-1	Additional Information and Analysis Required	57
TABLE 8-1	Existing and Future Groundwater Well Assumptions for this Update	67
TABLE 9-1	Summary of Average Water Supply and Reliability Facilities in the Current Plan	69
TABLE 9-2	Summary of Average Water Supply and Reliability Facilities in Portfolio A	71
TABLE 9-3	Summary of Average Water Supply and Reliability Facilities in Portfolio B	72
TABLE 9-4	Summary of Average Water Supply and Reliability Facilities in Portfolio C	74

TABLE 10-1	Core Mission Metrics Used to Evaluate Portfolios	77
TABLE 10-2	Lower Priority Metrics Used to Evaluate Portfolios	77
TABLE 11-1	Unit Energy Consumption	84
TABLE 11-2	Summary of Portfolio Costs	86
TABLE 11-3	Comparison of Core Mission Benefits for Each Portfolio	87
TABLE 11-4	Comparison of Lower Priority Benefits for Each Portfolio	88

Appendices

Appendix A	HDR Focused Preliminary Review of Recycled Water and Desalination Options for the Tri-Valley Area
Appendix B	Proposed Cost Estimates for Key Future Facilities

ACRONYMS AND DEFINITIONS

The following terms and acronyms have been used throughout this update to improve document clarity and readability.

ACWD	Alameda County Water District
AF	Acre-feet
AFA	Acre-feet annually
Basin	Livermore-Amador Valley Groundwater Basin
BARDP	Bay Area Regional Desalination Project
BBID	Byron-Bethany Irrigation District
BDCP	Bay Delta Conservation Plan
CalSim	California Statewide Integrated Model
Cal Water	California Water Service Company
Cawelo	Cawelo Water District
CCSM	Community Climate System Model
CCWD	Contra Costa Water District
CEQA	California Environmental Quality Act
CIP	Capital Improvement Program
CNRM	Centre National de Recherches Meteorologiques (France)
COL	Chain of Lakes
CVP	Central Valley Project
DCR	DWR's Delivery Capability Report
Delta	Sacramento-San Joaquin Delta
District	Alameda County Flood Control and Water Conservation District
DPR	Direct Potable Reuse
DRMS	Delta Risk Management Strategy
DSRSD	Dublin San Ramon Services District
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utility District
EBRPD	East Bay Regional Parks District
EC-ELT	Existing Conditions – Early Long Term Average
EC-LO	Existing Conditions – Low Outflow
EC-HO	Existing Conditions – High Outflow
ETO	Average temperatures, rainfall and evapotranspiration rates
GFDL	Geophysical Fluid Dynamics Laboratory (NOAA)
GMP	Groundwater Management Plan
GPCD	Gallons per capita per day
GPQ	Groundwater Pumping Quotas
IPR	Indirect Potable Reuse
LAVWMA	Livermore-Amador Valley Water Management Agency
Livermore	City of Livermore
LLNL	Lawrence Livermore National Laboratory
LVE	Los Vaqueros Reservoir

M&I	Municipal and Industrial
Main Basin	The Portion of the Livermore-Amador Valley Groundwater Basin that contains high-yielding aquifers and good quality groundwater
Metropolitan	Metropolitan Water District
MGD	Million gallons per day
MOU	Memorandum of Understanding Regarding Urban Water Conservation in California
MWH	Megawatt-Hour
PCM	Parallel Climate Model (Department of Energy)
Pleasanton	City of Pleasanton
Retailers	Cal Water, DSRSD, Livermore, and Pleasanton
SBA	South Bay Aqueduct
Semitropic	Semitropic Water Storage District
SFPUC	San Francisco Public Utilities Commission
SLR	Sal Luis Reservoir
State	State of California
SWP	State Water Project
TAF	Thousands of Acre-Feet
TDS	Total Dissolved Solids
Tri-Valley	Livermore-Amador Valley
UWMP	Urban Water Management Plan
VA	Veterans Association
WSE	Water Supply Evaluation
Yuba Accord	Lower Yuba River Accord
Zone 7	Zone 7 of Alameda County Flood Control and Water Conservation District (Also referred to as Zone 7 Water Agency)
Zone 7 Board	Zone 7 Water Agency Board of Directors

EXECUTIVE SUMMARY

In July 2011, Zone 7 Water Agency (Zone 7) completed an evaluation of its long-term water supply (2011 WSE) to provide background for and facilitate preparation of Zone 7's Urban Water Management Plan (UWMP) and other agency planning efforts. The key assumptions, approach, analysis, and results were thoroughly vetted with the Livermore-Amador Valley's¹ local water supply retailers.

The 2011 WSE identified three potential water supply portfolios (Current Plan [i.e., California WaterFix], In-Valley [i.e., expanding planned recycled water], and Intertie [increasing imported water]) to help guide future water supply investments. The Current Plan was chosen as the preferred alternative. However, since that time, the Livermore-Amador Valley, and California at large, has been experiencing a severe drought.

The current drought underscored the need to update key assumptions made in Zone 7's 2011 WSE.

Update Includes New Data and Assumptions for Zone 7's Existing Water Supplies

As part of this evaluation, Zone 7 included updated and more conservative assumptions for State Water Project (SWP) allocations, revised key assumptions for existing supplies from Byron Bethany Irrigation District (BBID) and capacity of its Kern County groundwater banking programs, and evaluated a complete loss of the Delta due to earthquake or water quality. This evaluation also incorporated potential delays in transferring ownership of the Chain of Lakes to Zone 7 and for the first time, included an analysis of local climate change.

Update Includes Revised Projected Water Demands

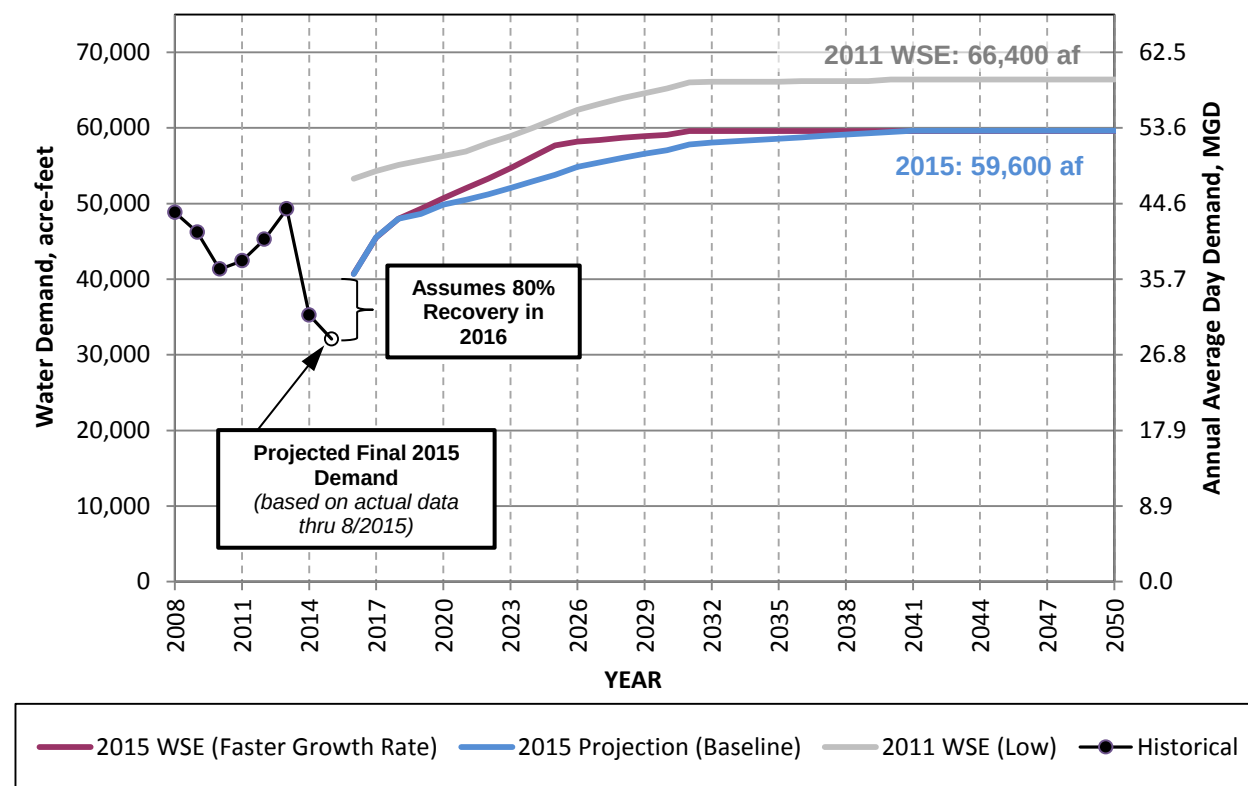
Zone 7 staff (Staff) worked closely with its local water supply retailers to revise projected water demands on Zone 7's water system, and evaluated both a "baseline" and "faster" growth rate to help account for uncertainty in some of the projections. Figure ES-1 compares the 2015 water demand estimates to both historical water demand and the estimates used in the 2011 WSE.

1 Livermore-Amador Valley, as defined in this report, refers to the cities of Livermore, Pleasanton, and Dublin. Zone 7 also serves, portions of San Ramon referred to as Dougherty Valley under a special agreement Dublin San Ramon Services District.



As shown in Figure ES-1, the 2015 projections are significantly higher than current demands and significantly lower than projections made as part of the 2011 WSE. Water demands in 2014 and 2015 are lower because of the Tri-Valley's successful response to water use reductions put in place by Zone 7 and the local water supply retailers in 2014, and continued through a mandate by the State of California in 2015. The 2015 projections are lower than the 2011 projections due to new recycled water projects and water conservation programs being implemented by the local water supply retailers.

Figure ES-1. Updated Projected Water Demands on Zone 7's Water System



Updated List of Feasible Water Supply Options

As part of the 2011 WSE, Staff worked with the local water supply retailers to develop an extensive list of potential water supply options for the Livermore-Amador Valley. The detailed list was included as Appendix G of the 2011 report. In preparing this update, staff reviewed each water supply option from 2011 and then met with all of its local water supply retailers to discuss which options on the list should be included in potential portfolios for this update and whether others should be added. Staff, with input from the local retailers, reduced the number of options available for building water supply portfolios to include only those that had at least

1,000 AF of supply and did not require end user compliance or ongoing enforcement.^{2,3} Projects with active partnerships (e.g., Bay Area Regional Desalination) were also included. Table ES-1 summarizes the water supply options used in this evaluation.

Table ES-1. Summary of Water Supply Options Used

Water Supply Option	Average Annual Yield, AFA	Average Annual Yield, MGD	Total Unit Cost, \$/AF
California WaterFix (i.e., BDCP or Delta Fix)	18,100 ^(a)	16.2	\$470
Regional Desalination	5,600	5	\$1,500 to \$2,100
Purified Recycled Water	4,800 to 7,770	4.3 to 6.9	\$1,500 to \$2,000

^(a) Incremental average water supply yield from improved SWP reliability if long-term average allocations increase from 48.5% to 71%.

Consideration of Facilities that Reduce Risk of Water Supply Shortage

As part of the 2011 WSE, Staff worked with the local water supply retailers to develop an extensive list of potential facilities or programs that would help reduce the risk of water supply shortages during droughts, Delta outages due to earthquakes or salinity, and emergency conditions (e.g., temporary loss of the South Bay Aqueduct or unplanned water treatment plant shutdowns). The detailed list was included as Appendix G of the 2011 report.

Staff worked with the local water supply retailers to reduce the list to five key facilities or programs. Table ES-2 summarizes the facilities and programs used in this evaluation. Note that the projects listed in Table ES-2 do not change water supply (except for California WaterFix), but help to leverage existing and/or planned water supplies.

² Zone 7 cannot rely on water supply options that require the end user (e.g., homes and businesses) to properly maintain and operate their own system for meeting projected long-term water demands; Zone 7 has no legal authority or funding to enforce the use of such systems.

³ Two examples of water supply options that require end user compliance and not included in portfolio analysis are greywater and rainwater capture systems.

Table ES-2. Summary of Facilities or Programs Used

Facility or Program	Description	Benefit	Estimate Cost, \$M
California WaterFix	Proposed water delivery upgrade for the State and Federal water projects that includes underground tunnels and state of the art fish screens.	In addition to water supply, the underground tunnels will help protect the Tri-Valley's largest source of supply from disruptions due to failure of levees in the Delta during earthquakes, sea level rise, or floods.	\$320
Reliability Intertie (already in CIP)	A 24-inch pipeline connecting Zone 7 with another major water agency.	Allows Zone 7 the opportunity to acquire emergency water supplies during rare events (e.g., earthquake).	\$24
Chain of Lakes Pipeline (already in CIP)	A 36-inch diameter pipeline from Cope Lake to Del Valle Water Treatment Plant (~6 miles) and a 12 MGD pump station.	Allows Zone 7 the ability to recharge the local groundwater basin, help perfect local water rights, and meet demands with stored water in the Chain of Lakes during catastrophic events (e.g., loss of the Delta).	\$32
Los Vaqueros Storage	Program stores a portion of SWP water, typically sent to Cawelo or Semitropic, in Los Vaqueros Reservoir.	Program might shore up available drought and emergency water supplies by providing alternative storage north of Zone 7's service area assuming the SBA is still operating or if the reliability intertie were in place.	\$3.5
Well Master Plan Wells	New wellfields constructed within the Livermore Valley Groundwater Basin	Provides access to additional groundwater storage.	\$53.7

Revised Portfolios

Staff worked with the local water supply retailers to combine the programs and projects listed in Tables ES-1 and ES-2 into four portfolios (Current Plan and Portfolios A through C). Table ES-3 presents each portfolio.

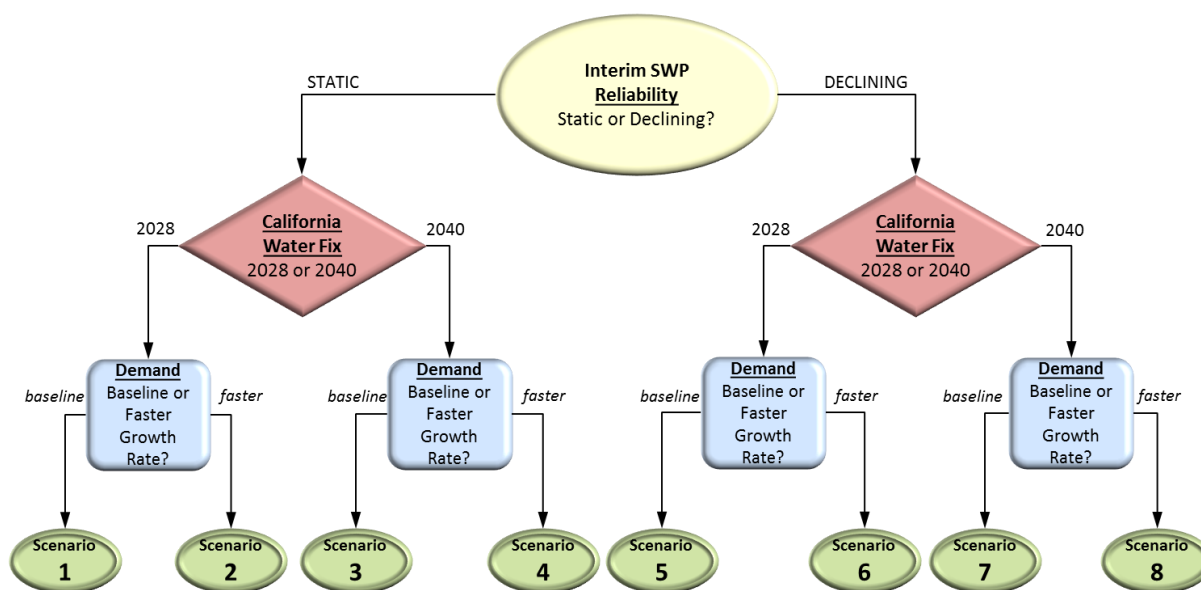
Table ES-3. Programs and Projects Included in Each Portfolio

Option		Portfolio			
		Current Plan	A (Desalination)	B (Purified Recycled Water)	C (Desalination & Purified Recycled Water)
Water Supply Options	California WaterFix (i.e., BDCP or Delta Fix)	✓	✓	✓	✓
	Bay Area Regional Desalination		✓		✓
	Purified Recycled Water			✓	✓
Facilities	Chain of Lakes Pipeline	✓	✓	✓	✓
	Reliability Intertie	✓	✓	✓	✓
	Well Master Plan Wells	✓	✓	✓	✓
	Los Vaqueros Storage		✓	✓	✓

Eight Scenarios used for Analysis

Although the future yield from Zone 7's existing water supplies depend on many variables, three have the largest influence on determining future water supply needs: (1) interim reliability of the State Water Project until completion of the California WaterFix; (2) timing of the California WaterFix; and (3) projected water demands. Unlike the analysis completed in 2011, which looked at a static interim reliability of the State Water Project, a defined year for completion of the California WaterFix, and one set of projected water demands, this update used an expanded approach, evaluating several different outcomes for all three conditions. As shown in Figure ES-2, this resulted in eight scenarios.

Figure ES-2. Scenarios Used for Portfolio Analysis



Five Core Metrics and Three Lower Priority Metrics

Three key components within Zone 7's core mission are water supply reliability (i.e., reducing the risk of water shortages), managing the Livermore-Valley Groundwater Basin (i.e., local groundwater storage), and being fiscally responsible (i.e., considering and managing costs). Consequently, in addition to shortage, groundwater supply, and costs, which were included in the 2011 WSE, Staff added average reliability and minimum supply. Table ES-4 presents the core metrics used for this evaluation.

Table ES-4. Core Mission Metrics Used to Evaluate Portfolios

Metric	Description	Relation to Zone 7's Core Mission
Average Reliability	Average percent of demand met over all hydrologic conditions	The frequency Zone 7's system experiences no shortages indicates the benefits to reliability provided by a portfolio
Rare Large Shortages	Largest percent of unmet demand during major events (e.g., drought or loss of SBA)	The estimated magnitude of the rarest and largest shortages indicates how well a portfolio can reliably meet demands during extreme situations
Minimum Water Supply	Smallest per capita demand met during major events (e.g., drought or loss of SBA)	The estimated minimum supply indicates how well a portfolio can reliably meet demands during extreme situations
Average Groundwater Storage	Average percent full over all hydrologic conditions	The amount of available groundwater storage helps gage the success of a portfolio to help manage the local groundwater basin
Costs	Estimated total amortized dollars	Costs help identify the most fiscally prudent portfolios

Based on discussions at the Water Policy Roundtables, and in follow up discussions with the local water supply retailers, three other, lower priority metrics were also identified: Local Control, Diversification, and Energy Use. These three metrics are not considered core to Zone 7's mission but instead, provide additional information to help contrast the performance of each portfolio. Table ES-5 presents the three lower priority metrics used.

Table ES-5. Lower Priority Metrics Used to Evaluate Portfolios

Metric	Description
Diversification	The percentage of non-State Water Project water supplies within a water supply portfolio.
Local Control	The Largest percentage of total long-term average water supply under local control. Local control was defined as within the San Francisco Bay Area.
Energy Use	The Estimated long-term average energy use in Megawatt-Hours per year.

Results of the Portfolio Analysis

Table ES-6 presents the average calculated benefit for each portfolio across all eight scenarios, along with the estimated cost per unit of water demand. As shown in Table ES-5, Portfolios A through C have a higher benefit in all categories except cost. The additional unit cost of Portfolios A through C is 61% to 150% higher than the Current Plan. A significant investment would be required to implement any of those Portfolios. Table ES-5 also shows that although both local control and diversification can nearly double with Portfolios A through C, externally controlled SWP water supplies will continue to make up a majority (~70%) of total long-term average water supplies.

Table ES-6 also indicates that energy use could increase by 20% to 50% over the Current Plan if desalination, purified recycled water, or both are added to future water supply portfolios. This large increase in energy use could make Zone 7's future operational costs susceptible to increases associated with potential future energy cost increases or reliability, and could drastically increase Zone 7's carbon footprint.

Table ES-6. Summary of Benefits Provided by Each Portfolio

Metric		Comparative Target	Portfolio			
			Current Plan	A (Desalination)	B (Purified Recycled Water)	C (Desalination & Purified Recycled Water)
Core to Zone 7's Mission	Average Reliability <i>% of demand, average of all hydrologic conditions</i>	≥ 98%	98%	99.3%	99.5%	99.8%
	Rare Large Shortages (1% of the time) <i>average % rationing required</i>	≤ 61%	65%	50%	46%	32%
	Rare Minimum Supply (1% of the time) <i>average gallons per capita per day</i>	≥ 55 GPCD	39	65	72	96
	Average Groundwater <i>% Full</i>	≥ 80%	75%	80%	85%	89%
	Costs	Capital, \$ M	\$192	\$268	\$345	\$417
		O&M, \$ M/year	\$1.3	\$5.7	\$6.4	\$10.1
		Amortized, \$ M/year	\$16	\$25	\$31	\$39
		Additional Unit Cost, \$/AF of demand	\$260	\$420	\$510	\$650
Lower Priority	Local Control, % locally controlled		11%	18%	21%	26%
	Diversification, % diversified		12%	19%	21%	27%
	Energy Use, MWH/year		81,370	98,170	102,349	119,149

Additionally, a detailed review, by scenario, indicates that the Current Plan performs well in scenarios where the California WaterFix is not delayed or the interim SWP Reliability does not



decline. Consequently, future investments in Portfolios A through C, which might not be available for 6 to 7 years (i.e., around 2022), may only provide 6 to 10 years of “reliability” insurance if the California WaterFix is completed anywhere between 2028 to 2032, and if interim SWP reliability does not decline.



1.0 PURPOSE & OBJECTIVES

In July 2011, Zone 7 Water Agency (Zone 7) completed an evaluation of its long-term water supply (2011 WSE) to provide background and facilitate preparation of Zone 7's Urban Water Management Plan (UWMP) and other agency planning efforts. The key assumptions, approach, analysis, and results were discussed with the Livermore-Amador Valley's local water supply retailers. Many of the projects and recommendations from that report were incorporated into Zone 7's Fiscal Year 15/16 Capital Improvement Program (CIP), and are actively being implemented by both Zone 7 and the local water supply retailers.

In early January 2014, Staff learned that all pumping from the Sacramento-San Joaquin Delta (Delta) could be stopped due to severe, persistent, and record drought conditions. California Governor, Jerry Brown, declared a Drought State of Emergency on January 17, 2014, and requested voluntary conservation of 20%.

Under a Delta pumping outage, the Livermore-Amador Valley would have no water supply coming from the South Bay Aqueduct, and would be limited to previously stored surface water in the local groundwater basin or water available in Lake Del Valle. In January 2014, about 60% of operational storage was available in the groundwater basin and Lake Del Valle was not full.

For the first time in its history, Zone 7 was facing a potential water supply crisis. Consequently, Zone 7's Board of Directors declared a local drought state of emergency on January 29, 2014, and requested that the local water supply retailers and untreated customers reduce their water use by 25% under Stage 2 Actions defined in its 2010 UWMP. Governor Brown subsequently mandated water use reductions in April 2015. Through an amazing effort by the entire Livermore-Amador Valley, Zone 7 saw a 28.6% reduction in total water demand (treated and untreated) in 2014, and a 39% reduction in total water demand in 2015.

The conditions that led to requiring Stage 2 water use reductions in 2014 underscored the need to update key assumptions made in the 2011 WSE. The purpose of this update is to document Zone 7 Water Agency's revised assumptions, approach, and recommendations based on new information and experience gained over the past two years, which will facilitate completion of its 2015 UWMP and other future planning efforts.⁴

⁴ Note that this analysis focuses on long-term strategies for managing future uncertainty. Zone 7 evaluates near-term (5-year outlook) reliability and needs every year as part of the Annual Sustainability Report.



2.0 DESCRIPTION OF ZONE 7 WATER AGENCY AND ITS SERVICE AREA

Zone 7 is a public agency that supplies both municipal and agricultural water, manages the local groundwater basin, and provides flood control services for the Livermore-Amador Valley. This chapter provides an overview of the history and primary functions of Zone 7, along with a description of the area served.

2.1 ZONE 7 WATER AGENCY: HISTORY AND PRIMARY FUNCTION

The Alameda County Flood Control and Water Conservation District (District) was created in 1949 by the California State Legislature to provide control of flood and storm waters and to conserve water for beneficial uses in ten zones in Alameda County. The District is also vested with the power to store water in surface or underground reservoirs within or outside of the District for the common benefit of the District; conserve and reclaim water for present and future use within the District; appropriate and acquire water and water rights; and import water into the District.

The District is further authorized by the District Act to prevent interference with or diminution of, or to declare rights, in the natural flow of any stream or surface or subterranean supply of waters used or useful for any purpose of the District. Additionally, the District has the authority to prevent contamination that would render surface or subsurface water unfit for beneficial use in the District and to levy replenishment assessments upon the production of groundwater from all water-producing facilities, whether public or private, within the District.

In the mid-1950s, the Livermore-Amador Valley—designated as Zone 7 of the District—was primarily rural in character, with a population of approximately 30,000 people. The area faced a number of problems, including groundwater overdraft, poor drainage and flood hazards, and uncertainty over the status of future water supplies. It was against this backdrop that the residents of the Livermore-Amador Valley voted, in 1957, to create Zone 7 as a separate agency governed by a seven-member board of directors (Zone 7 Board). Each director is elected at-large by residents within Zone 7's service area to a four-year term. The Zone 7 Board sets policy and provides direction to agency management and staff.

In 2003, the legislature passed Assembly Bill 1125 and gave the Zone 7 Board full authority and autonomy to govern matters solely affecting Zone 7 independently of the District's governing body, the Alameda County Board of Supervisors, which governs the other zones of the District.



2.1.1 Key Management and Administrative Activities

Zone 7's key functions include:

- providing treated and untreated water supply;
- monitoring and protecting surface water and groundwater quality;
- operating and maintaining a water treatment and transmission system; and
- managing regional flood and storm water for public safety and protection of property.

Under Zone 7's Groundwater Management Program, Zone 7 also administers oversight of the local groundwater basin, the Livermore Valley Groundwater Basin, and prevents groundwater overdraft. The Main Basin is the portion of the Livermore Valley Groundwater Basin that contains high-yielding aquifers and good quality groundwater. Within this capacity, Zone 7 monitors groundwater extractions and imports water to both artificially recharge the Main Basin (thereby supplementing natural recharge) and to provide water to Retailers and other users (thereby reducing pumping demands on the Main Basin). Zone 7's groundwater management policies and programs are described in the Groundwater Management Plan (GMP). Every year Zone 7 completes an annual report for its Groundwater Management Program. The most recent report was completed in May 2015 for the 2014 water year. Additionally, as part of the Groundwater Management Bill (SB 1168) passed in 2015, Zone 7 was named, by statute, the local groundwater sustainability agency for the Livermore Valley Groundwater Basin.

2.1.2 Wholesale Water Supply

This WSE update focuses on Zone 7's key function as a water wholesaler for the Livermore-Amador Valley, also known as the Tri-Valley Area. Zone 7 supplies untreated water for agriculture and golf courses, and treated drinking water to four retail water supply agencies (Retailers):

- California Water Service Company (Cal Water),
- Dublin San Ramon Services District (DSRSD),
- City of Livermore (Livermore), and
- City of Pleasanton (Pleasanton).

These Retailers deliver water for municipal and industrial (M&I) purposes within their individual service areas. While the Retailers represent most of the demand on Zone 7's system, Zone 7 also sells treated water directly to smaller customers.

2.2 SERVICE AREA

Zone 7's water service area is located about 40 miles south-east of San Francisco, and encompasses an area of approximately 425 square miles of the eastern portion of Alameda County, including the Livermore-Amador Valley, Sunol Valley, and portions of the Diablo Range. Zone 7's service area also overlies the Alameda Creek Watershed. This watershed encompasses almost 700 square miles, and extends from Altamont Pass to the east, San Francisco Bay to the west, Mount Diablo to the north, and Mount Hamilton to the south.

2.2.1 Major Streams and Arroyos in the Service Area

Some of the major streams in Zone 7's service area include the Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, Alamo Canal, South San Ramon Creek, Tassajara Creek, and Arroyo de la Laguna. These are all part of the Northern Alameda Creek Watershed (see Figure 2-1). Both the Arroyo Valle and Arroyo Mocho originate in the woodland forests of the Burnt Hills region in Santa Clara County, in the sub-watershed above Lake Del Valle. The Arroyo Valle and Arroyo Mocho have the largest drainage areas within the Zone 7 service area.

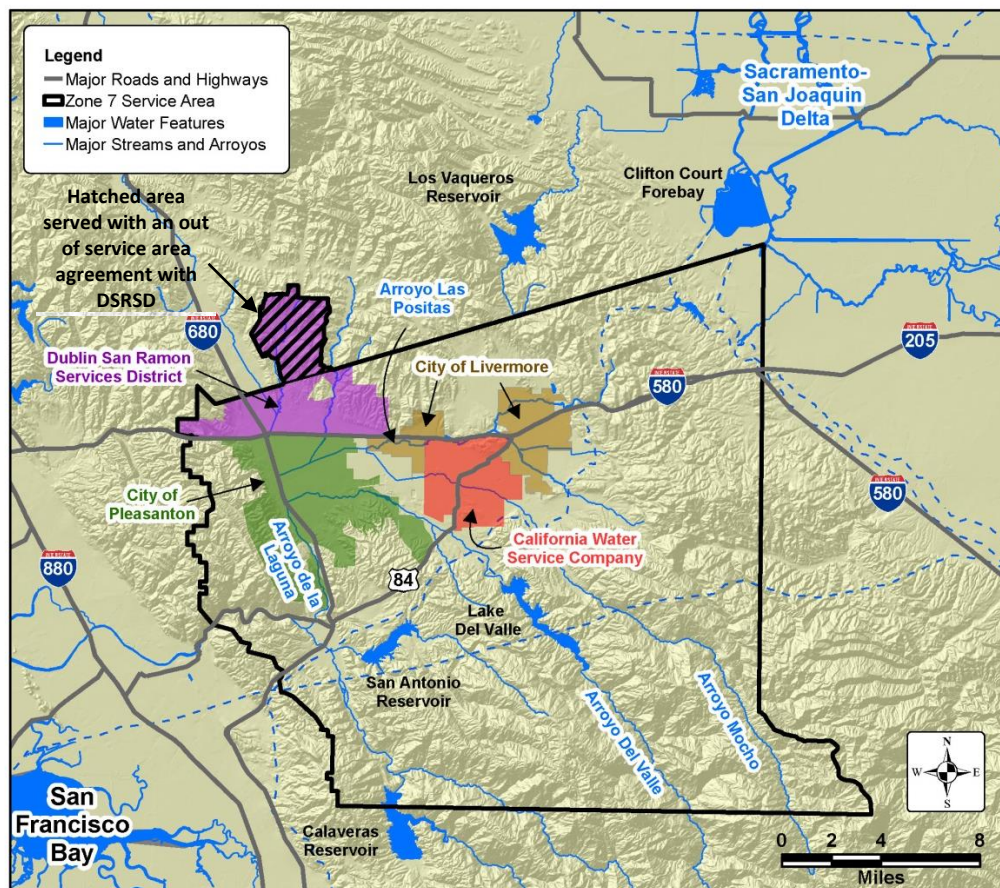
The Arroyo Valle flows into Lake Del Valle above Lang Canyon, and then continues its journey below the Del Valle Dam and flows westerly through a regional park on the southern border of Livermore and reaches Pleasanton. The Arroyo Valle then flows southwesterly through the historical downtown area of Pleasanton and joins the Arroyo de la Laguna. It is used by Zone 7 for groundwater recharge.

The Arroyo Mocho remains a natural waterway as it flows southwest through the oak woodlands east of Livermore, and then flows through the southern portion of Livermore; from there, it becomes an improved channel and proceeds through the gravel mining area west of Livermore and meets the Arroyo Las Positas in Pleasanton. This stream is also a major component of Zone 7's groundwater recharge program. At the request of Zone 7, the Department of Water Resources (DWR) releases water into both Arroyo Mocho and Arroyo Valle for groundwater recharge purposes, also providing secondary aesthetic and environmental benefits.

The Arroyo Las Positas mainly flows westerly along I-580, and is fed by the Arroyo Seco, Altamont Creek, Cayetano Creek, Collier Canyon Creek, and Cottonwood Creek. In northeast Pleasanton, the Arroyo Las Positas joins the Arroyo Mocho, where the streambed becomes a wide, trapezoidal-shaped flood control channel. The Arroyo Mocho then flows into the Arroyo de la Laguna, which is a tributary of Alameda Creek.



Figure 2-1. Location of Service Area and Major Streams and Arroyos



2.3 EXISTING WATER USE SECTORS

Zone 7's service area is home to a diverse, vibrant, and rapidly growing community that supports a population of approximately 245,215 and a myriad of vital and dynamic commercial, agricultural, and industrial enterprises. The eastern reaches of Zone 7's service area include oil wells and acres of energy-generating windmills, while other areas include large employers such as Oracle, Providian Financial, SAP, and Lawrence Livermore National Laboratory (LLNL). The area also supports a number of award-winning wineries. Industrial water use is not a major component of water use in the area but industrial users do exist, such as Clorox Services Company (chemical company), Roche Molecular Systems (medical research and development), and A-1 Enterprise (waste hauler).

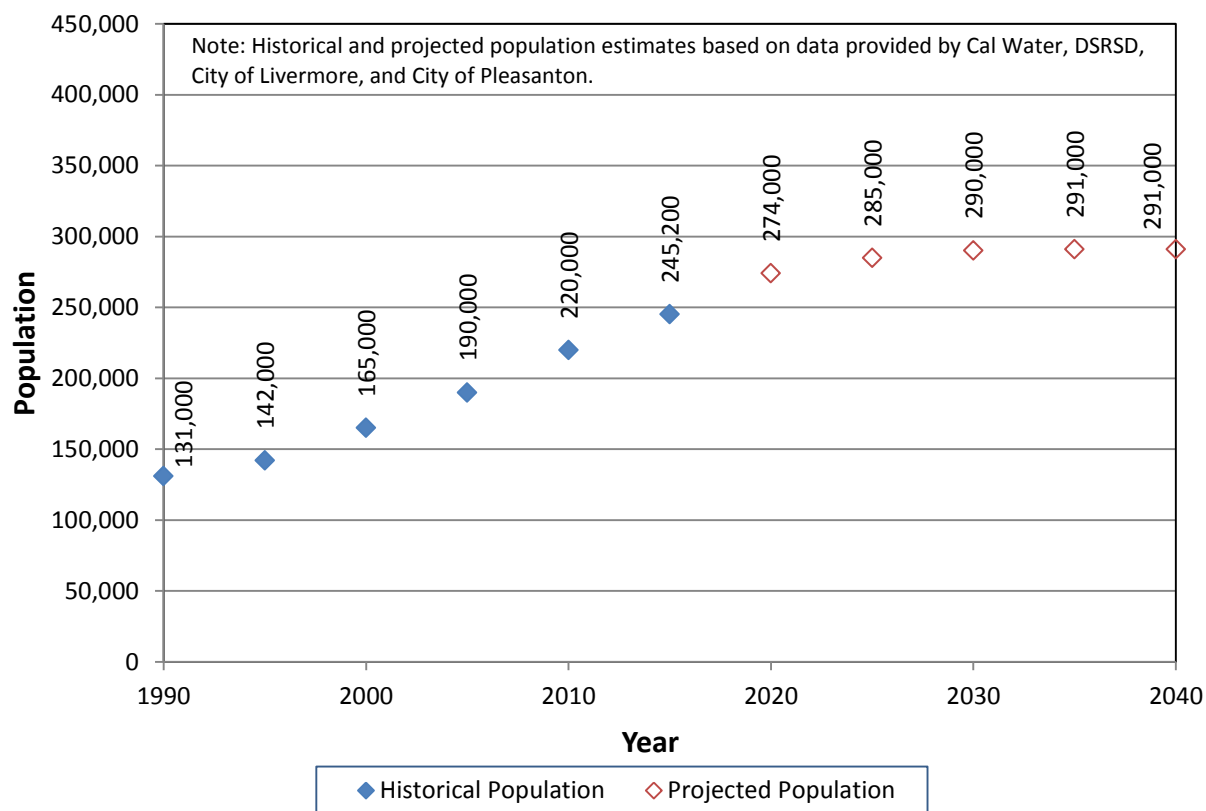
In addition to supplying treated water, Zone 7 also supplies raw or untreated water for agricultural purposes to 3,500 acres, primarily consisting of vineyards in the southern portion of Livermore. Agriculture in the Livermore area also produces olives, pistachios, and prime beef.

Seven direct retail customers are also served by Zone 7; they represent a small percentage of demand.

2.4 POPULATION GROWTH

As shown on Figure 2-2, the population within Zone 7's service area increased 47% between 1990 and 2015, and is projected to grow by another 19% by 2040, from 245,200 in 2015 to 291,000; a majority of the projected growth occurs within the next 10 years.

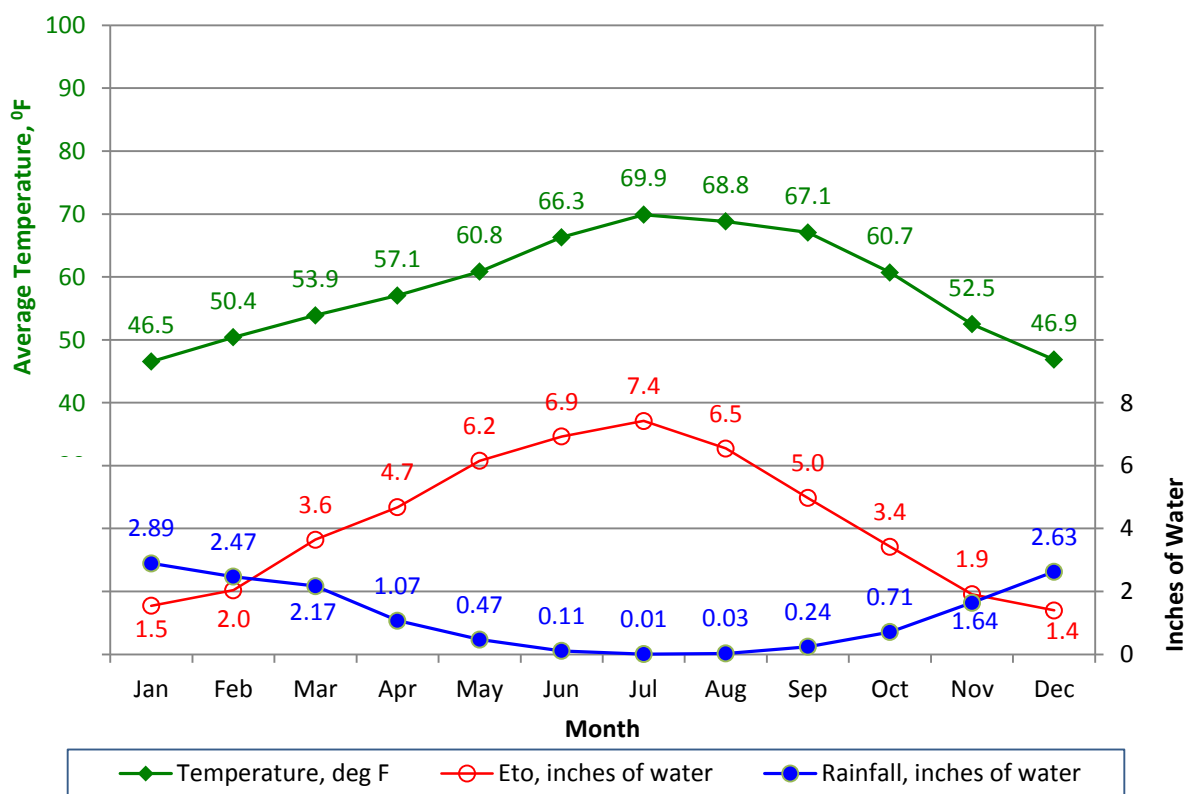
Figure 2-2. Historical and Projected Population within Zone 7's Service Area



2.5 CLIMATE

The climate within Zone 7's service area is best described as Mediterranean, characterized by hot, dry summers and cool, moist winters. Figure 2-3 provides data for average temperatures, rainfall, and evapotranspiration rates (Eto) within Zone 7's service area over the year. Average annual precipitation is approximately 14.4 inches of water, while total evapotranspiration is approximately 50 inches of water; average monthly temperatures vary from 46 to 70 degrees Fahrenheit throughout the year.

Figure 2-3. Climate Data for the Zone 7 Service Area



3.0 WATER DEMANDS

The purpose of this chapter is to describe the historical and projected water demands used for the analysis completed in this WSE update, including assumptions regarding water conservation and other forms of demand reduction, for Zone 7.

3.1 HISTORICAL WATER DEMANDS SERVED BY ZONE 7

Historically, treated water provided to water supply retailers have represented, on average, 86% of the demand on Zone 7's water supply system. Raw or untreated water served to agricultural customers make up most of the remaining 14% of demand; treated water served directly to several smaller customers represents a minor fraction. Water losses through Zone 7's treated water transmission system also exert a small but significant demand (2-6%) on Zone 7's water supplies; these system losses have historically been referred to as "unaccounted-for water".

Table 3-1 presents historical water demands met by Zone 7 within its service area between 1990 and 2014, while Table 3-2 presents the historical M&I per capita demand served by Zone 7 and the Retailers (includes all groundwater pumping). M&I demand is derived by subtracting untreated surface water demand from the total water demand that includes groundwater pumping quotas (GPQs) listed in Table 3-1.⁵

As shown in Table 3-1, water served by Zone 7 increased by 64.3% between 1990 and 2013, while Table 3-2 shows that the total population increased by 79.4% over the same period. Table 3-1 also show that water demands decreased by 28.5% relative to 2013 in 2014 due to the Livermore-Amador Valley's incredible response to the local and statewide drought emergency. Preliminary estimates indicate Zone 7's water demands in 2015 will likely be nearly 40% lower than 2013 water demands. Table 3-1 also indicates that unaccounted-for water has ranged from approximately 2 to 6% of Zone 7's total water demand since 2003, and that when including water pumped directly by three of the four retailers from the Main Basin as part of their (GPQs, the total demand in the Livermore-Amador Valley has increased by 54.6% from 1990 to 2013. Total demand in the Livermore-Amador Valley decreased by 25.1% relative to 2013 in 2014.

As shown in Table 3-2, per capita demands have stayed above the historical average of 205 gallons per capita per day (gpcd) between 1996 and 2008, but there has been a downward

⁵ Note that Table 3-1 does not include any recycled water served by the Retailers to meet outdoor water use. Please see the individual 2015 Urban Water Management Plans for each Retailer for recycled water information.

trend between 2009 and 2013 due to a combination of water conservation measures, economic recession, and drought. Table 3-2 also shows that 2014 has a significantly lower per capita demand; this is due to the Tri-Valley's aggressive response to the local and statewide drought emergency in 2014.

Figure 3-1 compares historical M&I per capita demand to precipitation, which is used as an inverse indicator of outdoor water demands. As shown, the demand pattern is generally responsive to the pattern of precipitation: that is, with an increasing rainfall trend, there is a decreasing trend in water demand.



Table 3-1. Historical Water Demand in the Zone 7 Service Area, acre-feet

Year	Total Municipal and Industrial Water Use Served by Zone 7				Untreated Water for Agriculture ^(d)	Total Demand on Zone 7	Retailer Pumping (GPQs)	Total Water Demand
	Retailers ^(a)	Zone 7 Retail ^(b)	UAFW ^(c)	Total				
1990	23,869	1,070	1,876	26,815	3,170	29,985	5,882	35,867
1991	14,831	500	754	16,085	1,845	17,930	9,730	27,660
1992	20,714	1,010	1	21,725	2,344	24,069	6,447	30,516
1993	23,926	1,200	59	25,185	1,782	26,967	4,146	31,113
1994	22,734	680	691	24,105	1,985	26,090	6,598	32,688
1995	28,519	1,190	316	30,025	3,481	33,506	1,819	35,325
1996	29,901	790	4	30,695	4,329	35,024	2,920	37,944
1997	28,802	780	63	29,645	6,287	35,932	7,602	43,534
1998	26,640	510	5	27,155	4,370	31,525	7,573	39,098
1999	32,292	240	3	32,535	5,607	38,142	6,934	45,076
2000	34,632	270	423	35,325	5,899	41,224	6,826	48,050
2001	36,601	320	24	36,945	4,845	41,790	7,237	49,027
2002	38,176	260	4	38,440	3,523	41,963	6,981	48,944
2003	38,169	370	1,321	39,860	3,359	43,219	6,911	50,130
2004	42,371	770	819	43,960	3,422	47,382	6,573	53,955
2005	38,912	282	1,676	40,870	3,309	44,179	6,583	50,762
2006	40,414	316	1,064	41,794	3,488	45,282	6,581	51,863
2007	43,132	312	1,940	45,384	3,642	49,026	6,434	55,461
2008	42,982	270	1,649	44,901	4,164	49,065	6,026	55,091
2009	38,083	233	1,900	40,216	4,920	45,136	6,569	51,705
2010	35,174	133	2,232	37,539	3,771	41,310	6,605	47,915
2011	35,956	165	2,366	38,487	3,923	42,410	6,319	48,729
2012	38,261	168	1,279	39,708	5,540	45,248	6,712	51,960
2013	41,313	178	1,601	43,093	6,174	49,267	6,183	55,450
2014	28,711	199	1,706	30,617	4,630	35,247	6,308	41,554
Historical Average	33,005	489	951	34,444	3,992	38,437	6,340	44,777
% Increase: 1990 to 2013						64.3%		54.6%
% Decrease: 2013 to 2014						28.5%		25.1%

^(a) Data collected from the Retailers and from the Zone 7 databases. Includes groundwater pumping quota for DSRSD, but not for the other retailer since Zone 7 pumps DSRSD's quota for them.

^(b) Zone 7 directly serves six customers with potable water. Data based on historical records.

^(c) Unaccounted-for water (UAFW) is based on the difference between total production and actual deliveries. Production is water purchased from the State Water Project plus Zone 7 groundwater pumping minus brine concentrate losses (beginning in 2009 when the demineralization facility started operating).

^(d) Zone 7 serves approximately 3,500 acres of agricultural demand with untreated surface water.



Table 3-2. Historical Municipal and Industrial Per Capita Water Demands in the Zone 7 Service Area

Year	Total Municipal and Industrial (M&I) Demand in the Service Area, acre-feet^(a)	Total M&I Demand in the Service Area, gallons per day^(a)	Total Population^(b)	M&I Per Capita Demand, gpcd	Precipitation, inches^(d)
1990	32,697	29,188,012	131,000	223	9.4
1991	25,815	23,044,577	132,000	175	11.3
1992	28,172	25,148,627	135,000	186	11.6
1993	29,331	26,183,245	138,000	190	21.3
1994	30,703	27,408,005	140,000	196	11.8
1995	31,844	28,426,554	142,000	200	21.3
1996	33,615	30,007,493	144,000	208	20.0
1997	37,247	33,249,713	148,000	225	15.1
1998	34,728	31,001,048	154,000	201	25.3
1999	39,469	35,233,252	159,000	222	13.1
2000	42,151	37,627,424	165,000	228	14.1
2001	44,182	39,440,460	174,000	227	11.0
2002	45,421	40,546,493	176,000	230	11.2
2003	46,771	41,751,613	181,000	231	17.0
2004	50,533	45,109,882	185,000	244	13.1
2005	47,453	42,360,422	190,000	223	19.3
2006	48,375	43,183,475	199,000	217	17.5
2007	51,819	46,257,870	204,000	227	9.7
2008	50,927	45,461,598	211,000	215	10.7
2009	46,785	41,764,111	216,000	193	11.4
2010	44,144	39,406,590	220,000	179	14.8
2011	44,806	39,997,227	225,000	178	16.2
2012	46,420	41,438,666	230,000	180	8.8
2013	49,276	43,987,584	235,000	187	10.7
2014	36,924	32,961,782	240,000	137	6.8
Historical Average			178,960	205	14.1
% Increase: 1990 to 2013			79.4%	-16.1%	
% Decrease: 2013 to 2014			-2.1%	26.7%	

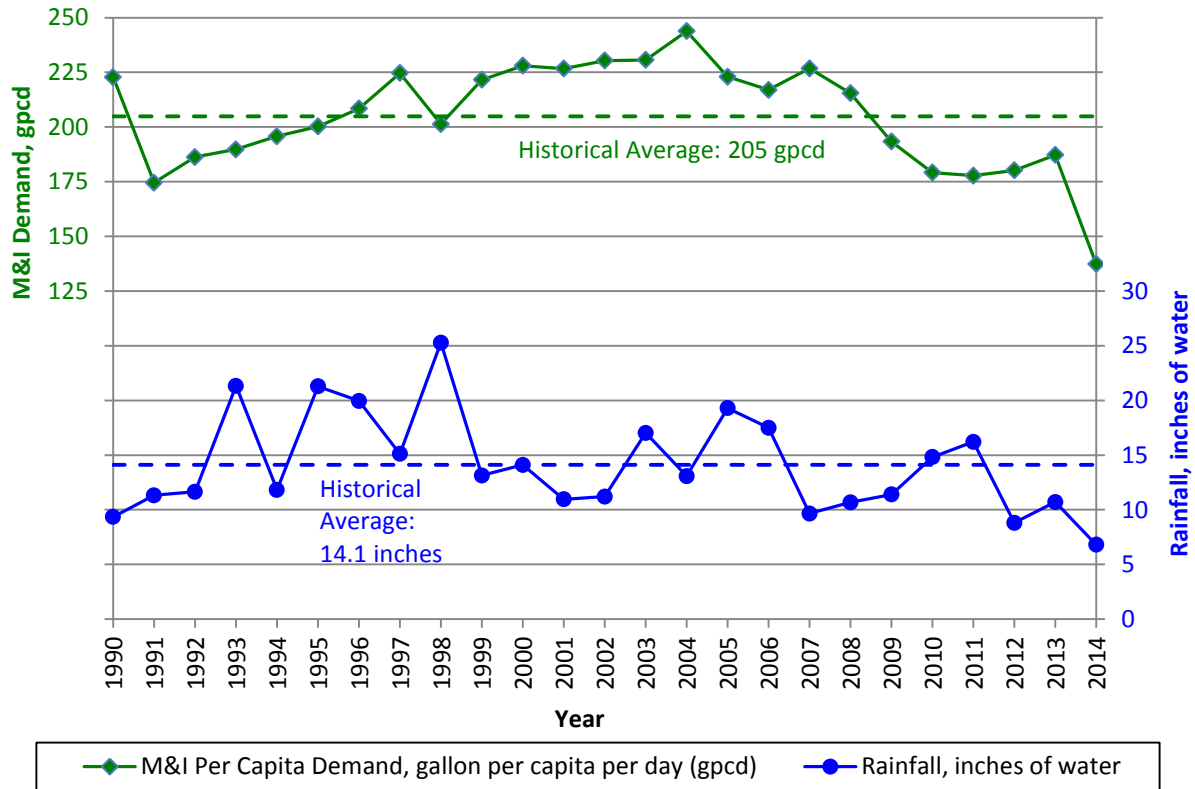
^(a) Obtained from Table 3-1, total water demand (including GPQ) minus untreated water

^(b) Data provided by the Retailers.

^(c) Source: Zone 7's Groundwater Management Annual Review for WY 2014



Figure 3-1. Comparison of Historical Municipal and Industrial (M&I) Per Capita Demand to Rainfall



3.3 PROJECTED WATER DEMANDS

Projected water requirements for Zone 7 were estimated by evaluating demands from the Retailers, Zone 7's retail customers, and untreated water customers. Demands were also adjusted for projected unaccounted-for water. Each of these factors is discussed in more detail below.

3.3.1 Treated Water Retailer Demands

Zone 7 obtained projected water demands from each of the retailers through a series of stakeholder and one-on-one meetings. Zone 7 staff met with and collected water demand and supply information from the four retailers in February and March 2015.

Retailer water demands consist of three components: treated water supplied by Zone 7, groundwater pumped by the Retailers under their GPQ and recycled water. Table 3-3 presents the amounts of water supply required from Zone 7 by the Retailers. These amounts include compliance with the Water Conservation Act of 2009 (i.e., SBX 7-7 or 20% by 2020) and do not include groundwater pumped by three of the four retailers under their GPQ to meet the rest of

their demands: Cal Water (3,069 Acre-feet annually [AFA]), Pleasanton (3,500 AFA), and Livermore (31 AFA). Zone 7 pumps DSRSD's GPQ of 645 AFA and this amount is included in the table. DSRSD, Livermore, and Pleasanton currently produce recycled water to supplement their water supplies; recycled water demands are not included in the table. The water demand projections presented in Table 3-3 already account for the Retailers water conservation efforts.

As shown in Table 3-3, Zone 7 staff and the Retailers assumed that water demands would recover to approximately 80% of 2013 demands in 2016 (32,567 acre-feet [see Table 3-3] versus 41,313 acre-feet [see Table 3-1]).



Table 3-3. Projected Treated Water Demands from Retailers, acre-feet

Year	Demands from Zone 7, AF					GPQs, AF ^(a)	Total Potable Demands in the Service Area, AF
	Cal Water	DSRSD	Livermore	Pleasanton	TOTAL		
2016	6,663	9,448	5,386	11,070	32,567	6,569	39,136
2017	8,260	12,480	6,230	10,160	37,130	6,569	43,699
2018	8,150	12,900	6,540	11,900	39,490	6,569	46,059
2019	8,030	13,440	6,770	11,910	40,150	6,569	46,719
2020	7,910	14,490	6,910	11,940	41,250	6,569	47,819
2021	7,800	15,120	6,980	11,980	41,880	6,569	48,449
2022	7,970	15,450	7,050	12,140	42,610	6,569	49,179
2023	8,150	15,800	7,120	12,290	43,360	6,569	49,929
2024	8,330	16,080	7,190	12,450	44,050	6,569	50,619
2025	8,500	16,340	7,260	12,600	44,700	6,569	51,269
2026	8,680	16,570	7,320	12,760	45,330	6,569	51,899
2027	8,720	16,740	7,370	12,910	45,740	6,569	52,309
2028	8,760	16,840	7,410	13,070	46,080	6,569	52,649
2029	8,800	16,890	7,460	13,220	46,370	6,569	52,939
2030	8,840	16,920	7,500	13,380	46,640	6,569	53,209
2031	8,880	16,950	7,540	13,530	46,900	6,569	53,469
2032	8,880	16,950	7,540	13,700	47,070	6,569	53,639
2033	8,880	16,950	7,540	13,880	47,250	6,569	53,819
2034	8,880	16,950	7,540	14,050	47,420	6,569	53,989
2035	8,880	16,950	7,540	14,220	47,590	6,569	54,159
2036	8,880	16,950	7,540	14,390	47,760	6,569	54,329
2037	8,880	16,950	7,540	14,570	47,940	6,569	54,509
2038	8,880	16,950	7,540	14,740	48,110	6,569	54,679
2039	8,880	16,950	7,540	14,910	48,280	6,569	54,849
2040	8,880	16,950	7,540	15,080	48,450	6,569	55,019
2041	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2042	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2043	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2044	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2045	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2046	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2047	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2048	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2049	8,880	16,950	7,540	15,260	48,630	6,569	55,199
2050	8,880	16,950	7,540	15,260	48,630	6,569	55,199

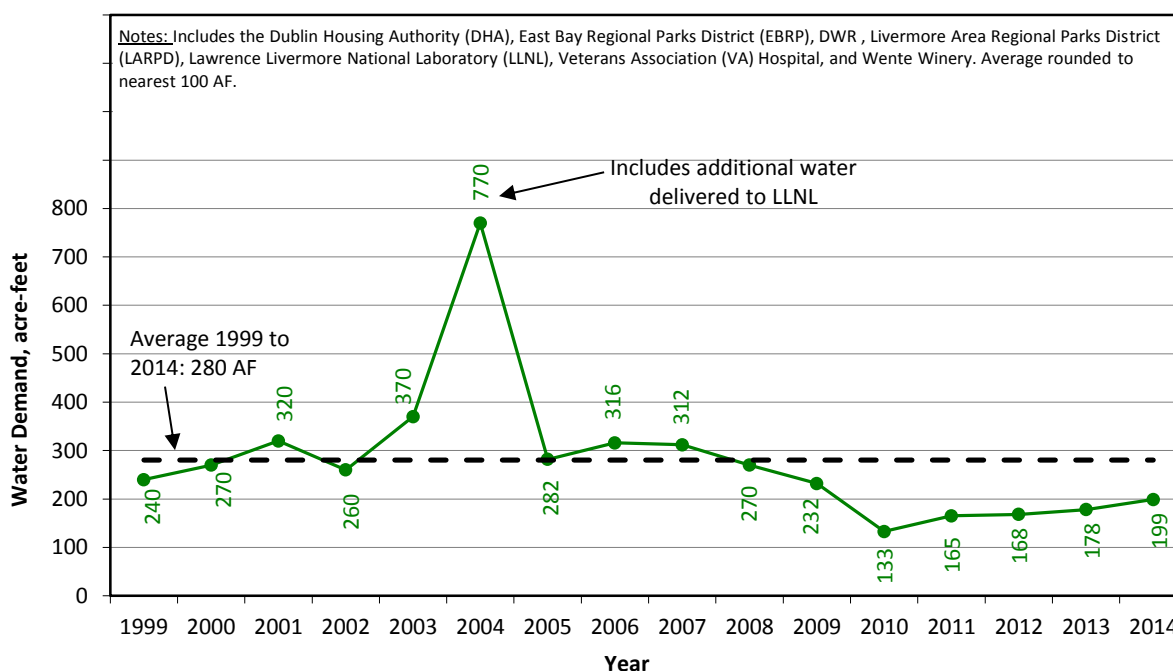
^(a) Includes Cal Water (3,069 AF) and Pleasanton (3,500 AF). DSRSD is included in their demand estimate.

3.3.2 Zone 7 Direct Demands

Zone 7 provides treated water directly to a number of smaller customers within the service area. These customers currently include the East Bay Regional Parks District (EBRPD), DWR, Livermore Area Regional Parks District (LARPD), LLNL, Veterans Association (VA) Hospital, and Wente Winery.

Figure 3-2 illustrates the historical water demand from Zone 7's direct customers between 1999 and 2014. As shown on Figure 3-2, water demand for these direct retail customers has been relatively steady and below average for the past five years with the exception of 2004. The spike in water demand in 2004 is the result of additional water supplied to LLNL resulting from an interruption in supplies normally provided to LLNL by the San Francisco Public Utilities Commission.

Figure 3-2. Historical Zone 7 Direct Customer Demand, acre-feet



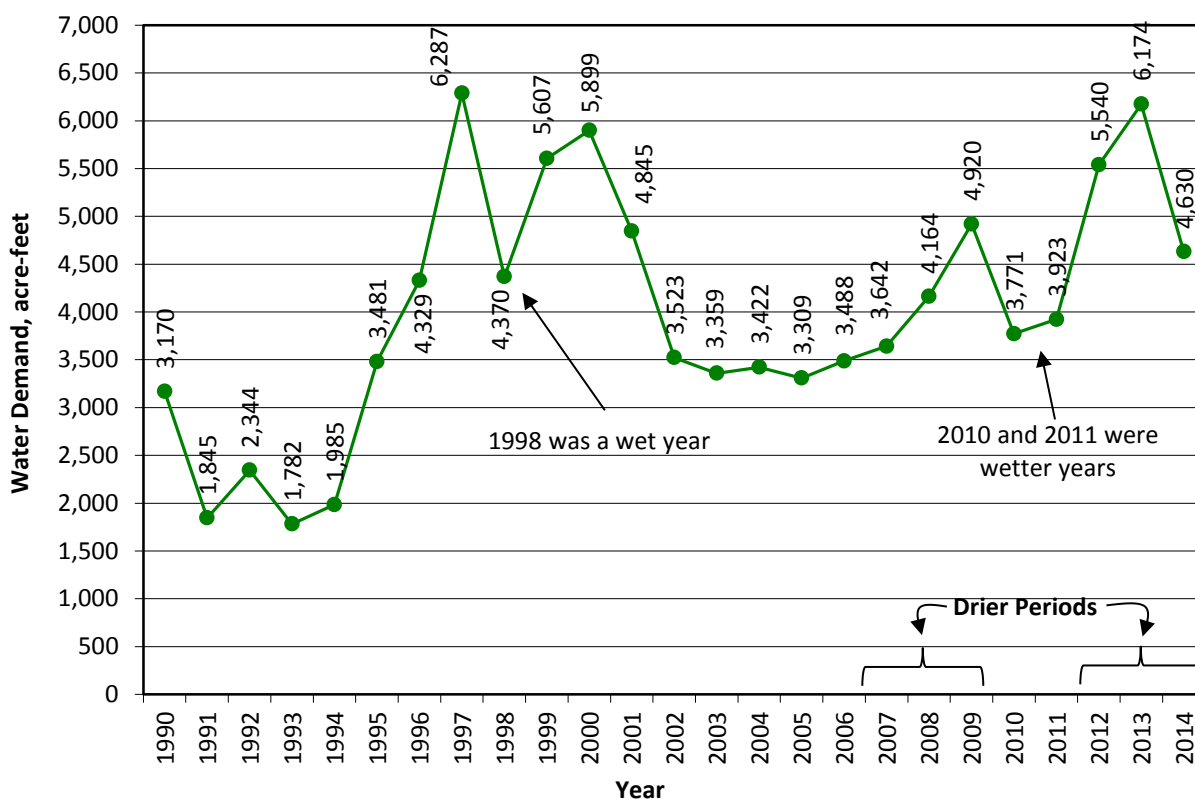
For planning purposes in this analysis, Zone 7 staff assumed that the long-term (2016-2050) water demands for Zone 7's direct customers would be equal to the average demand observed from 1999 to 2014, which is approximately 300 AF after rounding to the nearest 100 AF. The additional water demand spike resulting from LLNL is relatively infrequent, and can likely be accommodated using existing facilities, if necessary.

3.3.3 Zone 7's Untreated Water Demands

Zone 7 currently supplies untreated surface water directly to seven “turnout” irrigation customers through eleven South Bay Aqueduct (SBA) turnouts. These seven turnout customers in turn serve another 74 indirect irrigation customers.

Figure 3-3 presents historical untreated water demands between 1990 and 2014. As shown on Figure 3-3, untreated water demands vary over this period. Increases and decreases are typically associated with available rainfall. The one exception, 2014, is lower despite low rainfall due to local agriculture’s response to conservation requests from Zone 7 under the current local and statewide drought emergency.

Figure 3-3. Historical Zone 7 Untreated Water Demand



Based on actual 2013 water use and current delivery requests, and the fact that it similar demands were observed in 1997, this update conservatively assumes untreated water demands will remain constant at approximately 6,200 AFA over the next five years. However, Zone 7 has existing contractual obligations up to 8,250 AFA (or 8,300 AFA after rounding to the nearest 100 AFA); it is unknown when untreated water demands could increase to 8,300 AF. Consequently, for planning purposes, it was assumed that untreated water demand would increase linearly from 6,200 AF starting in 2023 to 8,300 AF by 2031 and remain at that level through 2050. Table 3-4 presents the projected supply required for Zone 7’s untreated water customers.

Table 3-4. Projected Demands from Zone 7's Untreated Water Customers

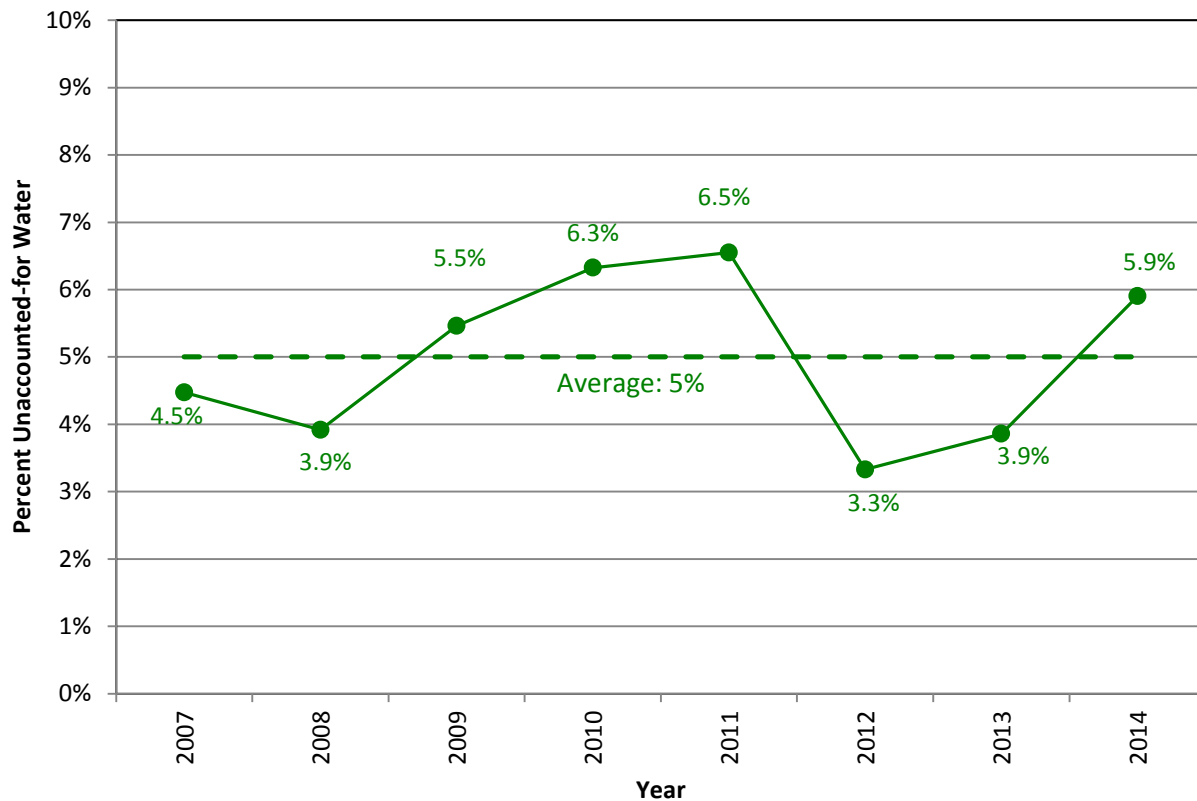
Year	Untreated Demand, AF
2016	6,200
2017	6,200
2018	6,200
2019	6,200
2020	6,200
2021	6,200
2022	6,200
2023	6,200
2024	6,400
2025	6,600
2026	6,900
2027	7,100
2028	7,350
2029	7,600
2030	7,800
2031 to 2050	8,300

3.3.4 Zone 7's Unaccounted-for Water

Unaccounted-for water is generally defined as the difference between metered total production (water delivered from the SBA to water treatment plants and groundwater pumped from Zone 7 wells) and the total metered deliveries made at each of Zone 7's transmission system turnouts. Figure 3-4 illustrates historical unaccounted-for water within Zone 7's system from 2007 to 2014 as a percentage of total production. As shown on Figure 3-4, Zone 7's unaccounted-for water has averaged 5% over the past 8 years. For planning-level purposes in this WSE Update, Zone 7 used 5% for future projections.⁶

⁶ Other operational losses from recharge and storage operations are accounted-for in Zone 7's water supply model, and vary with each scenario and portfolio evaluated.

Figure 3-4. Historical Zone 7 Unaccounted-for Water



3.3.5 Summary of Projected Water Demands

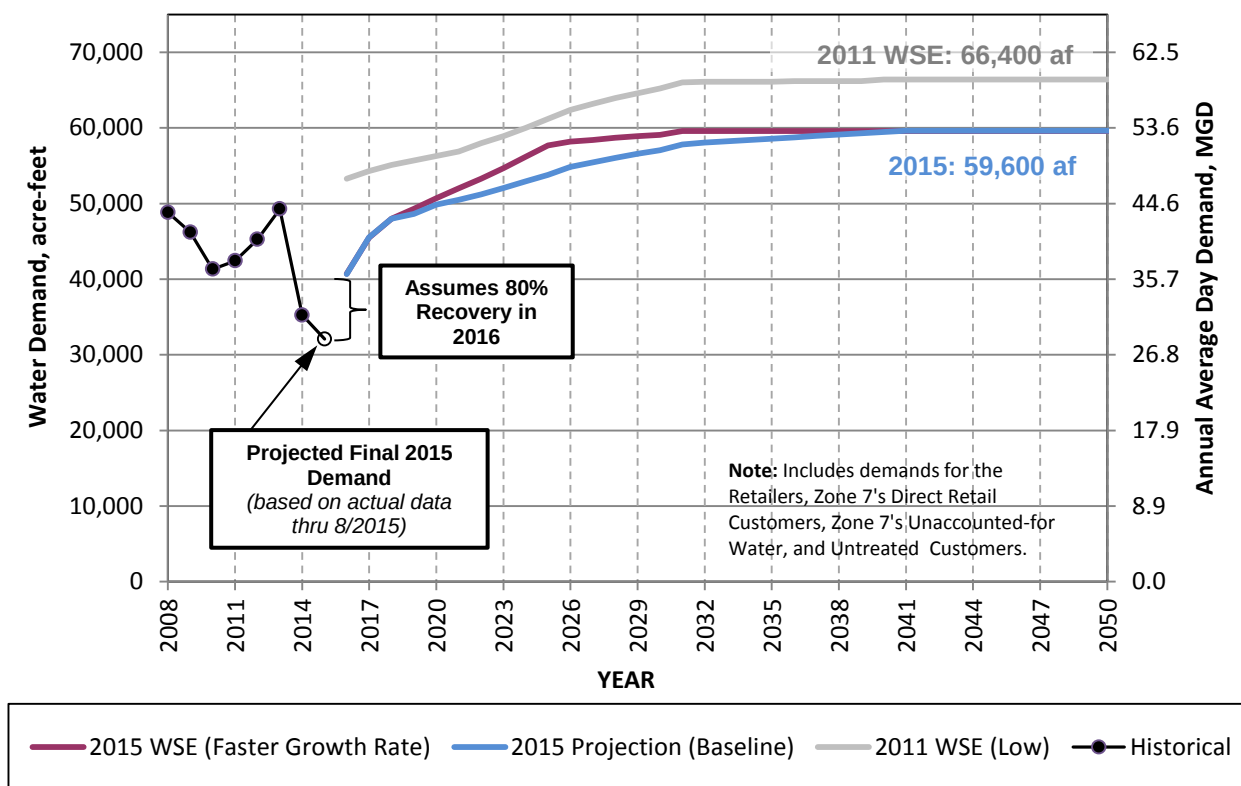
As described in the previous chapters, Zone 7 needs sufficient water supply to meet water demands from the Retailers, Zone 7's direct retail customers, and untreated water customers. Water supplies are also lost through unaccounted-for water losses. However, as with all water demand projections, the timing of increases is a best guess by the estimator, and they could be lower in the future or increase faster than projected.

For example, due to a local drought emergency declared in 2014, and statewide water use restrictions in place in 2015, water use within Zone 7's service area is projected to be almost 40% lower in 2015 than in 2013. A significant portion of the reduction is likely associated with lower outdoor water use, including residential sectors letting lawns die. Fewer lawns and/or lawn conversions to drought tolerant landscapes and increased use of recycled water for irrigation could be the new normal, or residents could simply replace their lawns with new ones. It is difficult to predict how water demands will recover from the current drought.

Consequently, Zone 7 worked with the water supply retailers to develop both a "baseline" water demand and "faster" growth rate water demand estimate to evaluate the resiliency of potential future water supply portfolios to two different water demand growth rates. A faster growth rate provides a more conservative evaluation.

Figure 3-5 compares the 2015 water demand estimates to both historical water demand and the estimates used in the 2011 WSE; the 2015 estimates are significantly higher than current demands and significantly lower than 2011 estimates. Water demands in 2014 and 2015 are lower because of Stage 2 water use reductions put in place by Zone 7 in 2014, and continued by the State of California in 2015. The future 2015 projections are lower than the 2011 projections due to new recycled water projects and water conservation programs being implemented by the local water supply retailers.

Figure 3-5. Projected Water Demands Used for the WSE Update



4.0 EXISTING WATER SUPPLIES AND ASSUMPTIONS

The purpose of this chapter is to describe the sources of Zone 7's existing water supplies, and the modified assumptions used to reflect recent changes and observations made during the current drought. Zone 7 staff also modified local rainfall to account for anticipated local climate change.

4.1 STATE WATER PROJECT

Imported surface water is by far Zone 7's largest water source, providing approximately 90% of the treated water supplied to its customers on an annual basis, either directly or after storage. Zone 7 imports surface water from the State Water Project (SWP) and when available, from Byron-Bethany Irrigation District (BBID), but the SWP by itself represents approximately 80% of Zone 7's supply.

The SWP is the nation's largest publicly-built water storage and conveyance system and currently serves water to over 25 million people throughout California. It was built and is operated and managed by the DWR. In addition to delivering water, the SWP also generates power, controls floods, provides recreational facilities, and enhances habitat for fish and wildlife.

SWP water primarily originates within the Feather River watershed, is captured in and released from Lake Oroville, and flows through the Delta before it is conveyed by the SBA to Zone 7, Alameda County Water District (ACWD), or Santa Clara Valley Water District, or by the California Aqueduct to other south-of-Delta SWP contractors. Zone 7 entered into a 75-year agreement with DWR to receive water from the SWP in November 1961. Including Zone 7, there are 29 SWP contractors spread across California, serving areas as far north as Plumas County and as far south as San Diego County.

Within Zone 7, SWP water is used directly to meet treated water demands from M&I customers—both wholesale and direct—and untreated water demands from agricultural customers. Water from the SWP can also be stored in Lake Del Valle by DWR for later use. In addition to aboveground storage, SWP water is stored in the local groundwater basin, or stored remotely in Kern County groundwater banks. Aquifer storage of surface water supplies is a major component of Zone 7's water supply reliability portfolio.



4.1.1 SWP Table A Amount

Imported surface water is by far Zone 7's largest water source, providing approximately 90% of the treated water supplied to its customers on an annual basis, either directly or after storage. Zone 7 imports surface water from the SWP and from BBID, but the SWP by itself represents approximately 80% of Zone 7's supply.

The primary allocation agreement between DWR and its SWP contractors is recorded in Articles 12(a) and 18(a) of the agreements and is based on each contractor's annual water delivery request. Each contractor is limited to an annual contractual amount as specified in Article 6(c) and Table A (hence, water that falls under this contractual limit is commonly referred to as "Table A" water). As previously noted, Zone 7 first entered into an agreement with DWR in 1961. As the SWP was expanded and as Zone 7 demands increased over the years, Zone 7's Table A amount was increased, reaching the amount of 46,000 AFA in 1997.

Since 1997, Zone 7 has increased its supply from the SWP through a series of five permanent transfers. In December 1999, Zone 7 secured Table A SWP allocations from Lost Hills Water District of 15,000 AFA and Berrenda Mesa Water District of 7,000 AFA. In December 2000, 10,000 AFA of SWP allocation from Belridge Water Storage District was acquired. An additional 2,219 AFA was obtained from the same source in October 2003. Finally, 400 AFA of water was acquired from the Tulare Lake Basin Water Storage District in 2003. Together, these transfers have raised Zone 7's current Table A allocation to 80,619 AFA through 2036 with an option to renew for another 75 years.

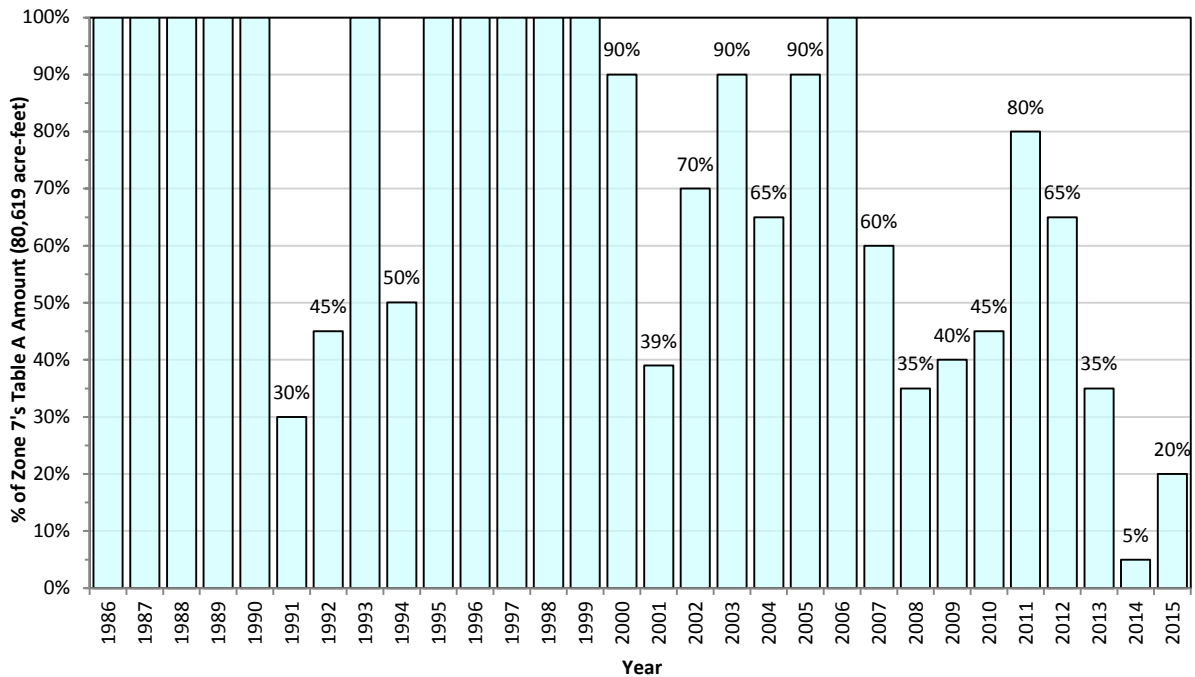
Each year, DWR offers its contractors, including Zone7, a percentage allocation of the maximum Table A amount (80,619 acre-feet for Zone 7) based on hydrologic conditions, water demands from other contractors, SWP facility capacity, amount in storage, and environmental/regulatory requirements.

4.1.2 2013 & 2014 A Reality Check on Minimum SWP Allocations

DWR typically provides an initial allocation in November or December to help facilitate yearly planning efforts, adjusts the allocation between November and April based on Sierra snowpack surveys and storage levels, and then issues a final allocation in May or June. Figure 4-1 presents historical final allocations from 1995 to 2015. As shown on Figure 4-1, final allocations were never less than 30% until 2014.



Figure 4-1. DWR's Historical Table A Percentage Allocations to Zone 7



Extremely Dry 2013 Led to a Record Low Percentage Allocation in 2014

The most uncertain factor influencing DWR's allocation is forecasted hydrology. In setting water supply allocations, DWR uses a conservative 90% exceedance hydrologic forecast, where nine out of ten years will be wetter and 1 out of 10 years drier than assumed. The period from October 1, 2012, to September 30, 2013, (Water Year 2013) had two hydrologic extremes. October through December 2012 was one of the wettest fall periods on record, but was followed by the driest consecutive 12 months on record. DWR's allocation in 2013 was a low 35% allocation of Table A. However, the hydrology in 2013 ended up being even drier than DWR's conservative hydrologic forecast, so the SWP began 2014 with reservoir storage lower than targeted levels and less stored water available for 2014 supplies. Compounding this low storage situation, 2014 also was an extremely dry year, with runoff for Water Year 2014 the fourth driest on record. The extremely dry sequence from the beginning of January 2013 through the end of 2014 was one of the driest two-year periods in the historical record.

Consequently, the initial 2014 SWP water supply allocation that was a historically low 5% of Table A amounts, was later reduced to 0% in January 2014, and was later raised back to 5%. Additionally, while the allocation was at 0% in January, DWR openly discussed the potential of no water being conveyed in the SBA due to increasing saline conditions in the Delta. Furthermore, even though the allocation was raised back to 5%, DWR indicated that it would not be available until September; hence, from a water demand perspective (i.e., need is

greatest from June through August), it was essentially a zero percent allocation during the high demand period.

4.1.3 DWR's Previous Projections of SWP Allocations

DWR publishes a delivery reliability/capability report⁷ every two years that projects minimum, long-term average, and maximum percentage allocations under existing and future (2035) conditions. Typically, the existing conditions scenario evaluated by DWR assumes that not all of the contractors request 100% of their Table A amount, and does not account for future regulatory or hydrologic constraints. Consequently, for conservative planning level purposes, Zone 7 staff has historically used their future scenarios, which do account for full requests and future regulatory or hydrologic conditions, to evaluate water supply reliability.

Table 4-1 presents the projected allocations from DWR's reliability/capability reports published between 2002 and 2013 for existing conditions. As shown in Table 4-1, DWR's capability reports from 2002 to 2013 projected minimum allocations equal to or greater than 5%, and the last three reports (2009, 2011, and 2013) were above 10%. Table 4-1 also shows that the projected long-term average allocation decreased from 76% in 2002 to 60% in 2009, and stayed at about 60% through the 2013 report. Maximum allocations have always been above 95%.

⁷ DWR used to call this report the Delivery Reliability Report.



Table 4-1. Previous Projected SWP Allocations from DWR Used by Zone 7

Report Year	Scenario		Allocation		
	Label	Assumptions	Minimum	Long-term Average	Maximum
2002	2021B	- 2021 Level of Development - Maximum Table A Request - Static Regulatory/Operating Standards	20%	76%	100%
2005	2025	- 2025 Level of Development - Maximum Table A Request - Future Regulatory/Operating Standards - no Climate Change	5%	77%	100%
2007	2027	- 2027 Level of Development - Maximum Table A Request - Future Regulatory/Operating Standards - Includes Climate Change	7%	66%	100%
2009	2029	- 2029 Level of Development - Maximum Table A Request - Future Regulatory/Operating Standards - Includes Climate Change	11%	60%	97%
2011	Future Conditions	- 2031 Level of Development - Maximum Table A Request - Future Regulatory/Operating Standards - Includes Climate Change	11%	60%	98%
2013	Future Conditions	- 2033 Level of Development - Maximum Table A Request - Future Regulatory/Operating Standards - Includes Climate Change	11%	59%	100%

4.1.4 Updated Projected SWP Allocations from DWR

In the most recent 2015 Delivery Capability Report (2015 DCR), DWR provides five different future scenarios leading to four different potential long-term average and minimum yields, based on a combination of factors from regulatory uncertainty to whether or not the California WaterFix will move forward. The five scenarios included:

1. **Base:** Essentially an existing conditions evaluation without climate change impacts.
2. **Existing Conveyance – Early Long-term Average (EC-ELT):** The Base scenario with climate change impacts included, but no California WaterFix.
3. **Existing Conveyance – Low Outflow (EC-LO):** The EC-ELT scenario, but with moderate diversion restrictions in the Delta.
4. **Existing Conveyance – High Outflow (EC-HO):** The EC-ELT scenario, but with more severe pumping restrictions for high Delta outflow.

5. **Bay Delta Conservation Plan Alternative 4 H3:** EC-ELT scenario, but with the California WaterFix.

Table 4-2 summarizes projected allocations for each of the five scenarios evaluated by DWR; a more thorough explanation of each scenario is available on DWR's website.⁸ As shown in Table 4-2, the revised minimum projections are still well above five percent, even under the more dire future scenarios they evaluated. Furthermore, both the Base and EC-ELT scenarios have a higher long-term average yield (62%) than the 2013 report (59%, see Table). Both the EC-LO and EC-HO are the only options that have a maximum allocation less than 100%.

In summary, none of the scenarios includes SWP allocations of five percent or less, or zero percent due to a loss of the Delta. Additionally, DWR provides no indication as to which future condition scenario is most likely.

Table 4-2. Scenarios from DWR's Delivery Capability Report

Scenario		Difference from Base Scenario	Long-term Average	Minimum	Maximum
Base (Existing Conditions)		--	62%	11%	100%
FUTURE SCENARIOS	Existing Conveyance – Early Long-Term (EC-ELT)	Includes effects of climate change based on 2025 emissions level and 15 cm sea level rise	62%	9%	100%
	Existing Conveyance – Low Outflow (EC-LO)	EC-ELT + moderate diversion restrictions in the Delta	51%	12%	82%
	Existing Conveyance – High Outflow (EC-HO)	EC-ELT + severe diversion restrictions in the Delta	46%	9%	82%
	Bay Delta Conservation Plan Alt. 4 H3 (i.e., California WaterFix) ^(a)	EC-ELT + isolated facility with 9,000 cfs diversion capacity	72%	7%	100%

^(a) The latest alternative recommended under the California WaterFix (July 2015), Alternative 4A, is a slightly modified version of this scenario; however, the results are still draft and not available for this analysis.

4.1.5 Conservative Planning-Level Assumptions Used for SWP Allocations

For planning purposes in this update, Staff based the allocations on four of the scenarios presented in the 2015 DCR. However, staff modified the projected allocations from the SWP so that the minimum allocation could be zero under all scenarios except the one that included a California WaterFix, and extended the period to 2014⁹ so that recent record low allocations,

⁸ DWR posts its most current and previous delivery capability reports on its website here: <http://baydeltaoffice.water.ca.gov/swpreliability/>

⁹ Zone 7 did not complete additional CalSIM modeling, but instead, used actual allocations from 2004 to 2014. These allocations include additional wet and dry years, but more importantly, include 2013 and 2014 – two worst years on record from a precipitation perspective.

which are missing from the 2015 DCR,¹⁰ are evaluated. Furthermore, the EC-ELT scenario was used as the existing/static condition, while the remaining three scenarios (ECHO, ECLO, and California WaterFix) were incorporated into future scenarios. Table 4-3 presents the revised long-term average, minimum, and maximum Table A allocations used for this WSE after these changes were made.

As shown in Table 4-3, the existing conveyance scenarios used in the WSE are generally more conservative than DWR's 2015 DCR. However, these more conservative assumptions help account for actual conditions observed in 2013 through 2015, and help evaluate the reliability of Zone 7's water supply system against real potential threats (e.g., earthquakes or SWP allocations less than 5%) that are not accounted-for in the 2015 DCR.

Table 4-3. Conservative Table A SWP Allocations Used in this WSE

Modified Scenario	Difference from 2015 DCR	Long-term Average	Minimum	Maximum
WSE EC-ELT	- Includes 2004 to 2014 - Effective allocations can be 0% due to earthquakes or salinity issues in the Delta	60%	0%	100%
WSE EC-LO	- Includes 2004 to 2014 - - Effective allocations can be 0% due to earthquakes or salinity issues in the Delta	51%	0%	82%
WSE EC-HO	- Includes 2004 to 2014 - - Effective allocations can be 0% due to earthquakes or salinity issues in the Delta	46%	0%	82%
WSE California WaterFix	- Includes 2004 to 2014	71%	7%	100%

4.1.6 SWP Carryover

As a SWP contractor, Zone 7 has the option to carry over unused Table A water from one year to the next when there is available storage in San Luis Reservoir (SLR). The SLR is located approximately 70 miles southeast of Livermore. This "carryover" water is also called Article 12e and 56c water. Article 12e water must be taken by March 31 of the following year, while Article 56c water may be carried over as long as SLR storage is available. When SLR is full, and Article 21 water is available (see next section), a portion of carryover stored by each contractor is "spilled" or converted back to general SWP supplies, effectively reducing each contractor's carryover balance. The total amount of spill is equal to the amount of Article 21 water and is split amongst the contractors in proportion to their maximum Table A contract amounts.

¹⁰ Modeling for the 2015 DCR included using CalSIM II historical years from 1922 to 2003. DWR is currently updating the model.

The amount that Zone 7 can carry over from one year to the next depends on DWR's allocation for that year. For example, if the allocation is equal to or less than 50% of Zone 7's Table A amount, then carryover is limited to 25% of Zone 7's total Table A amount, or approximately 20,200 AFA (25% x 80,619 AFA). However, if allocations are equal to or greater than 75% of Zone 7's Table A amount, then carryover is limited to 50% of Zone 7's total Table A amount, or approximately 40,300 AFA (50% x 80,619 AFA). For drought protection, Zone 7 typically aims to have a total of 10,000 to 15,000 AF of carryover water available at all times to supplement the current year's allocation in case a dry year occurs.

The models used in this WSE account for both the potential of lost supply due to spills and the limits based on allocations.

4.1.7 Article 21 Water (Interruptible or Surplus Water)

Under Article 21 of Zone 7's contract with DWR, Zone 7 also has access to excess water supply from the SWP that is available only if: 1) it does not interfere with SWP operations or Table A allocations, 2) excess water is available in the Delta, and 3) it will not be stored in the SWP system. The amount of Article 21 water available is calculated as the pumping capacity available at Banks Pumping Plant minus the contractor demands. If there is no demand for Article 21 water, this excess water flows out to the ocean. Per the 2015 DCR, the projected yield from Article 21 is very low and represents neither a significant nor a reliable water supply for Zone 7.

4.1.8 Article 56d Water (Turnback Pool Water) and Multi-Year Pool Demonstration Program (Water Pool Program)

Article 56d is a contract provision that allows SWP contractors with unused Table A water to sell that water to other SWP contractors via a "turnback pool" administered by DWR on an annual basis. Historically, only a few SWP contractors have been in a position to make turnback pool water available for purchase, particularly in normal or dry years. Over 2013 and 2014, DWR began pilot-testing a Multi-Year Pool Demonstration Program ("Water Pool Program") to evaluate the feasibility of a multi-year water purchase program. The Water Pool Program could conceivably provide an alternative to the Turnback Pool, providing more incentive to prospective sellers and therefore increasing the amount of water available. In 2015, the Water Pool Program was re-introduced through the end of 2016 at a price more in line with the current market. The program remains on pilot status.

While Zone 7 received 2,500 AF of water from the Water Pool Program in 2013, Zone 7 currently does not anticipate a significant amount of water supply to be reliably available under Article 56d (or its alternative) until there is a resolution to the current Delta crisis.

4.1.9 Lower Yuba River Accord

In 2007, Zone 7 entered into a contract with DWR to purchase additional water under the Lower Yuba River Accord (Yuba Accord). The contract expires in 2025. There are four different types (“Components”) of water available; Zone 7 has the option to purchase Components 2 and 3 water during drought conditions, and Component 4 water when the Yuba County Water Agency has determined that it has excess water available to sell.

The annual amount of water supply available to Zone 7 during dry years under the Yuba Accord is relatively small. For long-term planning, Zone 7 estimates an average yield of 250 AFA under the Yuba Accord. This yield was estimated by assuming a maximum yield of 676 AF (Components 2 and 3 only) during critical dry years and zero yield during wet years. Although Component 4 water could increase the yield to 850 AFA, its future yield is still uncertain; consequently, for conservative planning-level purposes, Component 4 water was not included in the analysis.

4.2 BYRON BETHANY IRRIGATION DISTRICT

BBID diverts water from the Delta pursuant to a “Notice of Appropriation of Water” dated May 18, 1914. Zone 7 entered into a water transfer demonstration project in 1994 with BBID, which provided a minimum supplemental water supply of 2,000 AFA to Zone 7 when a surplus is available with a potential to purchase up to 5,000 AFA. This original agreement was valid for five years. In 1998, Zone 7 and BBID agreed to convert the demonstration project into a long-term 15-year contract, renewable every five years up to a total of 30 years. In August 2010, the contract was extended through 2030 with an option to extend through 2039 and beyond.

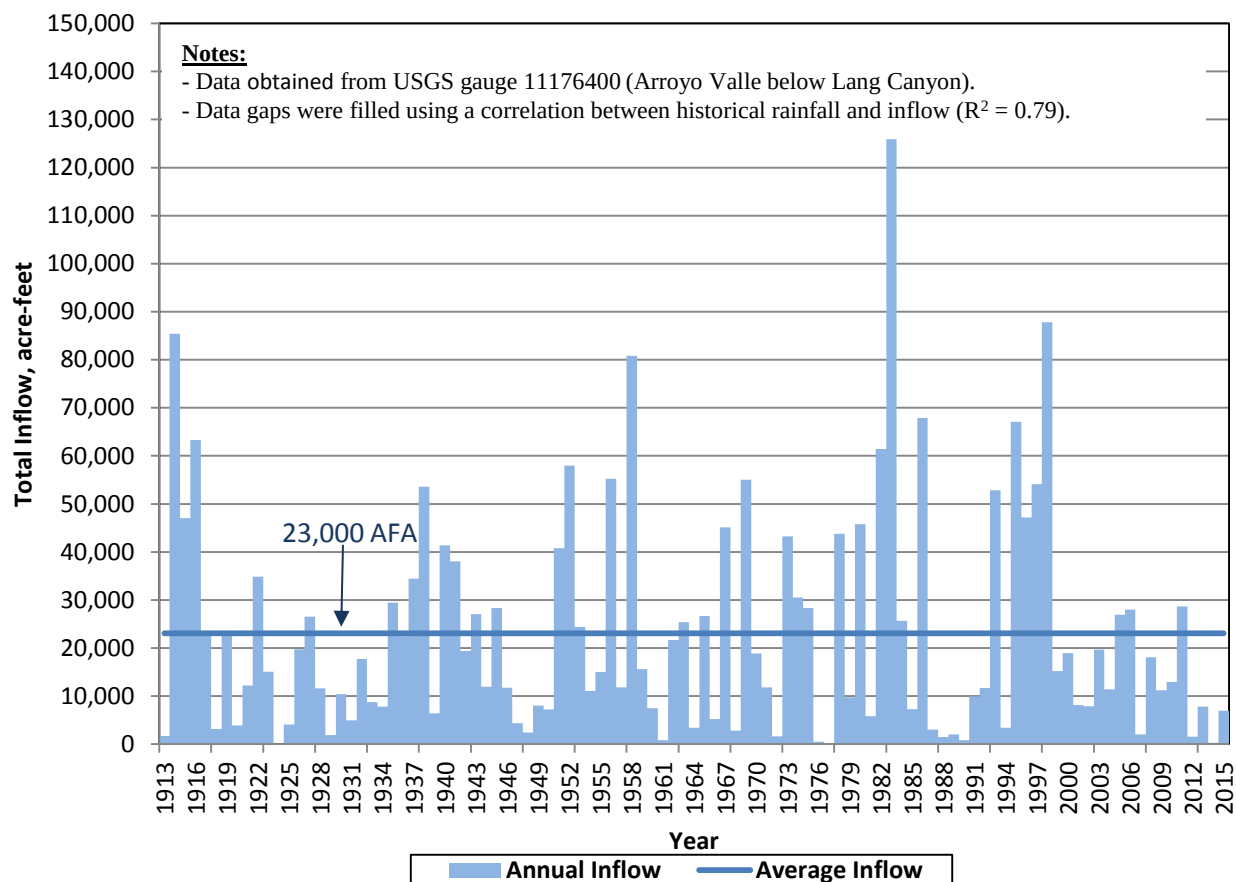
Zone 7 previously used a minimum yield of 2,000 AF; however, recently, BBID, Zone 7, and DWR have been reviewing the potential yield available for Zone 7, and discussing the future of the contract. Furthermore, Zone 7 would expect the available supply under this contract to diminish as BBID’s own water demands increase. Consequently, until discussions between BBID, DWR, and Zone 7 conclude, staff made the conservative assumption that no water is available via this contract for the analysis completed in this WSE.

4.3 LOCAL RUNOFF - ARROYO VALLE

Zone 7, along with ACWD, has a water right permit to divert flows from Arroyo Valle. Runoff from the Arroyo Valle watershed above Lake Del Valle is stored in the lake, which is managed by DWR. A review of historical runoff from Arroyo Valle over 1913 to 2015 indicates that the average total inflow into Lake Del Valle has been approximately 23,000 AFA (Figure 4-2). A maximum annual inflow of 126,000 AF was observed in 1983. Inflows into Lake Del Valle, after

accounting for permit conditions, are equally divided between ACWD and Zone 7; however, total diversions cannot exceed 60,000 AFA. Based on historical conditions and existing facilities, the average yield to Zone 7 is projected to be 7,300 AFA from local runoff.

Figure 4-2. Historical Total Inflows into Lake Del Valle from Arroyo Valle



5.0 EXISTING WATER STORAGE FACILITIES AND UPDATED ASSUMPTIONS

Zone 7 has three options for local storage: storage in Lake Del Valle, storage in the Livermore Valley Groundwater Basin, and surface storage in the Chain of Lakes, which will increase in the future. Zone 7 also has access to groundwater banking or storage facilities in Kern County through the Semitropic Water Storage District and the Cawelo Water District.

Water stored in the local groundwater basin and the aquifers in Kern County represents water from Zone 7's surface water supplies diverted during wet years; therefore, this water does not make a net contribution to Zone 7's water supply over the long-term and in fact result in some operational losses as described further below. Very importantly, however, this stored water provides a source of water during drought years. Note that the banked water supplies in Kern County are only accessible when the SBA is operational.

Each of Zone 7's storage options is described below.

5.1 LOCAL STORAGE: LAKE DEL VALLE

Lake Del Valle is a 77,110 acre-foot reservoir with a 235-foot high dam that is located approximately 10 miles southeast of Livermore. It was constructed by DWR in 1968 to provide recreation and fish and wildlife enhancement, flood control for Alameda Creek, and storage for SWP water delivered through the SBA. While the lake has a nominal capacity of 77,000 acre-feet, it normally stores from 25,000 to 40,000 acre-feet, with the remaining capacity left available for flood control. The storage capacity available to Zone 7 ranges from 7,000 to 10,000 AFA depending on lake drawdown and hydrology.

The 1.5-mile Del Valle Branch Pipeline, which branches off the SBA downstream of the Patterson Pass Water Treatment Plant, is used for filling the lake, as well as releasing water from it. The pipeline has a capacity of 120 cubic feet per second (CFS).¹¹ Water is pumped into the lake and released by gravity flow. Lake Del Valle is used to store runoff from the Arroyo Valle watershed above the lake (the rights to which are shared between Zone 7 and ACWD) and to store imported surface water deliveries from the SWP for the three SBA contractors (Zone 7, ACWD, and Santa Clara Valley Water District). After Labor Day, DWR typically lowers the lake

¹¹ Zone 7 has 45 CFS of capacity on the Del Valle Branch Pipeline (i.e., Reach 5 of the SBA) through a combination of original entitlements and the purchase of future contractor shares via Amendments 19 and 20 to its contract with DWR for SWP water.

level to 25,000 AF in anticipation of runoff from winter storm events, and to provide flood control capacity.

Water supply in Lake Del Valle is made available to the SBA contractors via the SBA through operating agreements with DWR. As is the case of SWP water taken directly from the SBA, water released from Lake Del Valle is also used by Zone 7 to be treated at DVWTP or recharge the local groundwater basin.

5.2 LOCAL STORAGE: GROUNDWATER BASIN AND RECHARGE FACILITIES

Zone 7 overlies the Livermore Valley Groundwater Basin (DWR Basin 2-10), which extends from the Pleasanton Ridge east to the Altamont Hills and from the Livermore Uplands north to the Tassajara Uplands. The portion of the Livermore Valley Groundwater Basin that contains high-yielding aquifers and good quality groundwater is called the “Main Basin,” which is composed of the Castle, Bernal, Amador, and Mocho II sub-basins.

The Main Basin has an estimated storage capacity of 254,000 acre-feet and receives an annual average natural recharge of approximately 13,400 AFA through percolation of rainfall, natural stream flow, and irrigation waters, and inflow of subsurface waters. This natural recharge is considered the long-term natural sustainable yield of the Main Basin, or the amount that can be pumped without lowering the long-term average groundwater volume in storage. The long-term natural sustainable yield is based on over a century of hydrologic records and projections of future recharge conditions.

Zone 7 uses the Main Basin as a storage facility and not a source of long-term water supply because Zone 7 only pumps groundwater it has artificially recharged using its surface water supplies. Natural recharge is allocated to users pre-dating the formation of Zone 7. As the groundwater basin manager, Zone 7’s policy is to maintain groundwater levels above historical lows in the Main Basin through artificial recharge operations. SWP water or runoff from Arroyo Valle (stored in and released from Lake Del Valle) is used to recharge the Main Basin by releasing water from turnouts along the SBA and the Del Valle Branch Pipeline into the Arroyo Mocho, Arroyo Valle, and Arroyo Las Positas for percolation down to the aquifers. The streams’ total recharge capacity varies depending on hydrologic conditions, with higher recharge capacities occurring during dry years.

Zone 7 established historical lows based on the lowest measured groundwater elevations in various wells in the Main Basin; historical lows correspond to a groundwater storage volume of about 128,000 AF. In general, the difference between water surface elevations when the Main Basin is full and water surface elevations when the Main Basin is at historical lows defines Zone



7's available operational storage. Operational storage is about 126,000 AF based on Zone 7's experience operating the Main Basin. The remaining 128,000 acre-feet is considered emergency reserve storage.

Before the construction of the SWP in the early 1960s, groundwater was the sole water source for the Livermore-Amador Valley. This resource has gone through several periods of extended withdrawal and subsequent recovery. In the early 1960s, when approximately 110,000 acre-feet of groundwater was extracted, the Main Basin reached its historical low of 128,000 acre-feet. The Main Basin was then allowed to recover from 1962 to 1983. It was during this era that Zone 7 first conducted a program of groundwater replenishment by recharging imported surface water via former gravel quarry pits and local streams ("in-stream recharge") for storage in the Main Basin, began supplying treated surface water to customers to augment groundwater supplies, and regulating municipal pumping by contractually establishing GPQs with each local retailer.

Figure 5-1 shows Zone 7's total annual artificial recharge amounts, pumping amounts, and their cumulative net impacts to operational storage from Water Year 1974 to 2014. Zone 7's operational policy is to maintain the balance between the combination of natural and artificial recharge and withdrawal or pumping to maintain groundwater levels above the emergency reserve storage. Zone 7 has generally been able to pump as much groundwater as it has needed over the last five years; however, during the current drought, some decreases in groundwater elevation did noticeably affect the production of certain wells. Zone 7 is continuing to study the groundwater basin and developing new tools (such as an improved groundwater model) to better understand the levels of groundwater extraction possible under various conditions, and contributing factors such as groundwater connectivity, spatial distribution of groundwater in the Main Basin, and others.



Figure 5-1. Artificial Recharge, Pumping, and Net Cumulative Impacts to Operational Storage from Water Year 1974 to 2014

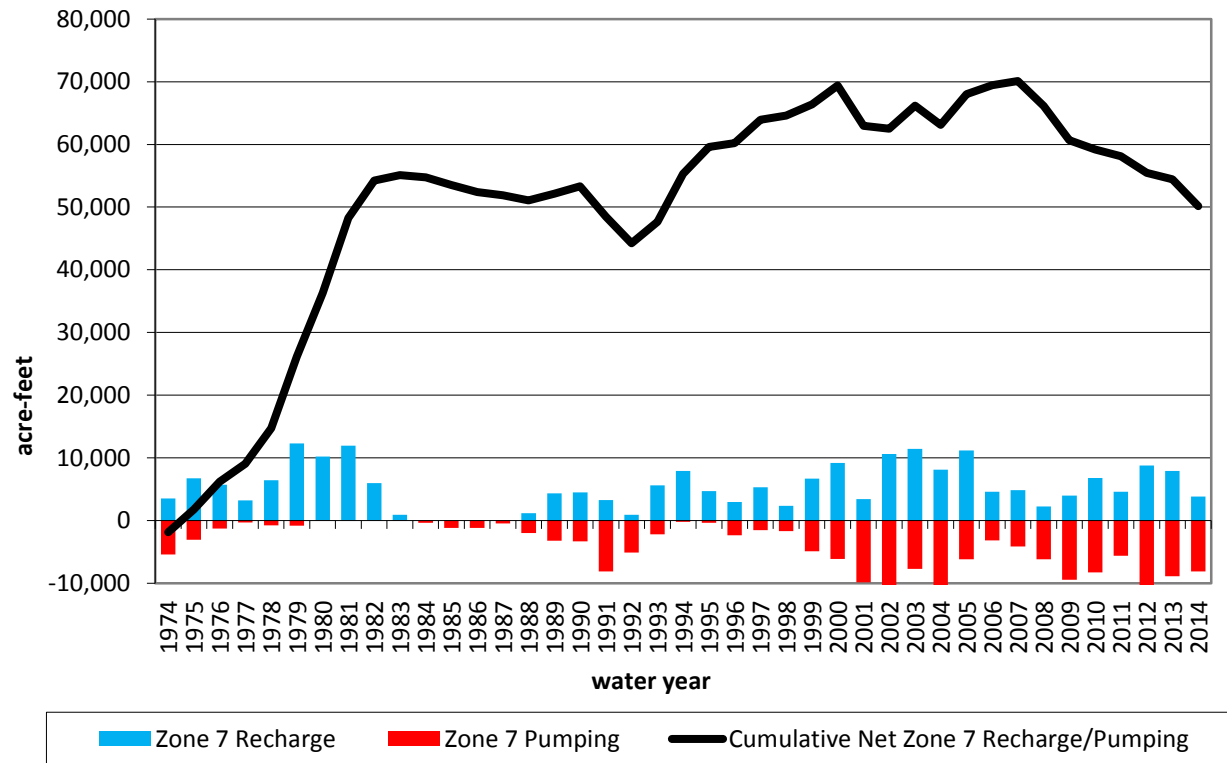
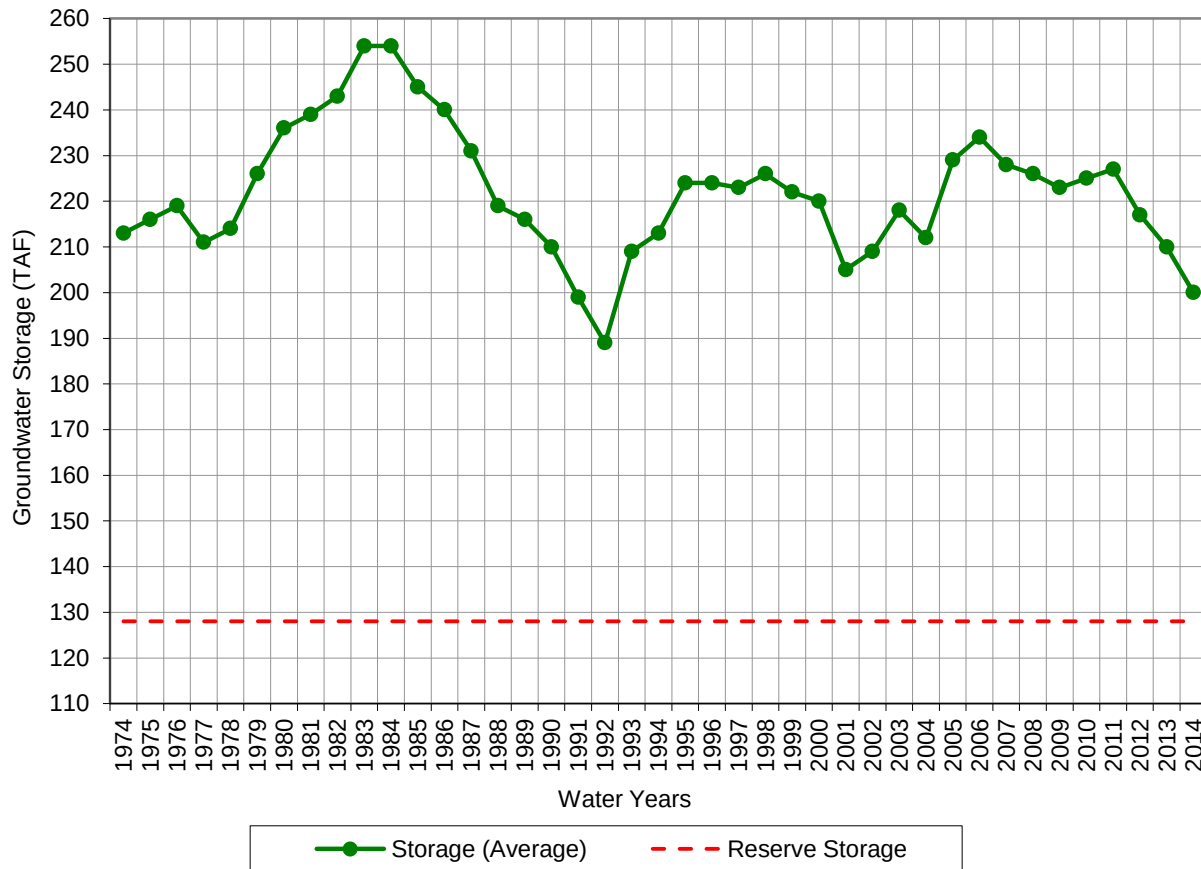


Figure 5-2 shows the volumes of storage in the Main Basin between 1974 and 2014. As shown, the Main Basin went through an extended withdrawal from 1987 to 1992 due to drought. Figure 5-2 also shows the Main Basin responding to the droughts that started in 2007 and 2012. At the end of the 2014 water year, there was 200,000 acre-feet of stored water in the Main Basin, and water levels were well within operational limits.

Figure 5-2. Main Basin Groundwater Storage



More detailed descriptions of the Main Basin are available in Zone 7's GMP and Annual Groundwater Management Program reports posted on Zone 7's website.

5.2.1 Zone 7 Groundwater Wells

Zone 7 owns and operates nine municipal supply wells located in four wellfields: the Chain of Lakes (COL), Hopyard, Mocho, and Stoneridge. These wellfields are located on the west side of Zone 7's service area, and therefore primarily serve retailers on the west side of Zone 7's system (DSRSD and Pleasanton). Together, the wellfields have a combined peak capacity of 41 million gallons per day (MGD). However, the newest two wells, which are located in the Chain of Lakes wellfield and represent approximately 9 MGD in capacity, are primarily intended for emergency or drought conditions. Therefore, under normal operating conditions, Zone 7 plans on a peak capacity of 32 MGD from the existing wells assuming the groundwater basin is 80% full. Additionally, previous groundwater modeling efforts indicate that the spatial distribution of the existing wells would allow Zone 7 to pump as much as 28,000 acre-feet in one year assuming the groundwater basin was about 80% full.

5.3 LOCAL STORAGE: CHAIN OF LAKES – LAKE I AND COPE LAKE

COL is a series of former or active gravel quarry pits located in the heart of the Livermore-Amador Valley. The COL was envisioned as a large facility to be used for water management and related purposes by Zone 7, including surface storage and recharge of the Livermore Valley Groundwater Basin. The COL will ultimately consist of ten lakes named Lakes A through I and Cope Lake, connected through a series of conduits (see Figure 5-3). Zone 7 currently owns Lake I and Cope Lake, and expects Lake H to be dedicated to Zone 7 within the next few years once reclamation is completed. The remaining lakes (A through G) were formerly expected to be dedicated to Zone 7 by around 2030. This previous timing was used in the 2011 WSE.

However, the gravel mining companies currently mining Lakes A through G have notified Staff that mining may extend well beyond 2030, and may not be completed until as late as 2060; consequently, for this update, Staff's evaluation only included Lake I and Cope Lake, Lake H starting in 2017, and Lake A starting in 2020.

Figure 5-3. Configuration of the Chain of Lakes and Timing of Anticipated Transfer to Zone 7



5.4 KERN COUNTY GROUNDWATER BANKING PROGRAMS

Zone 7 participates in two groundwater banking programs (Semitropic and Cawelo Water District [Cawelo]) located in Kern County. During normal or wet years, Zone 7 can send excess water to Kern County via the California Aqueduct for storage. However, Zone 7 must use exchanges with other SWP contractors located south of Kern County (e.g., Metropolitan Water District [Metropolitan]) to recover previously stored water supplies during times of need (e.g., drought) because Zone 7's location is upstream of Kern County. There must be sufficient water flowing through the State Water Project to facilitate exchanges between Zone 7 and SWP contractors located south of Kern County.

All recovered groundwater from these programs must be delivered to Zone 7 via Banks Pumping Plant in the Delta and then the South Bay Pumping Plant to the SBA. Therefore, if Delta conveyance is unavailable (e.g., earthquakes, salinity intrusion, etc.), then Zone 7 would not have access to banked water.

5.4.1 Groundwater Banking Programs Tested by Conditions in 2013 and 2014

In November 2013, when the initial SWP allocation was 5%, Staff requested the maximum recovery amounts from Semitropic (9,100 acre-feet) and Cawelo (10,000 acre-feet), and neither banking program indicated that the delivery requests could not be made. However, when DWR reduced the allocation to 0% in January 2014 due to extreme hydrologic conditions, and indicated that pumping in the Delta may cease due to salinity concerns, it became clear that Zone 7 might not be able to recover any previously stored water supplies in Kern County. This view persisted even after DWR increased the final allocation to five percent with use limited from September to December.

Ultimately, DWR was able to manage salinity so that pumping in the Delta could continue, and with coordination among Staff, other SWP contractors, DWR, and banking partners, DWR prioritized the delivery of banked water to Zone 7 and other SBA contractors. Eventually, even in a five percent allocation year Zone 7 was able to successfully recover 14,982 acre-feet, or approximately 78% of the maximum recovery requested.



5.4.2 Revised Assumptions for Groundwater Banking Program Recovery

Based on actual recovery in 2014 and potential issues if there is no pumping in the Delta, Staff modified the assumed recovery from its groundwater banking programs (see Table 5-1). Conversely, the 2011 WSE did not evaluate a SWP allocation less than 9.5% and assumed that Zone 7's maximum recovery would be available under all conditions.

Table 5-1. Revised Assumptions for Groundwater Banking Programs Located in Kern County

Condition	Semitropic		Cawelo		Both Programs	
	Recovery, acre-feet	% of Maximum	Recovery, acre-feet	% of Maximum	Recovery, acre-feet	% of Maximum
SWP Allocation is 0% or No pumping in Delta	0	0%	0	0%	0	0%
SWP Allocation is 5% or less	7,200	79%	7,800	78%	15,000	78.5%
SWP Allocation is 10% or more	9,100	100%	10,000	100%	19,100	100%

- (a) Zone 7 can also recover water via Semitropic exchange. Semitropic exchange capacity remains unchanged since it does not take effect until SWP allocation is at least 20%.
- (b) Zone 7 was able to recover 78% of its pumpback capacity in 2014 when SWP allocation was 5%.

6.0 CLIMATE CHANGE AND DISRUPTIONS IN THE DELTA

The 2011 WSE did not include any assumptions for the potential impacts of local climate change, and although staff previously reviewed a potential loss of the Delta due to earthquake, loss of the Delta due to water quality (e.g., salt water intrusion) was not included. The purpose of this section is to describe the data and assumptions used and to include both local climate change and disruptions in the Delta.

6.1 INCLUSION OF POTENTIAL LOCAL CLIMATE CHANGE

Changes in climate that affect the amount and frequency of local rainfall can have dramatic impacts on available groundwater supplies due to changed rainfall recharge or yield from local water supplies due to corresponding increased or decreased runoff. Consequently, Staff reviewed potential sources of projected precipitation estimates under future climate change models, and specifically, any sources of data downscaled at the local level.

One source available was Cal-Adapt, a web-based climate adaptation planning tool developed by the State of California to help planners obtain knowledge of potential climate impacts at the local level. Staff incorporated potential changes in local rainfall due to climate change using information available from Cal-Adapt.

Cal-Adapt.org downscales four Global Climate Models (GCMs) to local scales:

- CCSM: *Community Climate System Model (National Center for Atmospheric Research – Boulder, CO)*
- CNRM: *Centre National de Recherches Météorologiques (France)*
- GFDL: *Geophysical Fluid Dynamics Laboratory (NOAA)*
- PCM: *Parallel Climate Model (DOE)*

The output from each model is available for a given 12 kilometer by 12 kilometer grid; the grid chosen by Staff centers over Zone 7's service area (see Figure 6-1).

Figure 6-1. Map showing 12 km x 12 km grid in Cal-Adapt.org Centered over Zone 7's Service Area

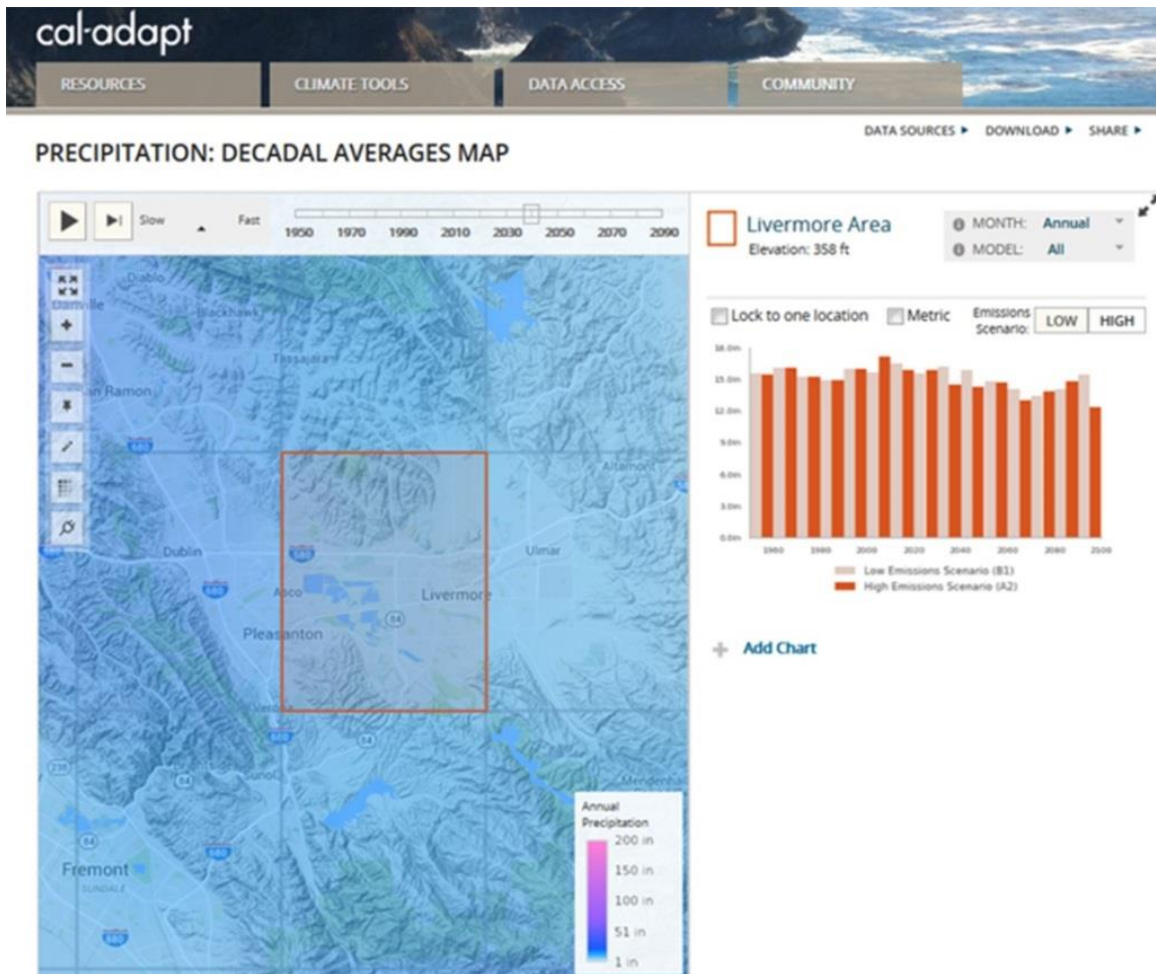
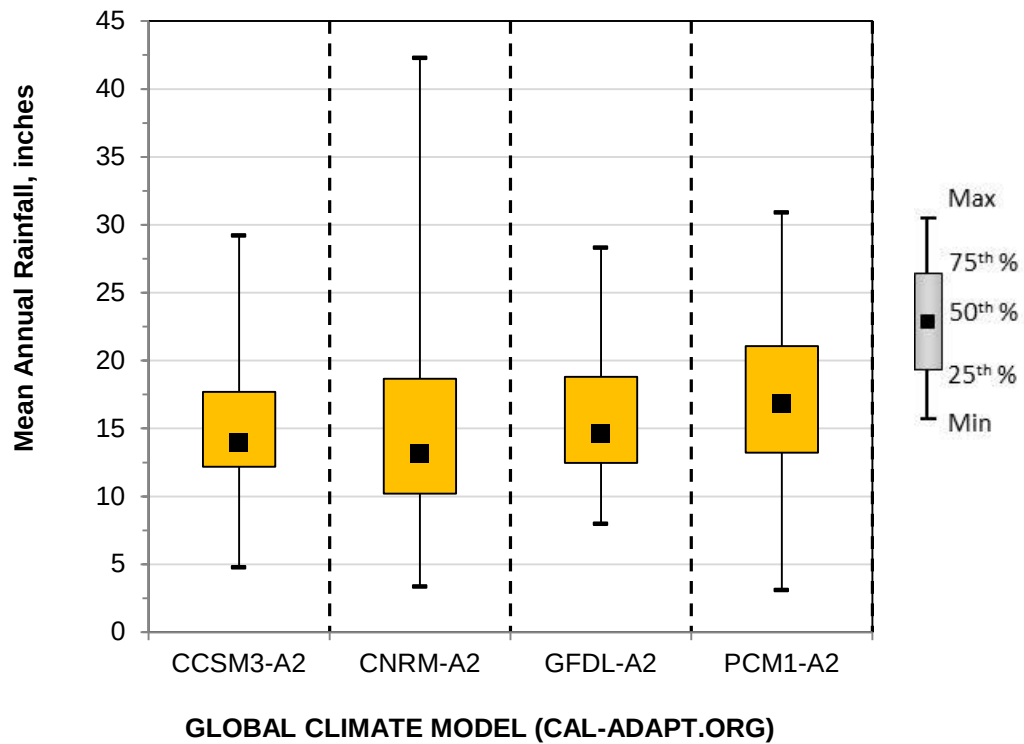


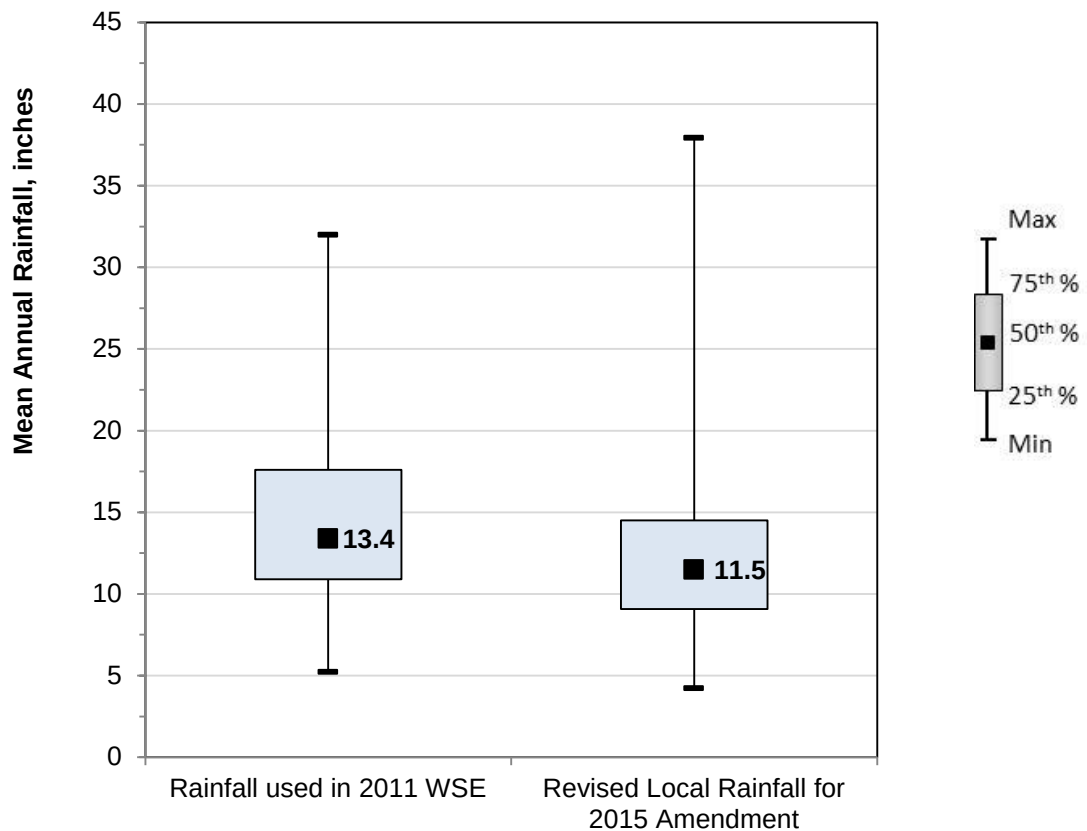
Figure 6-2, below, illustrates projected rainfall potential from 2016 to 2070 under the higher emissions scenario (Scenario A2). As shown, the CNRM model is the most conservative scenario; it has the lowest median rainfall, one of the lowest minimum rainfalls, yet still captures the potential that severe wet years may be more prevalent in the future.

Figure 6-2. Local Climate Model Results Obtained from Cal-Adapt.org



Consequently, Staff revised local rainfall projections affecting estimated groundwater recharge and local water supply yields to reflect the same reduction/increase observed in the CNRM modeling results (see Figure 6-3). As shown in Figure 6-3, the revised median rainfall is 2 inches lower.

Figure 6-3. Local Rainfall Assumptions used for this 2015 Update



6.2 INCLUSION OF EXTENDED DISRUPTIONS IN THE DELTA

In January 2014, DWR reduced the projected SWP allocation for Calendar Year 2014 from five percent to zero percent, and indicated the potential for all pumping in the Delta to cease due to anticipated saltwater intrusion from the San Francisco Bay. If pumping in the Delta ceased, no water would have flowed into the SBA, and Zone 7's only water supplies would have been previously stored water in the Livermore Valley Groundwater Basin and a portion of the State Water Project water stored in Lake Del Valle.

Although Staff previously reviewed a potential loss of Delta pumping and conveyance due to earthquake in the 2011 WSE, loss of the Delta due to water quality was not included. Consequently, given the potential impact to Zone 7's imported water supplies, the analysis in this update integrated both types of disruptions into its water supply model. The risk of an earthquake was based on the Delta Risk Management Strategy (DRMS) report published by

DWR in February 2009 with corrections released in August 2011.¹² Loss of the Delta due to water quality was assumed to occur anytime the average Table A allocation over a 2-year period is less than 10%. A trigger of 10% was chosen so that a loss of the Delta can occur if two critically dry years are back to back (e.g., 1977 followed by 2014) or if a moderately severe dry year (e.g., years with an allocation of 20% or less) follows a zero percent allocation year.

Historically, however, these conditions have not occurred. DWR has been able to manage salinity in the Delta since completion of the State Water Project. In fact, DWR demonstrated in 2015 that it will go to great lengths to manage salt water intrusion when it installed a 750-foot temporary rock barrier at False River within the Delta to help control salinity. The temporary rock barrier (installed in May and June 2015 and removed by mid-November 2015) helped keep high salinity concentrations from reaching the central Delta, and conserved about 90,000 acre-feet of storage for the last quarter of 2015 and for fish releases.¹³

¹² The DRMS report is available at www.water.ca.gov/floodsafe/fessro/levees/drms/.

¹³ Additional information on the rock barriers is available at:
<http://www.water.ca.gov/waterconditions/emergencybarriers.cfm>

7.0 POTENTIAL FUTURE WATER SUPPLY OPTIONS

As part of the 2011 WSE, staff worked with the local water supply retailers to develop an extensive list of potential water supply options for the Livermore-Amador Valley. The detailed list was included as Appendix G of the 2011 report. In preparing this update, staff reviewed each water supply option from 2011 and then met with all of its local water supply retailers to discuss the options on the list to see what should be added, deleted, or included in potential portfolios for this update.

Many of the 2011 options have been implemented by Zone 7 or the Retailers (e.g., Water Conservation Act of 2009), had very little water supply yield (e.g., reduction of well startup waste), or were no longer preferred by the Retailers (e.g., new Recycled Water – Turf Irrigation [i.e., purple pipe] not already planned or in design).

Staff, with input from the Retailers, reduced the number of options available for building the water supply portfolios for this 2015 update to include only those that had at least 1,000 AF of supply, did not require end user compliance and enforcement,^{14,15} had active partnerships (e.g., Bay Area Regional Desalination), or helped address changed conditions (e.g., Los Vaqueros Storage). The options included:

- California WaterFix (i.e., formerly BDCP/Delta Fix)
- Purified Recycled Water
- Desalination

Each option is discussed in more detail below.

7.1 CALIFORNIA WATERFIX (FORMERLY BDCP/DELTA FIX)

The SWP, which conveys water to Zone 7 via the Delta, currently provides most of the Livermore-Amador Valley area's water supply.¹⁶ Furthermore, due to low average local rainfall (~14.5 inches per year)¹⁷ and the scarcity or cost of new imported water supplies, the

¹⁴ Zone 7 cannot rely on water supply options that require the end user (e.g., homes and businesses) to properly maintain and operate their own system for meeting projected long-term water demands; Zone 7 has no legal authority or funding to enforce the use of such systems.

¹⁵ Two examples of water supply options that require end user compliance and not included in portfolio analysis are greywater and rainwater capture systems.

¹⁶ Zone 7, 2015. Annual Review of Sustainable Water Supplies.

¹⁷ Zone 7, 2015. Annual Report for the Groundwater Management Plan Program – 2014 Water Year.

Livermore-Amador Valley area will always be dependent on the SWP for most of its water supply. Even locally controlled supplies (e.g., purified recycled water) require imported water supply to produce a significant amount. Therefore, the biggest water supply issue facing the Livermore-Amador Valley area is how, when, and if a solution to the existing crisis in the Delta is finalized. The State's response is the California WaterFix, which is part of the comprehensive California Water Action Plan, a plan that also includes support for reservoir expansion (e.g., Sites Reservoir).¹⁸

There is currently uncertainty surrounding the completion year for the California WaterFix and its effects on the long-term yield from the SWP. Consequently, this update evaluated various yields and timing. Assumed yields were discussed in Chapter 4 and timing is discussed in Chapter 10.

The supply yield from the California WaterFix depends on estimates of the existing long-term average Table A yield and estimates of the potential long-term average Table A yield once a project is completed (see previous discussion in Chapter 4). As will be further discussed in Chapter 10, the analysis in this update included all of the existing conveyance options, but the EC-LO and EC-HO represent the most conservative conditions. As previously shown in Table 4-3, the long-term average Table A yields were 51%, and 46% for the EC-LO and EC-HO conditions, respectively, and the long-term average yield could increase to as high as 71% (California WaterFix) once dual conveyance facilities are constructed. Using the average of both the EC-LO and EC-HO conditions (48.5%) and the projected yield of the California WaterFix (71%) results in a net increase of Table A water to Zone 7 of approximately 18,100 AFA ($[71\% - 48.5\%] \times 80,619$).

Costs for the California WaterFix were based on preliminary SWP cost estimates, indicating a total present worth capital investment of about \$320 million between 2017 and 2055, and an average annual cost of \$8.5 million over the same period. This results in an average incremental unit cost of about \$470 per acre-foot of supply assuming a yield of approximately 18,100 AF of replaced long-term average Table A water.

7.2 PURIFIED RECYCLED WATER

Recycled water has been used within the Livermore-Amador Valley as a source of irrigation water for parks, schools, medians, and other types of landscapes for many years. The supply is generated through tertiary treatment of local wastewater and conveyed through a separate "purple pipe" system that delivers it to each customer. These purple pipe systems, however, do

¹⁸ Additional information on the California Water Action Plan can be found at:
http://resources.ca.gov/california_water_action_plan/

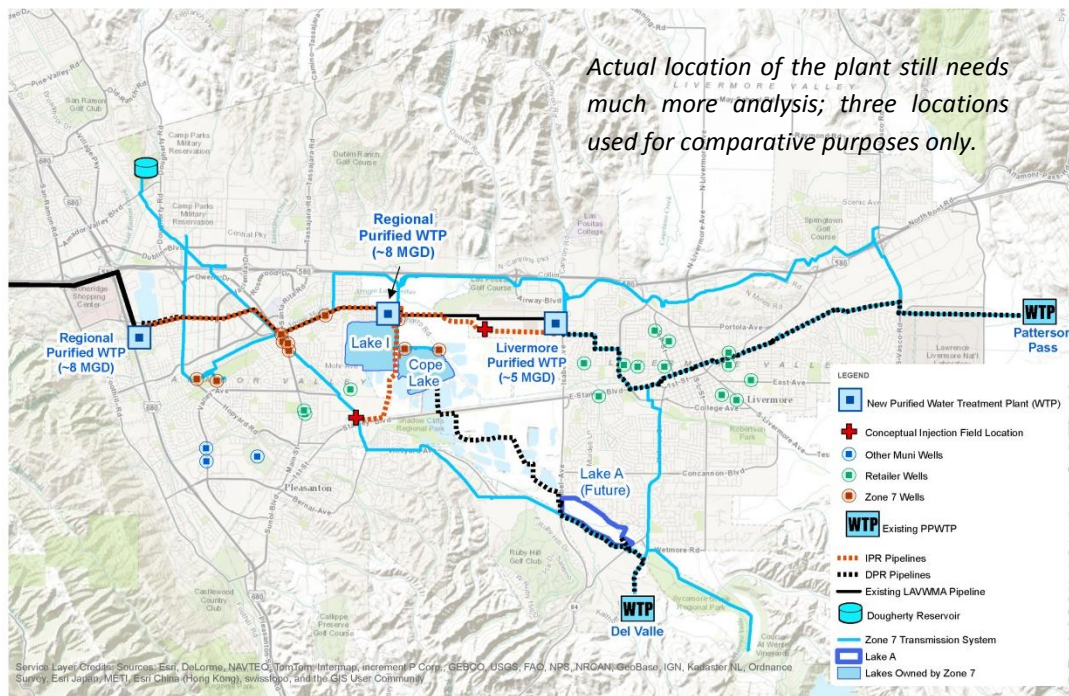
not leverage existing infrastructure because they are entirely separate from existing potable water systems. Furthermore, these systems must be designed to meet irrigation needs, which typically peak in the summer and are near zero in winter months, which increases operation and maintenance costs. Lastly, many of the potential users of purple pipe systems are not centrally located, and it can take many years or even decades to fully develop.

Advanced Treatment Recycled Water (i.e., purified recycled water) avoids many of the pitfalls associated with purple pipe systems because they leverage existing infrastructure, can be implemented in much shorter time frames, and can meet a larger portion of water demands (e.g., winter indoor water use). Additionally, preliminary analysis completed by Staff as part of this update indicated that purified recycled water treatment options might be an option to meet existing water supply reliability policies and goals.

Consequently, HDR, Inc., (HDR) was engaged to complete a preliminary feasibility review of potential purified recycled water options for the Livermore-Amador Valley area to refine potential supply yields and costs; a copy of HDR's white paper is included as Appendix A.

Although HDR identified over 20 different indirect and direct potable reuse options (i.e., purified recycled water) for the Livermore-Amador Valley, only 8 were considered promising (i.e., feasible and implementable within a reasonable time frame [~6 to 7 years]). Figure 7-1 presents the promising indirect and direct potable reuse concepts identified by HDR. As shown on Figure 7-1, HDR reviewed three potential locations for the purified water treatment plant; however, much more analysis is required and the locations are for preliminary cost estimating only.

Figure 7-1. Promising Purified Recycled Water Concepts Identified by HDR



Additionally, the maximum amount of water available, even combining these projects, cannot exceed approximately 7,700 AF (6.9 MGD) because all of the options rely on the same sources of wastewater. Furthermore, this yield may be even lower due to potential blending needed for discharge of the waste concentrate anticipated from reverse osmosis treatment.

Finally, these purified recycled water options were included in this update because they are essentially drought-proof and under complete local control; however, as noted below, they will require significantly more analysis to find solutions to key implementation issues identified by HDR (e.g., multiple barriers, the feasibility of injection, and regulatory uncertainty).

7.2.1 Indirect Potable Reuse for Groundwater Recharge

Indirect Potable Reuse (IPR) is defined in Water Code Section 13561(c) as the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system. Note that pond or stream recharge is very similar to recharge with SWP water and is regulated differently than groundwater injection since it provides additional environmental treatment. HDR identified three promising IPR concepts for the Livermore-Amador Valley area (see Figure 7-1):

- Pond Percolation via Lake I Recharge with Purified Water
- Groundwater Injection with Purified Water
- Combined Pond Percolation and Groundwater Injection using Purified Water

Potential yields from all three options depends on the smallest of four constraints: (1) the amount of source water, (2) assumed percolation capacity of Lake I, (3) assumed injection capacity, and (4) size of the purified water treatment plant.

HDR estimated the potential purified water available from both DSRSD and Livermore combined at 8,200 AFA after 20% losses through advanced treatment. The percolation rate of Lake I, 4,800 AFA, was obtained from the 2004 Management Plan for Lakes H, I, and Cope Lake completed by Stetson Engineers. The assumed annual injection capacity (~11,600 AFA) was based on an assumed injection well size of 1,200 gallons per minute per well, three wells per well field, and two well fields. HDR determined that the optimal “regional” plant size would be 12 million gallons per day, yielding 7,770 AFA. Of course, smaller projects are possible if only one source (e.g., Livermore) were used.

Consequently, the limiting factors are percolation capacity of Lake I and regional treatment plant size, the available percolation capacity of Lake I,¹⁹ and the capacity of a regional plant after accounting for losses (e.g., evaporation). These factors limit the yield to anywhere from 4,800 AFA to 7,120 AFA.

HDR also estimated amortized costs for these options that ranged from \$8 to \$14 million per year, which translates to an estimated incremental cost of about \$1,700 to \$2,000 per acre-foot of new water supply.

Potential Ancillary Benefit: One potential benefit of IPR projects not mentioned in the HDR report is the potential for reduced salt loading assuming that issues such as blending of the concentrated waste discharge can be solved and that a higher degree of minerals (including regulated minerals such as chromium, arsenic, and boron) are not mobilized in the process. Future analysis may be needed to review the benefits or drawbacks of percolation or injection of highly purified water (i.e., extremely low total dissolved solids [TDS] concentration) to Zone 7’s overall Groundwater Salt and Nutrient Management Strategy.

7.2.2 Direct Potable Reuse

Direct Potable Reuse (DPR) is defined in Water Code Section 13561(b) as the introduction of recycled water either directly into a public water system or into a raw water supply immediately upstream of a water treatment plant. DPR has no environmental barriers, and all treatment is done at engineered treatment facilities. Technically, adding purified water upstream of an existing water treatment plant is similar to existing contributions to SWP source water so no changes in the water treatment process (beyond those already planned) would be needed.

¹⁹ A portion of capacity is already in use to recapture quarry water; more capacity is needed for artificial recharge once the Lake H diversion structure is built.

HDR identified five promising DPR projects for the Livermore-Amador Valley area (Figure 7-1):

- DPR with further treatment
 - Sending Purified Water from Livermore to PPWTP's Raw Water Reservoir
 - Sending Purified Water from Livermore to DVWTP via Cope Lake
 - Sending Purified Water from a Regional Plant to DVWTP via Cope Lake
- DPR without additional treatment
 - Sending Purified Water from Livermore directly to Zone 7's transmission system
 - Sending Purified Water from a Regional Plant to Zone 7's transmission system

Potential yields from all of the DPR concepts depend on the smaller of two constraints: (1) the amount of source water and (2) the size of the purified water treatment plant. HDR estimated the potential purified water available from both DSRSD and Livermore combined at 8,200 AFA after 20% losses through advanced treatment. HDR determined that the optimal "regional" plant size would be 12 million gallons per day, yielding 7,770 AFA. Consequently, the limiting factor for DPR was treatment plant size, yielding up to 7,770 AFA. Of course, smaller projects are possible if only one source (e.g., Livermore) were used.

HDR also estimated amortized costs for these options that ranged from \$7.8 to \$14 million per year, which translates to an estimated incremental cost of about \$1,500 to \$1,800 per acre-foot of new water supply.

7.2.3 Key Implementation Issues Identified by HDR Need Additional Investigation

Zone 7's core mission is providing a reliable supply of high quality water and an effective flood protection system, while managing water resources, including the Livermore-Valley Groundwater Basin, in a fiscally responsible, innovative, proactive, and environmentally sensitive way. Consequently, Zone 7 must exercise due diligence when investigating innovative water supplies like IPR/DPR to ensure that the health of the public is protected and the quality of water in the local groundwater basin is not degraded.

Although reviewed in the context of water supply reliability, these supply sources will require additional investigation. Table 7-1 provides a list of next steps recommended by HDR.

Table 7-1 Additional Information and Analysis Required

Issue	Description	Tasks
Water Quantity	The supply yield is determined by LAVWMA pipeline permitting requirements, treatment process recovery, and capacity of reuse receptors (Lake I, Cope Lake, injection wells, etc.)	- Confirm yield and availability for treatment plants, lakes, and injections wells. - Determine recovery efficiency for treatment processes and process modifications/ cost tradeoffs to improve efficiency. - Determine LAVWMA minimum pipeline volumes and flow/ quality requirements to meet permitted discharge limits.
Public Health	The number of barriers appropriate for public health protection	Technical, regulatory and policy level discussions to determine the appropriate contaminant barriers
Hydrologic Feasibility	The annual and long-term recharge capacity for both lake and injection well recharge needs to be defined	- Review existing reports to estimate recharge rates and aquifer capacity. - Develop preliminary siting, well design, and delivery system design. - Evaluate operational constraints (e.g., flood control, increased gravel pumping) and timing of acquisition - Assess injection well feasibility in light of prior experiences in the Livermore-Amador Valley
Facilities Sizing	Costs are affected by facilities sizing (e.g. DSRSD plant size)	- Optimize sizing treatment plant and other facilities after confirming water availability and yield. - Assess nitrification-denitrification implementation for wastewater plants or other methods for ammonia reduction.
Siting	Multiple sites are available	- Assess significant cost differentials between locations. - Identify operational pros and cons of each location.
Power Availability	Adequacy of existing electrical service needs to be assessed	With projected power requirements, assess existing capacity, the need for additional power and associated capital and operating costs
Treatability Testing	Treatability testing can verify expected yields, optimize pre-treatment to minimize fouling, and optimize contaminant reduction	- Develop a treatability testing plan for the recommended alternative(s). - Perform testing to inform design - Consider using pilot-scale treatment facility to foster public acceptance.
Water Quality and Aquifer Impacts	Interaction of natural deposits could result in mobilization of contaminants (e.g., arsenic, chromium) or precipitation	- Conduct lab studies of core samples taken from injection well locations. - Determine necessary adjustments to water chemistry to limit dissolution

Issue	Description	Tasks
		without other adverse impacts. Evaluate potential for precipitation and/or plugging.
Water Quality and Re-equilibration	New source water can impact corrosion in the distribution system	Evaluate impacts to pipes, built-up scale, and disinfection on distribution system water quality under the range of potential future water supply scenarios.
Groundwater Basin Management	Purified water becomes a part of the overall groundwater management plan	Determine impacts of reuse options on overall groundwater sustainability.
Regulatory Framework	Direct potable reuse framework under development	Develop a program implementation strategy to bracket potential regulatory outcomes.
Personnel Requirements	Water supplies requiring advanced treatment require proper staffing with adequate training	- Develop a staffing plan for operations and maintenance. - Identify the required training and certifications necessary to assure the safety of the delivered water quality.

7.2.4 Assumed Yields for the 2015 WSE Update

Zone 7's analysis started with 4,800 AFA of new water supply, and then added additional supply until the total reached about 7,700 AFA. If IPR options were used in a portfolio, then it indirectly met water demands by increasing the amount of available groundwater supply achieved by either percolation through Lake I or injection. If DPR options were used, then it was modeled as a direct demand offset, similar to surface water treated at one of Zone 7's water treatment plants. Costs were taken directly from HDR's white paper based on the option included. Additionally, HDR indicated that it could take 6 to 7 years to implement and construct any IPR or DPR project; consequently, it was assumed any of these options would not be available until around 2022.

7.3 DESALINATION

Preliminary analysis completed by Staff as part of this update indicated that desalination would likely be necessary to meet existing water supply reliability policies and goals. Consequently, Staff hired HDR, to complete a preliminary feasibility review of potential desalination options for the Livermore-Amador Valley area, particularly, a review of options for the Bay Area Regional Desalination Project (BARDP). A copy of HDR's white paper is included as Appendix A.

Including desalination in future portfolios will help make overall water supplies more resilient to extreme droughts and climate change; however, as discussed below, the BARDP is a joint

venture involving five Bay Area agencies, and supplies must be imported to the Livermore-Amador Valley area.

7.3.1 Description of the BARDP

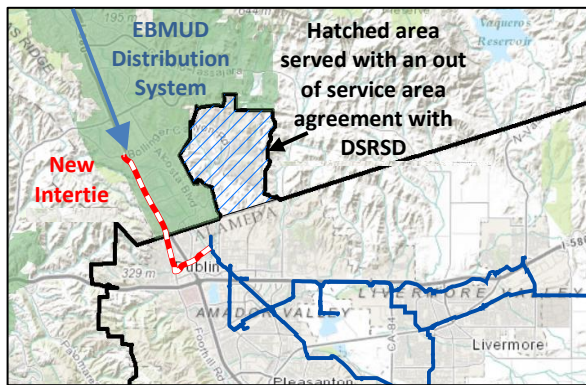
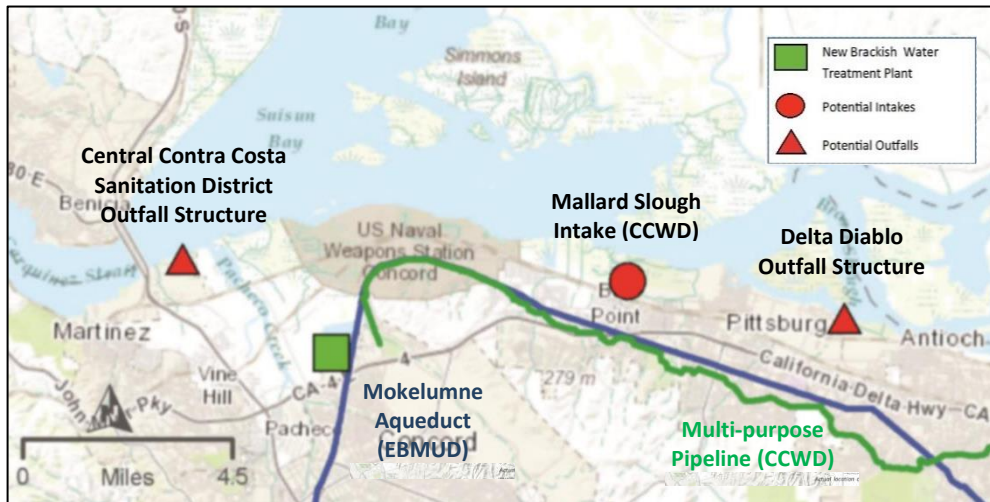
BARDP is a joint venture among five²⁰ of the Bay Area's water agencies working together to investigate a regional brackish water treatment plant located in eastern Contra Costa County.²¹ The costs and potential environmental impacts of brackish water (estimated at 5,000 mg/L total dissolved solids [TDS]) desalination are significantly less than seawater (estimated at more than 30,000 mg/L TDS) desalination, which is why treatment costs (estimated at \$800 per acre-foot) are significantly lower than other desalination plants (\$2,000 to \$3,000 per AF).

Through the use of an existing water right license and permit, both held by Contra Costa Water District (CCWD), and/or a new water right, the BARDP could provide all five agencies with a combined yield of 22,400 AFA (20 MGD) of new water supply. Zone 7 could potentially receive 5,600 AFA (5 MGD). Zone 7 could take delivery of this new water supply through a new intertie with East Bay Municipal Utility District (EBMUD) or through the SBA via an exchange with CCWD (see Figure 7-2).

²⁰ The BARDP currently consists of Zone 7 Water Agency, Contra Costa Water Agency, East Bay Municipal Utility District, San Francisco Public Utilities Commission, and Santa Clara Valley Water District.

²¹ The current location being used for cost estimates is at CCWD's existing Bollman WTP.

Figure 7-2. Regional Desalination Concepts

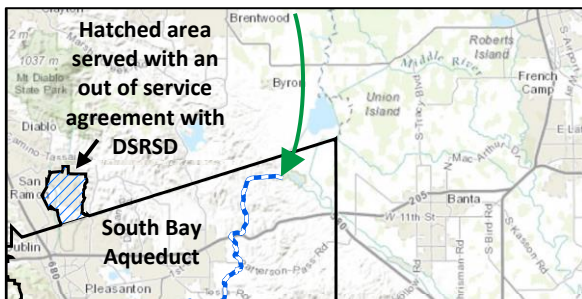


□ Zone 7 Service Area ■ EBMUD

DESAL 1-C: (5,600 AF/YEAR)
Bay Area Regional Desalination

5,600 AF (5 MGD) of Zone 7's Desalination Water wheeled through EBMUD's System to Zone 7, and requires EBMUD to retreat water prior to delivery

Capital Cost: \$94.4 M
O/M Cost: \$5.7 M per year
Unit Cost: \$2,100 per AF



□ Zone 7 Service Area

DESAL 1-D: (5,600 AF/YEAR)
Bay Area Regional Desalination

5,600 AF (5 MGD) of Zone 7's Desalination Water delivered to CCWD in exchange for 5,600 AF (5 MGD) of CCWD's CVP Water delivered to Zone 7

Capital Cost: \$72 M
O/M Cost: \$3.7 M per year
Unit Cost: \$1,500 per AF

Zone 7 could take delivery of the new water supply from the Bay Area Regional Desalination Project (BARDP) (top) through (middle) a new intertie with EBMUD, or (bottom) through the South Bay Aqueduct via an exchange with CCWD.

Conveyance to Zone 7 via Exchange with Contra Costa Water District

Zone 7 would receive water under this alternative by allowing CCWD to take delivery of its portion of treated water produced by the brackish water desalination plant in exchange for a like portion of CCWD's Central Valley Project water, which would be delivered to Zone 7's existing drinking water treatment plants via the South Bay Aqueduct. This alternative avoids the additional costs of wheeling water through EBMUD's treatment and distribution system, but is not resilient to outages of the Delta due to earthquakes or water quality. This option is also dependent on the availability of CCWD's Central Valley Project water for exchange.

HDR estimated the amortized cost for this option at \$8.4 million per year. Assuming an annual yield of 5,600 acre-feet per year, this translates to an estimated incremental cost of about \$1,500 per acre-foot of new water supply.

Conveyance to Zone 7 via Wheeling through East Bay Municipal Utility District

Zone 7 would receive water under this alternative by paying EBMUD to wheel the water through its treatment and distribution system, which includes introducing the desalinated water into the EBMUD raw water aqueduct, re-treating the supply, into a new intertie constructed on the western-side of Zone 7's system. This alternative has significantly higher capital and operating costs, but is more resilient to outages of the Delta due to an earthquake or water quality.

HDR estimated the amortized cost for this option at \$11.9 million per year. Assuming an annual yield of 5,600 acre-feet per year, this translates to an estimated incremental cost of about \$2,100 per acre-foot of new water supply.

7.3.2 Assumed Yields for the 2015 WSE Update

Zone 7 assumed that 5,600 AFA would be available from the regional brackish water desalination plant, and would not be available until around 2022 (i.e., a 6 to 7 year expedited implementation schedule).

8.0 POTENTIAL RISK REDUCTION FACILITIES

As part of this update, staff worked with the retailers to develop the following list of new facilities or projects that would help reduce the risk of water supply shortages during droughts, Delta outages due to earthquakes or salinity, and emergency conditions (e.g., temporary loss of the SBA or unplanned water treatment plant shutdowns):

- California WaterFix
- Reliability Intertie
- Chain of Lakes Pipeline
- Los Vaqueros Emergency/Drought Storage
- Well Master Plan Wells

Besides the California WaterFix, these facilities and projects do not change water supply, but help provide flexibility and leverage existing and/or planned water supplies to improve reliability in certain scenarios. The purpose of this section is to describe each of the facilities and/or projects identified.

8.1 CALIFORNIA WATERFIX

The SWP system currently relies on a system of levees that are vulnerable to subsiding peat soils, earthquake, sea level rise, flooding, and even burrowing of ground squirrels. The California WaterFix will construct two tunnels up to 150 feet below ground that would provide protection against water supply disruptions should these levees fail. Furthermore, since the intake for these tunnels would be located along the Sacramento River, they also protect against potential loss of the Delta due to salt water intrusion caused by extreme drought conditions (e.g., similar to those observed in January 2014). The associated costs of the California WaterFix was previously discussed in Section 7.1.

8.2 RELIABILITY INTERTIE

As discussed previously, Zone 7 could experience a significant water supply shortage if SWP Table A allocations are less than 10%, there is a loss of the SBA, or a catastrophic event in the Delta (earthquake or poor water quality due to drought). As part of its existing Capital Improvement Program (CIP), Zone 7 is planning to construct a reliability intertie with another

major water agency (e.g., EBMUD or San Francisco Public Utilities Commission [SFPUC]) to help mitigate some of this risk. This intertie might allow Zone 7 the opportunity to acquire emergency water supplies to help meet minimum health and safety water supply needs during these major outages assuming the partnering agency has available supply and the transmission capacity available during the emergency period.

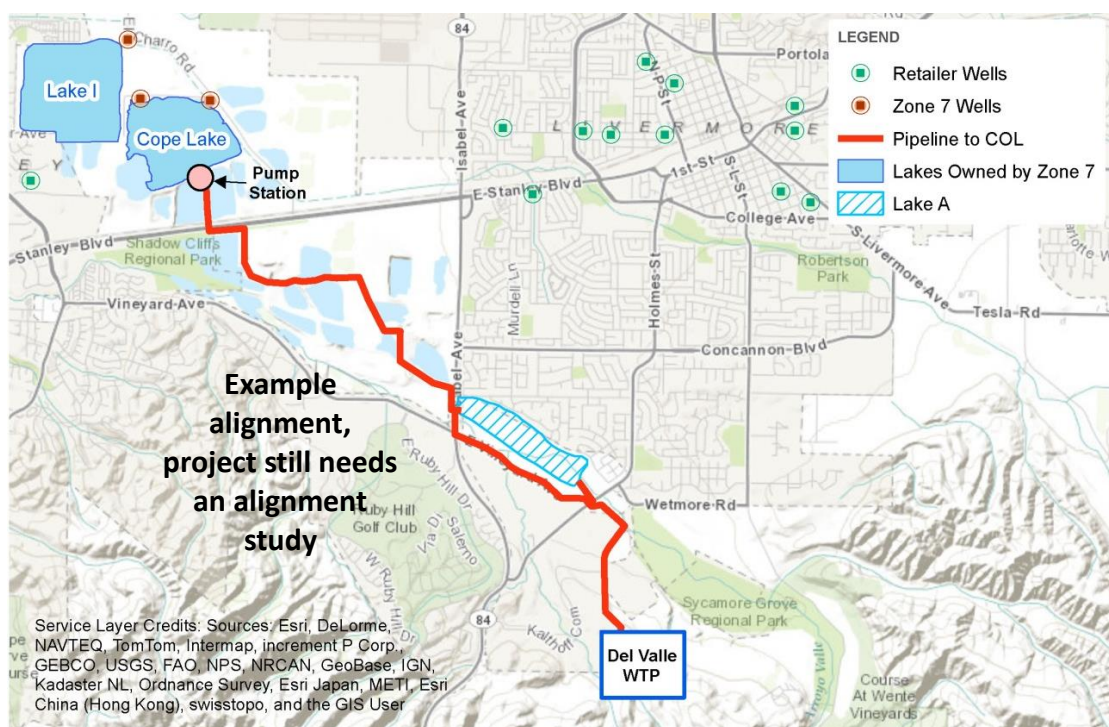
The estimated cost of the intertie is approximately \$24 million based on a connection to EBMUD, and for planning purposes in this analysis, was assumed in place by 2022.

8.3 CHAIN OF LAKES PIPELINE

As discussed previously, many of the active gravel mining operations may continue until 2060, delaying completion of the Chain of Lakes by 30 years beyond the previous planning horizon. This means that previously planned groundwater recharge, existing water right perfection, and other key water management strategies (e.g., to reduce salt loading) are also potentially delayed because they are tied to the Chain of Lakes.

Consequently, as part of its existing CIP, Zone 7 is planning to construct a 36-inch diameter pipeline from Cope Lake to the Del Valle Water Treatment Plant (~6 miles) and a 12 MGD pump station (see Figure 8-1). Regardless of extended mining activities, this project would allow Zone 7 to improve recharge of the local groundwater basin, help perfect local water rights, meet demands with stored water in the Chain of Lakes during catastrophic events (e.g., loss of the Delta), and increase options for new water supplies (e.g., potential Direct Potable Reuse).

Figure 8-1. Proposed Chain of Lakes Pipeline



A 36-inch diameter pipeline from Cope Lake to the Del Valle Water Treatment Plant (~6 miles) and a 12 MGD pump station would allow Zone 7 to recharge the local groundwater basin, help perfect local water rights, meet demands with stored water in the Chain of Lakes during catastrophic events (e.g., loss of the Delta), and increase options for new water supplies (e.g., potential direct potable reuse)

The estimated cost of the pipeline and pump station is approximately \$32 million, and for planning purposes in this analysis, was assumed in place by 2020 (i.e., assumed dedication year for Lake A). A detailed cost estimate is provided in Appendix B. Note that the alignment shown is for planning-level purposes only, and that a more detailed alignment study is necessary.

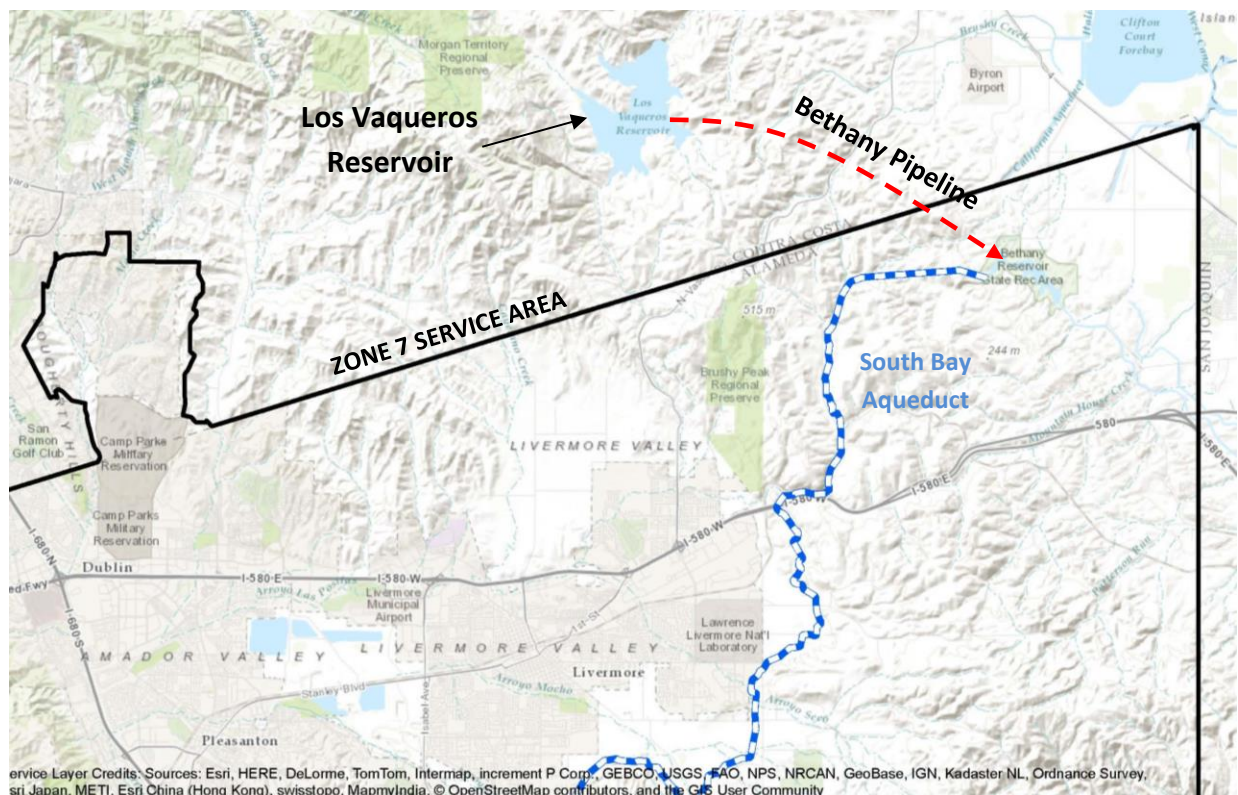
8.4 LOS VAQUEROS EMERGENCY/DROUGHT STORAGE

Based on actual drought conditions in 2014 and 2015, Zone 7 found that access to previously stored surface water in Kern County is vulnerable during low allocations on the SWP (< 10%), or during disruptions in the Delta. The availability of this water is also highly dependent on the operations of two State Water Contractors (Metropolitan and Kern County Water Agency) located in Southern California.

This project might shore up available drought and emergency water supplies by providing alternative storage north of Zone 7's service area (see Figure 8-2), assuming the SBA is still

operating. Also, if the emergency intertie is in place or a new pipeline is constructed from Los Vaqueros to the SBA (i.e., the Bethany Pipeline), having stored water north of Zone 7 might allow access even during outages of the SBA due to a major event like an earthquake in the Delta, assuming that CCWD and EBMUD could accommodate the transfer.

Figure 8-2. Storage in Los Vaqueros Reservoir



Los Vaqueros Emergency/Drought Storage could improve access to emergency water supplies by exchanging water from Kern County, which is located south of Zone 7's service area, to Los Vaqueros, which is located north of Zone 7's service area.

For planning purposes in this update, it was assumed that this project would store a portion of SWP water, typically sent to Cawelo or Semitropic, in Los Vaqueros Reservoir, which is owned and operated by CCWD. CCWD would divert Zone 7's SWP water at their Old and/or Middle River intakes. Zone 7 could then request this stored water through an exchange with CCWD's water sources during times of drought or other limited surface water scenarios, when neither Cawelo nor Semitropic would be available, or by having the water wheeled through both CCWD and EBMUD's systems using a future Reliability Intertie between Zone 7 and EBMUD.

The estimated cost of this project is approximately \$3.5 million for up to 10,000 AF of storage in Los Vaqueros, and do not include the cost of the Bethany Pipeline.²² Zone 7, in partnership with ACWD and CCWD is already planning to pilot exchange (non-Reliability Intertie-dependent) project in 2016, it was assumed that a full-scale exchange project could be in place as early as 2017 without a reliability intertie.

8.4 WELL MASTER PLAN WELLS

The ability to use groundwater during drought periods or during extended outages of either the SBA or the Delta greatly increases the reliability and resiliency of Zone 7's water supplies. The wells outlined in the Well Master Plan, and currently included as part of Zone 7's existing CIP, will help access additional groundwater supply when it is needed most.

As discussed previously in Chapter 5, previous groundwater modeling efforts indicate that the spatial distribution of the existing wells would allow Zone 7 to pump as much as 28,000 AF in one year assuming the groundwater basin was about 80% full. Additional modeling completed as part of the Well Master Plan evaluated three new well fields: Busch Valley wellfield, the Bernal wellfield, and the Chain of Lakes 3 and 4 wellfield.

Table 8-1 presents the estimated increase in capital cost, assumed timing used for the analysis completed as part of this update, and the assumed maximum recovery in one year if the Main Basin were 80% full. As shown in Table 8-1, these three new wellfields could increase total maximum recovery by over 20% (from 28,000 to 34,400 acre-feet). Detailed cost estimates are included in Appendix B.

²² Costs for LVE storage are based on the costs outlined in the MOU between CCWD and Zone 7 for the pilot concept being tested in 2015/2016, and do not include the Bethany Pipeline since that aspect of the project could take years to decades to complete.

Table 8-1. Existing and Future Groundwater Well Assumptions for this Update

Wellfield	Incremental Cost	Cumulative Cost	Assumed Timing	Projected Maximum Recovery if Basin is 80% Full, acre-feet^(b)
Existing Wells ^(a)	None	None	Already in place	28,000 ^(c)
Existing + Busch Valley	\$10.8 million	\$10.8 million	2020	30,000
Existing + Busch Valley + Bernal	\$28.7 million	\$39.5 million	2025	32,000
Existing + Busch Valley + Chain of Lakes 3 and 4	\$14.2 million	\$53.7 million	2030	34,400

^(a) Includes the following wells: Mocho, Hopyard, Stoneridge, COL 1, 2, and 5.

^(b) The most Zone 7 has pumped between 1974-2014 is 12,100 AF.

^(c) Although the capacity of the existing wells is 32 MGD or 35,850 acre-feet assuming the wells run at full capacity for 365 days, the annual recovery is actually only 28,000 acre-feet due to well field locations and the historic low.

9.0 PORTFOLIOS USED TO EVALUATE ZONE 7'S WATER SUPPLY SYSTEM

Staff worked with the Retailers to develop the following four future portfolios to help identify potential investments that might improve the resiliency of Zone 7's water supply system:

- Current Plan
- Portfolio A: Desalination
- Portfolio B: Purified Recycled Water
- Portfolio C: Desalination and Purified Recycled Water

As discussed previously, the Livermore-Amador Valley area will always depend on the SWP. In fact, as will be shown, the reliance on the SWP could only be reduced from 88% down to 73%. Therefore, each portfolio includes the California WaterFix (i.e., BDCP preferred project); however, as discussed in Chapter 10, the timing and yield of the SWP was varied for each portfolio. Each portfolio also includes the Reliability Intertie, Chain of Lakes Pipeline, and planned future groundwater wells because not only are they already in Zone 7's CIP, they help improve many other aspects of Zone 7's system.

9.1 CURRENT PLAN

This is the recommended portfolio from the 2011 Water Supply Evaluation, and includes only those projects that are already in Zone 7's currently adopted CIP. This portfolio is dependent on the State of California finalizing plans for a solution to the crisis in the Delta. However, the resiliency of this approach to key issues (e.g., climate change and declining reliability of the SWP until new facilities are online) was reevaluated as part of this update. The analysis also adjusted the yield from BBID to zero acre-feet as a conservative assumption used for this update.

Figure 9-1 provides a summary of projected average water supply under the Current Plan. As shown in Figure 9-1, the only additional water supply is replacement water supply provided by the California WaterFix (see Section 7.1), and does not include desalination nor purified recycled water. Figure 9-1 also shows that about 88% of total average supply is associated with the SWP (Table A and the California WaterFix combined).

Figure 9-1. Projected Average Water Supply Mix for the Current Plan, TAF

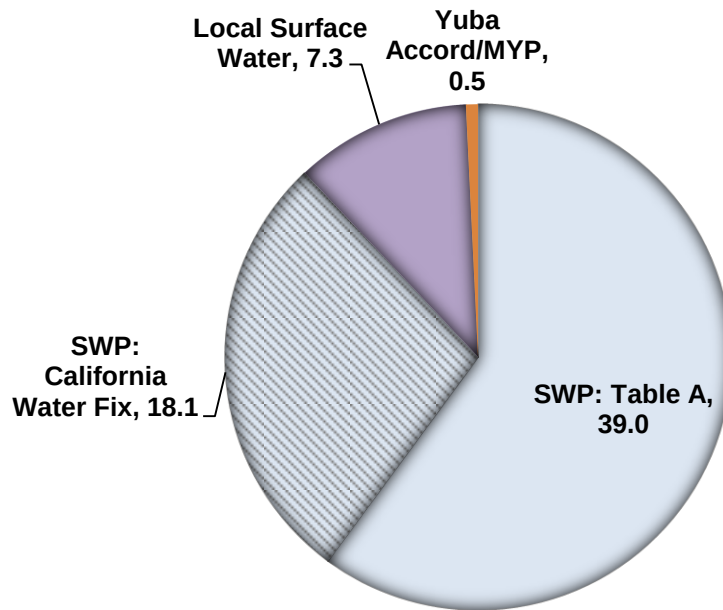


Table 9-1 summarizes both the water supply projects and facilities included in the Current Plan to help reduce future risk of shortages. As shown in Table 9-1, up to 18,100 acre-feet of replacement water supply might be available from the California WaterFix (see Section 7.1), while the only reliability facility discussed in Chapter 8 but not included was Los Vaqueros Storage project since it is not already in Zone 7's existing CIP. The details for the facilities included are described in Section 8.1 (Reliability Intertie), Section 8.2 (Chain of Lakes Pipeline), and Section 8.4 (Well Master Plan Wells).

Table 9-1. Summary of Average Water Supply and Reliability Facilities in the Current Plan

Option		Current Plan
Water Supply Options	California WaterFix (i.e., BDCP or Delta Fix)	✓
	Bay Area Regional Desalination	
	Purified Recycled Water	
Reliability Facilities	Chain of Lakes Pipeline	✓
	Reliability Intertie	✓
	Well Master Plan Wells	✓
	Los Vaqueros Storage	

9.2 DESALINATION ONLY (PORTFOLIO A)

This portfolio includes all of the elements of the Current Plan, but adds desalination (see Section 7.3) and storage in Los Vaqueros (see Section 8.3); the yields and cost estimates associated with desalination were estimated by HDR as part of a preliminary feasibility study. The HDR report is included as Appendix B. Current estimates provided by CCWD were included for Los Vaqueros.

The objective of this portfolio is to evaluate the potential benefits of implementing desalination to help mitigate potential delays in the California WaterFix or interim reductions in the reliability of the State Water Project. This portfolio also includes Los Vaqueros Storage to help mitigate some of the exchange issues observed in 2014 that prevented Zone 7 from accessing a small portion of its stored water in Kern County banking programs.

Figure 9-2 provides a summary of projected average water supply under Portfolio A. As shown in Figure 9-2, in addition to the California WaterFix (see Section 7.1), this portfolio also includes desalination (see description in Section 7.3). Figure 9-1 also shows that even if desalination is added, it will make up less than 10% of total average water supplies, and the Tri-Valley area is still primarily reliant on the State Water Project for its water supply.

Figure 9-2. Projected Average Water Supply Mix for Portfolio A, TAF

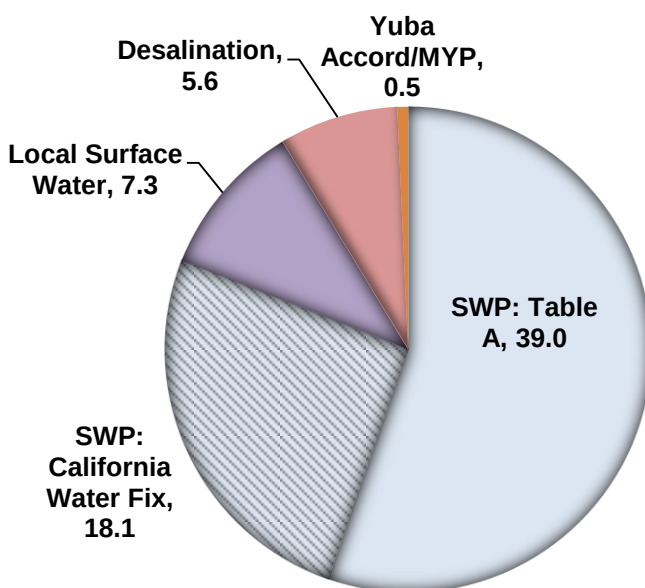


Table 9-2 summarizes both the water supply projects and facilities included in Portfolio A to help reduce future risk of shortages. As shown in Table 9-2, up to 18,100 acre-feet of

replacement water supply might be available from the California WaterFix (see Section 7.1) and up to 5,600 acre-feet from desalination (see Section 7.3). Table 9-2 also shows that Portfolio includes all of the reliability facilities identified (see Chapter 8).

Table 9-2. Summary of Average Water Supply and Reliability Facilities in Portfolio A

Option		A
Water Supply Options	California WaterFix (i.e., BDCP or Delta Fix)	✓
	Bay Area Regional Desalination	✓
	Purified Recycled Water	
Reliability Facilities	Chain of Lakes Pipeline	✓
	Reliability Intertie	✓
	Well Master Plan Wells	✓
	Los Vaqueros Storage	✓

9.3 PURIFIED RECYCLED WATER ONLY (PORTFOLIO B)

This portfolio includes all of the elements of the Current Plan, but adds purified recycled water (see Section 7.2) and storage in Los Vaqueros Reservoir (see Section 8.3); the yields and cost estimates for portable reuse were estimated by HDR as part of a preliminary feasibility study. The HDR report is included as Appendix A.

The objective of this portfolio is to evaluate the potential benefits of implementing purified recycled water to help mitigate potential delays in the California WaterFix or interim reductions in the reliability of the SWP. This portfolio also includes storage in Los Vaqueros Reservoir to help mitigate some of the exchange issues observed in 2014 that prevented Zone 7 from accessing all of its stored water in Kern County banking programs.

Figure 9-3 provides a summary of projected average water supply under Portfolio B. As shown in Figure 9-3, in addition to the California WaterFix (see Section 7.1), this portfolio also includes purified recycled water (see description in Section 7.2). Figure 9-3 also shows that even if purified recycled water is added, it will make just over 10% of total average water supplies, and the Livermore-Amador Valley is still primarily reliant on the SWP for its water supply.

Figure 9-3. Projected Average Water Supply Mix for Portfolio B, TAF

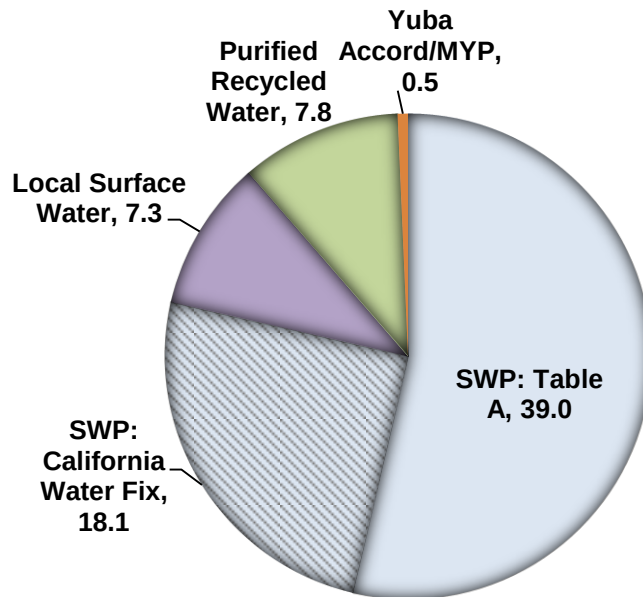


Table 9-3 summarizes both the water supply projects and facilities included in Portfolio B to help reduce future risk of shortages. As shown in Table 9-3, replacement water supply might be available from the California WaterFix (see Section 7.1) and from purified recycled water (see Section 7.2). Table 9-3 also shows that Portfolio B includes all of the reliability facilities identified (see Chapter 8).

Table 9-3. Summary of Average Water Supply and Reliability Facilities in Portfolio B

Option		B
Water Supply Options	California WaterFix (i.e., BDCP or Delta Fix)	✓
	Bay Area Regional Desalination	
	Purified Recycled Water	✓
Reliability Facilities	Chain of Lakes Pipeline	✓
	Reliability Intertie	✓
	Well Master Plan Wells	✓
	Los Vaqueros Storage	✓

For modeling purposes, the initial yield was set at 4,800 AF (4.3 MGD), and then increased to as much as 7,700 AF (6.9 MGD) depending on the need identified for each scenario evaluated, as

explained in Section 7.2. The yield of both IPR and DPR projects were not added together since they rely on the same source of raw water.

9.4 DESALINATION PLUS PURIFIED RECYCLED WATER (PORTFOLIO C)

This portfolio includes all of the elements of the Current Plan, but adds every project included in Portfolios A and B for further analysis. The yields and cost estimates for desalination and purified recycled water were estimated by HDR as part of a preliminary feasibility study. The HDR report is included as Appendix A.

The objective of this portfolio is to evaluate the potential benefits of implementing all of the waters supply options (see Chapter 7) and reliability facilities (see Chapter 8) to help mitigate potential delays in the California WaterFix or interim reductions in the reliability of the SWP. This portfolio also includes storage in Los Vaqueros Reservoir to help mitigate some of the exchange issues observed in 2014 that prevented Zone 7 from accessing all of its stored water in Kern County banking programs.

Figure 9-4 provides a summary of projected average water supply under Portfolio B. As shown in Figure 9-4, in addition to the California WaterFix (see Section 7.1), this portfolio also includes desalination (see Section 7.3) and purified recycled water (see Section 7.2). Figure 9-4 also shows that even if both purified recycled water and desalination are added, the State Water Project will still make up over 70 percent of total average water supply (Table A plus California WaterFix), and the Livermore-Amador area is still primarily reliant on the SWP for its water supply.



Figure 9-4. Projected Average Water Supply Mix for Portfolio C, TAF

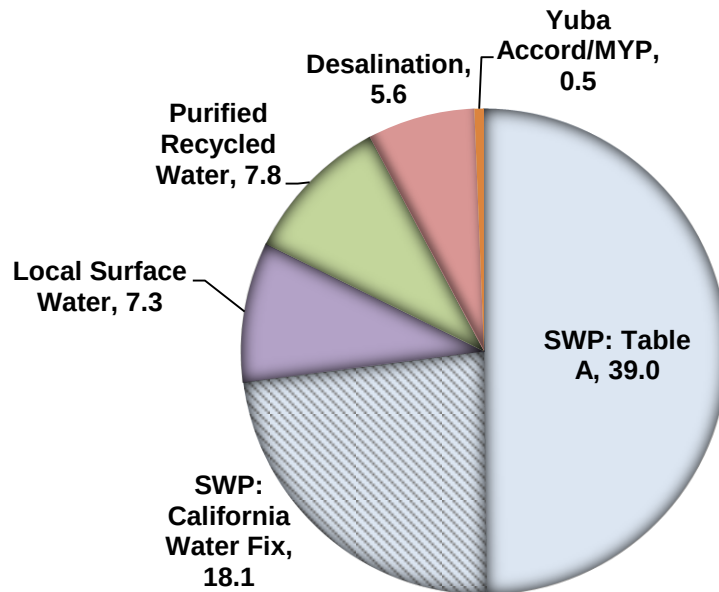


Table 9-4 summarizes both the water supply projects and facilities included in Portfolio C to help reduce future risk of shortages. As shown in Table 9-4, replacement water supply might be available from the California WaterFix (see Section 7.1), and up to approximately 13,400 acre-feet might be available from both desalination (see Section 7.3), and purified recycled water (see Section 7.2) combined. Table 9-4 also shows that Portfolio C includes all of the reliability facilities identified (see Chapter 8).

Table 9-4. Summary of Average Water Supply and Reliability Facilities in Portfolio C

Option		C
Water Supply Options	California WaterFix (i.e., BDCP or Delta Fix)	✓
	Bay Area Regional Desalination	✓
	Purified Recycled Water	✓
Reliability Facilities	Chain of Lakes Pipeline	✓
	Reliability Intertie	✓
	Well Master Plan Wells	✓
	Los Vaqueros Storage	✓

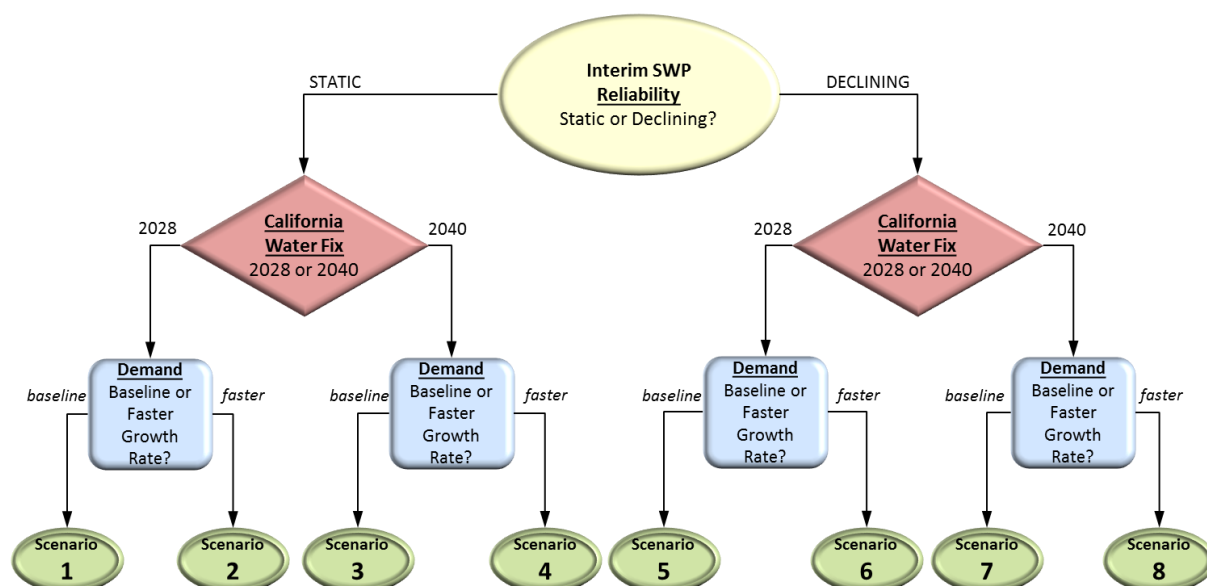
10.0 ANALYSIS USED IN THIS UPDATE: MORE CONSERVATIVE AND EXPANDED

Based on observations made during the current drought from 2012 to 2015 and input from Retailers, Zone 7 updated its approach to identifying both vulnerabilities and future water supply needs. Although the same probability-based water supply model from 2011 was used, Staff used it to evaluate eight scenarios instead of only one scenario and analyzed eight metrics instead of only two. Additional scenarios and metrics increased the complexity of the analysis, but also evaluated any potential portfolio against a larger number of uncertainties.

10.1 Scenarios Used in the WSE Update

Although the future yield from Zone 7's existing water supplies depend on many variables, three have the largest influence on determining future water supply needs: (1) interim reliability of the SWP until completion of the California WaterFix; (2) timing of the California WaterFix; and (3) projected water demands. Unlike the analysis completed in 2011, which looked at a static interim reliability of the SWP, a defined year for completion of the California WaterFix, and one set of projected water demands, this update used an expanded approach, evaluating several different combination of all three conditions. As shown in Figure 10-1, this resulted in eight scenarios.

Figure 10-1. Scenarios Used for Portfolio Analysis



When combined with the number of portfolios (four), this analysis provides 32 different potential futures (four portfolios times eight scenarios). Furthermore, using Zone 7's probability-based water supply model, each of the 32 different futures was subjected to 10,000 different potential hydrologic sequences; representing over 320,000 years (32 futures times 10,000 years) of analysis.

10.2 METRICS USED FOR THIS WSE UPDATE

Three key components within Zone 7's core mission are water supply reliability (i.e., reducing the magnitude and frequency of water shortages), managing the Livermore-Valley Groundwater Basin (i.e., local groundwater storage), and being fiscally responsible (i.e., considering and managing costs). Consequently, the analysis completed in 2011 focused on water supply shortages, available groundwater storage, and costs to measure the performance of potential future water supply portfolios. Although important and core to Zone 7's mission, these three metrics, alone, did not provide a complete picture of the potential benefits or disadvantages of one portfolio over another.

Based on actual drought experience obtained between 2012 and 2015, Staff worked with the local water supply retailers to identify five additional metrics to help evaluate Zone 7's wholesale water system. In addition to shortage, groundwater supply, and costs, Zone 7 added the following: average reliability, minimum supply, diversification of supplies, local control, and energy use.

Although the combination of the eight metrics provides a sense of the benefits of one portfolio over another, the original core metrics (shortages, groundwater supply, and cost) and two additional core metrics (Average Reliability and Minimum Supply) should still carry the most weight when evaluating the potential benefits since they are part of Zone 7's mission.

Table 10-1 presents the five core metrics, while Table 10-2 presents the three other lower priority metrics used to help evaluate the benefits of one portfolio over another.

Table 10-1. Core Mission Metrics Used to Evaluate Portfolios

Metric	Description	Relation to Zone 7's Core Mission
Average Reliability	Average percent of demand met overall hydrologic conditions	The frequency Zone 7's system experiences no shortages indicates the benefits to reliability provided by a portfolio
Rare Large Shortages	Largest percent of unmet demand during major events (e.g., drought or loss of SBA)	The estimated magnitude of the rarest and largest shortages indicates how well a portfolio can reliably meet demands during extreme situations
Minimum Water Supply	Smallest per capita demand met during major events (e.g., drought or loss of SBA)	The estimated minimum supply indicates how well a portfolio can reliably meet demands during extreme situations
Average Groundwater Storage	Average percent full over all hydrologic conditions	The amount of available groundwater storage helps gage the success of a portfolio to help manage the local groundwater basin
Costs	Estimated total amortized dollars	Costs help identify the most fiscally prudent portfolios

Table 10-2. Lower Priority Metrics Used to Evaluate Portfolios

Metric	Description
Diversification	Percentage of non-State Water Project water supplies within a water supply portfolio
Local Control	Largest percentage of total long-term average water supply under local control. For this update, local control was defined as within the San Francisco Bay Area
Energy Use	Estimated long-term average energy use in Megawatt-Hours per year

11.0 FINDINGS FROM ANALYZING THE PORTFOLIOS

This chapter presents the calculated benefits for each of the four portfolios against all eight scenarios from 2016 to 2050, a period that extends 10 years past the projected build out of adopted general plans. Each of the eight metrics is discussed separately.

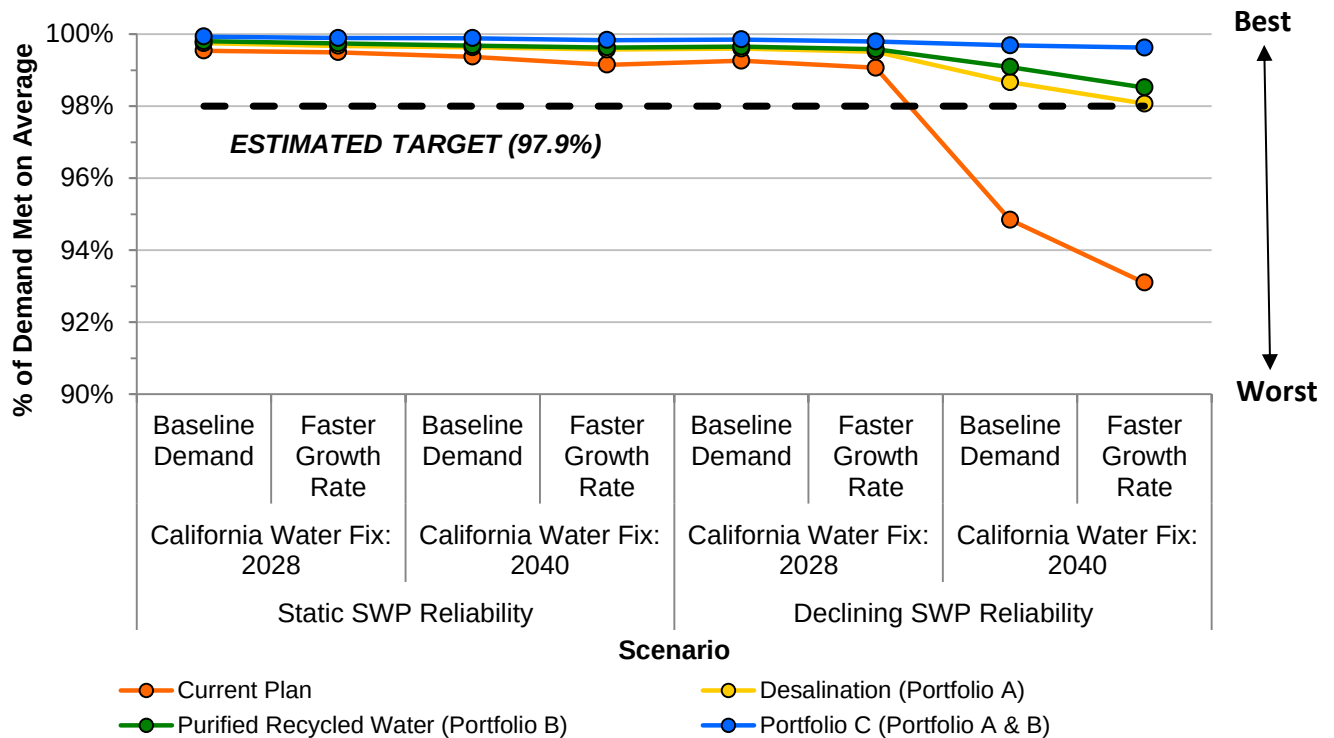
11.1 AVERAGE RELIABILITY

In October 2012, the Zone 7 Board of Directors adopted Zone 7's Water Supply Reliability Policy (Resolution 13-4230). The first goal of the Water Supply Reliability Policy helps guide the management of M&I water supplies, and states that Zone 7 shall try to meet 100% of M&I demands 90% of the time, 85% of demands 99% of the time, and acknowledges that one percent of the time, less than 85% of demands will be met.

For comparative purposes only, Staff translated this policy into an average reliability using Governor Brown's 2015 mandated water use reduction target of 25% to "book-end" the largest shortage that might occur one percent of the time. Using the Governor's target, along with the adopted reliability policy translates into an estimated target average reliability of 97.9 percent ($100\% \times 0.9 + 15\% \times 0.09 + 25\% \times 0.01$).

Figure 11-1 compares the average reliability calculated for each portfolio under all eight scenarios to this estimated target. As shown in Figure 11-1, three of the four portfolios exceed this target under all eight scenarios evaluated, and it is only in the last two most dire and rare scenarios (Scenarios 7 and 8) that the Current Plan might not be able to meet this target. Figure 11-1 also shows that although Portfolios A and B show minimal response to the more severe scenarios (7 and 8), only Portfolio C, which combines desalination with purified recycled water shows almost no change (i.e., very resilient) in average reliability relative to future extreme scenarios.

Figure 11-1. Outcome of Portfolio Analysis for Average Reliability



11.2. RARE EXTREME SHORTAGES

Extreme water supply shortages may occur due to an earthquake in the Delta that disrupts the flow of fresh water, excessive salinity in the Delta, or record drought; these events are rare. For example, DWR's 2015 DCR indicates that only one in 81 years (i.e., 1.2% probability) will have hydrologic conditions similar to 1977, one of the driest years on record; the probability of 2013 and 2014 conditions is likely even lower (tree ring records suggest a 1 in 1200 year likelihood, or 0.08%).²³

For comparative purposes, rare extreme shortages were compared to the average percentage of indoor and outdoor water use within the Livermore-Amador Valley area. Indoor use was based on data recently collected in December 2014 and November 2015, a recent rare event, which indicates that indoor water use is about 17 MGD for residential, commercial, industrial, and institutional customers in Zone 7's service area.

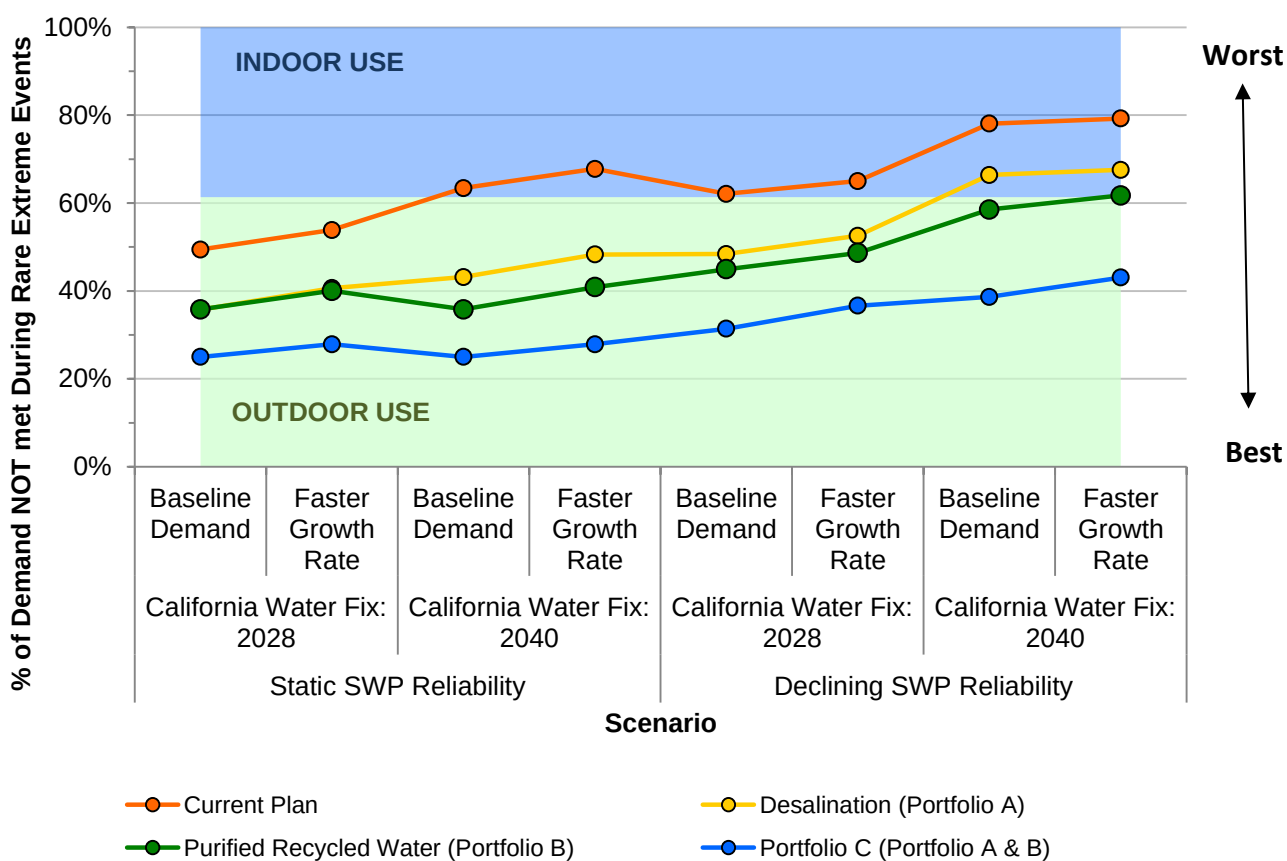
Figure 11-2 compares maximum calculated extreme rare large shortage between 2022 (when new projects are online) and 2040 (build out of general plans) for each portfolio under all eight scenarios to average percent of indoor and outdoor water use. As shown on Figure 11-2, the

²³ Griffin, Anchukaitis, 2014. *How unusual is the 2012-2014 California Drought?*, *Geophys. Res. Lett.*, 41, doi:10.1002/2013GL062433

Current Plan may not provide sufficient supply to meet any outdoor water needs and only some indoor water needs under rare events (e.g., record drought or loss of the Delta).

Figure 11-2 also shows that projected shortages within the Current Plan increase by 30% (from 50% to nearly 80%) under more extreme scenarios, especially those with a delayed Cal WaterFix. Although both desalination and purified recycled water appear to reduce shortages (purified recycled water may be slightly better but further analysis is needed), they also may not be able to provide 100% of the Livermore-Amador Valley's indoor water needs in more severe scenarios. Only the combination of both supply sources (desalination and purified recycled water) may meet indoor water needs during rare extreme shortage events under all scenarios.

Figure 11-2. Outcome of Portfolio Analysis for Rare Extreme Shortages



11.3. MINIMUM M&I SUPPLY DURING RARE EVENTS

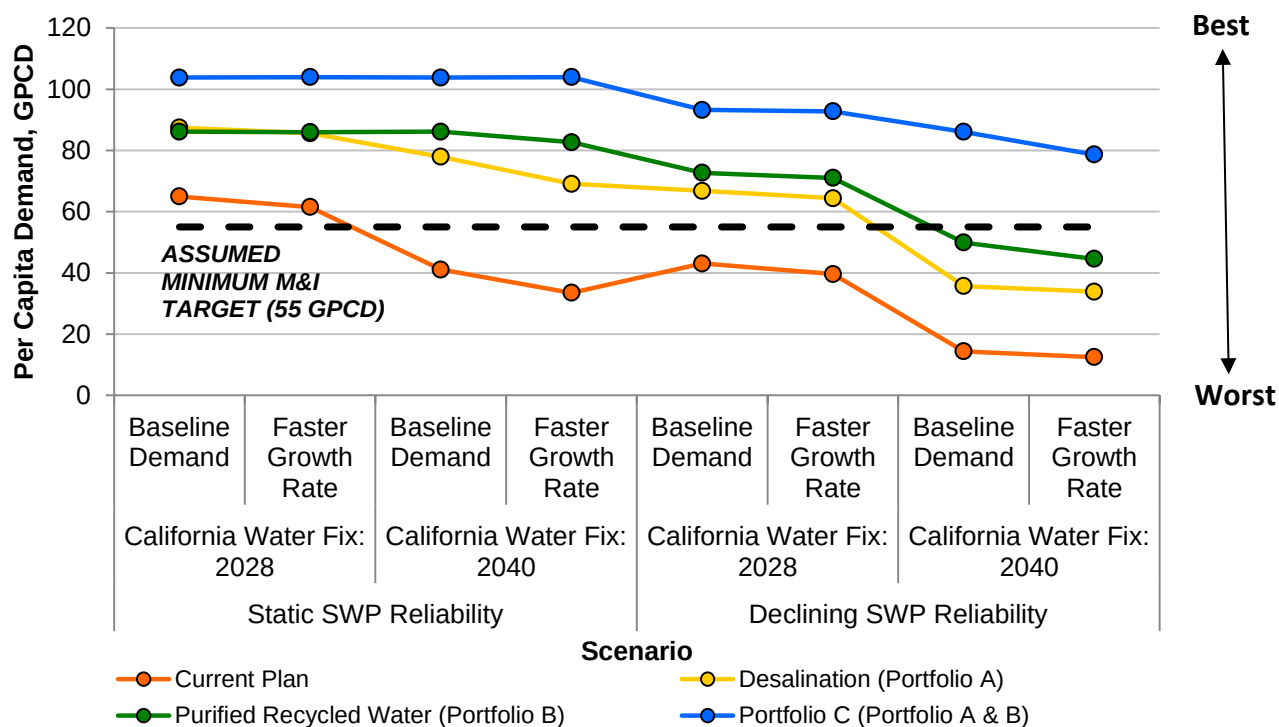
In addition to extreme water supply shortages, the update also reviewed minimum water supply, which is essentially the inverse of shortage. Extreme minimum supply situations may occur due to an earthquake in the Delta that disrupts the flow of fresh water, excessive salinity

in the Delta, or record drought. As discussed previously (see Section 11.1), these events are rare.

There is currently no defined minimum health and safety requirement for the SWP or the State of California; however, the Federal Central Valley Project defines minimum health and safety supply as 55 GPCD. The SWP used 55 GPCD during the current drought discussions even though this may be misleading since this approach ignores commercial, industrial, and institutional uses. However, for comparative purposes only, minimum M&I supply provided by each portfolio was compared to 55 GPCD.

Figure 11-3 compares the calculated extreme minimum water supply between 2022 (when new projects are online) and 2040 (build out of general plans) for each portfolio under all eight scenarios to 55 GPCD. As shown on Figure 11-3, the Current Plan might not be able to provide 55 GPCD under six of the eight scenarios, while Portfolios A, B, and C might be able to in six of the eight scenarios. Only Portfolio C, which includes both desalination and purified recycled water, might provide more than 55 GPCD under all scenarios evaluated.

Figure 11-3. Outcome of Portfolio Analysis for Extreme Minimum Supply



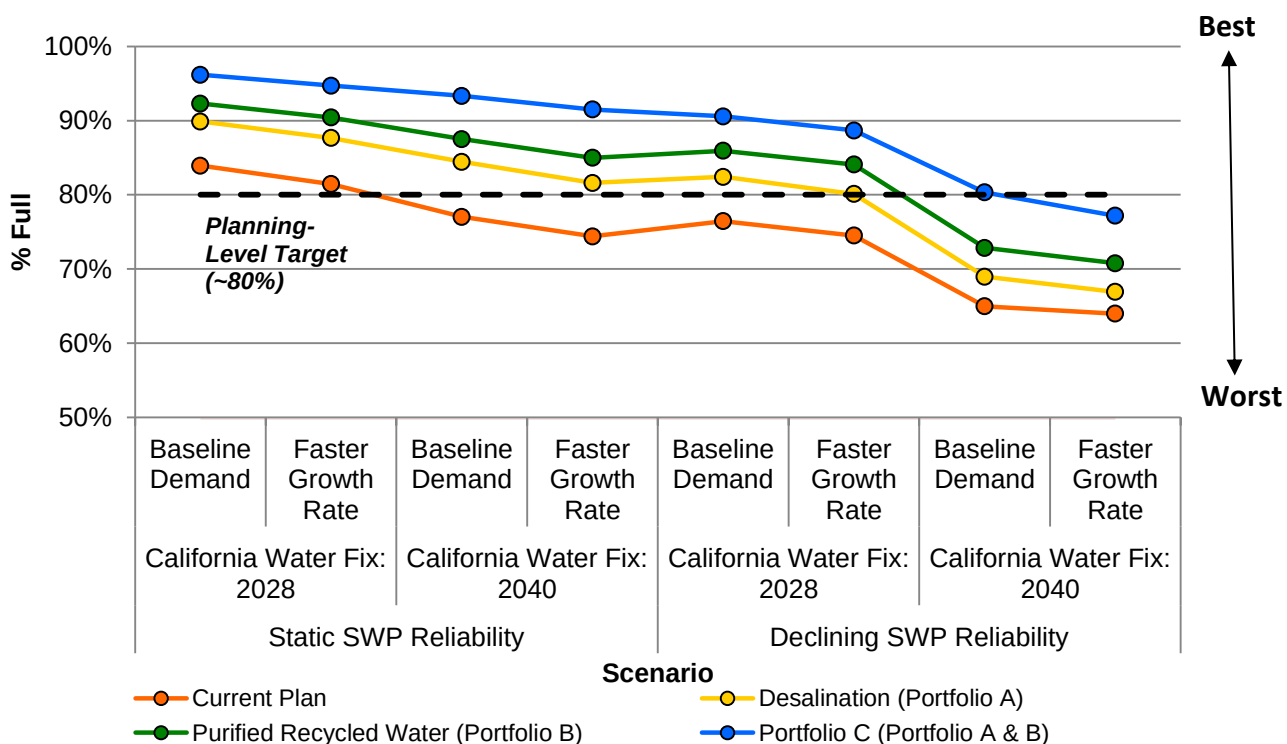
11.4. AVERAGE GROUNDWATER STORAGE

Most of Zone 7's previous planning-level efforts for pumping groundwater from the Livermore Valley Groundwater basin during droughts or other rare events assumed that the main basin

was approximately 80% full heading into droughts. Consequently, for comparative purposes, the average groundwater storage calculated for each portfolio was compared to 80%.

Figure 11-4 compares the calculated average groundwater storage for each portfolio under all eight scenarios to 80%. As shown on Figure 11-4, the Current Plan may not be able to keep groundwater storage at approximately 80% under six of the eight scenarios. Portfolios A and B may not be able to keep groundwater storage above 80% in only the two most extreme scenarios, while Portfolio C meets this target under 7 of the 8 scenarios evaluated.

Figure 11-4. Outcome of Portfolio Analysis for Average Groundwater Storage

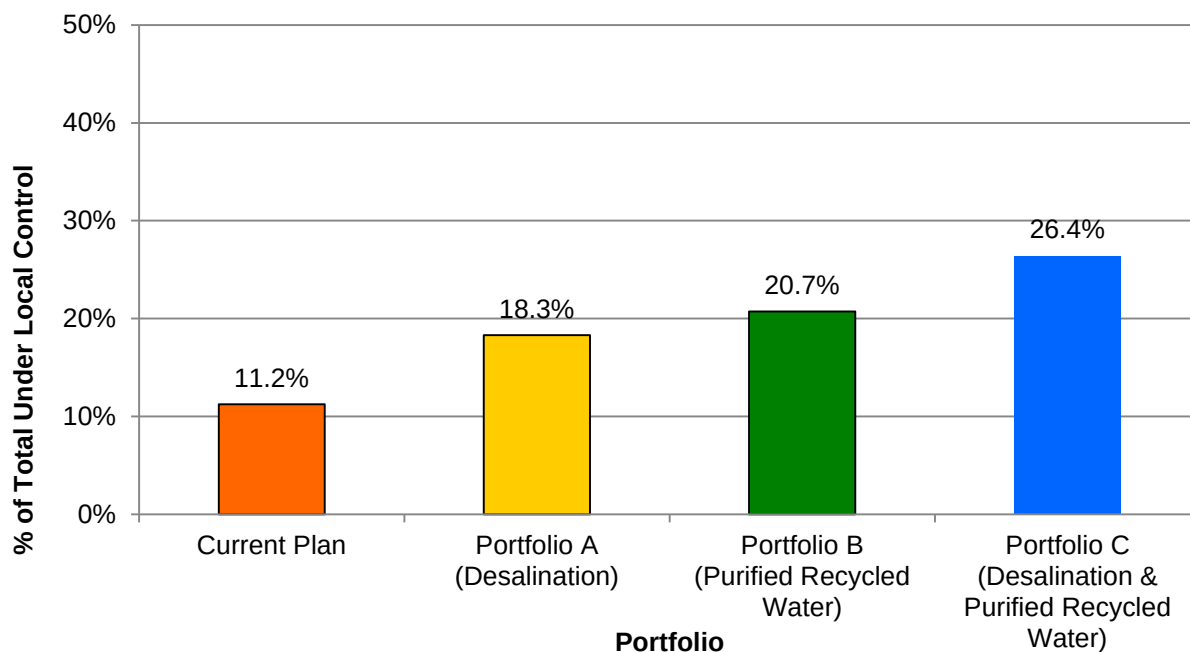


11.5 LOCAL CONTROL

Discussions at the Water Policy Roundtables suggest that the Retailers value local control. Although this is not a part of Zone 7's core mission, it was considered as a metric in this update. However, Zone 7 has long-standing good relationships with its sister agencies in the San Francisco Bay Area, and unlike programs and projects on the SWP or in Kern County, any projects in the San Francisco Bay Area have a much higher degree of local control. Consequently, for this analysis, any new water supply generated entirely within the San Francisco Bay Area was considered a local supply.

Figure 11-5 presents the percentage of total long-term average water supply under local control. As shown in Figure 11-5, even with desalination and purified recycled water, only about 26% of total average supply is under local control, and over 70% of water supply will be under some external control.

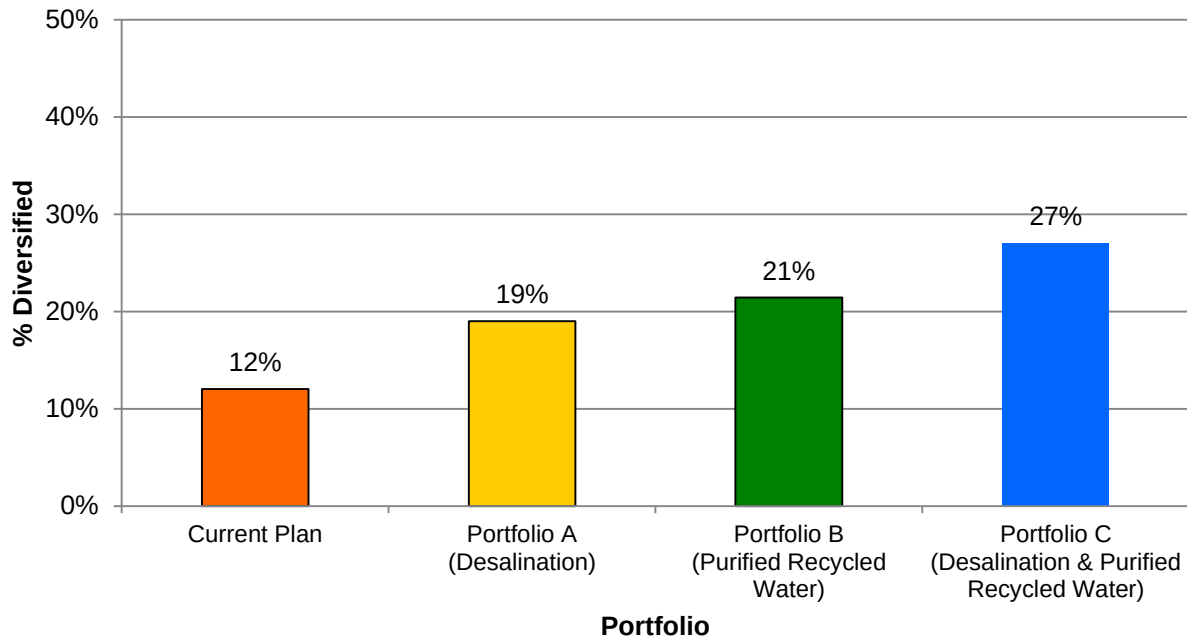
Figure 11-5. Outcome of Portfolio Analysis for Local Control



11.6 DIVERSIFICATION

Discussions at the Water Policy Roundtables suggest that Retailers value diversification. Although this is not a part of Zone 7's mission, it was considered as a metric in this update. Figure 11-6 presents the percentage of total long-term average water supply not associated with the SWP (i.e., the largest source of water). As shown in Figure 11-6, even with desalination and purified recycled water, total average water supply would only be about 27% diversified, and over 70% of water supply would still come from the SWP.

Figure 11-6. Outcome of Portfolio Analysis for Diversification



11.7 Energy Use

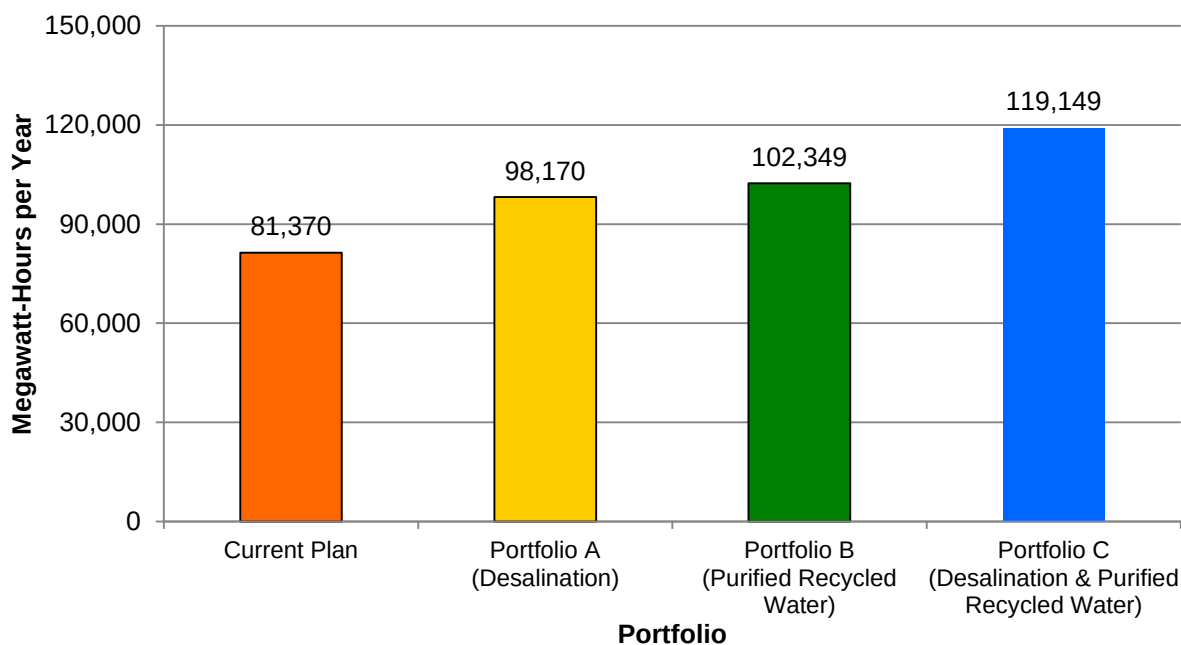
Desalination and purified recycled water rely on energy-intensive treatment technologies (e.g., reverse osmosis); consequently, adding either to Zone 7's water supplies will increase future energy use and, by extension, expand its carbon footprint. Energy use was added as a metric to help understand the potential increase in energy need that might be expected. Table 11-1 presents the unit energy use by water supply used for this update.

Table 11-1. Unit Energy Consumption

Supply Source	Energy, KWH/AF	Source
Table A Water	1,400	Includes SWP pumping, Zone 7 treatment and pumping
California WaterFix	1,400	Includes SWP pumping, Zone 7 treatment and pumping
Local Surface Water	100	Based on treatment only
Yuba Accord or Multi-Year Pool	1,400	Includes SWP pumping, Zone 7 treatment and pumping
Desalination	3,000	Regional Desalination Planning Studies
Purified Recycled Water	2,700	Based on demineralization, and discussions with HDR

Figure 11-7 presents the calculated average annual energy use in megawatt-hours per year for each portfolio. As shown in Figure 11-7, energy use could increase by 20% to 50% over the Current Plan if either desalination, purified recycled water, or both are added to future water supply portfolios. This large increase in energy use could make Zone 7's future operational costs susceptible to increases associated with potential future energy cost increases or reliability, and could drastically increase Zone 7's carbon footprint.

Figure 11-7. Outcome of Portfolio Analysis for Energy Use



11.8 Costs

One of Zone 7's core missions is being fiscally responsible, so costs are an important aspect to consider when evaluating future water supply portfolios. Figure 11-8 presents the calculated total amortized costs for each portfolio. As shown in Figure 11-8, implementing desalination, purified recycled water, or both will not only increase future capital investments required, but also increase annual operations and maintenance (O&M) costs. Figure 11-8 also indicates that total amortized costs could be more than double the Current Plan's costs if both desalination and purified recycled water are added to future water supply portfolios.

Figure 11-8. Outcome of Portfolio Analysis for Amortized Costs

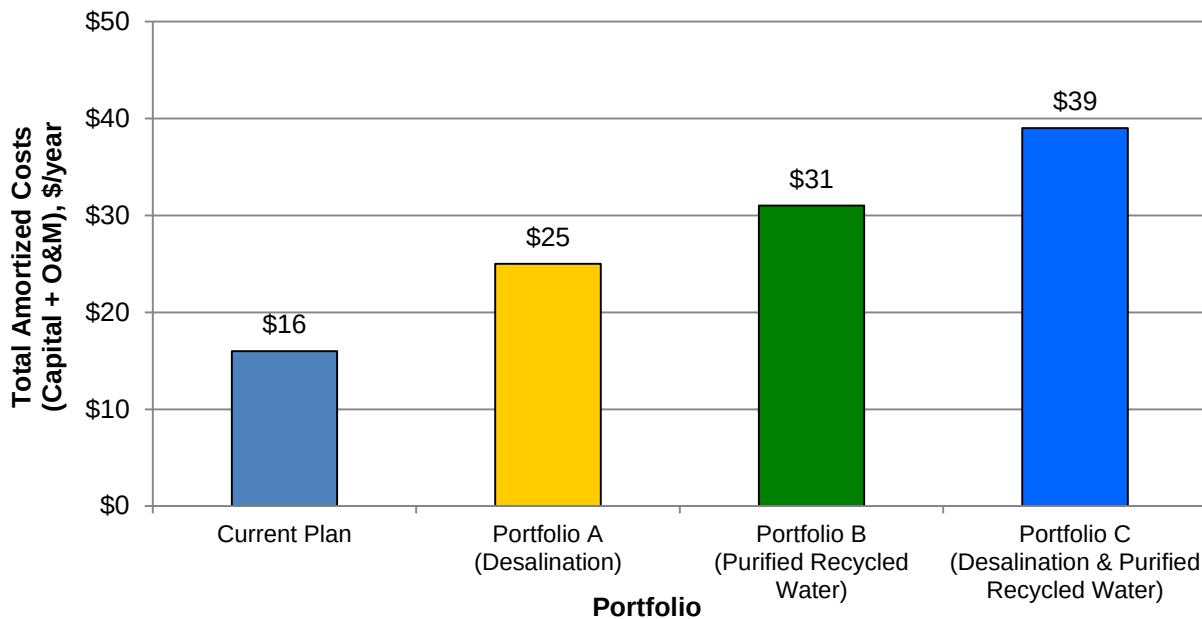


Table 11-2 presents the total capital costs, along with operating and maintenance costs, totaled as amortized costs for each portfolio, along with an estimated unit cost for the entire portfolio in acre-feet of water demand. Table 11-2 clearly shows that when expressed as a unit cost of demand, costs could increase by approximately \$160 (\$420 minus \$260) to \$390 (\$650 minus \$260) per acre-foot.

Table 11-2. Summary of Portfolio Costs

Cost Component	Portfolio			
	Current Plan	A	B	C
Capital, \$ M	\$192	\$268	\$345	\$417
O&M, \$ M/year	\$1.3	\$5.7	\$6.4	\$10.1
Amortized, \$ M/year	\$16	\$25	\$31	\$39
Additional Unit Cost, \$/AF of demand	\$260	\$420	\$510	\$650

11.9 COMPARISON OF THE BENEFITS PROVIDED BY EACH PORTFOLIO

As discussed previously, five of the metrics are core to Zone 7's mission; the average calculated benefit across all eight scenarios is presented in Table 11-3, along with an estimated unit cost for each portfolio in dollars per acre-foot of water demand above current costs. As shown in Table 11-3, Portfolios A through C have a higher benefit in all categories except cost. The additional unit cost of Portfolios A through C is 61% to 150% higher than the Current Plan. A significant investment would be required to implement any of those Portfolios.

Table 11-3. Comparison of Core Mission Benefits for Each Portfolio

Metric	Comparative Target	Portfolio			
		Current Plan	A (Desalination)	B (Purified Recycled Water)	C (Desalination & Purified Recycled Water)
Average Reliability <i>% of demand, average of all hydrologic conditions</i>	$\geq 98\%$	98%	99.3%	99.5%	99.8%
Rare Large Shortages (1% of the time) <i>average % rationing required</i>	$\leq 61\%$	65%	50%	46%	32%
Rare Minimum Supply (1% of the time) <i>average gallons per capita per day</i>	≥ 55 GPCD	39	65	72	96
Average Groundwater <i>% Full</i>	$\geq 80\%$	75%	80%	85%	89%
Costs	Capital, \$ M	\$192	\$268	\$345	\$417
	O&M, \$ M/year	\$1.3	\$5.7	\$6.4	\$10.1
	Amortized, \$ M/year	\$16	\$25	\$31	\$39
	Additional Unit Cost, \$/AF of demand	\$260	\$420	\$510	\$650

Additionally, a more detailed comparison of Figures 11-1 through 11-4 indicate that the Current Plan performs well in Scenarios where the California WaterFix is not delayed or interim SWP Reliability does not decline. Consequently, future investments in Portfolios A through C, which might not be available for 6 to 7 years (i.e., around 2022), may only provide 6 to 10 years of insurance if the California WaterFix is completed anywhere between 2028 to 2032, and if interim SWP reliability does not decline.

Table 11-4 compares the average calculated benefit across all eight scenarios for the three lower priority metrics used in this evaluation. As shown in Table 11-4, although both local control and diversification can nearly double, externally controlled SWP water supplies will continue to make up a majority (~70%) of total long-term average water supplies. Table 11-4 also indicates that energy use could increase significantly.

Table 11-4. Comparison of Lower Priority Benefits for Each Portfolio

Metric	Portfolio			
	Current Plan	A (Desalination)	B (Purified Recycled Water)	C (Desalination & Purified Recycled Water)
Local Control, % <i>locally controlled</i>	11%	18%	21%	26%
Diversification, % <i>diversified</i>	12%	19%	21%	27%
Energy Use, <i>MWH/year</i>	81,370	98,170	102,349	119,149

Appendix A

HDR Focused Preliminary Review of Recycled Water and Desalination Options
for the Tri-Valley Area

Focused Preliminary Review of Recycled Water and Desalination Options for the Tri-Valley Area

*A white paper completed in support of the Water
Supply Evaluation Update*

December 11, 2015



Table of Contents

Summary	3
1.0 Background	7
2.0 Scope of Work	8
3.0 Conceptual Alternatives	8
4.0 Reuse Analysis.....	9
4.1 Regulatory Philosophy – Multiple Barriers	8
4.2 Assumptions Used for Cost Estimates	12
4.3 Cost Components Overall.....	17
4.4 Implementation Issues	28
5.0 Desalination Analysis	30
5.1 Assumptions	30
5.2 Cost Components.....	31
5.3 Implementation Issues	34
6.0 Cost Analysis.....	35
6.1 Cost Assumptions.....	35
6.2 Cost Summary	35
Appendices	36

List of Figures

Figure 1 – Indirect and Direct Potable Reuse Concepts.....	4
Figure 2 – Cost-Yield Comparison of Key Options	5
Figure 3 – Potable Reuse Implementation Schedule.....	6
Figure 4 - Overview of Tasks	8
Figure 5 - Total Costs of IPR to COL and Injection Wells with Assumed Plant Capacity of 4.8 MGD at Livermore (Base Load) and Varying Plant Capacity at DSRSD	14
Figure 6 - Full Advanced Treatment Train for IPR and DPR	15
Figure 7 - Lake I Recharge (Livermore WRP) – IPR-1	20
Figure 8 - IPR to Injection Wells (Livermore WRP) – IPR-2A	21
Figure 9 - IPR to COL and Injections Wells (Regional Plant at DSRSD) – IPR-3C	22
Figure 10 – IPR to COL and Injection Wells (Regional Plant at Chain of Lakes) – IPR-3D.....	23
Figure 11 - DPR to Patterson Pass Reservoir (Livermore) – DPR-1	24
Figure 12 - DPR to Cope Lake and Del Valle WTP (Livermore) – DPR-2A.....	25



Figure 13 - DPR to Cope Lake and Del Valle WTP (Regional DSRSD) – DPR 2D	26
Figure 14 - DPR to Potable Water System (Livermore) – DPR-3A.....	27
Figure 15 - DPR to Potable Water System (Regional Plant at DSRSD) – DPR-3C.....	28
Figure 16 - BARDP to Zone 7 - via Exchange with CCWD Desal 1-D	33
Figure 17 - BARDP to Zone 7 - via Wheeling through EBMUD Desal 1-C	34

List of Tables

Table 1 - Initial Portfolios Used for Updating WSE	8
Table 2 - Cost Summary for Alternatives Considered.....	10
Table 3 - Public Health and Environmental Concerns Considered in Program Analysis	11
Table 4 - Multiple Barriers for Public Health Protection Associated with Each Alternative	12
Table 5 - Recommendations for Potable Reuse Feasibility Study	29

Summary

In support of Zone 7's re-evaluation of its water supply strategy and in light of the acute drought conditions of 2012 to 2015, HDR Engineering was tasked to perform a high-level preliminary review of potable reuse and desalination options for the Tri-Valley area. Both options have considerable appeal as they provide significant local control, are drought-resistant, and would improve the resilience of Zone 7's water supplies over a range of future scenarios.

Twenty-two specific alternatives were evaluated including:

- Indirect potable reuse (IPR):
 - Advanced treatment facility located at a site near the Chain of Lakes, in Livermore only, a regional plant at Dublin San Ramon Sanitation District (DSRSD), or individual plants at Livermore and DSRSD.
 - Water is either percolated into the groundwater basin through Lake I or injected into the supply aquifer, or both.
- Direct potable reuse (DPR):
 - Advanced treatment facility located as noted above.
 - Water is conveyed to either the Del Valle or Patterson Pass Water Treatment Plant (WTP).
- Desalination:
 - Brackish water treatment plant located near one of Contra Costa Water District's Water Treatment Plants (Bollman in Concord, CA)

The location of the IPR and DPR facilities are shown in Figure 1. The potential yields of the IPR/DPR options range from ~4,800 acre-feet per year (AFY) to ~7,700 AFY. The desalination yield is estimated at ~5,600 AFY.

The unit costs, based on a preliminary analysis, range from ~\$1,500/AF to \$2,700/AF, though the most promising alternatives ranged from ~ \$1,500 to ~ \$1,900 (see Figure 2).

Amongst the major observations:

1. Promising alternatives (i.e., IPR, DPR and desalination) with yields of ~ 5,500 AFY exist around ~\$1,500/AF. The capital costs range from \$68M to \$93M.
2. Alternatives (i.e., IPR/DPR) with higher yields (~7,700 AFY) range from \$1,600/AF to \$1,800/AF. The capital costs range from \$123M to \$149M.
3. Costs are based on a pre-feasibility estimate which assumes a range of -20% and +50%. The costs should be refined if any of the options progress further.

Key Consideration: Selecting an Appropriate Number of Barriers

One important consideration in terms of both public health protection and public perception is the level of treatment barriers associated with each IPR/DPR alternative. All alternatives would employ membrane filtration followed by reverse osmosis, UV disinfection coupled with hydrogen peroxide for enhanced oxidation, and chlorine disinfection for the wastewater to purify it. The differences in the alternatives reside in how many additional post-purification barriers are present prior to the water being utilized by the customer. The additional barriers vary in the degree of removal and attenuation provided. Details are provided in the body of this white paper.

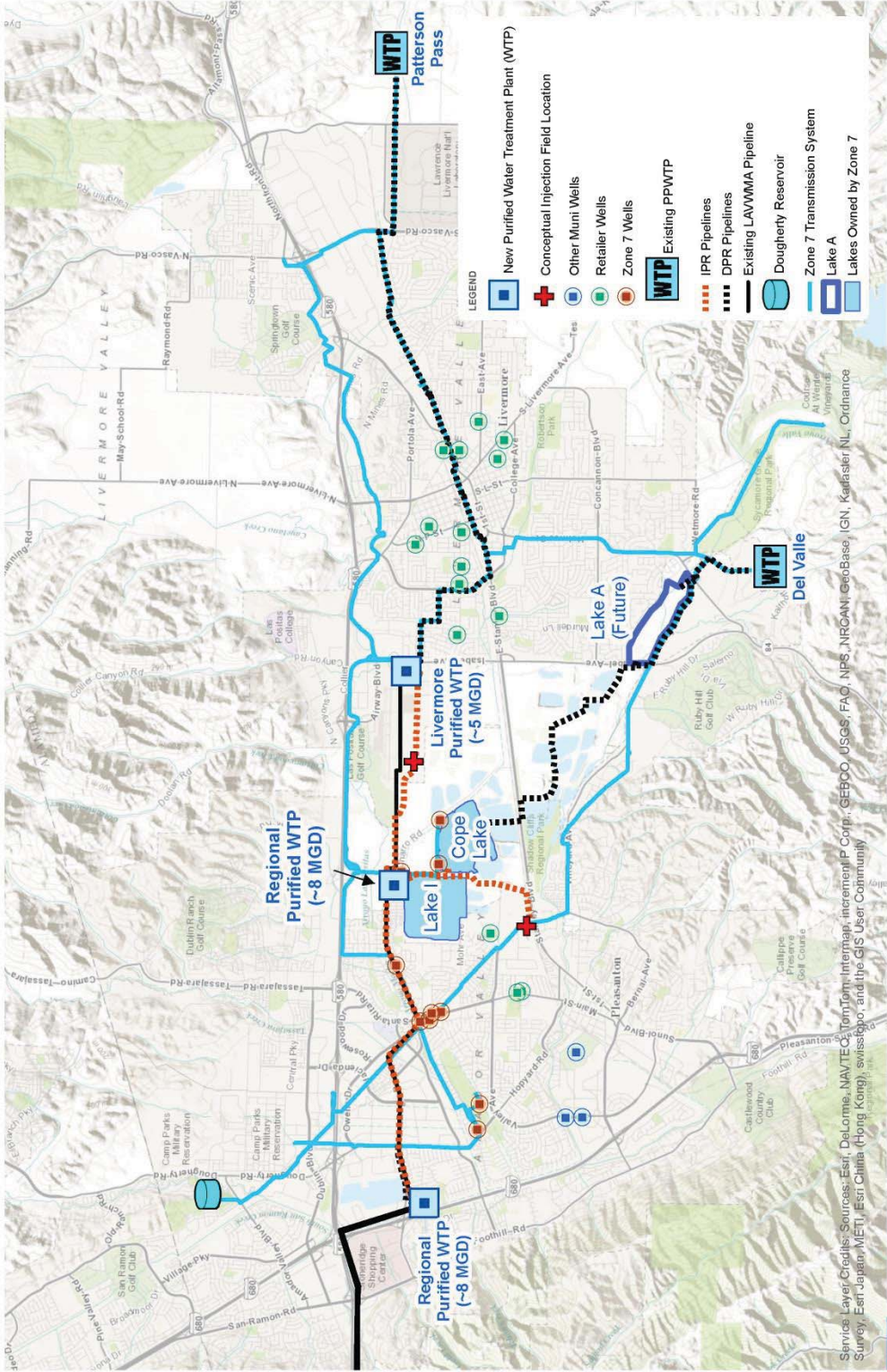


Figure 1 – Indirect and Direct Potable Reuse Concepts

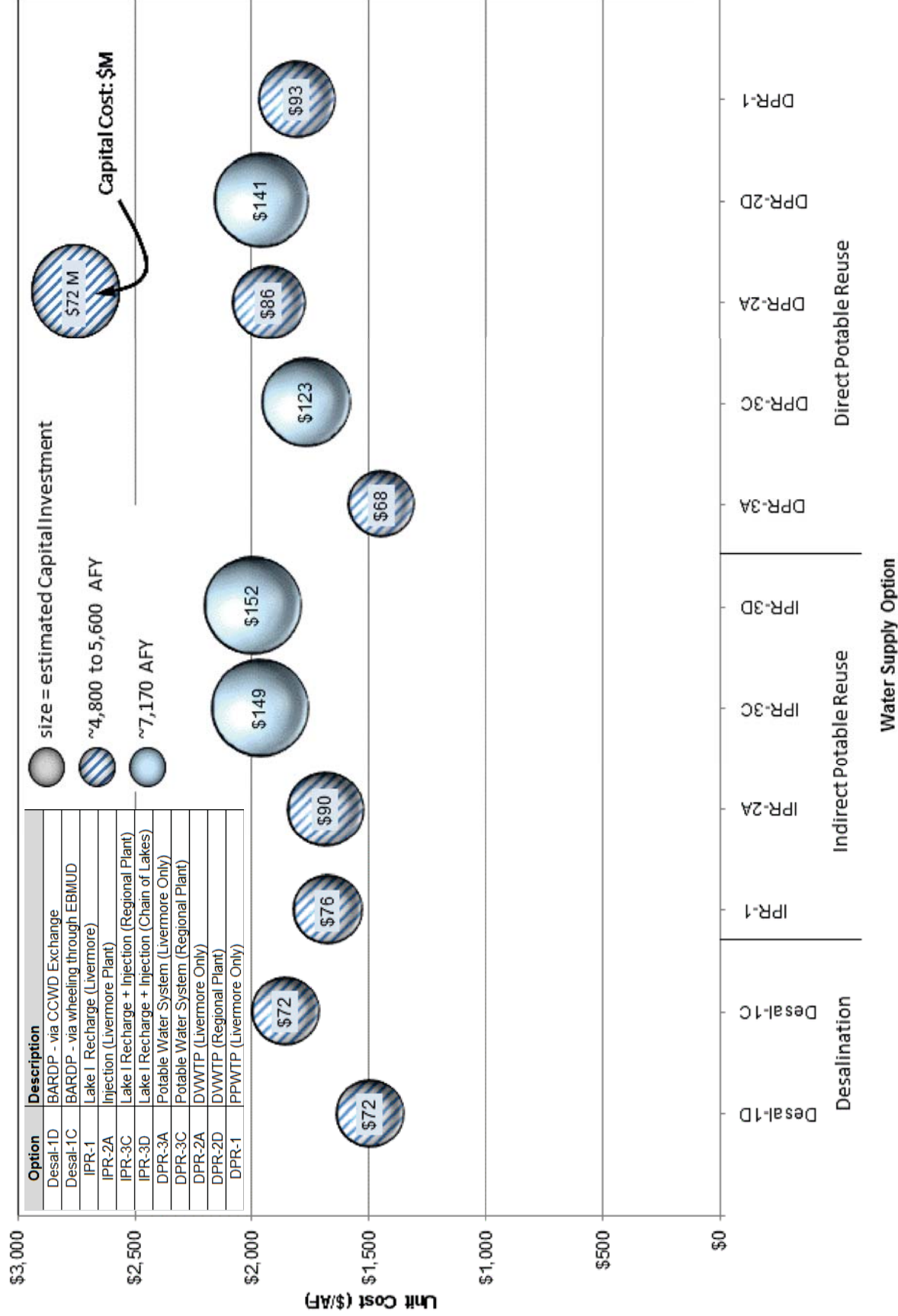


Figure 2 – Cost-Yield Comparison of Key Options

Potential Implementation Issues and Recommended Next Steps

A number of issues need to be investigated more fully to better assess the feasibility, risks and costs. These include:

- Potential program phasing;
- Facility sizing, necessary upstream wastewater plant modifications;
- Regulatory developments for DPR;
- Percolation pond capacity given other operational constraints including flood control;
- Injection well viability;
- Assessment of water quality impacts to aquifer and distribution system;
- Potential environmental impacts;
- Inter-agency agreements; operational strategies, etc.

Critical Evaluations Required

Storage capacity and percolation potential must account for groundwater levels, other recharge demands (e.g., stormwater or increased gravel pumping), and the actual timing of acquisition. Similarly, for injection wells which were considered for this preliminary review, the operational feasibility and cost requires careful analysis, especially since prior Zone 7 experience raises serious feasible concerns for conditions within the Livermore-Amador Valley.

A full feasibility study is recommended to address these and other necessary elements, including environmental documentation, potential financing strategies, and regulatory requirements. The overall implementation schedule is anticipated to have a duration of ~ 6 years as shown in Figure 3.

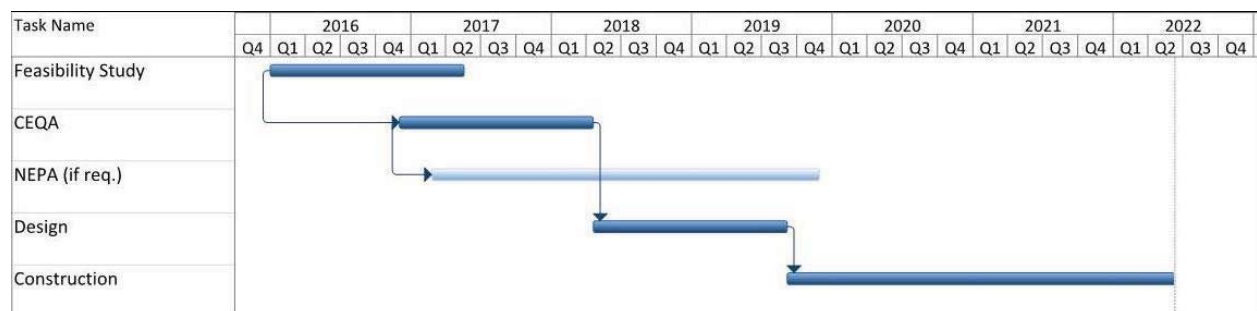


Figure 3 – Potable Reuse Implementation Schedule

Organization

The remainder of this white paper includes the following sections:

1. Background.
2. Scope of Work.
3. Conceptual Alternatives.
4. Reuse Analysis.
5. Desalination Analysis.
6. Cost Summary.
7. Appendices.



1.0 Background

In July 2011, Zone 7 completed a long-term evaluation of its water supplies (2011 WSE); however, during acute drought conditions in 2014, Zone 7 staff learned that some of the key assumptions used in the 2011 evaluation needed to be modified. Some of the modifications include:

1. State Water Project (SWP):
 - a. Zero percent Table A allocations due to drought are possible.
 - b. Loss of the Delta water supply due to water quality is possible.
 - c. Deliveries may be limited to fall months.
 - d. Near-term reliability of the SWP supply may be declining.
2. Kern County Banking Programs:
 - a. There is limited access to storage during very low Table A allocations (i.e., less than 10 percent).
 - b. Very limited to no access at zero percent Table A Allocations.
 - c. Little to no local control.
3. Byron Bethany Irrigation District Contract:
 - a. Supply is curtailed or not available during severe drought conditions.
 - b. Future of the contract is uncertain.

In addition to these changes, Zone 7 also learned that existing gravel quarry operators might not complete mining activities until 2060, which has a significant impact on Zone 7's existing plans for artificial groundwater recharge, salt management, and other water management operations.

Consequently, Zone 7 staff has been re-analyzing available water supplies under these changed conditions. In the process of developing an amendment to the 2011 WSE, several portfolios were investigated for the preliminary analysis. Preliminary results indicated that both potable reuse and desalination will likely be necessary to meet existing water supply reliability policies and goals (see Table 1). This white paper focuses only on the new water supplies related to desalination and expanded water recycled. Both indirect potable reuse (IPR) and direct potable reuse (DPR) were added to the evaluation in recognition of ongoing efforts in the State to determine the feasibility as viable water supply alternatives.

Table 1 - Initial Portfolios Used for Updating WSE

Project		Current Plan	Portfolio A	Portfolio B	Portfolio C
New Water Supplies	Cal Water Fix (i.e., Delta Fix)	•	•	•	•
	Desalination (up to 5,600 AF)		•		•
	Indirect Potable Reuse (up to 8,700 AF)			•	•
Interties	Reliability Intertie	•	•	•	•
Groundwater Storage	Chain of Lakes Pipeline	•	•	•	•
	Well Master Plan Wells	•	•	•	•
Other Storage	Los Vaqueros Emergency/ Drought Storage		•	•	•

2.0 Scope of Work

As part of the amendment of the 2011 WSE, Zone 7 retained HDR to perform a high-level review of additional uses of recycled water beyond current irrigation-only use (i.e., direct and indirect potable reuse), as well as desalination for the Tri-Valley area. As shown in Figure 4, the high level review identified conceptual alternatives, assessed capacity/yield of each, performed an initial cost analysis, estimated the time for implementation and outlined required next steps to select and implement a preferred alternative. Information from this review will be used to inform the analysis and will be documented as an appendix to the larger WSE amendment.

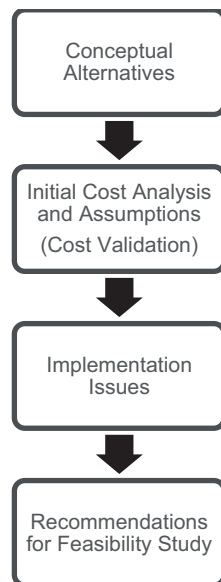


Figure 4 - Overview of Tasks

3.0 Conceptual Alternatives

Conceptual alternatives were based on three major options for improving supply of reliable water: Indirect potable reuse of available wastewater, direct potable reuse using available wastewater, and brackish water desalination. These three main options were further subdivided into likely alternatives for additional analysis. This list was not considered to be all-inclusive or exhaustive, but rather to provide some examples for consideration:

1. Indirect potable reuse (IPR):
 - a. To the Chain of Lakes (COL).
 - b. To Injection Wells.
 - c. To COL and Injection Wells.
2. Direct potable reuse (DPR):
 - a. To Patterson Pass Water Treatment Plant (PPWTP).
 - b. To Del Valle Water Treatment Plant (DVWTP).
 - c. To potable water distribution system.
3. Desalination:
 - a. Bay Area Regional Desalination Plant – Wheeled via East Bay Municipal Utilities District (EBMUD) to Zone 7.
 - b. Bay Area Regional Desalination Plant – Exchange with Contra Costa Water District to Zone 7.

Note that IPR to Lake Del Valle was part of the portfolio considered in the preliminary analysis. However, this option was dropped from consideration in this analysis due to increased level of coordination required with multiple agencies (i.e., the US Army Corps of Engineers, the Department of Water Resources (DWR), the Alameda County Water District and the Santa Clara Valley Water District), potential public concerns related to recreational contact with recycled water, and no obvious cost advantage of this option over others. Of 22 alternatives considered, 10 were considered the most promising in terms of overall costs. Note that these do not consider technical feasibility (i.e., previous injection testing has not been promising), which is discussed in the following sections. These are summarized in Table 2 and discussed in the subsequent sections.

Table 2 – Cost Summary for Alternatives Considered

<i>Option</i>	<i>Alternative</i>	<i>Yield (AFY)</i>	<i>Total Construction Cost (\$M)</i>	<i>Annual O&M Cost (\$M)</i>	<i>30-Year Present Value Cost (\$M)</i>	<i>Cost per AF(\$)</i>
IPR-1	Chain of Lakes (treatment at Livermore)	4,800	\$ 76	\$ 3.1	\$ 124	\$ 1,680
IPR-2A	Injection Wells - Livermore Only	5,370	\$ 90	\$ 3.3	\$ 140	\$ 1,690
IPR-3C	COL and Injection Wells - DSRSD Only (LAVWMA pipeline alignment)	7,167	\$ 149	\$ 4.4	\$ 217	\$ 1,970
IPR-3D	COL and Injection Wells - Regional WTP (LAVWMA pipeline alignment)	7,167	\$ 152	\$ 4.4	\$ 220	\$ 2,000
DPR-1	PPWTP Reservoir	5,370	\$ 93	\$ 3.7	\$ 126	\$ 1,810
DPR-2A	DVWTP - Livermore Only	5,370	\$ 86	\$ 3.7	\$ 142	\$ 1,720
DPR-2D	DVWTP - DSRSD Only (LAVWMA pipeline alignment)	7,767	\$ 141	\$ 4.9	\$ 216	\$ 1,810
DPR-3A	Potable Water System - Livermore Only	5,370	\$ 68	\$ 3.4	\$ 103	\$ 1,450
DPR-3C	Potable Water System - DSRSD Only	7,767	\$ 123	\$ 4.7	\$ 165	\$ 1,630
Desal-1C	Bay Area Regional Desalination Plant - 10 MGD (Final Phase) - Wheeling with Intertie	5,600	\$ 72	\$ 5.7	\$ 160	\$ 1,860
Desal-1D	Bay Area Regional Desalination Plant - 10 MGD (Final Phase) - No Wheeling (Transfer) and No Intertie	5,600	\$ 72	\$ 3.7	\$ 129	\$ 1,500

4.0 Reuse Analysis

In addition to costs, alternatives were evaluated based on yield, infrastructure elements, basic facilities sizing, potential ancillary elements, and potential risk factors. Assumptions, cost components, and risk factors are provided below.

4.1 Regulatory Philosophy – Multiple Barriers

The governing philosophy and overall mission is for Zone 7 to provide a reliable supply of high quality water and effective flood control in a fiscally-responsible, innovative, proactive and environmentally sensitive way. Flood control may limit access during certain seasons to recharge facilities (e.g., streams, arroyos, and chain of lakes). To achieve high quality water

objectives while also meeting regulatory, public health, and environmental goals, multiple barriers are required, and include:

- Source protection.
- Treatment technology.
- Performance thresholds.
- Operational proficiency.
- Meaningful monitoring
- Buffering (e.g., on-site storage, groundwater travel time).

Table 3 summarizes the public health and environmental concerns associated with potable reuse water sources and the specific ways these concerns can be addressed.

Table 3 - Public Health and Environmental Concerns Considered in Program Analysis

Concern	How Addressed?
Chemical contaminants (including Chemicals of Emerging Concern)	Source control
	Reverse osmosis
	Advanced oxidation processes
	Monitoring
	Biodegradation (<i>in situ</i> or in biofilters)
Microbial contaminants	Microfiltration
	Reverse osmosis
	UV treatment
	Chlorination
	Buffers (travel time, detention time, other)
	Monitoring
Environmental impacts on groundwater or receiving waters	Maintaining constituents in brine such that there is no impact on receiving waters or the groundwater basin
	Monitoring

Table 4 summarizes the barriers associated with each IPR and DPR alternative considered. A list of common barriers shared by all alternatives is given. Some alternatives have additional barriers that make them more attractive for public and environmental health.

Table 4 - Multiple Barriers for Public Health Protection Associated with Each Alternative

<i>Alternative</i>	<i>Common Barriers</i>	<i>Additional Barriers</i>
"Direct" DPR	1. Source control 2. Microfiltration 3. Reverse osmosis 4. Ultraviolet light coupled with hydrogen peroxide 5. Chlorination 6. Monitoring	None
IPR – Injection wells		7. Travel time through soil to well
DPR – Patterson Pass WTP		Storage and blending in raw water reservoir? Full surface water treatment 7. Clarification 8. Ozonation 9. Biofiltration)
IPR – Lake I		7. Time and blending in Lake I 8. Percolation through ground 9. Travel through upper aquifer 10. Travel time through soil to well
DPR – Del Valle WTP		7. Storage and blending in Cope Lake Full surface water treatment 8. Clarification 9. Ozonation 10. Biofiltration

4.2 Assumptions Used for Cost Estimates

The following assumptions were used in the development of cost estimates for the alternatives.

AVAILABLE WASTEWATER

For the IPR and DPR options, the amount of recycled water available for advanced treatment was determined from the amount of available treated wastewater effluent in the Livermore-Amador Valley Water Management Agency (LAVWMA) pipeline from the Dublin San Ramon Sanitation District Regional Wastewater Facility (DSRSD RWF) and Livermore Water Reclamation Plant (Livermore WRP) that is discharged to the East Bay Dischargers Authority (EBDA) outfall in the San Francisco Bay, as projected in the year 2022. The average annual amount of wastewater available accounts for delivery to (current and proposed) Title 22 recycled water customers and assumes the remaining LAVWMA flow (up to plant capacity) is available for advanced treatment for IPR or DPR. The DSRSD and Livermore plants would be modified for advanced treatment to produce reuse water for IPR or DPR. A Chain of Lakes plant would draw water from Livermore via the LAVWMA line and DSRSD via a pump station. Note that demineralization plant brine from Zone 7's Mocho Groundwater Demineralization Plant is also discharged in the LAVWMA pipeline and should be considered in any future feasibility study.

Based on a preliminary review of the National Pollutant Discharge Elimination System (NPDES) permits for both DSRSD WRP, the Livermore WRP, and for the EBDA outfall, reducing wastewater flow from Livermore and DSRSD WRPs in the LAVWMA pipeline may lead to an exceedance of permit discharge requirements for a few constituents, specifically ammonia-N and total suspended solids (TSS). Capturing wastewater for advanced treatment will also increase the proportion of the Zone 7 demineralization plant (reverse osmosis -- RO) discharge, which contains concentrated contaminants. A cursory analysis conservatively assumed that RO reject water had 10 times the concentration of constituents present in the feed water. If all available Livermore and DSRSD effluent is taken for reuse, only RO reject (and backwash) from the new advanced treatment facility and the Zone 7 demineralization plant will be present in the LAVWMA pipeline flow. Under this scenario, both ammonia-N and TSS concentrations in the LAVWMA pipeline will exceed current permit requirements. Therefore, some blend of WRP effluent and demineralization plant discharge will be required in the pipeline to meet the permit if no other changes are made at the facilities to reduce ammonia and TSS. With no changes to treatment technology (e.g., nitrification-denitrification) or permit limits, the maximum wastewater available for reuse would be approximately 5 million gallons per day (MGD) at DSRSD (60% of plant permeate capacity) and 1.0 MGD at Livermore (20% of plant permeate capacity – see Appendix B).

Other constituents were also briefly considered. For example, total dissolved solids (TDS) in demineralization plant RO reject is higher than in treated effluent from the Livermore and DSRSD plants. However, there are no TDS requirements indicated in the NPDES permits and the final TDS concentration for the comingled wastes discharged via the EBDA outfall is lower in salinity than the receiving bay water. Other constituents listed in the NPDES permits, such as copper, cyanide, dioxin, etc. also are not expected to exceed requirements with the increased proportion of demineralization plant RO reject water discharged.

For the purposes of this analysis, it was assumed that the WRPs could implement the appropriate technology (e.g., nutrient treatment) within either the wastewater treatment process or as a sidestream process to treat RO reject to continue to meet permit requirements. Therefore, it was assumed that sizing of advanced treatment processes at the DSRSD and Livermore facilities are not affected by permit limitations for LAVWMA discharge (i.e., 6.0 mgd does not constitute a rate cap). In addition, the cost of facility improvements was not included in the cost estimate. The issue and costs could be significant, however, and should be fully investigated in any future feasibility study.

TREATMENT FACILITIES

There were three scenarios considered for sources of wastewater for an advanced treatment facility:

1. Livermore WRP operating as a base load plant able to produce 4.8 MGD (5,370 AFY) of permeate available for reuse.

2. Providing treatment of DSRSD flows for 5 months a year when water is available sized for the optimal (see Figure 5) 8.0 MGD (2,360 AFY).¹
3. Centralizing treatment at a single facility by taking combined flow from Livermore and DSRSD through the LAVWMA pipeline. Preliminary sizing analysis suggests a 12 MGD plant yielding 7,770 AFY.²

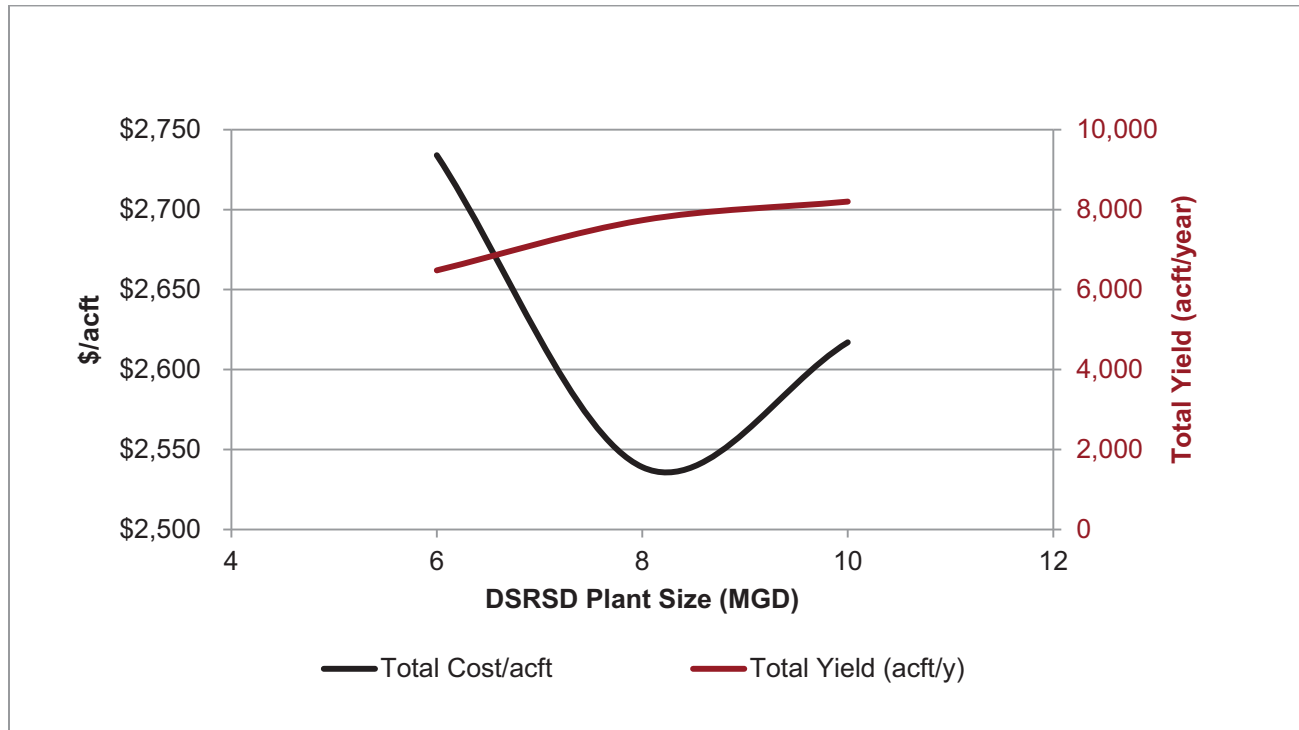


Figure 5 - Total Costs of IPR to COL and Injection Wells with Assumed Plant Capacity of 4.8 MGD at Livermore (Base Load) and Varying Plant Capacity at DSRSD

For all IPR and DPR alternatives, it was assumed that sufficient upstream source water controls were present and that the DSRSD and Livermore plants produced effluent of sufficient quality for additional advanced treatment. Full advanced treatment (FAT) is assumed and consists of microfiltration (MF), reverse osmosis (RO), and advanced oxidation processes (AOP) such as ultraviolet (UV) coupled with hydrogen peroxide (Figure 6). Recoveries were assumed to be 94% for the MF system and 85% for the RO system, resulting in a total assumed recovery of 80% for advanced treatment.

¹ A cost-benefit sensitivity analysis was performed to size the DSRSD plant for the IPR and DPR options (Figures 5). In this scenario, limited availability of secondary effluent at DSRSD results in higher overall cost and indicates that a DSRSD plant size of 8 MGD is optimum. An 8 MGD facility can capture approximately 94% of the available wastewater. Larger plant sizes can capture more of the available wastewater but at a higher incremental cost. For options where the DSRSD plant is included, the estimated yield is 7,730 AFY. For options where only Livermore plant is included, the estimated yield is 5,370 AFY.

² A similar cost benefit analysis was performed for the regional DSRSD plant which indicated an optimum, single plant size of 12 MGD (able to capture 95% of the available wastewater).

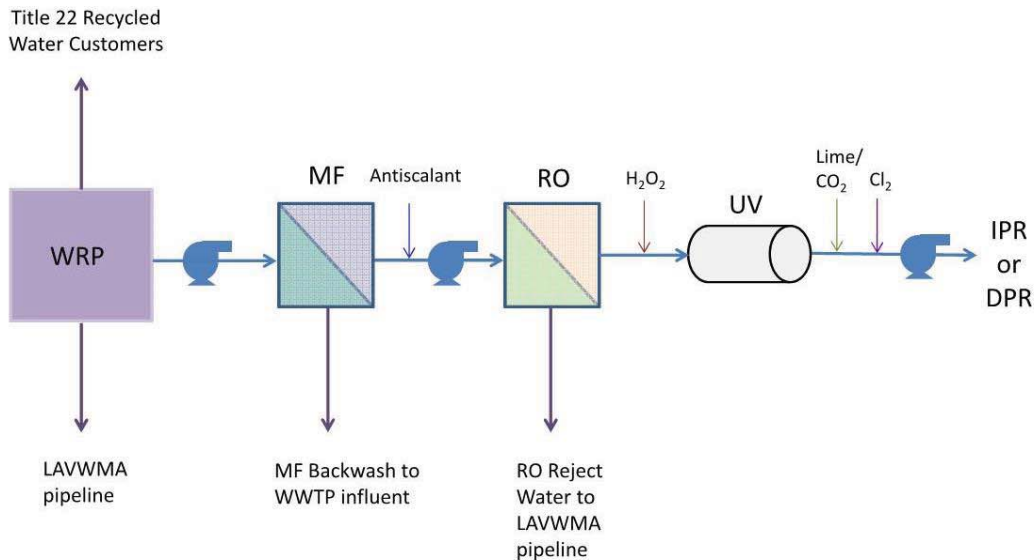


Figure 6 - Full Advanced Treatment Train for IPR and DPR

The DPR options also assumed the planned addition of ozone at both the DVWTP (in 2018) and PPWTP (in 2019) plants will be implemented prior to addition of the advanced reuse projects. The estimated capital cost of ozone treatment, \$26.9M for DVWTP and \$28.1M at PPWTP, were not included in the cost estimates for this technical memorandum since they are already planned as part of Zone 7's existing Capital Improvement Program (CIP).

Potential Plant Sites

Screening of potential sites for locating an advanced purification facility was not included in this preliminary review. A variety of considerations will determine what site location is optimal, including land availability, capacity of existing infrastructure (i.e., power, water, sewer), security, staffing, as well as capital and operating costs.

For feasibility purposes only, three sites were included in this analysis: DSRSD, Livermore WWTP and near Lake I.

Subsequent analysis will evaluate these sites, and potentially others, to determine the best location in the Livermore-Amador Valley.

PIPELINES AND PUMP STATIONS

Costs for pipelines and pump stations were based on assuming full WRP capacity flow from the plant to the delivery end-point (e.g., Lake I, injection wells, etc.). Pump stations were designed to pump flow to the maximum water surface elevation (for reservoirs and lakes) and to overcome frictional and minor losses. For DPR options that tie directly into the potable water

system, pipelines tied into the system at the closest location to the plant and previous distribution system hydraulic modeling completed by Zone 7 was used to determine the injection pressures required at discharge.

In general, pipelines to convey IPR and DPR water to their respective endpoints followed the existing right of way or along potable or wastewater pipeline alignments where possible. The pipelines were sized for a maximum velocity of 4.5 ft/sec (at maximum flow) and at an assumed installed cost of \$15 per inch per linear foot (in-LF). Major crossings for some pipelines (e.g. across Interstate 580 for IPR options from DSRSD WRP that did not use the LAVWMA alignment) assumed horizontal directional drilling with an estimated cost of \$750K per crossing.

LAKE I AND COPE LAKE ASSUMPTIONS

Lake I and Cope Lake are the former gravel quarries located in the “Chain of Lakes” (COL) area with volumes of 26,800 AF and 4,500 AF, respectively. In previous analyses, Lake I was identified as the best candidate for groundwater recharge and Cope Lake as an intermediary storage basin for DPR water going to DVWTP. Analyses performed by Stetson Engineers (2004) and internal Zone 7 modeling suggested that an average diversion amount of 5,400 AFY (4.8 MGD) was available for recharge. The diversion amount is influenced by surface water level in the lake, groundwater elevation in the basin, and the extent of potential clogging layers identified in prior hydrogeological investigations. Total recharge of IPR water is limited by evaporative and other losses as well as seepage inflows and was estimated to range between 3,900 AFY (cursory Zone 7 estimate) and 4,800 AFY (Management Plan for Lakes H, I, and Cope Lake, Stetson Engineers, 2004). For purposes of costing, it was assumed that 4,800 AFY represented the upper yield of water going to Lake I.

Cope Lake has been designated as a stormwater detention facility for flood protection purposes but also for recycled water storage. These competing purposes and operations of Cope Lake for reuse during storm events were not evaluated in this analysis but will require further investigation in the feasibility study.

INJECTION WELLS

Injection wells were located on public land at two well field locations indicated in Figures 7 through 8; no land acquisition costs were associated with placement of these wells on public lands. The wells were spaced to minimize interference and mounding and were placed beyond a two-year travel time radius to existing drinking water wells.³ The design injection rate is slightly lower than nearby extraction wells rates; the injection wells are sized for 1,200 gallons per minute (gpm) maximum. Depending on the option and yield of reuse water available for injection, the number of wells at each well field varies between three and seven wells (does not include a standby well as the second well field acts in standby mode).

Several potential issues that may limit the feasibility of IPR injection wells were not evaluated as part of this analysis. For example, the location of IPR injection wells may limit the future placement of groundwater production wells in the vicinity to meet travel time restrictions.

³ Travel times were estimated by Zone 7 staff using the modified fixed radius method used by the California Division of Drinking Water as part of its Drinking Water Source Assessment and Protection Program.

Injection well IPR consists of no vertical barrier, soil removal, or photo effects as would be associated with IPR surface water recharge. In addition, previous injection well experience conducted several years ago using treated surface water at Zone 7's Hopyard 6 well were unsuccessful given the local geology. With injection, mobilization of certain constituents (e.g., arsenic or hexavalent chromium) could also become an issue. A hydrogeological assessment at the injection locations would need to be completed prior to determining feasibility of this option.

4.3 Cost Components

Overall, 21 alternatives were considered but only the top 13 preferred alternatives are discussed below. The cost components for each of the preferred alternatives are summarized here, and more detailed cost breakdown can be found in Appendix A, in addition to costs for alternatives not described below.

LAKE I RECHARGE (LIVERMORE WRP) – IPR-1

This alternative assumes that the Livermore WRP produces treated IPR water for delivery to Lake I via approximately 15,300 LF of 18-inch diameter pipeline (Figure 7). Other capital cost components include the IPR pump station, monitoring equipment, CEQA, and a feasibility study. O&M cost components include treatment costs (electrical, chemical, equipment and membrane replacement, and personnel), pump station costs (energy and maintenance), pipeline costs (maintenance), Lake I costs (clogging layer maintenance), and monitoring costs.

IPR TO INJECTION WELLS (LIVERMORE WRP)

This alternative assumes that the Livermore WRP produces treated IPR water (5,370 AFY) for delivery along 23,200 LF of 18-in pipeline to injection wells located in one of two fields (Figure 8). Other capital cost components include the IPR pump station at the plant, monitoring equipment, CEQA, and a feasibility study. O&M cost components include treatment costs (electrical, chemical, equipment and membrane replacement, and personnel), pump station costs (energy and maintenance), pipeline costs (maintenance), injection well costs (pump energy and maintenance), and monitoring costs.

IPR TO CHAIN OF LAKES AND INJECTION WELLS (REGIONAL PLANT AT DSRSD)

This alternative combines the two aforementioned alternatives to provide additional flexibility. Livermore and DSRSD WRPs produce recycled water for treatment at a regional facility located at DSRSD (Figure 9). IPR water is delivered to Lake I in the amount of up to 5,370 AFY (equivalent to 4,800 AFY yield) with the remaining flow of 2,360 AFY being sent to injection wells at two well field locations. Capital cost components include 30-in diameter pipelines, pump stations at the plant, injection wells, monitoring equipment, CEQA, and a feasibility study. O&M cost components include treatment costs (electrical, chemical, equipment and membrane replacement, and personnel), pump station costs (energy and maintenance), pipeline costs (maintenance), Lake I maintenance costs, injection well costs (pump energy and maintenance), and monitoring costs.

IPR TO CHAIN OF LAKES AND INJECTION WELLS (REGIONAL PLANT AT CHAIN OF LAKES)

This alternative is similar to the previous alternative but with a regional facility located at the Chain of Lakes (Figure 10). IPR water is delivered to Lake I in the amount of up to 5,370 AFY (equivalent to 4,800 AFY yield) with the remaining flow of 2,360 AFY being sent to injection wells at two well field locations. Capital cost components include a 24-in diameter pipeline from

DSRSD WRP, a 30-in shared line (including LAVWMA flow from Livermore WRP) to the regional plant, pump stations at the plant and pipelines to Lake I and injection wells, injection wells, monitoring equipment, land acquisition costs, CEQA, and a feasibility study. O&M cost components include treatment costs (electrical, chemical, equipment and membrane replacement, and personnel), pump station costs (energy and maintenance), pipeline costs (maintenance), Lake I maintenance costs, injection well costs (pump energy and maintenance), and monitoring costs.

DPR TO PATTERSON PASS RESERVOIR (LIVERMORE WRP)

This alternative consists of advanced treatment at Livermore and conveyance of DPR water using an 18-in diameter pipeline to the raw water reservoir at Patterson Pass WTP in the amount of 5,370 AFY (Figure 11). An advanced treatment plant could also be located at the PPWTP instead of at Livermore; however, pipeline capacity could limit the ability to increase the plant size to accommodate both DPR and IPR unless it was initially oversized. For preliminary evaluative purposes, costs estimates are based on a plant located near Livermore. Other capital cost components include the pump station at Livermore WRP, modification to the Patterson Reservoir, monitoring equipment, CEQA, and a feasibility study. O&M cost components include treatment costs (electrical, chemical, equipment and membrane replacement, and personnel), pump station costs (energy and maintenance), pipeline costs (maintenance), and monitoring costs.

DPR TO COPE LAKE AND DEL VALLE WTP (LIVERMORE OR REGIONAL PLANT AT DSRSD)

These alternatives consist of advanced treatment at Livermore (Figure 12) or a regional DSRSD WRPs (Figure 13) and conveyance of DPR water using 18-in to 30-in diameter pipelines to temporary storage in Cope Lake and final conveyance via an already planned 30-in line (not included in the cost estimate) to DVWTP. Other capital cost components include the pump stations at Livermore and DSRSD WRPs and Cope Lake, monitoring equipment, CEQA, and a feasibility study. O&M cost components include treatment costs (electrical, chemical, equipment and membrane replacement, and personnel), pump station costs (energy and maintenance), pipeline costs (maintenance), and monitoring costs. Although a pipeline could be built around Cope Lake to minimize evaporative losses, the intent is to use the existing facilities and planned projects as much as possible.

DPR TO POTABLE WATER SYSTEM (LIVERMORE AND REGIONAL PLANT AT DSRSD)

This alternative consists of advanced treatment at the Livermore or Regional DSRSD WRPs and conveyance of DPR water using 18-in (Livermore) or 30-in (Regional DSRSD) pipelines directly to the closest potable water main. Other capital cost components include the pump stations at Livermore and Regional DSRSD WRPs, connections to the potable water system, monitoring equipment, CEQA, and a feasibility study. O&M cost components include treatment costs (electrical, chemical, equipment and membrane replacement, and personnel), pump station costs (energy and maintenance), pipeline costs (maintenance), and monitoring costs. Figures 13 and 14 illustrate these alternatives.

4.4 Implementation Issues

The following are remaining uncertainties in the cost model which will need to be investigated or verified in any future feasibility study:

1. Plant recycled water production, operating conditions and sizing of facilities (pipes, pump stations, treatment systems) for any advanced purification plants.
2. The number of well fields and injection wells, capacities, and desired standby status and operations.
3. Well spacing, time to travel, and injection rates.
4. A power study to determine loads, the triggers for additional service, and standby charges.
5. Inclusion of monitoring wells.
6. For DPR options, a water quality re-equilibration study and advanced monitoring in the distribution system.
7. Groundwater hydrogeochemistry effects from injection well operations and the potential mobilization of currently stable contaminants (e.g. chromium, arsenic).

Recommendations for Feasibility Study

Table 5 summarizes some of the issues to be addressed in the reuse feasibility study.

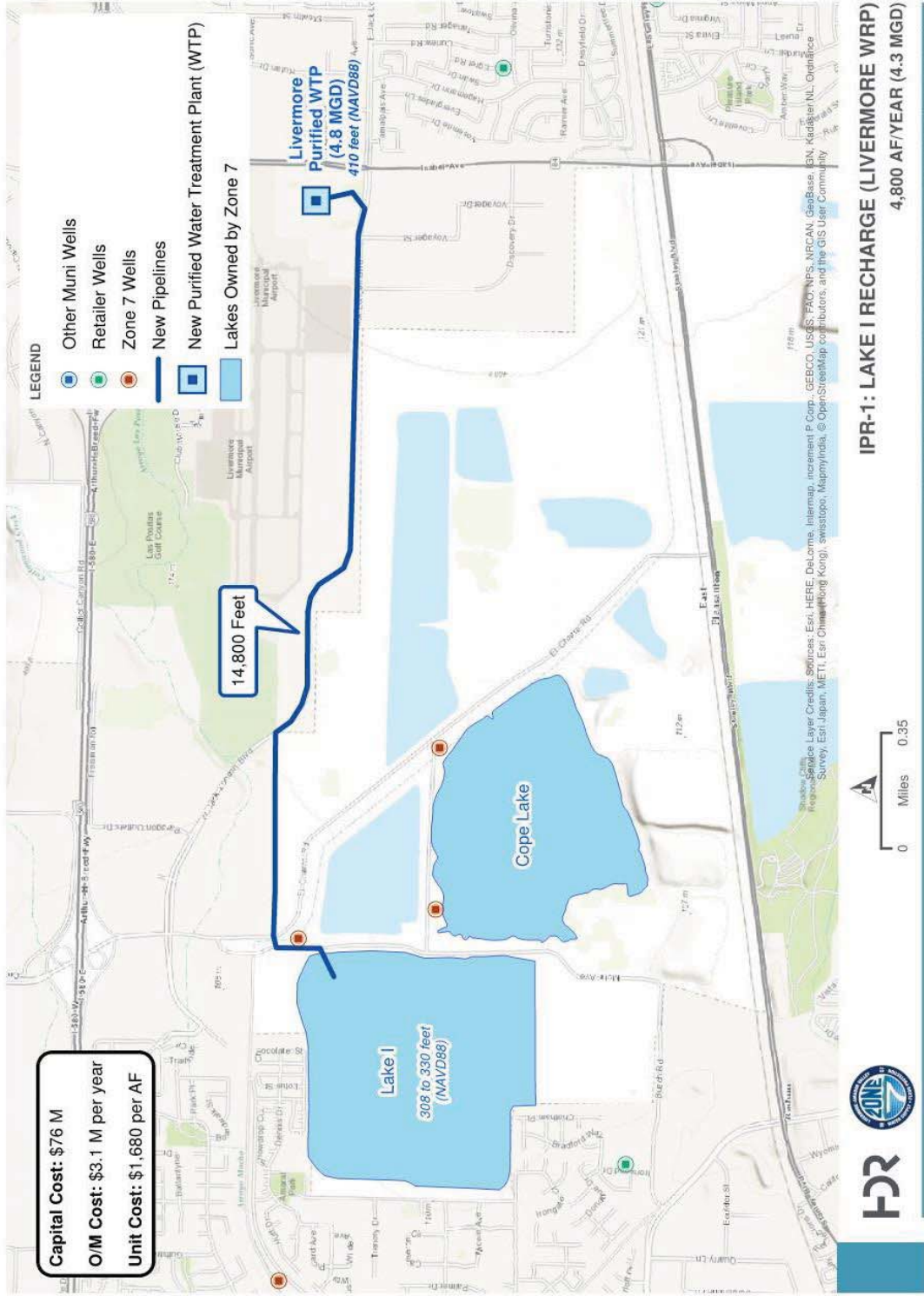


Figure 7 - Lake I Recharge (Livermore WRP) – IPR-1

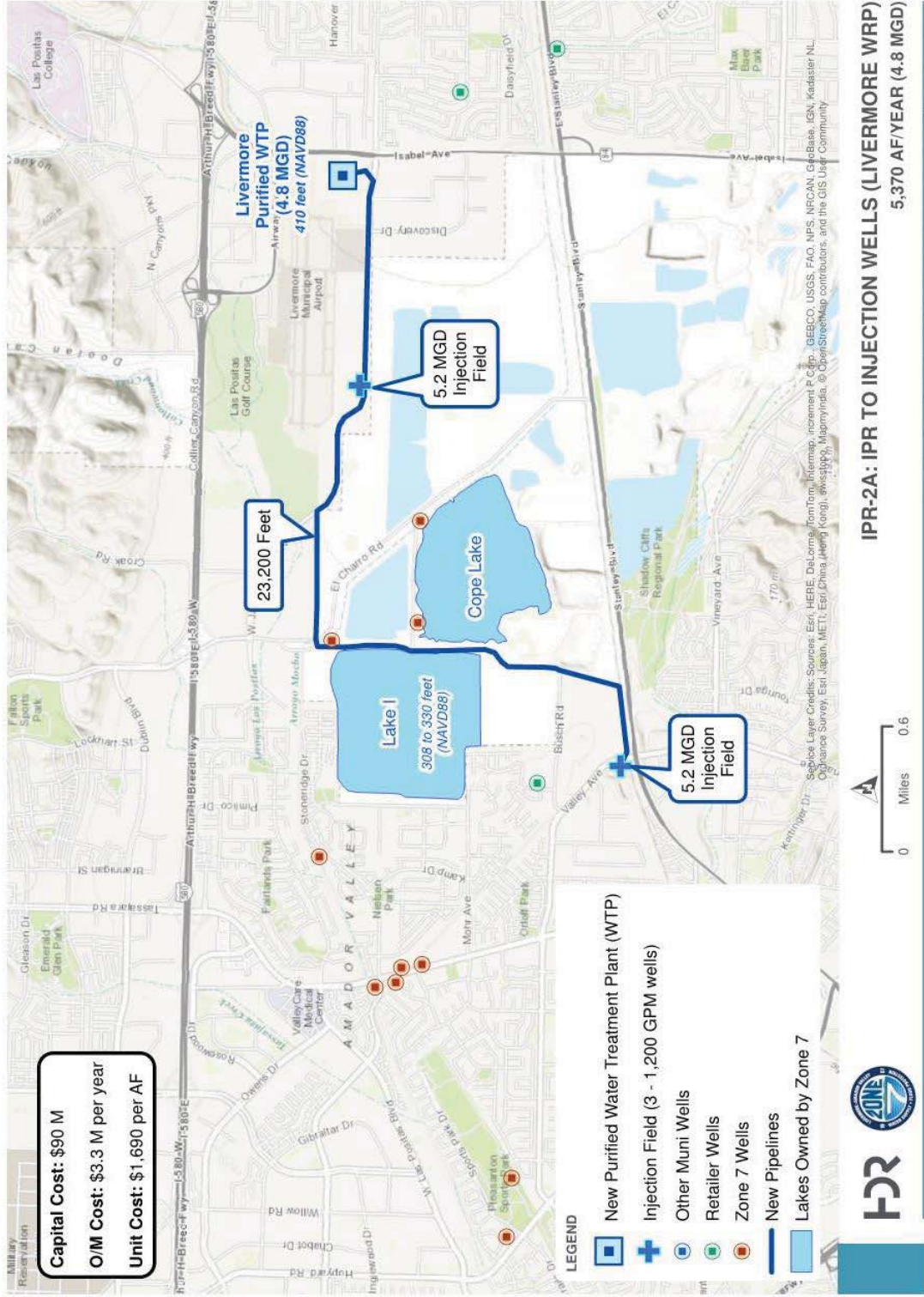


Figure 8 - IPR to Injection Wells (Livermore WRP) – IPR-2A

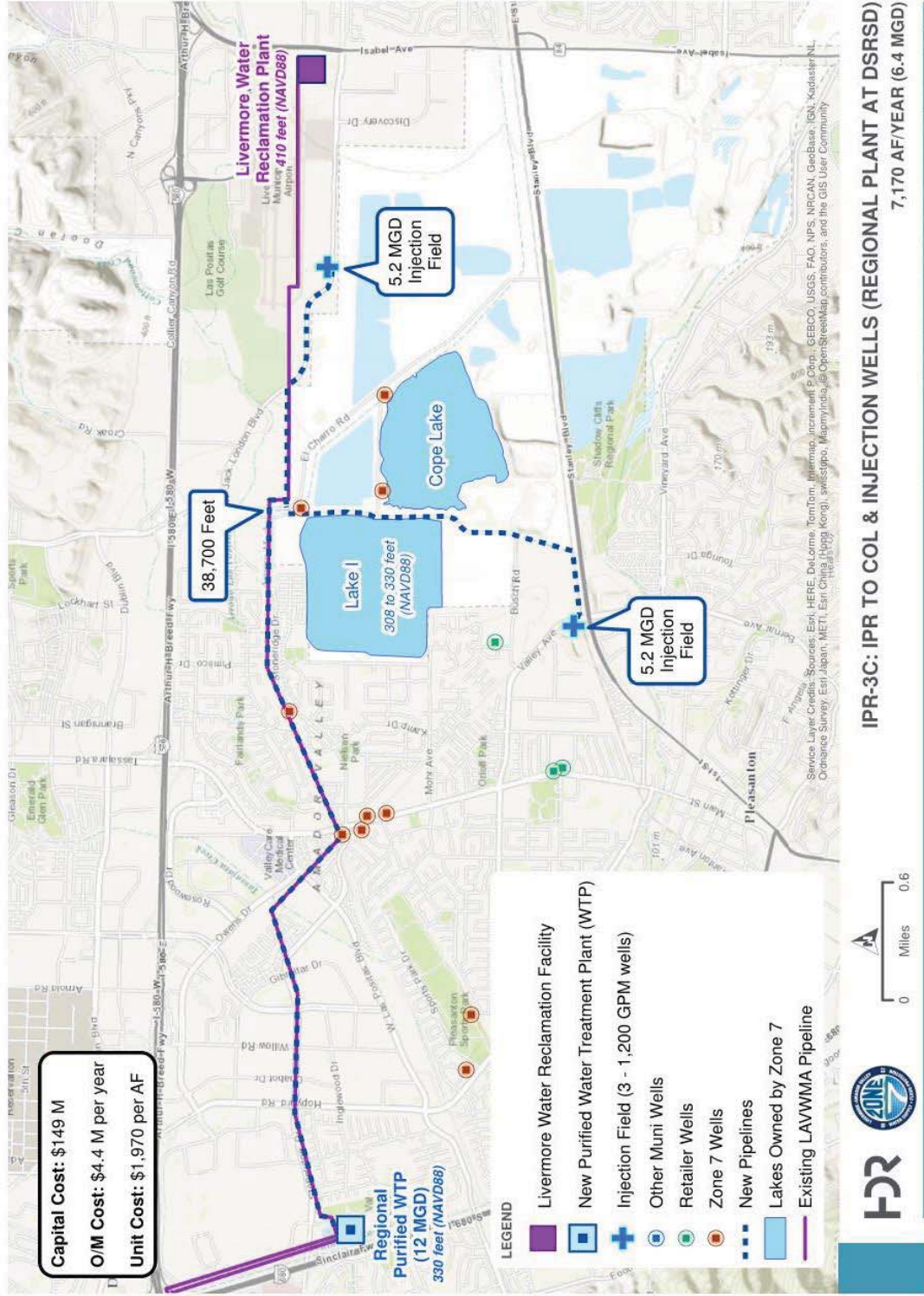


Figure 9 - IPR to COL and Injections Wells (Regional Plant at DSRSD) – IPR-3C

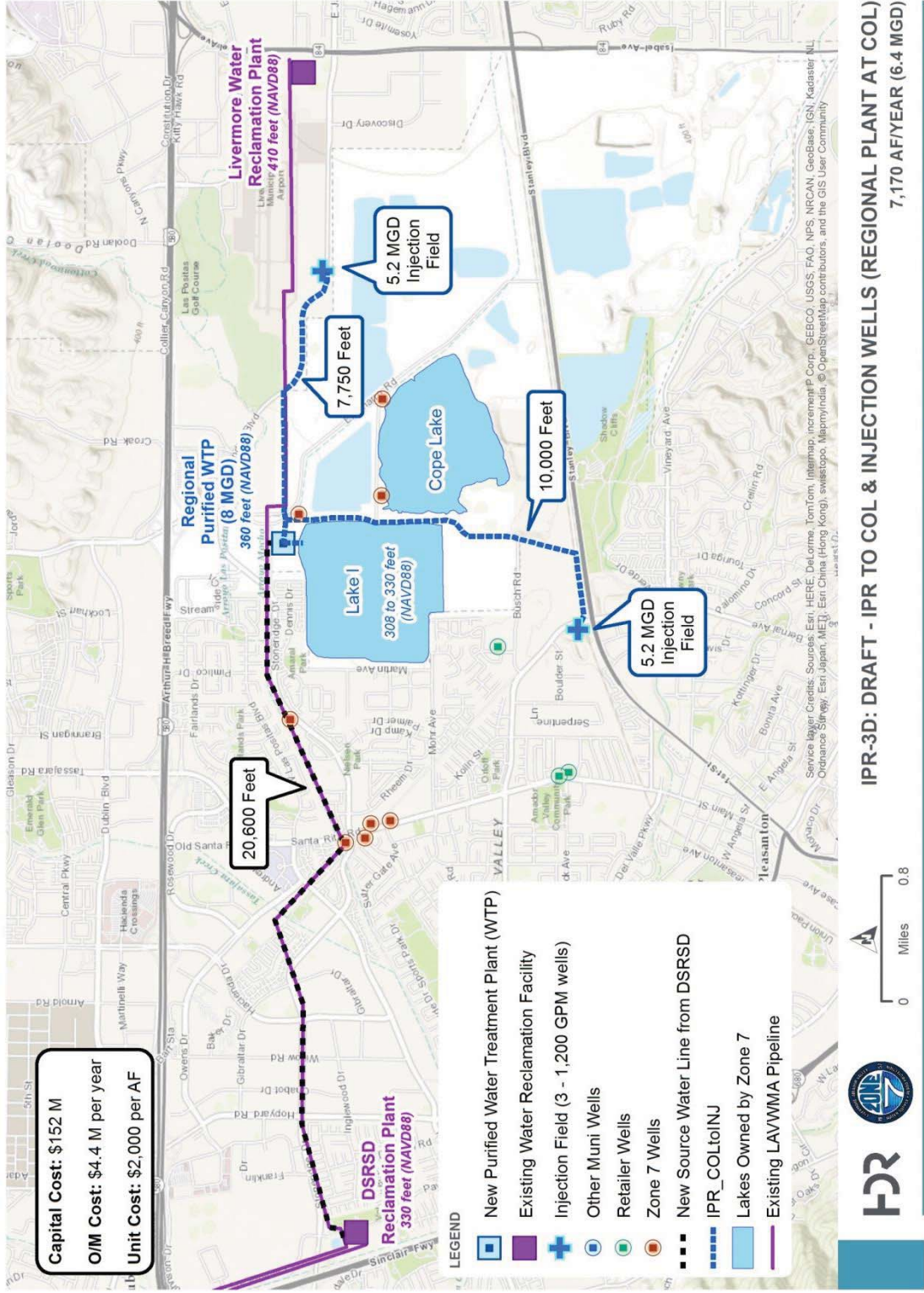


Figure 10 - IPR COL and Injections Wells (Regional Plant at Chain of Lakes) – IPR-3D

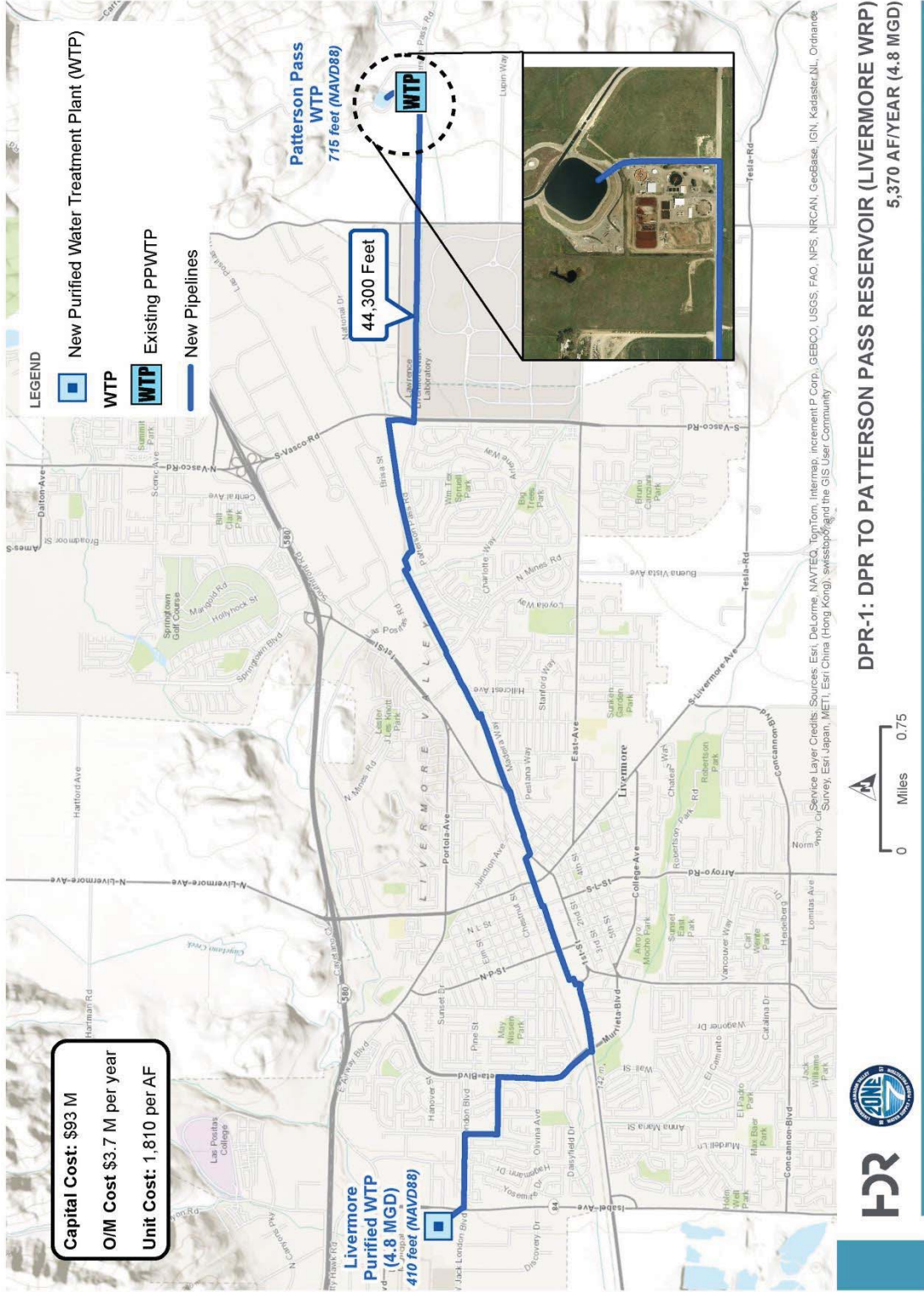


Figure 11 - DPR to Patterson Pass Reservoir (Livermore) – DPR-1

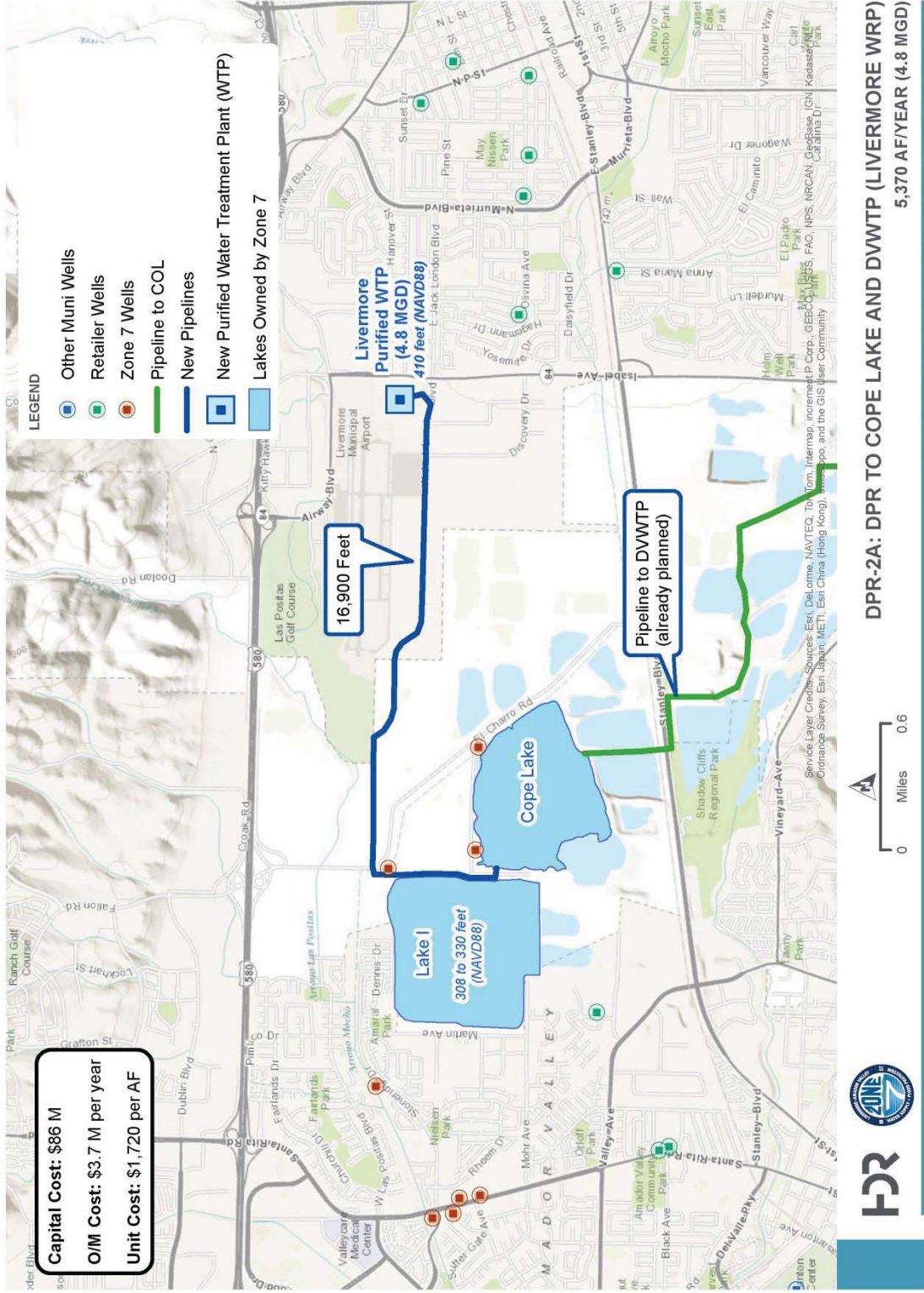


Figure 12 - DPR to Cope Lake and Del Valle WTP (Livermore) – DPR-2A

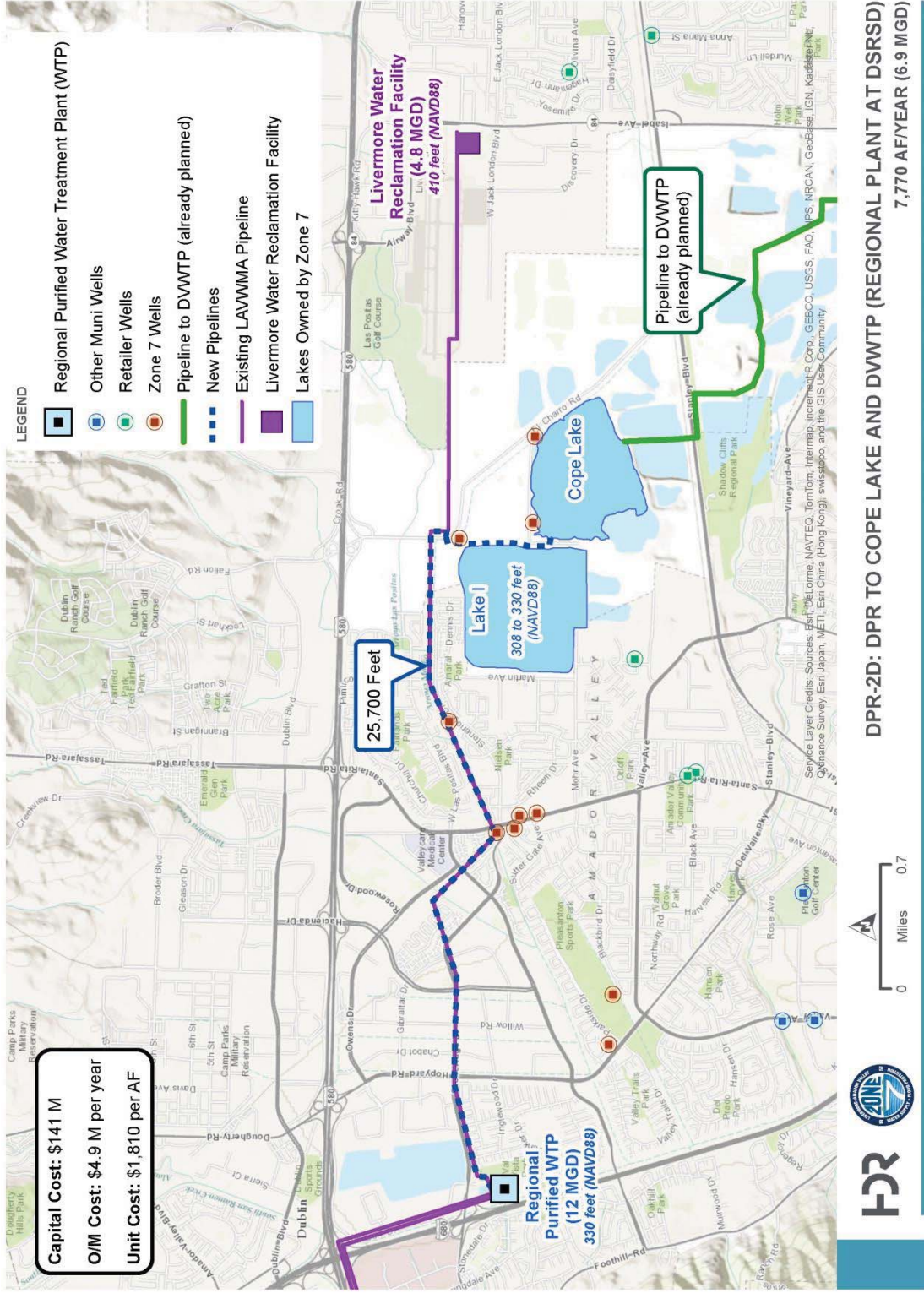


Figure 13 - DPR to Cope Lake and Del Valle WTP (Regional DSRSD) – DPR 2D



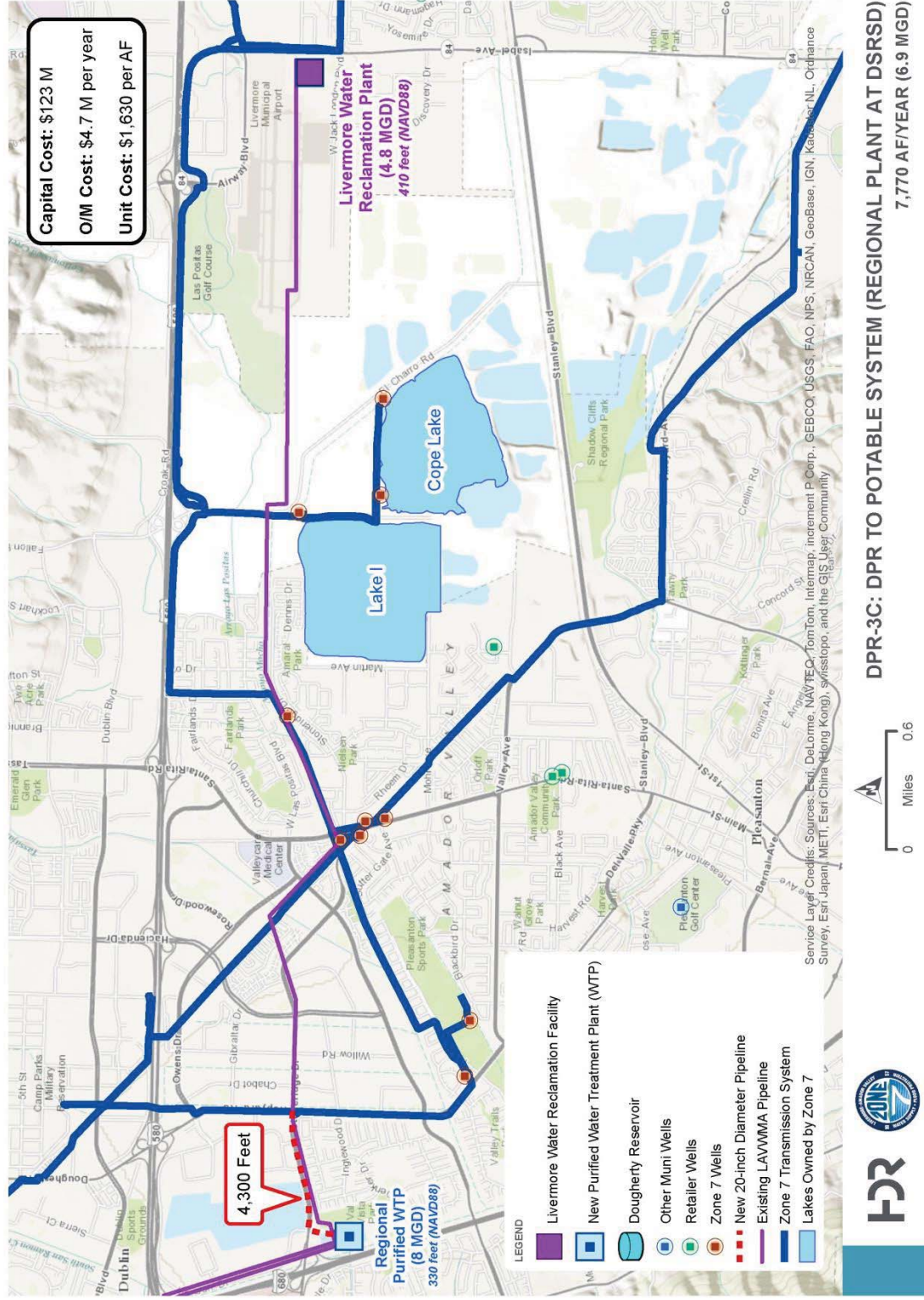


Figure 15 - DPR to Potable Water System (Regional Plant at DSRSD) – DPR-3C

Table 5 - Recommendations for Potable Reuse Feasibility Study

<i>Issue</i>	<i>Description</i>	<i>Tasks</i>
Water Quantity	The supply/ yield is determined by LAVWMA pipeline permitting requirements, treatment process recovery, and capacity of reuse receptors (Lake I, Cope Lake, injection wells, etc.)	- Confirm yield and availability for treatment plants, lakes, and injections wells. - Determine recovery efficiency for treatment processes and process modifications/ cost tradeoffs to improve efficiency. - Determine LAVWMA minimum pipeline volumes and flow/ quality requirements to meet permitted discharge limits.
Public Health	The number of barriers appropriate for public health protection	Technical, regulatory and policy level discussions to determine the appropriate contaminant barriers
Hydrologic Feasibility	The annual and long-term recharge capacity for both lake and injection well recharge needs to be defined	- Review existing reports to estimate recharge rates and aquifer capacity. - Develop preliminary siting, well design, and delivery system design. - Evaluate operational constraints (e.g., flood control, increased gravel pumping) and timing of acquisition - Assess injection well feasibility in light of prior experiences in the Livermore-Amador Valley
Facilities Sizing	Costs are affected by facilities sizing (e.g. DSRSD plant size)	- Optimize sizing treatment plant and other facilities after confirming water availability and yield. - Assess nitrification-denitrification implementation for wastewater plants or other methods for ammonia reduction.
Siting	Multiple sites are available	- Assess significant cost differentials between locations. - Identify operational pros and cons of each location.
Power Availability	Adequacy of existing electrical service needs to be assessed	With projected power requirements, assess existing capacity, the need for additional power and associated capital and operating costs
Treatability Testing	Treatability testing can verify expected yields, optimize pre-treatment to minimize fouling, and optimize contaminant reduction	- Develop a treatability testing plan for the recommended alternative(s). - Perform testing to inform design - Consider using pilot-scale treatment facility to foster public acceptance.
Water Quality and Aquifer Impacts	Interaction of natural deposits could result in mobilization of contaminants (e.g., arsenic, chromium) or precipitation	- Conduct lab studies of core samples taken from injection well locations. - Determine necessary adjustments to water chemistry to limit dissolution without other adverse impacts. - Evaluate potential for precipitation and/or plugging.
Water Quality and Re-equilibration	New source water can impact corrosion in the distribution system	Evaluate impacts to pipes, built-up scale, and disinfection on distribution system water quality under the range of potential future water supply scenarios.
Groundwater Basin Management	Reuse water is a part of the overall groundwater management plan	Determine impacts of reuse options on overall groundwater sustainability.
Regulatory Framework	Potable reuse framework under development	Develop a program implementation strategy to bracket potential regulatory outcomes.

<i>Issue</i>	<i>Description</i>	<i>Tasks</i>
Personnel Requirements	Water supplies requiring advanced treatment require proper staffing with adequate training	• Develop a staffing plan for operations and maintenance. • Identify the required training and certifications necessary to assure the safety of the delivered water quality.
Public Acceptance	Public acceptance/ public support of potable reuse requires a proactive strategy.	• Develop communications strategy based on identified best practices. • Advance key messages on the need for investing in additional water supply.
Permitting and Clearances	Obtaining the required environmental permits and clearances is a critical path for project success	• Identify the lead agency for permitting. • Develop a permitting strategy which identifies all permit needs. • Initiate long-lead permitting activities.
Contracts	Demonstrating ownership and control of the water resource from source to delivery	• Identify project partners for transmission, treatment, and delivery. • Develop contracts and/or intergovernmental agreements (IGAs) on ownership and operations as required to accomplish project goals.
Funding	Construction and O&M costs will drive funding needs and the implementation schedule	• Determine financing approach. • Advance the recommended alternative to preliminary design to refine cost opinions and reduce the assumed contingencies to aid financial planning.

5.0 Desalination Analysis

5.1 Assumptions

The brackish water desalination plant options assumed the same design parameters and assumptions as were presented in previous analyses of desalination for the Bay Area Regional Desalination Plant (BARDP). These documents include:

- Pilot Testing at Mallard Slough Pilot Plant Engineering Report (MWH, 2010).
- Bay Area Regional Desalination Project Wheeling Study (EBMUD, 2013).
- Final Draft Bay Area Regional Desalination Project Greenhouse Gas Analysis (K/J, 2013).
- Bay Area Regional Desalination Project Site Specific Analyses Final Report (CCWD, 2014).

It was assumed that Zone 7 would pay for a 5 MGD fraction (5,600 AFY) of the total 10 or 20 MGD facility and a proportional share of any additional infrastructure (e.g. pipelines) as required to accommodate the final plant capacity.

TREATMENT FACILITIES

Delta water (estimated 5,000 mg/L TDS) rather than seawater (estimated at greater than 30,000 mg/L TDS) is being used for the source water; thus, higher recovery and lower costs are expected for the brackish water plants compared to sea water desalination. However, TDS levels in the Bay vary widely over the course of the day, season, and between dry, normal, and

wet years. Because of the variation, plant design would need to balance the ability to treat higher salt concentrations but also maximize the utility of the plant.

The BARDP concept has been progressively developed over the last 10 years with a pilot study at the proposed Mallard Slough intake completed in 2010. The proposed 20 MGD plant capacity would provide reliable supply to Zone 7 and four other partner agencies (Contra Costa Water District, East Bay Municipal Utility District, the San Francisco Public Utilities Commission, and the Santa Clara Valley Water District). The 20 MGD plant could be located at Mallard Slough or adjacent to CCWD's Bollman WTP, but is assumed to be located at the Bollman WTP for purposes of cost estimation. The BARDP could be phased with an initial capacity of 10 MGD.

Cost savings associated with co-locating the desalination plant adjacent to local power plants and using power plant waste heat to improve energy efficiency and RO plant recovery were not evaluated.

INTAKES AND OUTAKES

For both desalination plant options, the use of existing infrastructure, as indicated in previous analyses, is assumed to minimize cost.

For the proposed BARDP, it is assumed that the project will use the existing intake at Mallard Slough and convey post-treatment brine to the CCCSD outfall via a new brine disposal pipeline.

Alternatively, the existing DDSD outfall could be used. An amendment to the permit (which currently has no TDS limit) to allow brine waste to be mixed with DDSD discharge would be required.

It is assumed that a positive barrier fish screen at the intake is required to protect/ screen delta smelt and other fish from entrainment and impingement. Fisheries mitigation is not included in the estimated O&M costs but may be required.

CONVEYANCE

Two options are available for conveyance to Zone 7. One option is to wheel the desalinated water supply through existing EBMUD and CCWD infrastructure and construct a new intertie that connects the existing system to Zone 7 (Figure 16). The second option is to provide water transfer via an exchange with CCWD. The exchange would function by Zone 7 receiving an equivalent amount of Central Valley Project (CVP) water transferred via the South Bay Aqueduct and treated by Zone 7 (Figure 17).

5.2 Cost Components

The cost components for each alternative are presented below. Costs for each are summarized in the next section.

BAY AREA REGIONAL DESALINATION PLANT (VIA CCWD EXCHANGE OR WHEELING THROUGH EBMUD)

This alternative consists of a brackish water desalination plant located adjacent to the Bollman WTP, using an existing intake at Mallard Slough, rehabilitating existing pipelines, and conveying waste brine via a new brine disposal pipeline. For the EBMUD wheeling alternative, other capital cost components include a new reliability intertie to convey water ("wheel") to Zone 7 and a rate

control station. O&M cost components include treatment costs (electrical, chemical, equipment and membrane replacement, and personnel), pump station costs (energy and maintenance), pipeline conveyance costs (e.g., wheeling, for the EBMUD alternative), and greenhouse gas offsets/reduction. A “Place of Use” change to an existing water right would be needed, but new water rights are not required.

5.3 Implementation Issues

The partner agencies have identified a schedule for the next 5 years that takes the project from CEQA through pre-design and initial permitting. Proceeding is contingent on resolving issues addressing project features (including initial capacity), water rights, cost-benefit sharing agreements and contracting for CEQA, pre-design and permitting.

The following are remaining uncertainties that should be investigated as the project development proceeds:

1. Confirm the use of available water rights, required amendments (e.g. place of use) and the need to obtain additional rights.
2. Intake requirements and operations to minimize adverse effects on aquatic resources.
3. Discharge requirements for brine, outfall capacity and operations to minimize adverse effects on aquatic resources.
4. Phasing and sizing of facilities.
5. Agreements with other agencies.
6. Availability and condition of existing infrastructure for use or repurpose.
7. Water re-equilibration study and advanced monitoring in the distribution system.
8. Determine financing approach.

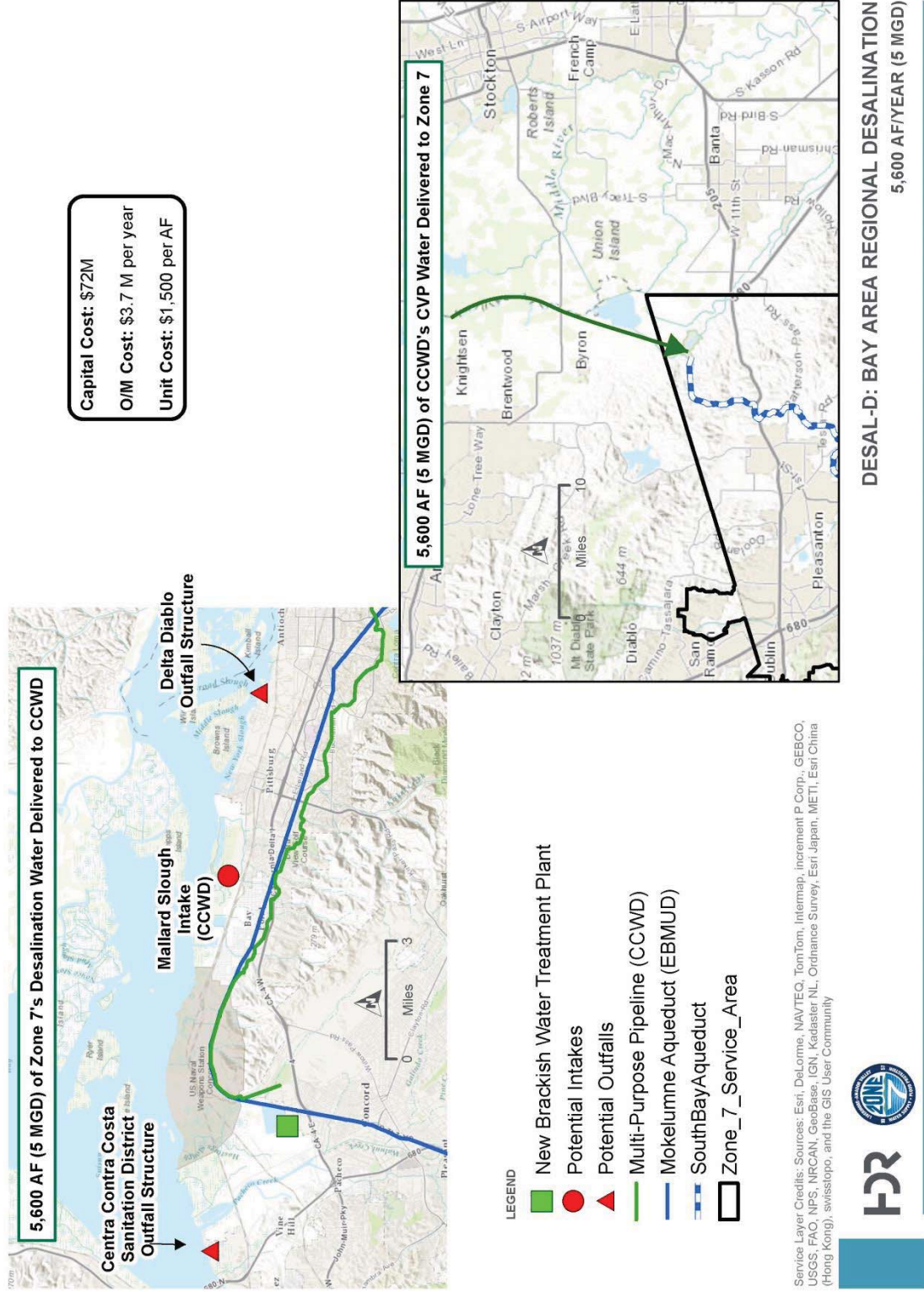


Figure 16 - BARDP to Zone 7 - via Exchange with CCWD Desal 1-D

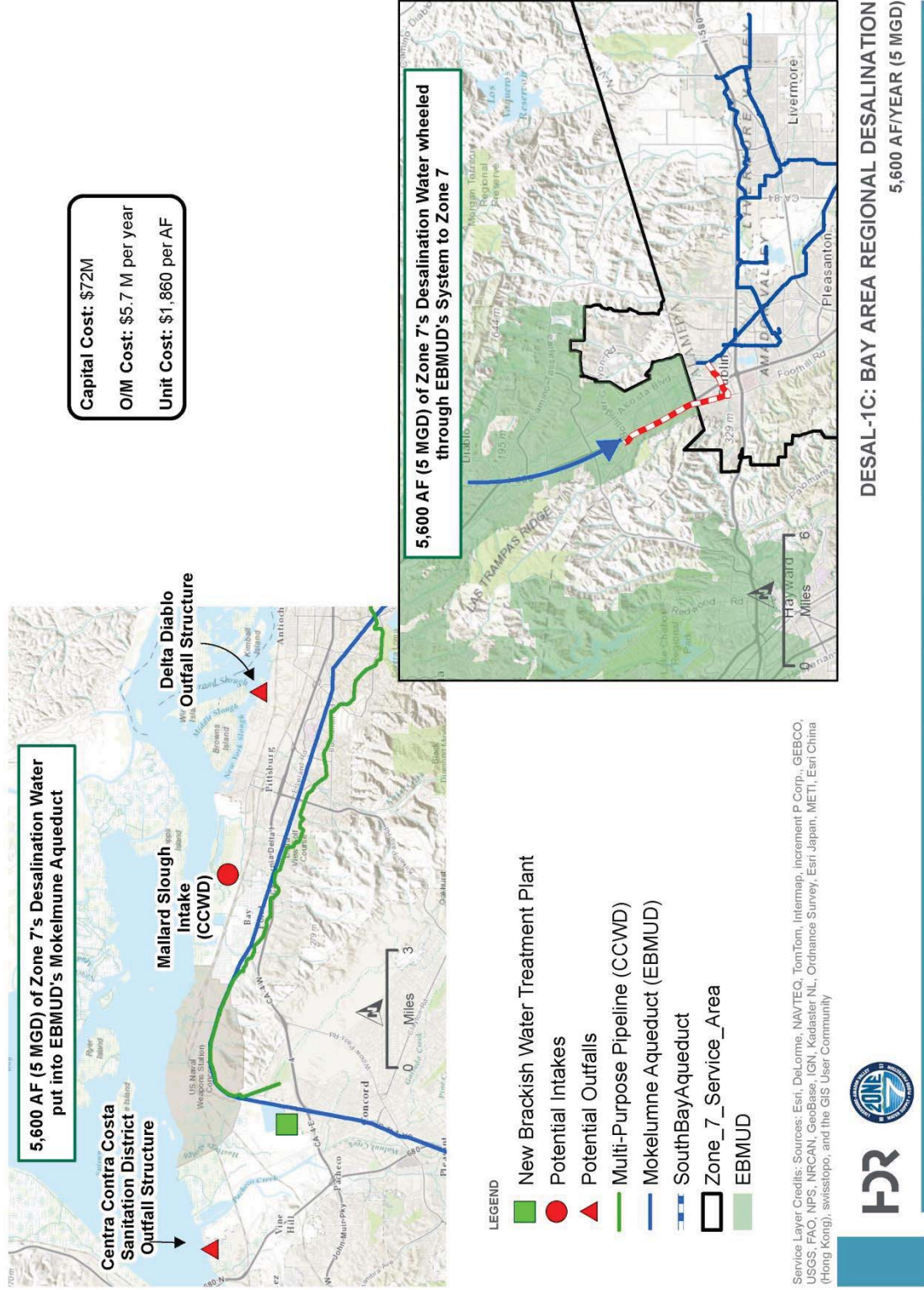


Figure 17 - BARDP to Zone 7 - via Wheeling through EBMUD Desal 1-C



6.0 Cost Analysis

6.1 Cost Assumptions

The cost estimate provided here is a high level planning cost estimate. Economic assumptions were the same for all alternatives, except where indicated. The amortization period was 30 years and an annual interest rate of 5% was assumed. A 25% contingency was added on to all capital construction costs. An additional 30% allowance was included for engineering, administration, and planning (EAP) to the construction cost, including contingency. Permitting, land acquisition, connection fees, and any required feasibility or monitoring studies were added in addition to the construction costs (after contingencies and EAP). The cost of CEQA compliance for each alternative was estimated to be 2-5% of the construction cost and ranged between \$0.8M and \$2.5M. The July 2015 Engineering News Record (ENR) Construction Cost Index (ENR CCI) value for the San Francisco Bay Area of 11155 was used as a baseline for all costs.

6.2 Cost Summary

Table A-1 in the Appendix summarizes the overall capital cost for each of the alternatives. Detailed cost estimates are also provided in Appendix A.



Appendices



Appendix A: Cost Estimates

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

IPR-1: IPR to Chain of Lakes	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at Livermore	125	HP	\$ 4,300	\$ 537,500
Pipelines from Livermore to Shared Pipeline (18 IN)	13400	LF	\$ 270	\$ 3,618,000
Shared Pipeline to Lake I (18 IN)	1400	LF	\$ 270	\$ 378,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 45,428,700
Contingency (25%)	25	%		\$ 11,357,000
Subtotal				\$ 56,785,700
EAP (30%)	30	%		\$ 17,036,000
CEQA	2	%	capital cost	\$ 909,000
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
Total Construction Cost				\$ 75,730,700
Amortized Capital Cost				\$ 4,926,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	4.8	MGD	\$ 525,000	\$ 2,517,170
Personnel	1	FTE	\$ 108,000	\$ 108,000
Lake I	1	LS	\$ 73,000	\$ 73,000
Pump Stations				\$ -
Energy	467,703	kWH	\$0.18	\$ 84,000
Maintenance	1.50%	pump station construction		\$ 400
Pipelines	0.15%	pipeline construction cost		\$ 300
Additional Monitoring	1	LS	\$ 350,000	\$ 350,000
Annual O&M Cost				\$ 3,132,870
30-Year Present Value O&M				\$ 48,160,000
Total 30-Year Present Value Cost				\$ 123,890,700
Total Annual Cost				\$ 8,058,870
Cost per Acre-Ft	4800	acft/yr		\$ 1,680

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

IPR-2A: IPR to Injection Wells (Livermore Only)	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at Livermore	175	HP	\$ 3,700	\$ 647,500
Pipelines from Livermore to Injection Wells (18 IN)	23200	LF	\$ 270	\$ 6,264,000
Injection Wells	6	LS	\$ 1,013,237	\$ 6,079,420
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 53,886,120
Contingency (25%)	25	%		\$ 13,471,500
Subtotal				\$ 67,357,620
EAP (30%)	30	%		\$ 20,207,290
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 1,078,000
Total Construction Cost				\$ 89,642,910
Amortized Capital Cost				\$ 5,831,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	4.8	MGD	\$ 245,000	\$ 2,517,170
Personnel	1	FTE	\$ 108,000	\$ 108,000
Injection Wells	6	EA	\$ 1,013,237	\$ 12,440.00
Pump Stations				\$ -
Energy	684,393	kWH	\$0.18	\$ 123,000
Maintenance	1.50%	pump station construction		\$ 500
Pipelines	0.15%	pipeline construction cost		\$ 1,500
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M Cost				\$ 3,262,610
30-Year Present Value O&M				\$ 50,154,000
Total 30-Year Present Value Cost				\$ 139,796,910
Total Annual Cost				\$ 9,093,610
Cost per Acre-Ft	5370	acft/yr		\$ 1,690

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

IPR-2B: IPR to Injection Wells	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	8.0	MGD	\$ 6,579,000	\$ 52,632,000
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at DSRSD	350	HP	\$ 3,100	\$ 1,085,000
Pump Station at Livermore	150	HP	\$ 3,900	\$ 585,000
Pipelines from DSRSD to Shared Pipeline (24 IN)	30100	LF	\$ 360	\$ 10,836,000
Pipelines from Livermore to Shared Pipeline (18 IN)	6100	LF	\$ 270	\$ 1,647,000
Shared Pipeline to Injection Wells (24 IN)	17100	LF	\$ 360	\$ 6,156,000
Highway Crossings	2	EA	\$ 750,000	\$ 1,500,000
Injection Wells	10	LS	\$ 1,013,000	\$ 10,130,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 125,466,200
Contingency (25%)	25	%		\$ 31,366,600
Subtotal				\$ 156,832,800
EAP (30%)	30	%		\$ 47,049,840
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 2,509,000
Total Construction Cost				\$ 207,391,640
Amortized Capital Cost				\$ 13,491,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	9.3	MGD	\$ 525,000	\$ 4,882,500
Personnel	2	FTE	\$ 108,000	\$ 216,000
Injection Wells	6	EA	\$ 2,000	\$ 12,000
Pump Stations				\$ -
Energy	1,121,058	kWH	\$0.18	\$ 202,000
Maintenance	1.50%	pump station construction		\$ 1,400
Pipelines	0.15%	pipeline construction cost		\$ 1,500
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M Cost				\$ 5,815,400
30-Year Present Value O&M				\$ 89,397,000
Total 30-Year Present Value Cost				\$ 296,788,640
Total Annual Cost				\$ 19,306,400
Cost per Acre-Ft	7734	acft/yr		\$ 2,500

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

IPR-2C: IPR to Injection Wells	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	8.0	MGD	\$ 6,579,000	\$ 52,632,000
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at DSRSD	350	HP	\$ 3,100	\$ 1,085,000
Pump Station at Livermore	150	HP	\$ 3,900	\$ 585,000
Pipelines from DSRSD to Shared Pipeline (24 IN)	21400	LF	\$ 360	\$ 7,704,000
Pipelines from Livermore to Shared Pipeline (18 IN)	6100	LF	\$ 270	\$ 1,647,000
Shared Pipeline to Lake I (24 IN)	17100	LF	\$ 360	\$ 6,156,000
Highway Crossings	0	EA	\$ 750,000	\$ -
Injection Wells	10	LS	\$ 1,013,000	\$ 10,130,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 120,834,200
Contingency (25%)	25	%		\$ 30,208,600
Subtotal				\$ 151,042,800
EAP (30%)	30	%		\$ 45,312,840
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 2,417,000
Total Construction Cost				\$ 199,772,640
Amortized Capital Cost				\$ 12,995,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	9.3	MGD	\$ 525,000	\$ 4,882,500
Personnel	2	FTE	\$ 108,000	\$ 216,000
Injection Wells	6	EA	\$ 2,000	\$ 12,000
Pump Stations				\$ -
Energy	1,062,957	kWH	\$0.18	\$ 191,000
Maintenance	1.50%	pump station construction		\$ 1,400
Pipelines	0.15%	pipeline construction cost		\$ 1,300
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M Cost				\$ 5,804,200
30-Year Present Value O&M				\$ 89,225,000
Total 30-Year Present Value Cost				\$ 288,997,640
Total Annual Cost				\$ 18,799,200
Cost per Acre-Ft	7734	acft/yr		\$ 2,430

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

IPR-2D: IPR to Injection Wells	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	12.0	MGD	\$ 5,633,000	\$ 67,596,000
Advanced Treatment at Livermore	0.0	MGD	\$ -	\$ -
Pump Station at DSRSD	350	HP	\$ 3,100	\$ 1,085,000
Pump Station at Livermore	0	HP	\$ -	\$ -
Pipelines from DSRSD to Shared Pipeline (30 IN)	21400	LF	\$ 450	\$ 9,630,000
Pipelines from Livermore Injection Well to Shared Pipelin	6900	LF	\$ 450	\$ 3,105,000
Shared Pipeline to Lake I (30 IN)	17100	LF	\$ 450	\$ 7,695,000
Highway Crossings	0	EA	\$ -	\$ -
Injection Wells	14	LS	\$ 1,013,000	\$ 14,182,000
Monitoring Equipment	1	LS	\$ -	\$ -
Total Capital Cost				\$ 103,293,000
Contingency (25%)	25	%	\$ -	\$ 25,823,300
Subtotal	0	0	\$ -	\$ 129,116,300
EAP (30%)	30	%	\$ -	\$ 38,734,890
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%	\$ -	\$ 2,066,000
Total Construction Cost				\$ 170,917,190
Amortized Capital Cost				\$ 11,118,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electical, Equipment	6.9	MGD	\$ 525,000	\$ 3,622,500
Personnel	1	FTE	\$ 108,000	\$ 108,000
Injection Wells	5	EA	\$ 2,000	\$ 10,000
Pump Stations				\$ -
Energy	302,833	kWH	\$0.18	\$ 55,000
Maintenance	1.50%	pump station construction	\$ -	\$ 900
Pipelines	0.15%	pipeline construction cost	\$ -	\$ 1,700
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M Cost				\$ 4,298,100
30-Year Present Value O&M				\$ 66,072,000
Total 30-Year Present Value Cost				\$ 236,989,190
Total Annual Cost				\$ 15,416,100
Cost per Acre-Ft	7767	acft/yr		\$ 1,980

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

IPR-3A: IPR to Chain of Lakes + Injection Wells	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	8.0	MGD	\$ 6,579,000	\$ 52,632,000
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at DSRSD	300	HP	\$ 2,900	\$ 870,000
Pump Station at Livermore	500	HP	\$ 3,000	\$ 1,500,000
Pipelines from DSRSD to Shared Pipeline (24 IN)	30100	LF	\$ 360	\$ 10,836,000
Pipelines from Livermore to Shared Pipeline (18 IN)	13400	LF	\$ 270	\$ 3,618,000
Shared Pipeline to Lake I (30 IN)	1400	LF	\$ 450	\$ 630,000
Pipeline to Injection Wells (16 IN)	9300	LF	\$ 240	\$ 2,232,000
Highway Crossings	2	EA	\$ 750,000	\$ 1,500,000
Injection Wells	6	LS	\$ 1,013,000	\$ 6,078,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 120,791,200
Contingency (25%)	25	%		\$ 30,197,800
Subtotal				\$ 150,989,000
EAP (30%)	30	%		\$ 45,296,700
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 2,416,000
Total Construction Cost				\$ 199,701,700
Amortized Capital Cost				\$ 12,991,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	9.3	MGD	\$ 525,000	\$ 4,882,500
Personnel	2	FTE	\$ 108,000	\$ 216,000
Injection Wells	6	EA	\$ 2,000	\$ 12,000
Lake I	1	LS	\$ 73,000	\$ 73,000
Pump Stations				\$ -
Energy	1,542,000	kWH	\$ 0.18	\$ 278,000
Maintenance	1.50%	pump station construction		\$ 1,900
Pipelines	0.15%	pipeline construction cost		\$ 1,400
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M Cost				\$ 5,964,800
30-Year Present Value O&M				\$ 91,694,000
Total 30-Year Present Value Cost				\$ 291,395,700
Total Annual Cost				\$ 18,955,800
Cost per Acre-Ft	7134	acft/yr		\$ 2,660

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

IPR-3B: IPR to Chain of Lakes + Injection Well	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	8.0	MGD	\$ 6,579,000	\$ 52,632,000
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at DSRSD	300	HP	\$ 2,900	\$ 870,000
Pump Station at Livermore	500	HP	\$ 3,000	\$ 1,500,000
Pipelines from DSRSD to Shared Pipeline (24 IN)	21600	LF	\$ 360	\$ 7,776,000
Pipelines from Livermore to Shared Pipeline (18 IN)	13400	LF	\$ 270	\$ 3,618,000
Shared Pipeline to Lake I (30 IN)	1400	LF	\$ 450	\$ 630,000
Pipeline to Injection Wells (16 IN)	9300	LF	\$ 240	\$ 2,232,000
Highway Crossings	0	EA	\$ 750,000	\$ -
Injection Wells	6	LS	\$ 1,013,000	\$ 6,078,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 116,231,200
Contingency (25%)	25	%		\$ 29,057,800
Subtotal				\$ 145,289,000
EAP (30%)	30	%		\$ 43,586,700
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 2,325,000
Total Construction Cost				\$ 192,200,700
Amortized Capital Cost				\$ 12,503,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	9.3	MGD	\$ 525,000	\$ 4,882,500
Personnel	2	FTE	\$ 108,000	\$ 216,000
Injection Wells	6	EA	\$ 2,000	\$ 12,000
Lake I	1	LS	\$ 73,000	\$ 73,000
Pump Stations				\$ -
Energy	2,235,963	kWH	\$0.18	\$ 402,000
Maintenance	1.50%	pump station construction		\$ 1,900
Pipelines	0.15%	pipeline construction cost		\$ 600
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M Cost				\$ 6,088,000
30-Year Present Value O&M				\$ 93,587,000
Total 30-Year Present Value Cost				\$ 285,787,700
Total Annual Cost				\$ 18,591,000
Cost per Acre-Ft	7134	acft/yr		\$ 2,610

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

IPR-3C: IPR to Chain of Lakes + Injection We	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	12.0	MGD	\$ 5,633,000	\$ 67,596,000
Advanced Treatment at Livermore	0.0	MGD	\$ -	\$ -
Pump Station at DSRSD	400	HP	\$ 3,100	\$ 1,240,000
Pump Station at Livermore	0	HP	\$ -	\$ -
Pipelines from DSRSD to Shared Pipeline(30 IN)	21600	LF	\$ 450	\$ 9,720,000
Pipelines from Livermore Injection Well to Shared Pipelin	6400	LF	\$ -	\$ -
Shared Pipeline to Lake I (30 IN)	1400	LF	\$ 450	\$ 630,000
Pipeline to Injection Wells (16 IN)	9300	LF	\$ 240	\$ 2,232,000
Highway Crossings	0	EA	\$ -	\$ -
Injection Wells	6	LS	\$ 1,013,000	\$ 6,078,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 89,996,000
Contingency (25%)	25	%		\$ 22,499,000
Subtotal				\$ 112,495,000
EAP (30%)	30	%	\$ -	\$ 33,748,500
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 1,800,000
Total Construction Cost				\$ 149,043,500
Amortized Capital Cost				\$ 9,695,000
Annual O&M				
Treatment				
Chemical, Electrical, Equipment	6.9	MGD	\$ 525,000	\$ 3,622,500
Personnel	1	FTE	\$ 108,000	\$ 108,000
Injection Wells	6	EA	\$ 2,000	\$ 12,000
Lake I	1	LS	\$ 73,333	\$ 73,333
Pump Stations				
Energy	419,937	kWH	\$0.18	\$ 76,000
Maintenance	1.50%	pump station construction		\$ 1,000
Pipelines	0.15%	pipeline construction cost		\$ 600
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M Cost				\$ 4,393,433
30-Year Present Value O&M				\$ 67,538,000
Total 30-Year Present Value Cost				\$ 216,581,500
Total Annual Cost				\$ 14,088,433
Cost per Acre-Ft	7167	acft/yr		\$ 1,970

Capital and O&M Cost Summary

Contingency	25%
Engineering, Administration, Permitting (EAP)	30%
All Costs in 2015 \$ (July 2015 - SF CCI = 11155)	
Interest Rate	5%
Amortization Period	30 years

IPR-3D: IPR to Chain of Lakes + Injection Wells (Regional WTP at Chain of Lakes)	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at Regional WTP	12.0	MGD	\$ 5,633,000	\$ 67,596,000
Pump Station at DSRSD	300	HP	\$ 3,200	\$ 960,000
Pump Station to Lake I	10	HP	\$ 8,200	\$ 82,000
Pump Station to Injection Wells	50	HP	\$ 6,800	\$ 340,000
Pipelines from DSRSD to Shared Pipeline(24 IN)	20160	LF	\$ 360	\$ 7,257,600
Shared Pipeline to Regional WTP (30 IN)	430	LF	\$ 450	\$ 193,500
Pipeline to Lake I (30 IN)	520	LF	\$ 450	\$ 234,000
Pipeline to Injection Wells (16 IN)	18370	LF	\$ 240	\$ 4,408,800
Injection Wells	6	LS	\$ 1,013,000	\$ 6,078,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 89,649,900
Contingency (25%)	25	%		\$ 22,412,500
Subtotal				\$ 112,062,400
EAP (30%)	30	%		\$ 33,618,720
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
Land Acquisition	7	AC	\$ 500,000	\$ 3,500,000
CEQA	2	%		\$ 1,793,000
Total Construction Cost				\$ 151,974,120
Amortized Capital Cost				\$ 9,886,000
Annual O&M				
Treatment				
Chemical, Electrical, Equipment	6.9	MGD	\$ 525,000	\$ 3,622,500
Personnel	1	FTE	\$ 108,000	\$ 108,000
Injection Wells	6	EA	\$ 2,000	\$ 12,000
Lake I	1	LS	\$ 73,000	\$ 73,000
Pump Stations				
Energy	601,878	kWH	\$0.18	\$ 108,000
Maintenance	1.50%	pump station construction		\$ 1,100
Pipelines	0.15%	pipeline construction cost		\$ 1,000
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M Cost				\$ 4,425,600
30-Year Present Value O&M				\$ 68,032,000
Total 30-Year Present Value Cost				\$ 220,006,120
Total Annual Cost				\$ 14,311,600
Cost per Acre-Ft	7167	acft/yr		\$ 2,000

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

DPR-1: Direct - To PPWTP Reservoir	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at Livermore WWTP	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at Livermore WWTP	650	HP	\$ 2,900	\$ 1,885,000
Pipelines from WWTP to Patterson Reservoir (18 IN)	44300	LF	\$ 270	\$ 11,961,000
Modification to Patterson Reservoir	1	LS	\$ 1,000,000	\$ 1,000,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital				\$ 55,741,200
Contingency (25%)	25	%		\$ 13,935,300
Subtotal				\$ 69,676,500
EAP (30%)	30	%		\$ 20,903,000
Water Quality Equilibration Study	1	LS	\$ 300,000	\$ 1,000,000
CEQA	2	%		\$ 1,115,000
Total Construction Cost				\$ 92,694,500
Amortized Capital Cost				\$ 6,030,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	4.8	MGD	\$ 525,000	\$ 2,520,000
Personnel	1	FTE	\$ 108,000	\$ 108,000
Pump Stations				\$ -
Energy	3,108,000	kWH	\$ 0.18	\$ 559,000
Maintenance	1.50%	pump station construction		\$ 2,000
Pipelines	0.15%	pipeline construction cost		\$ 1,800
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M				\$ 3,690,800
30-Year Present Value O&M				\$ 56,737,000
Total 30-Year Present Value Cost				\$ 126,413,500
Total Annual Cost				\$ 9,720,800
Cost per Acre-Ft	5370	acft/yr		\$ 1,810

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

DPR-2A: Direct - To DVWTP (Livermore Only)	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at Livermore	125	HP	\$ 4,300	\$ 537,500
Pump Station at Cope Lake	600	HP	\$ 2,900	\$ 1,740,000
Pipelines from Livermore to Lake I (18 IN)	31500	LF	\$ 270	\$ 8,505,000
Pipeline from Lake I to DVWTP (18 IN)	28700	LF	\$ 270	not included
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 51,677,700
Contingency (25%)	25	%		\$ 12,919,000.00
Subtotal				\$ 64,596,700
EAP (30%)	30	%		\$ 19,379,010
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 1,034,000
Total Construction Cost				\$ 86,009,710
Amortized Capital Cost				\$ 5,595,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	4.8	MGD	\$ 525,000	\$ 2,517,170
Personnel	1	FTE	\$ 108,000	\$ 108,000
Lake I	1	LS	\$ 73,300	\$ 73,300
Pump Stations				\$ -
Energy	3,360,910	kWH	\$0.18	\$ 605,000
Maintenance	1.50%	pump station construction		\$ 2,000
Pipelines	0.15%	pipeline construction cost		\$ 700
Additional Monitoring	1	LS	\$ 350,000	\$ 350,000
Annual O&M Cost				\$ 3,656,170
30-Year Present Value O&M				\$ 56,204,000
Total 30-Year Present Value Cost				\$ 142,213,710
Total Annual Cost				\$ 9,251,170
Cost per Acre-Ft	5370	acft/yr		\$ 1,720

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

DPR-2B: Direct - To DVWTP	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	8.0	MGD	\$ 6,579,000	\$ 52,632,000
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at DSRSD	275	HP	\$ 3,200	\$ 880,000
Pump Station at Livermore	125	HP	\$ 4,300	\$ 537,500
Pump Station at Cope Lake	1350	HP	\$ 2,600	\$ 3,510,000
Pipelines from DSRSD to Shared Pipeline (24 IN)	30100	LF	\$ 360	\$ 10,836,000
Pipelines from Livermore to Shared Pipeline (18 IN)	14200	LF	\$ 270	\$ 3,834,000
Shared Pipeline to Lake I (30 IN)	1400	LF	\$ 450	\$ 630,000
Pipeline from Lake I to DVWTP (30 IN)	28700	LF	\$ 450	not included
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 113,754,700
Contingency (25%)	25	%		\$ 28,439,000
Subtotal				\$ 142,193,700
EAP (30%)	30	%		\$ 42,658,110
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 1,222,000
Total Construction Cost				\$ 187,073,810
Amortized Capital Cost				\$ 12,169,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	9.3	MGD	\$ 525,000	\$ 4,900,320
Personnel	2	FTE	\$ 108,000	\$ 216,000
Lake I	1	LS	\$ 73,300	\$ 73,300
Pump Stations				\$ -
Energy	5,069,118	kWH	\$0.18	\$ 912,400
Maintenance	1.50%	pump station construction		\$ 4,000
Pipelines	0.15%	pipeline construction cost		\$ 1,200
Additional Monitoring	1	LS	\$ 350,000	\$ 350,000
Annual O&M Cost				\$ 6,457,220
30-Year Present Value O&M				\$ 99,263,000
Total 30-Year Present Value Cost				\$ 286,336,810
Total Annual Cost				\$ 18,626,220
Cost per Acre-Ft	7734	acft/yr		\$ 2,410

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

DPR-2C: Direct - To DVWTP	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	8.0	MGD	\$ 6,579,000	\$ 52,632,000
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at DSRSD	200	HP	\$ 3,500	\$ 700,000
Pump Station at Livermore	125	HP	\$ 4,300	\$ 537,500
Pump Station at Cope Lake	1350	HP	\$ 2,600	\$ 3,510,000
Pipelines from DSRSD to Shared Pipeline (24 IN)	21600	LF	\$ 360	\$ 7,776,000
Pipelines from Livermore to Shared Pipeline (18 IN)	14200	LF	\$ 270	\$ 3,834,000
Shared Pipeline to Lake I (30 IN)	1400	LF	\$ 450	\$ 630,000
Pipeline from Lake I to DVWTP (30 IN)	28700	LF	\$ -	not included
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 110,514,700
Contingency (25%)	25	%		\$ 27,629,000
Subtotal				\$ 138,143,700
EAP (30%)	30	%		\$ 41,443,110
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 1,158,000
Total Construction Cost				\$ 181,744,810
Amortized Capital Cost				\$ 11,823,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	9.3	MGD	\$ 525,000	\$ 4,900,320
Personnel	2	FTE	\$ 108,000	\$ 216,000
Lake I	1	LS	\$ 73,300	\$ 73,300
Pump Stations				\$ -
Energy	5,069,118	kWH	\$0.18	\$ 912,400
Maintenance	1.50%	pump station construction		\$ 3,900
Pipelines	0.15%	pipeline construction cost		\$ 1,000
Additional Monitoring	1	LS	\$ 350,000	\$ 350,000
Annual O&M Cost				\$ 6,456,920
30-Year Present Value O&M				\$ 99,259,000
Total 30-Year Present Value Cost				\$ 281,003,810
Total Annual Cost				\$ 18,279,920
Cost per Acre-Ft	7734	acft/yr		\$ 2,360

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

DPR-2D: Direct - To DVWTP (DSRSD Only)	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	12.0	MGD	\$ 5,633,218	\$ 67,598,616
Advanced Treatment at Livermore	0.0	MGD	\$ -	\$ -
Pump Station at DSRSD	175	HP	\$ 3,700	\$ 647,500
Pump Station at Livermore	0	HP	\$ -	\$ -
Pump Station at Cope Lake	1350	HP	\$ 2,600	\$ 3,510,000
Pipelines from DSRSD to Shared Pipeline (30 IN)	22000	LF	\$ 450	\$ 9,900,000
Pipelines from Livermore to Shared Pipeline (IN)	0	LF	\$ -	\$ -
Shared Pipeline to Cope Lake (30 IN)	3700	LF	\$ 450	\$ 1,665,000
Pipeline from Cope Lake to DVWTP (30 IN)	28700	LF	\$ 450	not included
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital Cost				\$ 85,821,116
Contingency (25%)	25	%		\$ 21,455,000
Subtotal				\$ 107,276,116
EAP (30%)	30	%	\$ -	\$ 32,182,835
Feasibility Study	1	LS	\$ 1,000,000	\$ 1,000,000
CEQA	2	%		\$ 364,000
Total Construction Cost				\$ 140,822,951
Amortized Capital Cost				\$ 9,161,000
Annual O&M				
Treatment				
Chemical, Electical, Equipment	6.9	MGD	\$ 525,000	\$ 3,622,500
Personnel	1	FTE	\$ 108,000	\$ 108,000
Lake I				
Pump Stations				
Energy	4,434,180	kWH	\$0.18	\$ 798,200
Maintenance	1.50%	pump station construction		\$ 3,800
Pipelines	0.15%	pipeline construction cost		\$ 900
Additional Monitoring	1	LS	\$ 350,000	\$ 350,000
Annual O&M Cost				\$ 4,895,400
30-Year Present Value O&M				\$ 75,254,000
Total 30-Year Present Value Cost				\$ 216,076,951
Total Annual Cost				\$ 14,056,400
Cost per Acre-Ft	7767	acft/yr		\$ 1,810

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

DPR-3A: Direct - To Potable Water System (Livermore Only)	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at Livermore	300	HP	\$ 3,200	\$ 960,000
Pipelines from Livermore to Potable Tie In (18-in)	600	LF	\$ 270	\$ 162,000
Connection to PWS	1	EA	\$ 317,000	\$ 317,000
Monitoring Equipment	1	LS	\$ 1,250,000	\$ 1,250,000
Total Capital				\$ 41,084,200
Contingency (25%)	25	%		\$ 10,271,100
Subtotal				\$ 51,355,300
EAP (30%)	30	%		\$ 15,406,600
Water Quality Equilibration Study	1	LS	\$ 300,000	\$ 317,000
CEQA	2	%		\$ 822,000
Total Construction Cost				\$ 67,900,900
Amortized Capital Cost				\$ 4,417,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	4.8	MGD	\$ 525,000	\$ 2,520,000
Personnel	1	FTE	\$ 108,000	\$ 108,000
Pump Stations				\$ -
Energy	1,322,487	kWH	\$0.18	\$ 238,000
Maintenance	1.50%	pump station construction		\$ 800
Pipelines	0.15%	pipeline construction cost		\$ 100
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M				\$ 3,366,900
30-Year Present Value O&M				\$ 51,758,000
Total 30-Year Present Value Cost				\$ 103,113,300
Total Annual Cost				\$ 7,783,900
Cost per Acre-Ft	5370	acft/yr		\$ 1,450

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

DPR-3B: Direct - To Potable Water System	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	8.0	MGD	\$ 6,579,000	\$ 52,632,000
Advanced Treatment at Livermore	4.8	MGD	\$ 7,999,000	\$ 38,395,200
Pump Station at DSRSD	600	HP	\$ 2,900	\$ 1,740,000
Pump Station at Livermore	300	HP	\$ 3,200	\$ 960,000
Pipelines from DSRSD to Potable Tie In (24-in)	4300	LF	\$ 360	\$ 1,548,000
Pipelines from Livermore to Potable Tie In (18-in)	600	LF	\$ 270	\$ 162,000
Connection to PWS	2	EA	\$ 317,000	\$ 634,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital				\$ 98,571,200
Contingency (25%)	25	%		\$ 24,642,800
Subtotal				\$ 123,214,000
EAP (30%)	30	%		\$ 36,964,200
Water Quality Equilibration Study	1	LS	\$ 300,000	\$ 300,000
CEQA	2	%		\$ 1,971,000
Total Construction Cost				\$ 162,449,200
Amortized Capital Cost				\$ 10,568,000
Annual O&M				\$ -
Treatment				\$ -
Chemical, Electrical, Equipment	9.3	MGD	\$ 525,000	\$ 4,882,500
Personnel	2	FTE	\$ 108,000	\$ 216,000
Pump Stations				\$ -
Energy	2,902,000	kWH	\$0.18	\$ 522,400
Maintenance	1.50%	pump station construction		\$ 2,000
Pipelines	0.15%	pipeline construction cost		\$ 200
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M				\$ 6,123,100
30-Year Present Value O&M				\$ 94,127,000
Total 30-Year Present Value Cost				\$ 217,341,000
Total Annual Cost				\$ 16,691,100
Cost per Acre-Ft	7734	acft/yr		\$ 2,160

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Amortization Period 30 years

DPR-3C: Direct - To Potable Water System (	Value	Unit	Unit Cost	Total Cost
Advanced Treatment at DSRSD	12.0	MGD	\$ 5,633,218	\$ 67,598,616
Advanced Treatment at Livermore	0.0	MGD	\$ -	\$ -
Pump Station at DSRSD	900	HP	\$ 2,700	\$ 2,430,000
Pump Station at Livermore	0	HP	\$ -	\$ -
Pipelines from DSRSD to Potable Tie In (30-in)	4300	LF	\$ 450	\$ 1,935,000
Pipelines from Livermore to Potable Tie In (-in)	0	LF	\$ 270	\$ -
Connection to PWS	1	EA	\$ 317,000	\$ 317,000
Monitoring Equipment	1	LS	\$ 2,500,000	\$ 2,500,000
Total Capital				\$ 74,780,616
Contingency (25%)	25	%		\$ 18,695,200
Subtotal				\$ 93,475,816
EAP (30%)	30	%		\$ 28,042,700
Water Quality Equilibration Study	1	LS	\$ 300,000	\$ 300,000
CEQA	2	%		\$ 1,496,000
Total Construction Cost				\$ 123,314,516
Amortized Capital Cost				\$ 8,022,000
Annual O&M				
Treatment				
Chemical, Electrical, Equipment	6.9	MGD	\$ 525,000	\$ 3,622,500
Personnel	1	FTE	\$ 108,000	\$ 108,000
Pump Stations				
Energy	2,398,256	kWH	\$0.18	\$ 431,700
Maintenance	1.50%	pump station construction	\$ -	\$ 2,000
Pipelines	0.15%	pipeline construction cost	\$ -	\$ 160
Additional Monitoring	1	LS	\$ 500,000	\$ 500,000
Annual O&M				\$ 4,664,360
30-Year Present Value O&M			\$ -	\$ 71,703,000
Total 30-Year Present Value Cost			\$ -	\$ 165,178,816
Total Annual Cost			\$ -	\$ 12,686,360
Cost per Acre-Ft	7767	acft/yr	\$ -	\$ 1,630

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Inflation Rate 0%
 Amortization Period 30 years

Desal-1A: Desalination - Regional (Wheeled) with Reliability Intertie - 20 MGD	Value	Unit	Unit Cost	Total Cost
Regional Desalination Plant	5.0	MGD	\$ 6,274,000	\$ 31,370,000
Reliability Intertie (24-IN)	36,250	LF	\$ 360	\$ 13,050,000
Reliability Intertie (30-IN)	750	LF	\$ 450	\$ 337,500
Rate Control Station	1	LS	\$ 250,000	\$ 250,000
Total Capital Cost				\$ 45,007,500
Contingency (25%)	25	%		\$ 11,252,000
Subtotal				\$ 56,259,500
EAP (30%)	30	%		\$ 16,878,000
CEQA	5	%	capital cost	\$ 2,250,000
Land Acquisition	1	LS	\$ 875,000	\$ 875,000
Concentrate Discharge Permit and Connection	1	LS	\$ 250,000	\$ 250,000
Total Construction Cost				\$ 76,512,500
Amortized Capital Cost				\$ 4,977,000
Annual O&M				
Treatment				
Chemical, Electrical, Equipment	5.0	MGD	\$ 574,000	\$ 2,870,000
Personnel	1	FTE	\$ 108,000	\$ 108,000
Mallard Slough Pump Station	5600	acft	\$ 130	\$ 728,000
Wheeling (Pipelines)	5600	acft	\$ 360	\$ 2,016,000
Greenhouse Gas	5600	acft	\$ 50	\$ 280,000
Water Rights	5600	acft	\$ 60	\$ 336,000
Annual O&M Cost				\$ 6,338,000
30-Year Present Value O&M				\$ 97,431,000
Total 30-Year Present Value Cost				\$ 173,943,500
Total Annual Cost				\$ 11,315,000
Cost per Acre-Ft	5600	acft/yr		\$ 2,020

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Inflation Rate 0%
 Amortization Period 30 years

Desal-1B: Desalination - Regional (Wheeled) with Reliability Intertie - 10 MGD	Value	Unit	Unit Cost	Total Cost
Regional Desalination Plant	5.0	MGD	\$ 8,278,000	\$ 41,390,000
Reliability Intertie (24-IN)	36250	LF	\$ 360	\$ 13,050,000
Reliability Intertie (30-IN)	750	LF	\$ 450	\$ 337,500
Rate Control Station	1	LS	\$ 250,000	\$ 250,000
Total Capital Cost				\$ 55,027,500
Contingency (25%)	25	%		\$ 13,757,000
Subtotal				\$ 68,784,500
EAP (30%)	30	%		\$ 20,635,000
CEQA	5	%	capital cost	\$ 2,751,000
Land Acquisition	1	LS	\$ 1,750,000	\$ 1,750,000
Concentrate Discharge Permit and Connection	1	LS	\$ 500,000	\$ 500,000
Total Construction Cost				\$ 94,420,500
Amortized Capital Cost				\$ 6,142,000
Annual O&M				
Treatment				
Chemical, Electrical, Equipment	5.0	MGD	\$ 574,000	\$ 2,870,000
Personnel	1	FTE	\$ 108,000	\$ 108,000
Mallard Slough Pump Station	5600	acft	\$ 130	\$ 728,000
Wheeling (Pipelines)	5600	acft	\$ 360	\$ 2,016,000
Annual O&M Cost				\$ 5,722,000
30-Year Present Value O&M				\$ 87,961,000
Total 30-Year Present Value Cost				\$ 182,381,500
Total Annual Cost				\$ 11,864,000
Cost per Acre-Ft	5600	acft/yr		\$ 2,120

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Inflation Rate 0%
 Amortization Period 30 years

Desal-1C: Desalination - Regional (Wheeled) without Reliability Intertie - 10 MGD	Value	Unit	Unit Cost	Total Cost
Regional Desalination Plant	5.0	MGD	\$ 8,278,000	\$ 41,390,000
Rate Control Station	1	LS	\$ 250,000	\$ 250,000
Total Capital Cost				\$ 41,640,000
Contingency (25%)	25	%		\$ 10,410,000
Subtotal				\$ 52,050,000
EAP (30%)	30	%		\$ 15,615,000
CEQA	5	%	capital cost	\$ 2,082,000
Land Acquisition	1	LS	\$ 1,750,000	\$ 1,750,000
Concentrate Discharge Permit and Connection	1	LS	\$ 500,000	\$ 500,000
Total Construction Cost				\$ 71,997,000
Amortized Capital Cost				\$ 4,684,000
Annual O&M				
Treatment				
Chemical, Electrical, Equipment	5.0	MGD	\$ 574,000	\$ 2,870,000
Personnel	1	FTE	\$ 108,000	\$ 108,000
Mallard Slough Pump Station	5600	acft	\$ 130	\$ 728,000
Wheeling (Pipelines)	5600	acft	\$ 360	\$ 2,016,000
Annual O&M Cost				\$ 5,722,000
30-Year Present Value O&M				\$ 87,961,000
Total 30-Year Present Value Cost				\$ 159,958,000
Total Annual Cost				\$ 10,406,000
Cost per Acre-Ft	5600	acft/yr		\$ 1,860

Capital and O&M Cost Summary

Contingency 25%
 Engineering, Administration, Permitting (EAP) 30%
 All Costs in 2015 \$ (July 2015 - SF CCI = 11155)

Interest Rate 5%
 Inflation Rate 0%
 Amortization Period 30 years

Desal-1D: Desalination - Regional (Transfer) without Reliability Intertie - 10 MGD	Value	Unit	Unit Cost	Total Cost
Regional Desalination Plant	5.0	MGD	\$ 8,278,000	\$ 41,390,000
Rate Control Station	1	LS	\$ 250,000	\$ 250,000
Total Capital Cost				\$ 41,640,000
Contingency (25%)	25	%		\$ 10,410,000
Subtotal				\$ 52,050,000
EAP (30%)	30	%		\$ 15,615,000
CEQA	5	%	capital cost	\$ 2,082,000
Land Acquisition	1	LS	\$ 1,750,000	\$ 1,750,000
Concentrate Discharge Permit and Connection	1	LS	\$ 500,000	\$ 500,000
Total Construction Cost				\$ 71,997,000
Amortized Capital Cost				\$ 4,684,000
Annual O&M				
Treatment				
Chemical, Electical, Equipment	5.0	MGD	\$ 574,000	\$ 2,870,000
Personnel	1	FTE	\$ 108,000	\$ 108,000
Mallard Slough Pump Station	5600	acft	\$ 130	\$ 728,000
Annual O&M Cost				\$ 3,706,000
30-Year Present Value O&M				\$ 56,970,000
Total 30-Year Present Value Cost				\$ 128,967,000
Total Annual Cost				\$ 8,390,000
Cost per Acre-Ft	5600	acft/yr		\$ 1,500



Appendix B: LAVWMA Analysis

DSRSD Effluent, Brine, and Blended LAVWMA Flow Characteristics

2013-2014 Data from BACWA info sheet:

Constituent	Annual Average		ADW		MM-dry	
	lb/day	lb/year	PF	PF	PF	PF
Flow	10.4	MGD	0.99	1.05	1.15	1.15
BOD	329	120,085	0.79	1.2	1.94	1.94
TSS	540	197,100	0.75	1.39	1.77	1.77
Total Ammonia	2,525	921,625	0.86	1.08	1.34	1.34
TKN	2,960	1,080,400	0.89	0.89	1.11	1.11
Total Phosphorous	116	42,340	0.34	0.34	1.66	1.66
Alkalinity	31,915	11,648,975	1.08	1.32	1.22	1.22

Assumptions:

80% recovery
90% constituent removal

Flows:

Feed flow 5.9 MGD

Permeate flow 4.7 MGD

Concentrate flow 1.2 MGD

LAVWMA Blended Flow

AA

MM-Wet 5.7 MGD

MD-Wet 7.3 MGD

11.9 MGD

59%

Design permeate flow = 8 MGD (if permit limits can be met)

Mass Balance Calcs:

Constituent	Loading (lb/day)		Permit lb/year	AA =		10.4		MGD		MM-Wet		12		MGD		MD-wet:		16.6		MGD		Max Day		Avg Day		Avg Month		Max Day	
	lb/day	lb/year		Feed	Permeate	Conc	Blended	Feed	Permeate	Conc	Blended	Feed	Permeate	Conc	Blended	Feed	Permeate	Conc	Blended	Max Day	Blended	Permit	Permit	Permit	Permit	Permit	Permit		
BOD	296	108,077		3.8	0.5	17	11			6.4	17	10.3	17	29	0.8	29	10.3	1.3	46	23	40	23	40	25					
TSS	486	177,390		6.2	0.8	28	19			9.5	26	6.2	26	43	1.2	43	6.2	0.8	28	14	45	14	45	30					
Total Ammonia	2,273	829,463	13,379,636	29.0	3.6	131	87			34.0	4.3	29.0	93	153	4.3	153	29.0	3.6	131	65				93			130		
TKN	2,664	972,360		34.0	4.3	153	102			33.0	4.1	34.0	90	149	4.1	149	34.0	4.3	153	76									
Total Phosphorous	104	38,106		1.3	0.2	6	4			1.9	0.2	1.3	5	9	0.2	9	1.3	0.2	6	3									
Alkalinity	28,724	10,484,078		367.0	45.9	1652	1096			389.0	48.6	367.0	1058	1751	48.6	1751	367.0	45.9	1652	824									

Livermore Effluent, Brine, and Blended LAVWMA Flow Characteristics

2013-2014 Data from BACWA info sheet:

Constituent	Annual Average		ADW		MM-dry	
	lb/day	lb/year	PF	PF	PF	PF
Flow	4.8	MGD	0.86	0.97	1.26	
BOD	175	63,875	0.76	1.02	1.81	
TSS	431	157,315	0.64	0.88	2.07	
Total Ammonia	1,745	636,925	0.84	0.98	1.28	
TKN	1,952	712,480	0.93	0.93	1.07	
Total Phosphorous	50	18,250	0.61	0.61	1.39	
Alkalinity	12,109	4,419,785	0.9	1.15	1.46	
Temp	23	8,249	1.17	1.22	1.11	

Assumption:
80% recovery
90% constituent removal

TSS Limited Production

Flows:
Feed flow 1.2 MGD
Permeate flow 1.0 MGD
Concentrate 0.2 MGD
Design permeate flow = 4.8 MGD (if permit limits can be met) 0.20
LAVWMA Blended Flow
AA 3.8 MGD
MM-Wet 5.1 MGD
MD-Wet 7.4 MGD

Mass Balance Calcs:

Constituent	Loading (lb/day)		Permit lb/year	AA = 4.8		MGD		MMA-Wet=		6.1		MD-wet =		8.4		Avg Day		Avg Month Max Day	
	lb/day	lb/year		Feed	Permeate	Conc	Blended	Feed	Permeate	Conc	Blended	Feed	Permeate	Conc	Blended	Permit	Permit	Permit	Permit
BOD	158	57,488		4.3	0.5	19	8	6.2	0.8	28	10	7.1	0.9	32	11	40	25		
TSS	388	141,584		10.7	1.3	48	20	18.0	2.3	81	30	20.0	2.5	90	30	45	30		
Total Ammonia	1,571	573,233	13,379,636	43.0	5.4	194	81	44.0	5.5	198	74	45.0	5.6	203	68		93	130	
TKN	1,757	641,232		49.0	6.1	221	92	41.0	5.1	185	69	30.0	3.8	135	45				
Total Phosphorous	45	16,425		1.2	0.2	5	2	1.3	0.2	6	2	1.0	0.1	4	1				
Alkalinity	10,898	3,977,807		300.0	37.5	1350	563	349.0	43.6	1571	589	261.0	32.6	1175	392				

Ammonia Limited Production

Flows:
Feed flow 2.0 MGD
Permeate flow 1.6 MGD
Concentrate 0.4 MGD
Design permeate flow = 4.8 MGD (if permit limits can be met) 0.325
LAVWMA Blended Flow
AA 3.8 MGD
MM-Wet 5.1 MGD
MD-Wet 7.4 MGD

Mass Balance Calcs:

	Loading (lb/day)		Permit	AA = 4.8		MGD		MM-Wet=		6.1		MGD		MD-wet =		8.4		MGD		Avg Day		Avg Month Max Day	
Constituent	lb/day	lb/year		Feed	Permeate	Conc	Blended	Feed	Permeate	Conc	Blended	Feed	Permeate	Conc	Blended	Feed	Permeate	Conc	Blended	Permit	Permit	Permit	Permit
BOD	158	57,488		4.3	0.5	19	10	6.2	0.8	28	13	7.1	0.9	32	13	7.1	0.9	32	13	40	25		
TSS	388	141,584		10.7	1.3	48	26	18.0	2.3	81	38	20.0	2.5	90	36	20.0	2.5	90	36	45	30		
Total Ammonia	1,571	573,233	13,379,636	43.0	5.4	194	104	44.0	5.5	198	93	45.0	5.6	203	82	45.0	5.6	203	82		93	130	
TKN	1,757	641,232		49.0	6.1	221	119	41.0	5.1	185	87	30.0	3.8	135	54	30.0	3.8	135	54				
Total Phosphorous	45	16,425		1.2	0.2	5	3	1.3	0.2	6	3	1.0	0.1	4	2	1.0	0.1	4	2				
Alkalinity	10,898	3,977,807		300.0	37.5	1350	727	349.0	43.6	1571	739	261.0	32.6	1175	473	261.0	32.6	1175	473				

Appendix B

Proposed Cost Estimates for Key Future Facilities

Chain of Lakes Pipeline

Project Description:

This project will construct a 36-inch diameter pipeline from Cope Lake to Del Valle Water Treatment Plant (~6 miles) and a 12-MGD pump station . This project would allow Zone 7 to perfect its local water right on Arroyo Valle, or treat and deliver stored water in the Chain of Lakes during rare events (e.g. long droughts or loss of the Delta).

Item	Quantity	Units	Unit Cost ^(a)	Units	Total Cost ^(b,c)
36-inch Diameter Pipeline ^(c)	30,000	feet	\$24.78	\$/lf/in	26,800,000
12 MGD Pump Station ^(d)	1,300	HP	\$4,001.90	\$/HP	5,200,000
Total Cost					32,000,000

^(a) All unit costs include contingencies.

^(b) All costs, except the grand total, were rounded to the nearest \$100,000.

^(c) All costs were adjusted to reflect the ENR San Francisco Construction Cost Index for March 2015, or 11169.32.

^(d) Pipeline & pump station size and lengths estimated by Facilities Engineering.

Reliability Intertie with EBMUD

Project Description:

Zone 7 plans to investigate the feasibility of constructing a new pipeline that connects to another major water agency. The cost estimates are based on connect to EBMUD.

Item	Quantity	Units	Unit Cost	Units	Total Cost ^(a,b)
24-inch Diameter Pipeline ^(c)	36,250	feet	\$15.2	\$/lf/in	13,200,000
30-inch Diameter Pipeline ^(d)	750	feet	\$15.2	\$/lf/in	300,000
Rate Control Station ^(e)					1,000,000
Capital Costs					14,500,000
Construction Contingency (25%)					3,600,000
Subtotal					18,100,000
Planning & Environmental (10%)					1,800,000
Design & Implementation (10%)					1,800,000
Construction Management (10%)					1,800,000
Grand Total ^(f)					23,500,000

^(a) All costs, except the grand total, were rounded to the nearest \$100,000.

^(b) All costs were adjusted to reflect the ENR San Francisco Construction Cost Index for March 2015, or 11169.32.

^(c) Pipeline sized based on Table 7 in the Draft 2003 Zone 7/EBMUD Conjointive Use Project-Preliminary Evaluation. Length obtained from GIS. The unit cost of the pipeline is based on recent projects completed by both EBMUD and Zone 7.

^(d) Rate control station cost is based on recent projects completed by EBMUD.

^(e) Grand total rounded to the nearest \$1,000,000.

Well Master Plan Wells

Project Description:

Construction Chain of Lakes 3 and 4, Busch Valley, and Bernal Wellfields per analysis completed in the Well Master Plan.

Item	Estimated Cost ^(a,b,c)
Test/MW drilling	\$300,000
Well Drilling	\$4,700,000
Pipeline Construction	\$6,400,000
Facilities & Sitework Construction	\$26,400,000
Property	\$3,400,000
Planning/Design/CM/Implementation Cost	\$12,400,000
Total	\$53,600,000

^(a) Estimates provided by Facilities Engineering

^(b) Includes COL 3/4, Busch Valley, and Bernal Wellfields

^(c) ENR SF CCI 11162.57 (May 2015)