STRATEGIC WATER RESOURCES PLAN

June 2023

0012222.00

Palmdale Water District

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EXECUTIVE SUMMARY

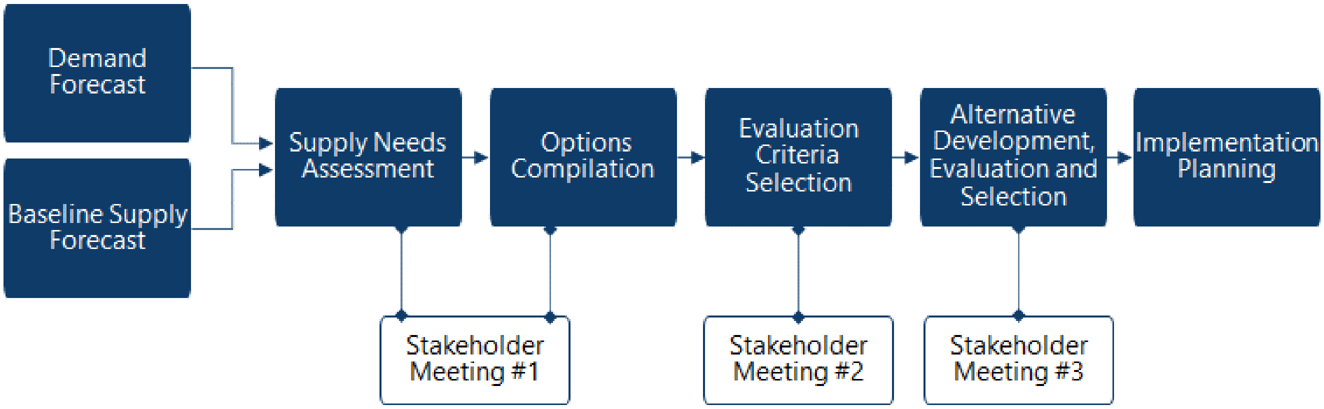
Palmdale Water District (PWD or the District), located in the Antelope Valley in Los Angeles County, provides water to the City of Palmdale and adjacent unincorporated areas of Los Angeles County. PWD has served water to the area in three different centuries, having started as the Palmdale Water Company in the late 1800s and later as the Palmdale Irritation District in the early 1900s to serve irrigation water to agricultural lands. The area has grown and developed significantly since that time, and today the District serves only municipal and industrial water. It continues serving and evolving in the 2000s to meet the needs of its customers.

PWD currently serves over 126,000 customers using a combination of groundwater from the Antelope Valley Groundwater Basin, surface water from Littlerock Reservoir, imported water from the State Water Project (SWP), and recycled water from the Palmdale Water Reclamation Facility.

PWD has developed this Strategic Water Resources Plan (SWRP) to provide a long-term water supply strategy that meets the needs of a growing population under changing future conditions and determines the appropriate funding sources.

The planning timeline for this study focused on three fundamental timeframes: today, near-term (2025 to 2035), and long term (2035 to 2050), and used the process depicted below. Throughout the process, PWD staff were engaged to gather technical information and feedback. In addition, stakeholder meetings were conducted with PWD staff and Board members at key points in the process to present information and decision points to be agreed upon.

Figure ES-1: SWRP Process and Stakeholder Engagement Points



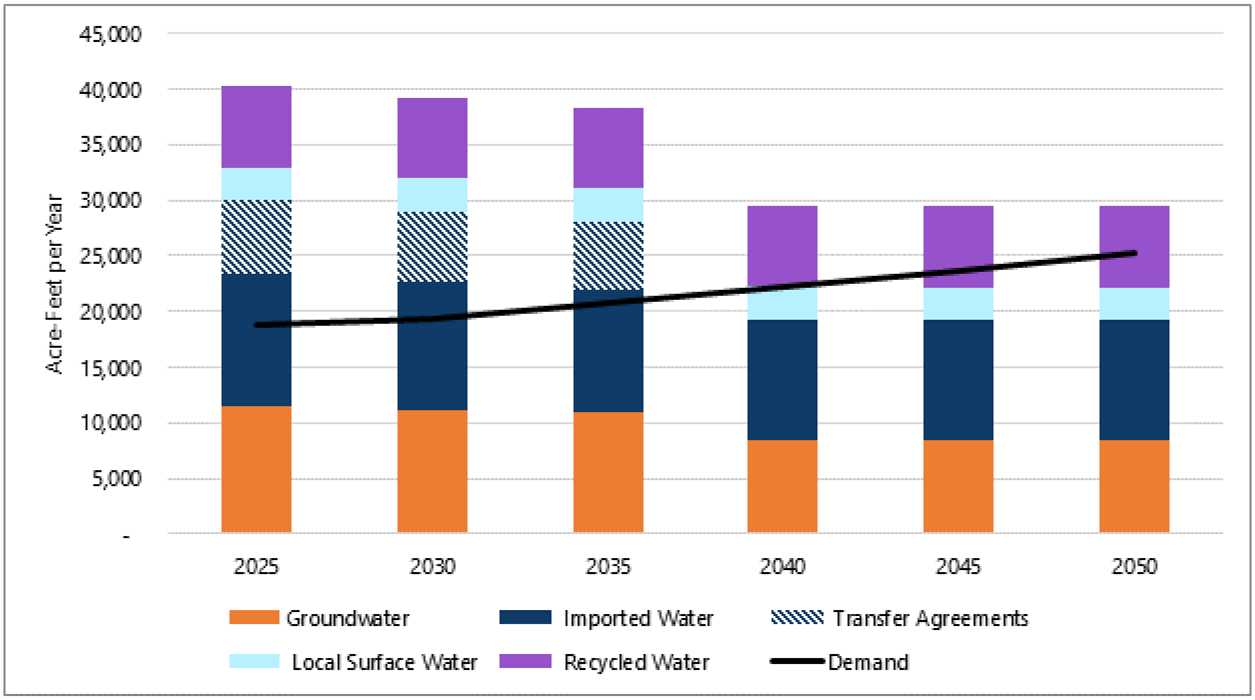
Supply Need

Demand in the PWD service area is projected to increase by 18,700 AFY to 25,200 AFY (an increase of 6,500 AFY) by 2050, as shown in **Figure ES-2**. Demand growth is expected to be driven by a combination of new residential development and densification of existing residential developments.

As mentioned above, PWD relies on a combination of groundwater, local surface water, imported water, transfer agreements and recycled water to meet demand. Through 2035, available potable and non-potable supplies are anticipated to average at least 38,000 AFY. These will be reduced to about 30,000 AFY in the period after 2035 through 2050, partly due to the expiration of transfer agreements with Butte County and

Littlerock Creek Irrigation District in 2035. In addition, while there is approximately 7,300 AFY of recycled water available for use, PWD currently only has non-potable demands for 100 AFY of recycled water. Projected average annual baseline water supplies available within PWD's service area are shown in **Figure ES-2.**

Figure ES-2: Projected Baseline Water Supplies Available within PWD Service Area (Facility Unconstrained) versus Demand Forecast



Due to a combination of growing demand, facility limitations that restrict the ability to access all of the supplies shown in **Figure ES-2**, and reduced supply reliability due to climate change, shortages are expected to occur every year starting in 2030. The projected water supply shortage frequency and depth of unmet demand through 2050 is summarized in **Table ES-1**.

Table ES-1: Projected Water Supply Shortage Frequency and Depth of Unmet Demand

	2025	2030	2035	2040	2045	2050
Shortage Probability	56%	100%	100%	100%	100%	100%
Average Annual Shortage (AF)	380	540	1,030	2,080	3,490	5,360
Average Annual Shortage (% of demand)	2%	3%	5%	9%	15%	21%
Maximum Annual Shortage (AF)	4,280	4,620	5,730	8,490	14,360	17,370
Maximum Annual Shortage (% of demand)	23%	24%	28%	38%	60%	67%

There are several water resources options available to address these projected water supply shortages, including imported water, groundwater, recycled water, local surface water, banking, and conservation. PWD evaluated these options with respect to a variety of factors including supply reliability under droughts and emergency outages, cost efficiency, water quality, sustainability, funding potential, implementability, and institutional independence. Through this evaluation process, PWD has developed the following recommended preferred alternative to meet PWD's future water supply needs.

Preferred Alternative

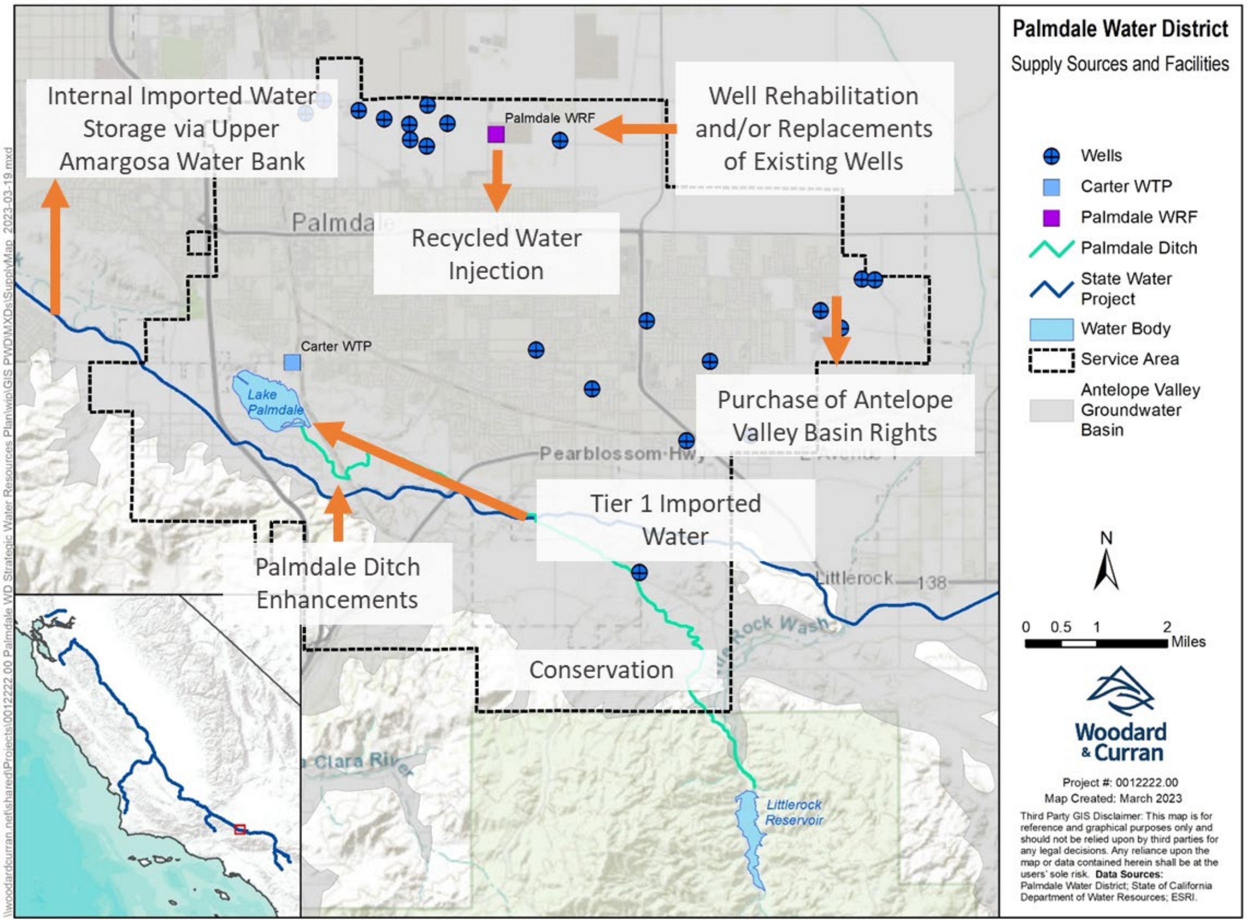
The preferred alternative focuses on maximizing local water supplies while storing water in the Antelope Valley for use during periods of supply shortage. The projects and water supply targets for the preferred alternative are shown in **Table ES-2**. The locations of new facilities included in the preferred alternative are shown in **Figure ES-3.**

Table ES-2: Water Supply Targets for the Preferred Alternative

Water Supply Element	Current	Target for 2050
Supply Volumes (average)		
Imported Water - Potable - Recharge	 6,400 AFY 0 AFY	 9,600 AFY[1] 1,200 AFY[1]
Groundwater Pumping	8,000 AFY	11,200 AFY
Littlerock Reservoir	3,000 AFY	4,500 AFY
Recycled Water - Non-potable - Recharge via injection	 100 AFY 0 AFY	 100 AFY 5,000 AFY
Facility Capacities		
Leslie O. Carter WTP (Carter WTP)	35 mgd	35 mgd
Pure Water Treatment	0 mgd	5 mgd
Injection Wells	0 mgd	4.5 mgd
Production Wells	9.8 mgd	32 mgd
Water Storage in Antelope Valley Basin	0 AF	32,500 AF

1. Actual volume of imported water used will vary significantly depending on Table A allocations. In years of lower imported water availability, it's assumed that pumping will be increased to meet demands.

Figure ES-3: Preferred Alternative Facility Locations



To help guide PWD in achieving these targets, the strategic objectives shown in **Table ES-3** have been established.

Table ES-3: Recommended Strategic Objectives for PWD

Water Supply Element	Strategic Objectives
Imported Water	• Support projects and initiatives that increase the resilience of State Water Project Supplies • Increase storage of SWP supplies in the Antelope Valley Basin • Maximize use of existing imported water supplies
Groundwater	• Be able to pump stored water to meet demands during imported water shortages • Establish and operate recharge facilities to offset proposed pumping increases • Leverage excess stored water to generate capital for PWD projects • Increase PWD's groundwater production rights
Littlerock Reservoir	• Continue Littlerock Reservoir sediment removal activities • Improve Palmdale Ditch to reduce water loss
Recycled Water	• Maximize the use of recycled water within PWD's service area to limit the need for more imported water • Obtain funding and partnerships to offset the cost of Pure Water AV
Conservation	• Continue to expand conservation efforts on a regular basis (e.g. every 3-5 years), attracting outside funding to help expand programs • Maintain and update policies as needed to reduce water waste and preserve PWD's ability to achieve sufficient conservation savings in the event of a water shortage emergency • Achieve conservation objectives set by the State as part of Assembly Bill (AB) 1668 and Senate Bill (SB) 606

Recommended Implementation Plan

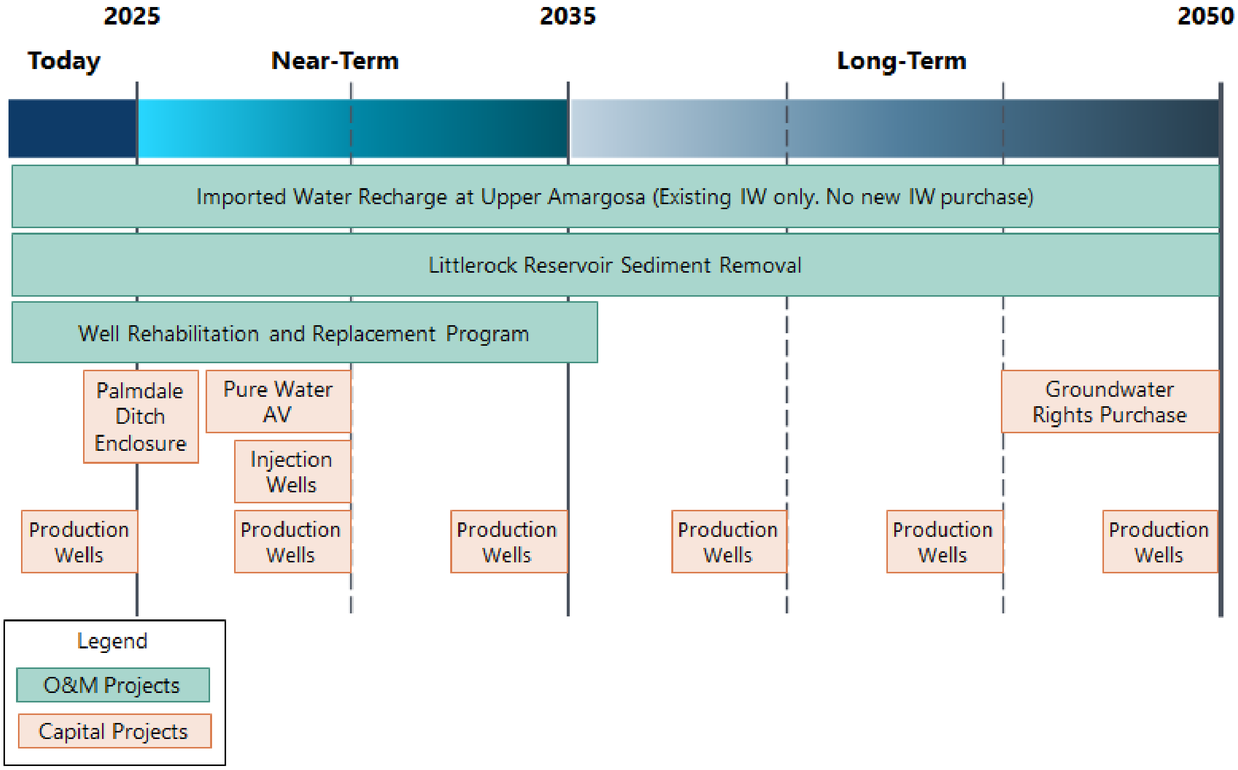
Implementation actions for the preferred alternative have been identified as follows:

- Maximize current Table A water usage
- Maximize beneficial use of recycled water through implementation of Pure Water Antelope Valley (AV)
- Store imported water in the Antelope Valley Basin via the Upper Amargosa Creek Project
- Store recycled water in the Antelope Valley Basin via injection
- Maintain storage capacity in Littlerock Reservoir through sediment removal
- Improve Palmdale Ditch to reduce water loss

- Add additional pumping capacity to access stored water during times of shortage
- Continue active conservation programs

The proposed implementation schedule for these actions are summarized in Figure ES-4 below. High-priority activities are scheduled for implementation in the near-term (2025 to 2035) to maximize existing supplies and meet long-term demands.

Figure ES-4: Implementation Schedule



Costs and Financing

Projected costs for implementing the preferred alternative according to the above schedule are shown in **Table ES-4**. Capital costs reflect the latest planning-level costs available for each project in 2022 dollars. O&M costs reflect the estimated annual O&M for each project in 2022 dollars. Total costs reflect the total capital and O&M cost for the overall planning period which extends from 2025 to 2050. It should be noted that capital costs do not reflect awarded or potential grant or loan funding, though as of the writing of this SWRP, PWD has received grant awards sufficient to fully fund implementation of the Palmdale Ditch Enclosure project.

Table ES-4: Preferred Alternative Projected Costs for the Planning Period (2025 to 2050)

Project	Capital[1] (2022 dollars)	O&M[2] (2022 dollars)
Maintenance of Existing Supply Reliability and Facilities		
Imported Water Recharge at Upper Amargosa Creek	$14 million	$466,000/year
Littlerock Reservoir Sediment Removal	$0	$1,900,000 every other year
Well R/R Program	$49 million (total for well replacement)	$1.34 million (total for well repair and rehabilitation)
Palmdale Ditch Enclosure	$18.1 million	$4,400/year
New Supply Projects		
Pure Water AV (including advanced treatment plant, injection wells and production wells)	$152.6 million	$6,120,000/year
Groundwater Rights Purchase (includes rights, new wells and conveyance to the PWD system)	$29.5 million	$410,000/year
Total Net Present Value[3]	**$169.8 million**	**$36.7 million/year**

1. Capital costs do not include grant funding that has already been awarded.
2. O&M costs are escalated to account for changes in the cost of power, materials and chemicals at the following rates: imported water conveyance is escalated at an average of 2%, Carter WTP treatment escalated at 3.3%, groundwater pumping escalated at 4.1%, other O&M costs escalated at 2.6%. Sources: PWD 2019 rate study and DWR Bulletin 132-22 Appendix B.
3. Assumes a 3% rate over the 25-year implementation. Does not consider funding and financing costs.

To fund the above SWRP activities, the proposed financing principles are:

- New customers establishing new connections must pay for new supplies and the infrastructure to deliver those supplies.
- Current and future customers must pay for reliability of current supply up to budgeted allotments for indoor and outdoor usage. This would include the costs to maintain Littlerock Reservoir, rehabilitate and replace existing wells, PWD's share of improvements to the Delta, and improvements needed to meet water quality standards.
- Those customers choosing to use more than their allotment will be responsible to fund higher cost water reliability projects including conservation and recycling.

- Current and future customers are to pay for all O&M costs
- Property owners pay fixed costs for the State Water Project
- Other system enhancements need to be able to pay for themselves without subsidy from other revenue sources.
- Financing strategy needs to provide for supply reliability assuming no future development or delayed future development.

Based on these principles, the recommended financing strategy includes the following elements:

- Implement a water supply connection fee for new connections of $37,500 per acre-foot and escalated every year by the rate of inflation.
- Use a combination of municipal debt financing, SRF loans, and collected water supply connection fees to fund capital projects identified in the SWRP.
- Continue to maintain current approach to setting water rates to cover O&M expenses associated with the SWRP.
- Further evaluate using property tax assessment(s) to fund potential future fixed costs associated with system improvements such as the well rehabilitation program and imported water reliability improvements, noting that voter approval may be required.
- Track and pursue grant opportunities for conservation, water recycling, and groundwater storage projects.
- Further evaluate partnership opportunities and engage with potential partners for recycling and groundwater storage projects as these projects evolve.

1. INTRODUCTION

1.1 Purpose of the Strategic Water Resources Plan

Palmdale Water District (PWD) is located within the Antelope Valley in Los Angeles County, approximately 60 miles north of the City of Los Angeles and includes the central and southern portions of the City of Palmdale and adjacent unincorporated areas of Los Angeles County. Historically, PWD relies on groundwater from the Antelope Valley Groundwater Basin, surface water from Littlerock Reservoir, and imported water from the State Water Project (SWP) including long-term Table "A" leases from Butte County and Littlerock Creek Irrigation District (LCID). Substantial periods of drought have significantly impacted water resources throughout the State of California, resulting in reduced imported water allocations and increased water use efficiency. Due to water supply uncertainties in the State and continued growth, PWD has updated its Strategic Water Resources Plan (SWRP) to develop a sound water supply strategy to meet the demands of both current and future customers through the year 2050.

The development of the SWRP is consistent with the mission, vision, and core values of PWD.

Mission: *The Mission of PWD is to provide high-quality water to our current and future customers at a reasonable cost.*

Vision Statement: *PWD will strive for excellence in providing great customer care; advocating for local water issues that help our residents; educating the community on water-use efficiency; and leading our region in researching and implementing emerging technologies that increase operational efficiency.*

Core Values: *Core values are essential to the success of PWD and its employees. The values set the tone for the organization and help employees make informed decisions that benefit PWD, staff, and customers.*

- *Integrity: Performing our duties in an ethical, fair, reliable, honest and courageous manner regardless of the situation.*
- *Teamwork: Working with colleagues to accomplish the organization's goals and respecting each other's contributions that best benefit the organization.*
- *Diversity: Embracing and respecting differing ideas, cultures, ethnicities, class and gender.*
- *Passion: Showing evidence of energy, enthusiasm, devotion and motivation while pursuing excellence in one's work, ideas and goals.*

Key questions to which this SWRP provides answers include the following:

1) How much water will PWD need to meet current and future demands?
2) Where will the water come from?
3) What facilities will be needed?
4) What will it cost and where will the money come from?
5) What happens when circumstances change?

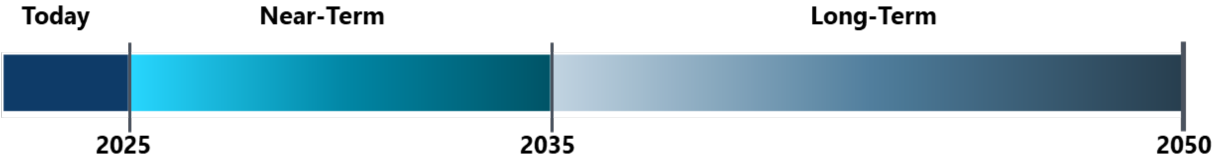
1.2 Overview

The SWRP includes the following six key elements:

- **Demand Forecast:** Compiles PWD's historical water use by sector and provides an analysis of its retail service demands from 2025 to 2050 and includes a demand envelope that considers climate change adjustment factors for outdoor demands and State water use objectives.
- **Supply Forecast:** Assesses PWD's current water supplies to identify gaps between future baseline water supplies and anticipated demands through 2050.
- **Supply Options:** Provides a series of options for improving supply reliability and identifying new supplies that were developed to help meet PWD's projected water demands.
- **Supply Alternatives:** Analyzes different groupings of supply options using a multi-criteria analysis to identify a preferred alternative to meet PWD's future supply needs.
- **Implementation Plan:** Provides a summary of the projects included in the preferred alternative, strategies for implementation, an implementation schedule and estimated capital and operations and maintenance costs.
- **Financing Plan:** Provides an outline for how funding will be provided to make the necessary improvements.

The planning timeline for this study focuses on three fundamental timeframes: today, near-term, and long term as illustrated below in **Figure 1-1**.

Figure 1-1: Strategic Water Resources Plan Timeframe



In developing the SWRP, several activities were undertaken between June 2022 to June 2023, including:

- **Data Compilation and Assessment:** Compiled and reviewed historical water use and demand data to determine an annual baseline.
- **Demand Modeling Analysis:** Developed a water demand model and drafted and finalized scenario recommendations for the demand forecast.
- **Evaluation of Water Supply Options:** Reviewed and assessed PWD's water supplies, including imported surface water, domestic surface water, groundwater, and reclaimed water.
- **Evaluation of Water Quality:** Reviewed water quality and other potential threats to PWD's current water supplies. The analysis was based on available water quality data, and existing maximum contaminant levels and perspective.

- **Options Development:** Identified 15 options that resulted from the options development process. Options are categorized as imported water, local groundwater, recharge/banking, recycled water, or other and described how the water will be conveyed, produced, and/or treated to meet demands.
- **Alternatives Evaluation:** Evaluated 11 supply alternatives using technical, financial, and regulatory considerations. Each alternative was simulated in WEAP using supply and demand scenarios.
- **Strategic Plan Development:** Compiled all analyses and recommendations into a SWRP. The final recommendation and analyses include a list of projects to implement and the fee for future water supplies.
- **Board Workshops:** PWD staff kept the Board of Directors informed of the SWRP progress throughout the development of the SWRP and solicited feedback on the options, alternatives evaluation, and recommendations.
- **Discussions with Involved Stakeholders:** Identified key stakeholders that have insight regarding or be impacted by the SWRP and shared progress and milestones about the SWRP.

Results from these activities are summarized throughout the SWRP.

1.3 Using and Updating the SWRP

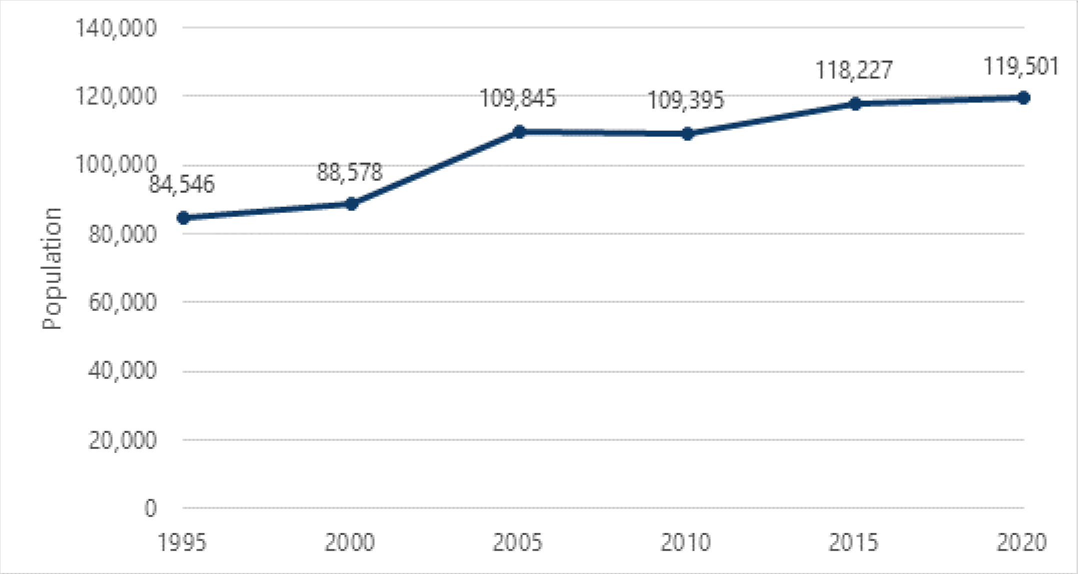
The SWRP is meant to serve as a guide to the PWD Board of Directors and staff as PWD develops and updates a variety of other planning documents including its urban water management plan, water system plan, financial plans, and other planning documents. The scope of this plan is far-reaching and is based upon the best available information at this time. However, it is not meant to be a static document and should be revisited regularly and updated as needed.

2. DEMAND FORECAST

2.1 Historic Trends

PWD currently serves approximately 26,900 connections, the majority of which are residential. The PWD service area has experienced stable population growth over the past 25 years, increasing by approximately 30 percent since 1995 as shown in **Figure 2-1** (PWD, 2021a). This steady growth has been driven by several factors, including affordable housing, employment opportunities, a good education system, and abundant recreational opportunities (City of Palmdale, 2022). Since 2012, housing units have steadily increased due to population growth and demand, the majority of which are single-family household units. Employment trends in the PWD service area have also steadily increased since 2010.

Figure 2-1: Historic Population for PWD's Retail Service Area

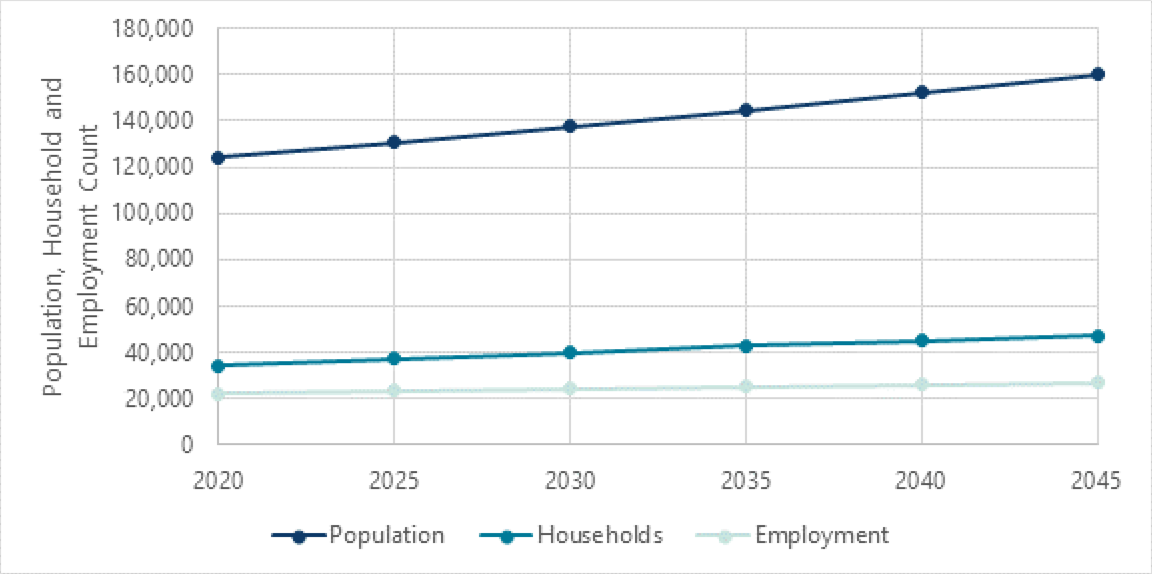


2.2 Service Area Growth

Future growth in the PWD service area was forecasted based on projected future development, population, and employment. The 2020 Connect SoCal forecast (SCAG, 2020) from the Southern California Association of Governments (SCAG) was used to project future growth in the service area.

The SCAG growth forecast for population, households, and employment are based on a combination of area general plans and comments from cities and counties, and are developed for the purpose of addressing transportation and land use challenges (SCAG, 2020). SCAG provides population, housing and employment forecasts at various levels of geographic units, including Transportation Analysis Zones (TAZs), which were developed independently by SCAG and highly resemble the U.S. Census Bureau's Block Groups. These TAZs were used to split forecasts of population, households, and employment within PWD's service area. To split individual TAZs, data were clipped along the service area boundary and allocated according to the percent of the TAZ falling within PWD's service area. **Figure 2-2** shows the SCAG population, household, and employment forecasts for the PWD service area.

Figure 2-2: SCAG Population, Household and Employment Forecasts for PWD's Service Area



2.3 Demand Forecast Methodology

The following steps were used to develop retail demand projections out to 2050:

1. Compile historical water use by sector
2. Determine annual baseline water use
3. Project growth
4. Calculate unit factors
5. Apply demand factors to the relevant growth factor (population or employment)
6. Estimate water loss
7. Compile demand projections
8. Create demand envelope

Each of these are described below.

Step 1 - Compile historical water use by sector

PWD's historic water use by sector was compiled to prepare demand projections, which include potable water demands out to 2050. Water usage is divided into sectors including single family, multi-family, institutional, commercial and industrial, construction, fire service, and other uses. Historical water use data from 2018 to 2021 was compiled for each sector, except for the categories of fire service and other which only had data available in 2018, and institutional which only had data available from 2019 to 2021. Historical billing data was combined for each supply type to create a combined set of historical demand data.

Step 2 - Determine annual baseline water use

The total annual water use in each year from 2018 through 2021 is shown in Table 2-1. The baseline water use for each sector is assumed to equal the four-year average measured from January 2018 to December

2021. The four-year average was selected since data was only available for 2018 to 2021. Note that the below table reflects only potable water demand met by water produced by PWD and does not include non-potable recycled water use. Non-potable recycled water use has ranged from 61 AF to 207 AF from 2018 to 2021.

Table 2-1: Baseline Water Use for Retail Demand (AFY)

Sector	2018	2019	2020	2021	4-Year Average
Single Family	11,355	10,777	11,757	12,099	**11,497**
Multiple Family	1,408	1,500	1,555	1,698	**1,540**
Irrigation	986	909	1,041	1,128	**1,016**
Commercial and Industrial	1,049	1,113	1,798	1,888	**1,462**
Other	43	n/a	n/a	n/a	**43**
Institutional	n/a	892	1,028	1,141	**1,021**
Fire Service	1,904	n/a	n/a	n/a	**1,904**
Construction	24	27	34	30	**29**
Total	**16,769**	**15,218**	**17,213**	**17,984**	**16,796**

Step 3- Project growth

Growth within each of the demand sectors was projected as part of PWD's 2020 Urban Water Management Plan (UWMP) based on acres of land expected to be developed to meet the population projections described in SCAG's 2020 Connect SoCal forecast (PWD, 2021a). **Table 2-2** provides a summary of current and projected acreage by land use type. The analysis completed for the 2020 UWMP only extended to 2045; therefore, it was assumed that the rate of growth from 2040 to 2045 would extend from 2045 to 2050. Since land use development does not line up exactly with demand sectors, commercial and industrial growth was used to estimate growth in the billing categories of commercial and industrial, other, institutional, fire service and construction.

Table 2-2: Projected Land Use Area (acres)

Land Use	2020	2025	2030	2035	2040	2045	2050
Single Family Residential	13,716	14,036	14,362	15,075	15,881	16,730	17,625
Multiple Family Residential	285	292	298	313	330	348	366
Irrigation	134	145	155	179	206	234	266
Commercial and Industrial	2,192	2,313	2,436	2,705	3,009	3,329	3,684

Step 4 - Calculate unit factors

Unit factors were calculated for every sector. Indoor unit factors were calculated by multiplying the baseline use by the percent of indoor use and then dividing by the indoor factor. This number was then multiplied by the conversion of acre-feet to gallons per day and then divided by the total number of days per year. Outdoor unit factors were calculated by multiplying the baseline water use by the percent of outdoor use and then dividing by the outdoor factor. This number was then multiplied by the conversion of acre-feet to gallons per day and then divided by the total number of days per year. The indoor and outdoor unit factors were then combined to calculate the total unit factors per sector, as shown in **Table 2-3**.

Step 5- Apply water use unit factors to growth

The results of Steps 3 and 4 were used to calculate indoor and outdoor demand projections for each sector within PWD's retail service area using the following formulas:

Water Use = Growth (acres) x Unit Factor (gallons per acre)

The projected gallons of water use were converted to acre-feet.

Step 6 - Estimate water loss

Seven years of available validated Water Loss Audit Reports were retrieved from the American Water Works Association to estimate water loss. The seven-year average of water loss as percent of water supplied, shown in **Table 2-4**, was used to project water losses and are assumed to be unchanged in the future.

Table 2-3: Retail Demand Unit Factors

Sector	Calculation	Unit	Water Use and Unit Factors
Single Family	Baseline Water Use	AF	11,497
	Unit Factor	Gallons per Single Family Residential Acre	748
Multiple Family	Baseline Water Use	AF	1,540
	Unit Factor	Gallons per Multiple Family Residential Acre	4,821
Irrigation	Baseline Water Use	AF	1,016
	Unit Factor	Gallons per Irrigated Acre	6,764
Commercial and Industrial	Baseline Water Use	AF	1,462
	Unit Factor	Gallons per Commercial and Industrial Acre	595
Other	Baseline Water Use	AF	11
	Unit Factor	Gallons per Commercial and Industrial Acre	4
Institutional	Baseline Water Use	AF	765
	Unit Factor	Gallons per Commercial and Industrial Acre	312
Fire Service	Baseline Water Use	AF	476
	Unit Factor	Gallons per Commercial and Industrial Acre	194
Construction	Baseline Water Use	AF	28
	Unit Factor	Gallons per Commercial and Industrial Acre	12

Table 2-4: PWD Water Loss Reporting

	2015	2016	2017	2018	2019	2020	2021	7 – Year Average
Total Losses (AF)	1,297	1,559	1,808	1,723	1,351	1,267	1,063	1.438
Water Loss as % of Water Supplied	7.7%	9.0%	10.0%	9.0%	7.7%	6.6%	5.6 %	7.9%

Step 7 - Compile demand projections

The results of Steps 5 and 6 were summed to generate the total demand projection, divided by sector and indoor versus outdoor use. In addition, baseline recycled water demand for non-potable uses was assumed to remain at approximately 100 AFY.

Step 8 - Create demand envelope

A demand envelope was developed to allow for a range of demand estimates for long-term supply planning.

The upper-level demand estimate was created by applying the potential impacts of climate change to the demand projections generated through Step 7. Climate change is expected to increase outdoor water demand due to higher temperatures and higher evapotranspiration rates. DWR has prepared sets of adjustment factors to be used to adjust precipitation and evapotranspiration for use in water supply planning and are downscaled from Global Climate Models to allow for regional planning application (DWR, 2022b). DWR's 2070 Central Tendency Scenario, which is an ensemble of GCMs that reflect the average of 20 climate projections, was used for this analysis. The impact of climate change on outdoor demands was calculated by calculating the average adjustment factors for precipitation and evapotranspiration identified for the PWD service area, then multiplying by the total outdoor water use projections. Overall, the climate change data estimates that there will be an average annual increase in precipitation (a change factor of 1.099 by 2070) and an average annual increase in evapotranspiration (a change factor of 1.170 by 2070). In total, this results in a net change factor for outdoor water demands of 1.071. Since the adjustment factor is projected for 2070, it was assumed that the factor would increase from 1.0 to 1.071 between 2020 and 2070. The adjustment factors applied to estimate climate change impacts are shown in **Table 2-5**.

Table 2-5: Climate Change Adjustment Factors for Outdoor Demands

	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Outdoor Adjustment Factor	1.00	1.007	1.014	1.021	1.029	1.036	1.043	1.050	1.057	1.064	1.071

The lower-level demand estimate was created by applying SB606/AB1668 water use requirements and more pessimistic growth projections than those described in Section 2.2. SB606 and AB1668 require that demand reduction goals be set for water suppliers in California. While guidance is still under development by the

State, draft guidance for residential water use goals were applied to the demand projection. The indoor residential water use goal is expected to be 42 GPCD by 2030, with an interim goal to reduce to 47 GPCD by 2025.

DWR's outdoor residential water use goal is expected to be calculated based on irrigable and irrigated area in residential land use parcels, effective precipitation, reference evapotranspiration, and an assumed outdoor water use standard using the following formula:

> *Efficient Outdoor Water use = (Evapotranspiration – Effective Precipitation) * 0.62 * Outdoor Water Use Standard * (Irrigated Area + (Irrigable Area * Buffer))*

An estimate of PWD's outdoor water use per capita was calculated based on the above formula using an estimate of the irrigable area provided by DWR, and evapotranspiration and precipitation data from CIMIS. The indoor and outdoor water use per capita goal were applied to the residential demand projections to develop the lower-level demand estimate.

2.4 Demand Forecast

The resulting demands from the approaches described in Section 2.3 are provided below for comparison. The mid-level projection (based on the results of Step 7 with no adjustments) and the upper-level projection with the climate change adjustments result in similar growth projections. The lower-level demand projection (which included the SB 606/AB 1668 adjustments) had a lower growth projection since these bills implement residential water use objectives that focus on water conservation, which lowers water demand. **Figure 2-3** and **Table 2-10 through 2-12** provide the retail demand projections using each method for the total retail area.

Figure 2-3: Forecasted PWD Demand (Acre-Feet per Year)

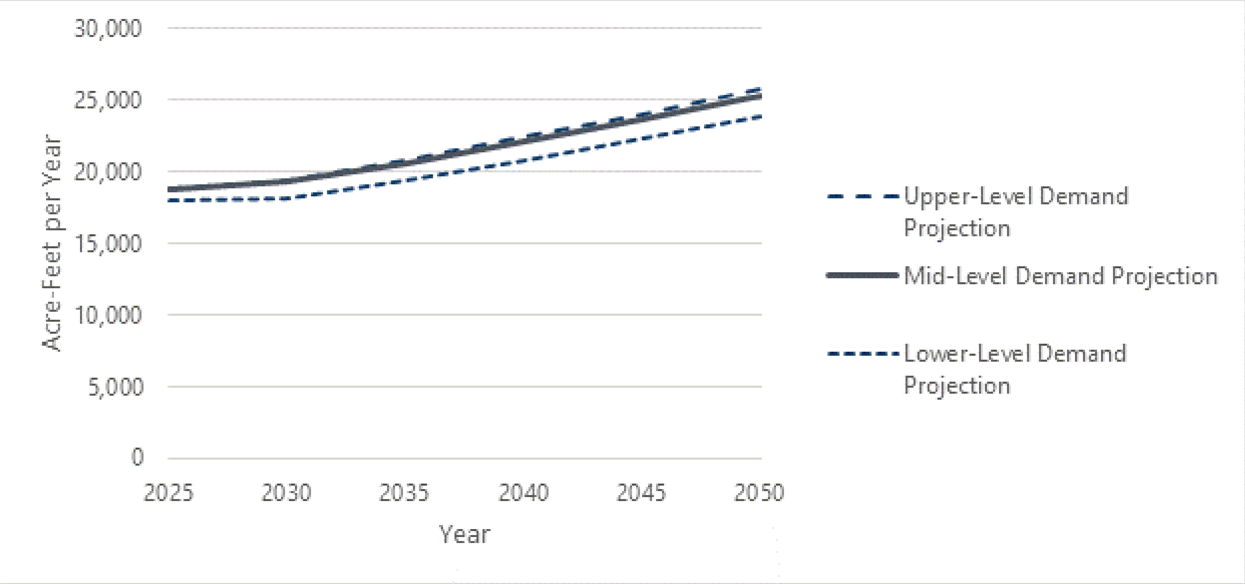


Table 2-6: Detailed Mid-Level Demand Projections (AFY)

Sector	2025	2030	2035	2040	2045	2050
Single Family	11,765	12,039	12,636	13,312	14,024	14,774
Multiple Family	1,576	1,613	1,693	1,783	1,878	1,978
Irrigation	1,096	1,178	1,357	1,559	1,772	2,014
Commercial and Industrial	1,542	1,625	1,804	2,007	2,220	2,457
Other	11	12	13	15	16	18
Institutional	807	851	944	1,051	1,162	1,286
Fire Service	502	529	587	653	723	800
Construction	30	32	35	39	43	48
Water Loss	1,375	1,418	1,513	1,620	1,732	1,854
Non-Potable	100	100	100	100	100	100
Total	**18,805**	**19,396**	**20,683**	**22,138**	**23,671**	**25,329**

Table 2-7: Detailed Lower-Level Demand Projections (AFY)

Sector	2025	2030	2035	2040	2045	2050
Single Family	10,628	10,435	10,950	11,542	12,131	12,718
Multiple Family	1,787	1,857	1,949	2,053	2,160	2,270
Irrigation	1,096	1,178	1,357	1,559	1,772	2,014
Commercial and Industrial	1,542	1,625	1,804	2,007	2,220	2,457
Other	11	12	13	15	16	18
Institutional	807	851	944	1,051	1,162	1,286
Fire Service	502	529	587	653	723	800
Construction	207	218	242	269	298	329
Water Loss	1,476	1,486	1,577	1,681	1,787	1,899
Non-Potable	100	100	100	100	100	100
Total	**18,158**	**18,290**	**19,532**	**20,929**	**22,370**	**23,893**

Table 2-8: Detailed Upper-Level Demand Projections (AFY)

Sector	2025	2030	2035	2040	2045	2050
Single Family	11,807	12,125	12,772	13,503	14,275	15,091
Multiple Family	1,581	1,624	1,710	1,807	1,910	2,081
Irrigation	1,104	1,195	1,386	1,603	1,835	2,100
Commercial and Industrial	1,548	1,636	1,823	2,034	2,259	2,508
Other	11	12	13	15	17	19
Institutional	811	857	955	1,067	1,185	1,317
Fire Service	504	534	595	665	739	822
Construction	30	32	36	40	44	49
Water Loss	1,380	1,429	1,530	1,645	1,766	1,898
Non-Potable	100	100	100	100	100	100
Total	**18,877**	**19,544**	**20,921**	**22,479**	**24,130**	**25,922**

3. BASELINE SUPPLY FORECAST

One of the key components of this SWRP is evaluating the ability of future baseline supplies to meet current and future water demands. A water supply assessment was completed to identify gaps between future baseline water supplies and anticipated demands through 2050, as well as to articulate the need for developing the SWRP options and solutions described in Chapter 4. This chapter provides an overview of the existing water supply sources available to PWD.

3.1 Supply Overview

PWD currently receives potable water from three main sources: imported water from the State Water Project (SWP), groundwater from the Antelope Valley Groundwater Basin (Basin), and surface water from Littlerock Dam Reservoir, shown in **Figure 3-1**. PWD has also developed recycled water supplies to diversify its water supply and offset potable water demand. A brief description of the water supply types available to PWD is provided in the following sections. For this SWRP, baseline water supply refers to the existing water supplies given available production, distribution, and storage infrastructure, assuming no future water supply projects or agreements are implemented.

3.1.1 Imported Water

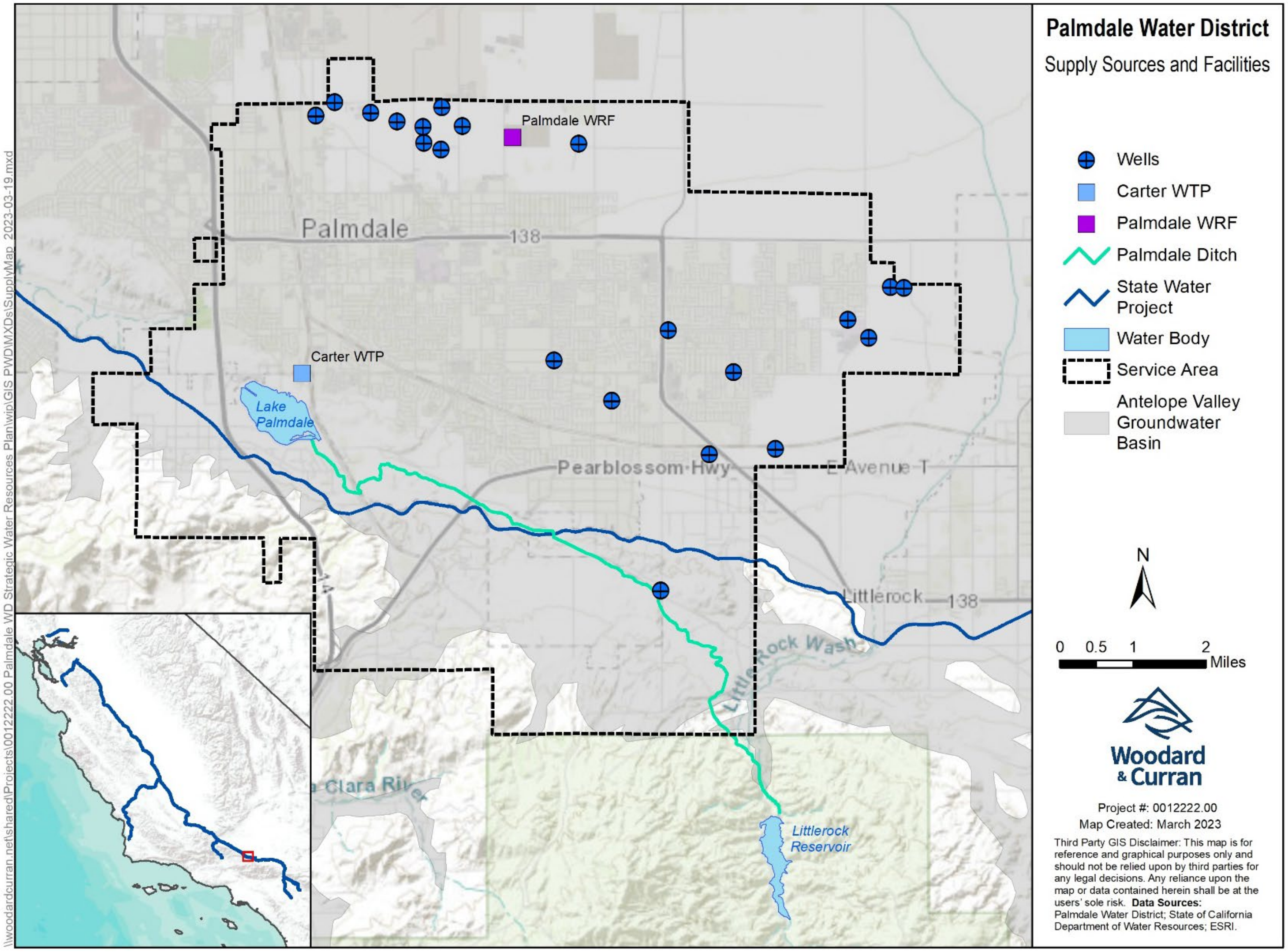
PWD is one of 29 water agencies (commonly referred to as “contractors”) that have a SWP Water Supply Contract with the California Department of Water Resources (DWR). Imported water is conveyed from the Sacramento-San Joaquin Delta through the East Branch of the California Aqueduct into Lake Palmdale, which acts as a forebay for the PWD’s Leslie O. Carter Water Treatment Plant (WTP). These features are shown in **Figure 3-1**.

Each SWP contractor’s Water Supply Contract contains a “Table A,” which lists the maximum amount of water supply an agency may request each year throughout the life of the contract. Currently, PWD’s Table A amount is 21,300 acre-feet per year (AFY). SWP Table A allocations differ each year based primarily on hydrology, current storage, and releases to be made throughout the year to meet SWP contractual and regulatory obligations. Between 2011 and 2021, Table A allocations ranged from 5 percent to 85 percent, averaging 30 percent which reflects the two drought periods during this time frame. Actual deliveries are dependent on PWD demand. Historical Table A allocations and deliveries to PWD for the years 2011 to 2021 are shown in **Table 3-1**.

Table 3-1: Historical Table A Supplies

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Avg
Table A Allocation (%)	*80%*	*65%*	*35%*	*5%*	*20%*	*60%*	*85%*	*35%*	*70%*	*20%*	*5%*	*30%*
Table A Water Delivered to PWD (AFY)	12,294	9,959	4,559	1,005	2,420	7,805	7,751	7,137	14,294	1,905	1,065	6,381

Figure 3-1: Water Supply Sources and Facilities



Project #: 0012222.00
Map Created: March 2023

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk. **Data Sources:** Palmdale Water District; State of California Department of Water Resources; ESRI.

In addition to the Table A amount, the water supply contract describes several types of SWP water that are available to PWD to supplement Table A water, including carryover water, "Article 21" water, and turnback pool water, which are described briefly below.

- **Carryover** water is Table A water that is allocated to a contractor and approved for delivery but is not used by the end of the SWP contract year. If space is available, contractors may store a maximum of 5,000 AF of Table A allocation in SWP's share of the San Luis Reservoir for delivery the following year. PWD has carried over an average of 2,442 AFY between 2011 and 2021.
- **Article 21** water is water that PWD may receive on a short-term basis in addition to its approved Table A water. Article 21 water is offered periodically, usually in wet hydrologic years, when water supply available in the Sacramento-San Joaquin Delta exceeds SWP contractors' total entitlements. The estimated range of Article 21 water availability for PWD is a relatively small amount. PWD has received a total of 335 AFY of Article 21 water since 2011.
- **Turnback pools** are a mechanism by which contractors with excess Table A allocations in a given hydrologic year may sell that surplus water to other contractors. Since 2011, PWD has only purchased a total of about 26 AF from turnback pools to supplement its water supplies.

Regardless of hydrologic conditions, Table A allocation water is given priority for delivery over other types of SWP water.

DWR's 2021 Delivery Capability Report (DCR) estimates the near and long-term availability of SWP water supplies based on a computer model that simulates monthly operations of the SWP system. The 2021 DCR includes DWR's estimates of SWP water supply availability under both current and future conditions. Key inputs to the model include the facilities in the system, hydrologic inflows to the system, regulatory and operational constraints on system operations, and contractor demands for SWP water.

DWR's model also accounts for anticipated climate change impacts on imported water availability. Climate change adds a layer of uncertainty in estimating the future availability of SWP source water as it may change existing precipitation patterns in California. While different climate change models show differing effects, potential changes could include higher temperatures and more precipitation falling in the form of rain rather than snow and earlier snowmelt, which would result in more runoff occurring in the winter rather than spread out over the winter and spring. In the 2021 DCR, DWR estimates that the SWP can deliver an average Table A supply of 56 percent of the total maximum Table A amounts by 2025 and 51 percent by 2050.

Projected imported water supplies from the SWP are shown in **Table 3-2** and include Table A water, and reflect the 2021 DCP estimates for near and long-term availability of SWP water deliveries. It is assumed that potential carryover, Article 21 water and turnback pool water are rolled into the Table A projections.

Table 3-2: Projected Imported SWP Water Supplies (AFY)

	2025	2030	2035	2040	2045	2050
Table A Allocation Forecast (%)	*56%*	*54%*	*52%*	*51%*	*51%*	*51%*
Table A Water	11,900	11,500	11,100	10,900	10,900	10,900

3.1.1.1 Transfer Agreements

In addition to its own Table A imported water from the SWP, PWD has long-term arrangements with other SWP contractors who hold Table A amounts exceeding their current demands. Currently, PWD has existing agreements with Butte County and Littlerock Creek Irrigation District (LCID) to access a portion of their Table A amounts for a predetermined time. Like Table A water, these transfers are subject to the SWP annual allocation and SWP delivery and reliability constraints.

Butte County Transfer Agreement

PWD currently has a long-term lease agreement with Butte County for 10,000 AFY of their SWP Table A amount. The amount available through this lease, anticipated to end in 2035, varies primarily on the annual Table A allocation from DWR such that PWD only has access to the water if the Table A allocation exceeds 20 percent. Assuming the 2021 DCR Table A estimates for near and long-term availability of SWP water, Butte Transfer supplies are projected to range from 5,600 AFY in 2025 to 5,200 AFY in 2035. Projected Butte Transfer supplies are shown in **Table 3-3**.

LCID Transfer Agreement

In 2022, PWD entered into a mutually beneficial water transfer agreement with LCID to receive between 75 percent and 100 percent of LCID's SWP annual Table A water, up to a maximum of 2,300 AFY, through 2035. LCID has an annual option to retain up to 25 percent of its Table A water. For planning purposes, this SWRP conservatively assumes 75 percent of LCID's Table A allocation will be transferred to PWD through 2035. Assuming the 2021 DCR Table A estimates for SWP water availability, it is anticipated that LCID transfer supplies will vary from 1,000 AFY in 2025 to 900 AFY in 2035. Projected imported water transfers from LCID are shown in **Table 3-3**.

Table 3-3: Projected Imported Water Transfers (AFY)

	2025	2030	2035	2040	2045	2050
Butte Transfer	5,600	5,400	5,200	0	0	0
LCID Transfer	1,000	900	900	0	0	0

3.1.1.2 Imported Water Facilities

SWP water is conveyed directly from the East Branch of the California Aqueduct into Lake Palmdale, which feeds the Leslie O. Carter WTP. PWD's allowable capacity in the East Branch is 31 cubic feet per second (cfs) from Reach 1 to Reach 11B and 30 cfs from Reach 12D to Reach 20B (where 20B is the reach that delivers water into Lake Palmdale). Diversion capacity into Lake Palmdale is 30 cfs. Lake Palmdale can store approximately 4,129 acre-feet (AF) of SWP and surface water from Littlerock Dam Reservoir water (see

Section 3.1.3). The Leslie O. Carter WTP, which has a treatment capacity of 35 million gallons per day (mgd), treats water conveyed from Lake Palmdale before distributing to customers. The Leslie O. Carter WTP is nonoperational for approximately 6 weeks each year for maintenance and repairs.

3.1.2 Groundwater

PWD operates 22 groundwater wells in the Antelope Valley Groundwater Basin (DWR Basin No. 6-44, Bulletin 118), as shown in **Figure 3-1**. Groundwater has accounted for an average of 48 percent of PWD's supplies since 2011, though it should be noted that this time period includes two droughts: the first from 2013 to 2016, and the second starting in 2020, resulting in higher-than-normal groundwater production to offset lower imported water availability. Historical groundwater supplies for the years 2011 through 2021 are shown in **Table 3-4**.

Table 3-4: Historical Groundwater Supplies (AFY)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Avg
Groundwater Production	7,025	7,543	9,378	12,398	11,227	8,474	4,355	6,058	4,425	7,599	9,844	8,030

The Basin was adjudicated in December 2015 after over 15 years of complex proceedings among more than 4,000 parties, including public water suppliers, landowners, small pumpers and non-pumping property owners, and the federal and state governments. The following sections summarize the adjudication process and resulting Antelope Valley Groundwater Basin Adjudication Judgment (Judgment).

3.1.2.1 Antelope Valley Groundwater Adjudication

PWD is one of the entities involved in the adjudication of groundwater rights for the Basin that began in 2004 to prevent further damage from declining groundwater levels. The adjudication, completed in 2015, determined the Basin was in a state of overdraft and defined the Basin boundaries, considered hydraulic connection throughout the basin, established a safe yield, and quantified groundwater production. The Judgment established respective water rights (i.e., Production Rights) among groundwater producers based on the Basin's safe yield and ordered a ramp-down of production to meet the safe yield by 2023. In accordance with the adjudication, the Antelope Valley Watermaster was formed to implement the Judgment. The Watermaster is charged with administering the adjudicated water rights and managing the groundwater resources within the adjudicated portion of the Antelope Valley to stabilize groundwater levels and prevent further damage that can result from declining groundwater levels.

3.1.2.2 Production Right, Federal Reserved Water Right, and Return Flow Credits

Per the Judgment, PWD has a groundwater production right of 2,770 AFY. PWD has been in full compliance with the Judgment, pumping within its final adjudicated right since 2016. In addition to its groundwater production right, PWD is entitled to a share of the unused federal reserved right. While the Judgment grants the federal government a Federal Reserved Water Right of up to 7,600 AFY, the federal government does not currently pump this amount. The unused Federal Reserved Water Right is allocated among public water suppliers listed in Exhibit 3 of the Judgement. Currently, PWD's average share of unused Federal Reserved Water Right is 1,450 AFY. Although the federal government has the authority to increase pumping at any time, it is assumed for this SWRP that PWD will be able to pump this amount at least until 2050. PWD is also entitled to a pumping allocation for return flow credit of all imported water used, including imported water transfers. The return flow credit is equal to 39.1 percent of all the imported water utilized by PWD based on a five-year rolling average. Return flows credits are available to PWD following imported water delivery or after banked imported water has been pumped. Return flow credits are projected to decrease from 4,220 AFY in 2025 to 4,100 AFY in 2050 consistent with decreased imported water supplies described in **Section 3.1.1**.

Climate change will have increasing impacts on groundwater resources. While groundwater is often considered a drought-resistant water resource, warmer temperatures, changing precipitation patterns, and more extreme drought conditions can all have an impact on rainfall and streamflows and, as a result, groundwater recharge. Climate change data developed by DWR for the California Water Commission's Water Storage Investment Program for hydrology in the region estimates streamflow may decrease groundwater recharge by 8 percent by 2070. The PWD's Production Right has been adjusted to reflect decreased groundwater availability because of climate change. Projected groundwater supplies from PWD's Production Right, Federal Reserved Water Right Production, and return flow credit are shown in **Table 3-5**.

Table 3-5: Projected Groundwater Supplies (AFY)

	2025	2030	2035	2040	2045	2050
Production Right	2,770	2,750	2,720	2,700	2,670	2,650
Federal Reserved Water Right	1,450	1,450	1,450	1,450	1,450	1,450
Return Flow Credits	4,220	4,200	4,170	4,150	4,120	4,100

3.1.2.3 Groundwater Pumping Capacity and Water Quality Limitations

Groundwater pumped from the Basin is treated with chlorine disinfection and pumped directly into the PWD's potable distribution system. Currently, PWD operates 22 active wells with a pumping capacity of approximately 11,000 AFY. Due to aging infrastructure, however, this pumping capacity is anticipated to decrease. PWD is in the process of rehabilitating and replacing production wells to maintain the total pumping capacity of 11,000 AFY.

PWD's well field is not currently experiencing water quality issues. Future changes to drinking water quality regulations may require PWD to conduct further analysis of water quality from certain wells that have detected constituents of concern. Constituents of concern that are expected to have a maximum contaminant level (MCL) in the future include hexavalent chromium, perfluorooctanoic acid (PFOA), and per- and polyfluoroalkyl substances (PFAS).

3.1.3 Local Surface Water

Littlerock Creek is the primary tributary stream that supplies surface water to the PWD service area, flowing north from the San Gabriel Mountains along PWD's southern boundary. PWD and Littlerock Creek Irrigation District (LCID) jointly hold long-standing water rights to divert 5,500 AFY from Littlerock Creek. Per an agreement between the two districts, the first 13 cfs of Littlerock Creek flows are available to LCID. Any flow above 13 cfs is shared between the two districts with 75 percent going to the PWD and 25 percent to LCID.

The Littlerock Dam Reservoir is currently managed by PWD to intercept flows from Littlerock Creek. LCID and PWD are each entitled to 50 percent of the Littlerock Dam Reservoir's storage capacity, which was recently renovated to increase storage capacity to 3,500 AF. Water is conveyed from Littlerock Dam Reservoir to Lake Palmdale via the Palmdale Ditch, an eight and a half mile long mostly open ditch, before being conveyed to and treated at PWD's Leslie O. Carter WTP.

Surface water runoff to the Littlerock Dam Reservoir is seasonal and varies widely from year to year. Although Littlerock Creek flows mainly during winter and spring months, this is buffered somewhat by Littlerock Dam Reservoir, allowing this water to be available throughout the year. Climate change is expected to have an impact on streamflows as precipitation patterns change and drought conditions become more extreme, and is projected to result in a streamflow reduction of approximately 4.4% by 2050.

PWD anticipates using approximately half of the average available yield from Littlerock Reservoir, or 4,000 AFY. Of that amount, up to 25 percent is projected to be lost to seepage and evaporation, for a remaining available local surface water supply of 3,000 AF. Projected local surface water supplies, accounting for climate change impacts, are summarized in **Table 3-6**.

Table 3-6: Projected Local Surface Water Supplies (AFY)

	2025	2030	2035	2040	2045	2050
Littlerock Reservoir	3,000	2,973	2,946	2,919	2,892	2,868

3.1.3.1 Local Surface Water Facility Capacities

Littlerock Dam Reservoir currently has a storage capacity of 2,870 AF due to over twenty years of sediment deposits, though current sediment removal operations are projected to increase capacity of the reservoir to 3,070 AF. The Reservoir must maintain a minimum water level of 500 AF through Labor Day (i.e., the first week of September), after which PWD and LCID draw water as needed. The Palmdale Ditch, which transports water from the Reservoir to Lake Palmdale, has a conveyance capacity of 25 cfs. It is estimated that approximately 25 percent of water supplies are lost due to seepage and evaporation, while the Reservoir is estimated to lose 200 AFY per year due to net evaporation (calculated evaporation minus precipitation). As described in **Section 3.1.1**, Lake Palmdale can store approximately 4,129 AF of SWP and Littlerock Dam Reservoir water, and is estimated to lose approximately 1,000 AFY per year due to net evaporation. Water from Lake Palmdale is conveyed to PWD's Leslie O. Carter WTP for treatment.

3.1.4 Recycled Water

In 2012, the Palmdale Recycled Water Authority (PRWA) was established to manage recycled water generated and used within the PWD service area. The PRWA boundaries consist of the overlap of City and PWD boundaries. PRWA is a joint powers authority comprised of the PWD and City of Palmdale and manages all aspects of recycled water use, including agreements to obtain recycled water, planning for, designing, and constructing supporting facilities, and financing these efforts.

Recycled water available for use within the PWD service area is supplied by the Sanitation Districts of Los Angeles County's (LACSD's) Palmdale Water Reclamation Plant (WRP) located in the City of Palmdale. The Palmdale WRP currently provides tertiary treatment for approximately 12,000 AFY of wastewater generated in and around the City of Palmdale and produces an average of 10,700 AFY of Title 22 recycled water. A contract with LACSD entitles PWD to up to 5,325 AFY of recycled water. The City of Palmdale also had an agreement with the LACSD for 2,000 AFY of recycled water to provide to customers throughout the City's service area, which has since been transferred to PRWA. Future recycled water supply projections shown in **Table 3-7** assume that recycled water entitlement within PWD's service area will remain the same through 2050.

Table 3-7: Projected Recycled Water Supplies (AFY)

	2025	2030	2035	2040	2045	2050
PWD Entitlement	5,325	5,325	5,325	5,325	5,325	5,325
PRWA's Entitlement	2,000	2,000	2,000	2,000	2,000	2,000

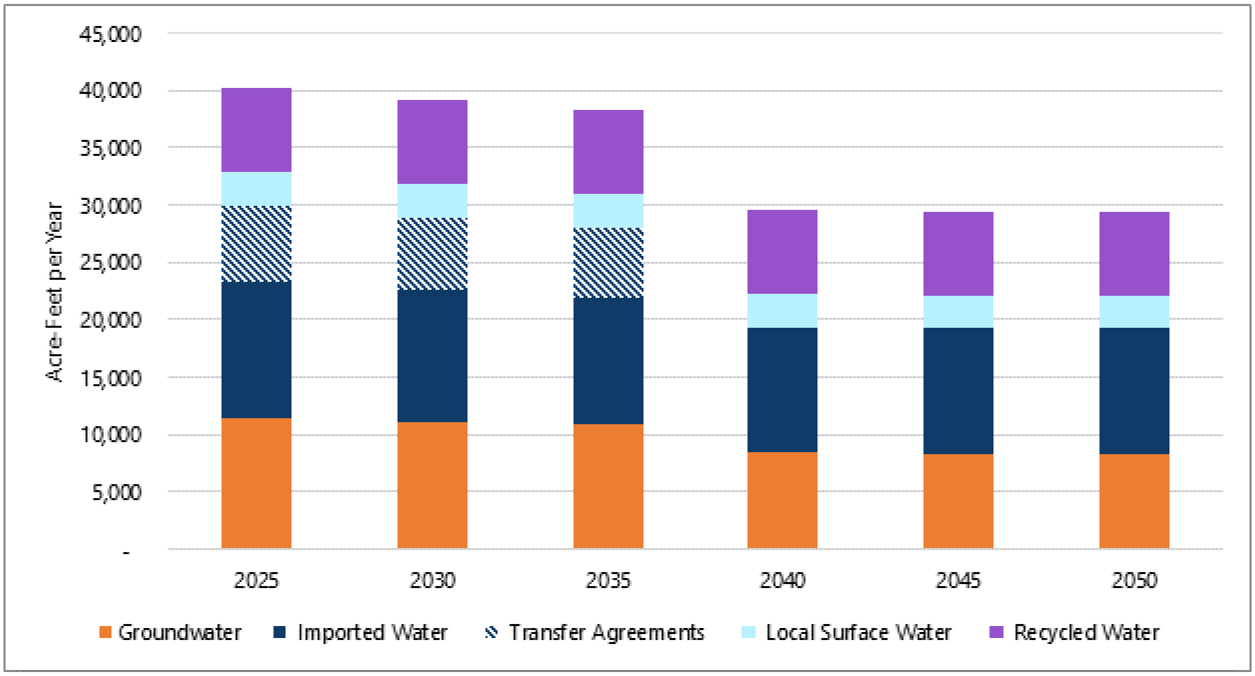
3.1.4.1 Recycled Water Capacity

Existing recycled water customers through PRWA include the City of Palmdale, for landscape irrigation and construction water. The remaining portion of Palmdale WRP recycled water is used for agricultural irrigation as a disposal method. The existing recycled water distribution system consists of about 7,900 feet of purple pipe with a current demand for recycled water of approximately 100 AFY.

3.1.5 Baseline Supply Projections

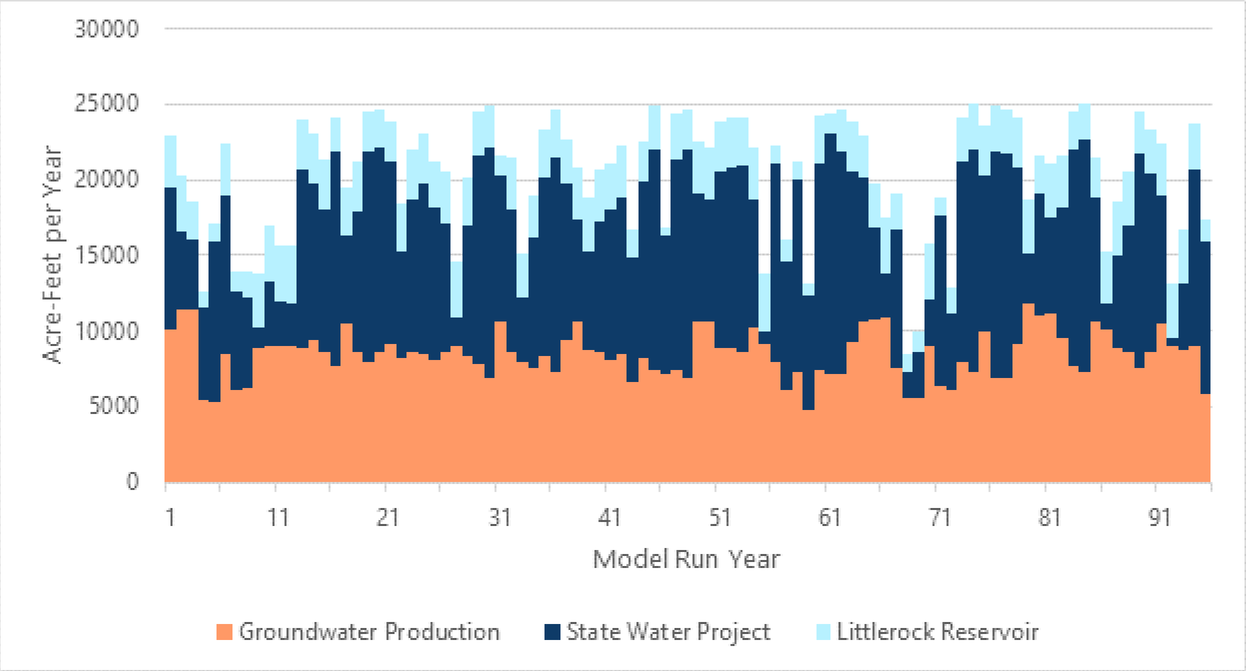
Through 2035, available potable and non-potable supplies are anticipated to average at least 38,000 AFY. These will be reduced to about 30,000 AFY in the period after 2035 through 2050, partly due to the expiration of transfer agreements with Butte County and Littlerock Creek Irrigation District in 2035. Projected annual baseline water supplies available within PWD's service area are shown in **Figure 3-2**.

Figure 3-2: Projected Baseline Water Supplies Available within PWD Service Area (Unconstrained)



The projections shown in **Figure 3-2** assume that PWD will have the capacity to access all available supplies. Water reliability, though, can be impacted by numerous external factors that influence the availability of water supplies, such as hydrologic fluctuations (which can be exacerbated as a result of climate change), constraints on distribution facilities, aging systems, or availability of storage. Because these factors limit PWD's ability to access all available water supplies, actual water deliveries may be smaller and more variable than projected available supplies. **Figure 3-3** shows the time series of projected baseline water supplies delivered within PWD's service area accounting for these external constraints.

Figure 3-3: Projected Potable Baseline Water Supplies in 2050 (constrained)



3.2 Baseline Supply and Demand Comparison

An assessment of water supply reliability measures the extent to which a water supply system effectively meets current and projected water demands. In the context of this SWRP, reliability is assessed by comparing projected supply and demand pressures.

This SWRP quantifies potential water supply shortages under multiple constraints that may limit future water reliability. To analyze these elements, a model was developed to simulate the water supply and demand balance and to quantify the long-term reliability of existing water supplies available to PWD through 2050.

3.2.1 Analysis Methodology

While comparing demands and supplies on an average basis is a straightforward exercise, comparing supply and demand accounting for external conditions requires a greater level of analysis. External conditions in the context of baseline assessment are related to hydrologic and weather variability, including climate change impacts, and how they affect demand and supply availability. Some levels of imported water shortage can occur under conditions of extended drought. Local surface water supply varies significantly and impacts local surface water availability and groundwater basin recharge.

A systems model was developed for PWD using Water Evaluation and Planning (WEAP) software, an integrated water resources planning tool used for visualizing and dynamically simulating complex systems. This systems model evaluates PWD's ability to meet future service area needs through 2050. Baseline supply projections incorporate historical monthly and annual variability, as well as operational and physical constraints such as long-term storage and facility capacities. Demand projections also incorporate monthly variability to capture seasonal changes. All model assumptions are included in **Appendix A**.

3.2.2 Baseline Supply Versus Demand Results

Projected mid-level water demand under baseline conditions described in Chapter 2 served as the basis for this analysis. Monthly demand factors were applied to characterize water consumption throughout the year with water demands peaking during dry summer months. The monthly demand factor is based on historical demand patterns for each use type. Key to the reliability assessment is analysis of supply under multiple hydrologic/weather conditions. The analysis uses historical data from 1922 to 2015 to evaluate future years under multiple hydrologic conditions. This allows the model to account for inherent variability and uncertainty in the system, which can occur at any time over the planning horizon.

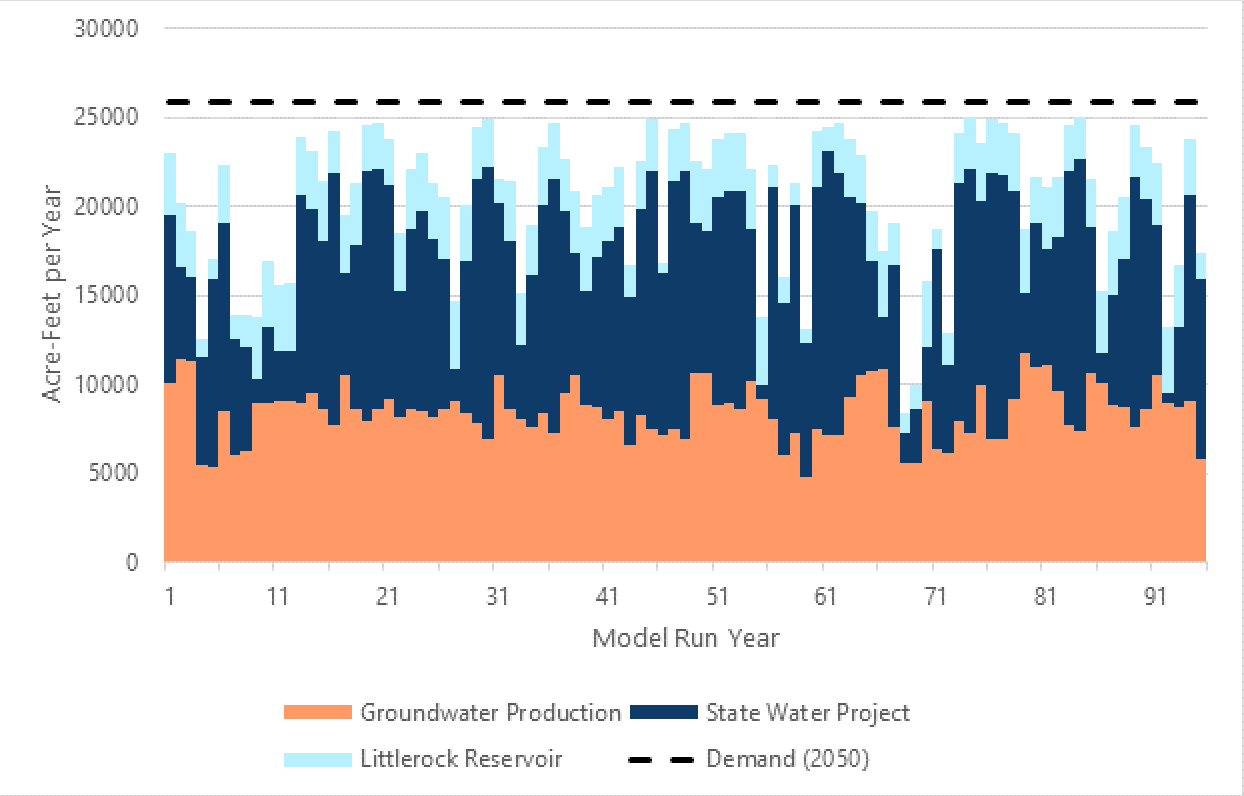
Starting in 2030, shortages are expected to occur every year due primarily to the regular 6-week shutdown of Carter WTP and the insufficient pumping capacity of wells to meet demand alone. In 2030 the average annual shortage is estimated as 540 AF while the maximum annual shortage is estimated as 4,620 AF. By 2050, the average annual shortage is estimated as 5,360 AF while the maximum annual shortage is estimated as 17,370 AF.

The projected water supply shortage frequency and depth of unmet demand is summarized in **Table 3-8**. An annual time series of 2050 demand versus baseline supplies is shown in **Figure 3-4**.

Table 3-8: Projected Water Supply Shortage Frequency and Depth of Unmet Demand

	2025	2030	2035	2040	2045	2050
Shortage Probability	56%	100%	100%	100%	100%	100%
Average Annual Shortage (AF)	380	540	1,030	2,080	3,490	5,360
Average Annual Shortage (% of demand)	2%	3%	5%	9%	15%	21%
Maximum Annual Shortage (AF)	4,280	4,620	5,730	8,490	14,360	17,370
Maximum Annual Shortage (% of demand)	23%	24%	28%	38%	60%	67%

Figure 3-4: Projected Potable Water Supplies (Constrained) and Demands within PWD Service Area in 2050



4. OPTIONS DEVELOPMENT AND DESCRIPTIONS

A series of water supply and production options were considered to help meet PWD's projected water demands presented in Chapter 2, and address supply reliability concerns described in Chapter 3. This chapter describes the process used to develop the water supply and production options, as well as describing the assumptions used for each option.

4.1 Options Development

Water supply and production options developed for this SWRP build upon existing project concepts, water supply plans, and feasibility studies. The first step involved developing a list of options considered feasible under current or reasonable future water resources within the planning horizon of 2050. This included reviewing and updating the water supply and production options that were developed in the 2010 SWRP based on current water resource conditions. Other relevant concepts from recent planning studies were incorporated into the analysis. PWD Board members and staff participated in interactive meetings to refine these options and develop additional supply and production concepts. PWD's existing supply and production operations were used as a baseline for considering additional supply options. In total, fifteen options were identified for this analysis.

A planning level analysis was conducted to estimate the potential volumes of supply for each option. These volumes were calculated from assumptions developed on the use of existing infrastructure as well as the need for new infrastructure to implement an option. The supply yields for each option were also estimated based on assumptions about the long-term impacts of climate change. Several pieces of existing infrastructure were assumed to be available for use with the options, including production and conveyance infrastructure owned by PWD. The sources of supply and existing infrastructure referenced in this chapter are shown in **Figure 3-1** in Chapter 3.

4.2 Options Descriptions

This section presents a brief description of each of the fifteen water supply options that resulted from the options development process. These options, listed in **Table 4-1**, are organized by supply source, with the subsections on each option below describing how the water will be conveyed, produced, and/or treated to meet demands.

Table 4-1: Water Supply Options

No.	Option Name	Option Category	Average Annual Supply Volume
1	Imported Water, Tier 1	Imported Water	740
2	Imported Water, Tier 2	Imported Water	3,060[1]
3	Imported Water, Tier 3	Imported Water	2,050[1]
4	Purchase of Antelope Valley Basin Rights	Local Groundwater	2,000
5	Well Rehabilitation and/or Replacements of Existing Wells	Local Groundwater	0[2]
6	Palmdale Ditch Enhancements	Local Surface Water	1,500
7	Sediment Removal at Littlerock Reservoir	Local Surface Water	500
8	External Imported Water Storage	Recharge/Banking	Variable[3]
9	Internal Imported Water Storage	Recharge/Banking	Variable[3]
10	Internal Imported Water Storage via Upper Amargosa Water Bank	Recharge/Banking	Variable[3]
11	Nonpotable Reuse	Recycled Water	5,000
12	Direct Potable Reuse	Recycled Water	5,000
13	Indirect Potable Reuse – Recycled Water Augmentation at Palmdale Lake	Recycled Water	5,000
14	Indirect Potable Reuse – Recycled Water Injection	Recycled Water	4,500
15	Conservation	Other	Variable

1. An average reliability factor for State Water Project water of 51% has been applied to obtain the average annual supply volume.
2. Option provides facilities to maintain existing supplies only and does not include new water supplies.
3. Supply benefits from new water storage are dependent on quantity of water available to place into storage.

The imported water options presented in **Table 4-1** are limited by existing facility constraints. For example, the existing diversion capacity from the California Aqueduct to Lake Palmdale is only 30 cfs. As a result, PWD is limited in terms of the volume of water it can obtain. While a greater diversion capacity could increase PWD's opportunity to access additional imported water, upsizing this diversion would be difficult due to piping and intake structure constraints. This facility constraint limits the ability to implement the imported water supply options unless they are accompanied by additional options that increase PWD's ability to store water.

Two options presented in **Table 4-1** were screened out due to demand and regulatory constraints. PWD considered both potable and nonpotable reuse options for tertiary effluent from PWRP. Nonpotable reuse expansion (Option 11) was screened out because demand for nonpotable supplies, such as landscape irrigation, is not anticipated to increase substantially in the region, resulting in a high unit cost of water. Potable reuse options were evaluated in the *Potable Reuse Alternatives Analysis* Technical Memorandum (TM) prepared for PWD (PWD 2022). The *Potable Reuse Alternatives Analysis* TM concluded that while direct potable reuse can increase the volume of existing supply, this option is not recommended because it is significantly more complex and expensive than indirect potable reuse options due to additional treatment (i.e., more energy consumption, higher capital costs), monitoring, and reporting, among other requirements. As a result, direct potable reuse (Option 12) was removed from this analysis.

4.2.1 Imported Water Options

As described in Chapter 3, PWD has received an average of 5,360 AFY of imported water from the SWP via the East Branch of the California Aqueduct over the last decade. The following options explore the feasibility of increasing imported supplies to PWD.

4.2.1.1 Imported Water, Tier 1 (Option 1)

Between 2011 and 2020, PWD had access to 7,339 AF of Article 21 water. However, PWD was only able to capture 335 AF due to storage capacity constraints. Under this option, PWD would capture as much Article 21 water as possible and convey it to a groundwater bank for later use. As a result, this option needs to be paired with an option to develop additional storage capacity to store water when it becomes available. On average, 740 AFY of Article 21 water would be made available to PWD.

There are no capital costs associated with this option. The water supply cost would be approximately $300 per AF in 2022 dollars for conveyance of the water through the aqueduct. Operations and maintenance (O&M) costs include the cost for treatment, which is approximately $817 per AF in 2022 dollars.

4.2.1.2 Imported Water, Tier 2 (Option 2)

PWD currently has long-term lease agreements with LCID and Butte County to access a portion of their Table A amounts through 2035. The existing lease agreement with Butte County allows for up to 10,000 AFY of their SWP Table A amount, while the lease agreement with LCID ranges between 75 percent and 100 percent of their SWP Table A amount, up to a maximum of 2,300 AFY. Under this option, PWD would renegotiate one or both agreements through at least 2050. Similar to Option 1, additional imported supplies would be conveyed to Lake Palmdale and/or a groundwater bank for later use. As a result, this option may need to be paired with an option to develop additional storage capacity. On average, it is estimated that this option would make 3,060 AFY of Tier 2 water available for diversion.

There are no capital costs associated with this option. The cost for LCID or Butte County transfer water is currently $340 per AF and is projected to increase by 4.3%, not including inflation. If projected out to 2050, this results in an average annual cost of $4.2 million per year in 2022 dollars. In addition, costs are assumed to include conveyance and treatment costs equal to $817 per AF. In total, this option is estimated to cost approximately $1,400 per AF.

4.2.1.3 Imported Water, Tier 3 (Option 3)

Under Option 3, PWD would enter into new agreements for the permanent transfer or exchange of imported water rights. Water supply exchange or transfer opportunities include, but are not limited to, SWP Table A rights, Central Valley Project water rights, or appropriative water rights acquired prior to 1914 (referred to as Pre-1914 appropriative water right). PWD could also partner with other SWP contractors to construct seawater desalination facilities in a coastal location in exchange for SWP supplies delivered via the East Branch of the Aqueduct. While this option is similar to Option 2, these types of transfers or exchanges would be considered Tier 3 because renegotiating an existing transfer agreement for SWP supplies (as proposed in Option 2) would be easier and thus prioritized over engaging in a new transfer of available SWP water. On average, it is estimated that this option would make up to 5,000 AFY of Tier 3 water available for diversion.

Capital costs for a permanent transfer of water rights are assumed to be $10,000 per AF of water rights purchased, which equals $40,000,000 in 2022 dollars for 4,000 AFY of water rights. In addition, costs are assumed to include conveyance and treatment costs equal to $817 per AF. In total, this option is estimated to cost approximately $1,300 per AF, assuming capital is financed at 3% over 30 years.

4.2.2 Local Groundwater Options

PWD has pumped an average of 8,030 AFY of groundwater supplies over the last decade. The following options explore the feasibility of increasing groundwater supplies to PWD.

4.2.2.1 Purchase of Antelope Valley Basin Rights (Option 4)

As described in Chapter 3, PWD currently has a groundwater production right of 2,770 AFY, an average Federal Reserved Water Right of 1,450 AFY, and a return flow credit equal to 39.1 percent of all the SWP water utilized by PWD. Under this option, PWD would purchase 4,000 AFY of production rights from other groundwater users in the Basin to access additional groundwater supplies. This option would require drilling and equipping eight new wells outside of PWD's service area, as well as a pipeline to convey groundwater to PWD’s distribution system. On average, it is estimated that this option would increase groundwater supplies by 4,000 AFY, but would primarily be needed to provide supply in peak demand months.

The option to purchase groundwater rights would have a capital cost of approximately $39.5 million in 2022 dollars for new wells and a pipeline, and an O&M cost for maintaining these facilities of approximately $409,000 per year. The cost to produce groundwater is approximately $200 per AF in 2022 dollars. In total, this option is estimated to cost approximately $1,400 per AF, assuming the purchase of rights is financed at 3% over 30 years.

4.2.2.2 Well Rehabilitation and/or Replacements of Existing Wells (Option 5)

PWD currently operates 22 groundwater wells in the Basin with a maximum pumping volume of approximately 11,000 AFY (approximately 9.8 mgd). Under this option, PWD would repair, rehabilitate and/or replace the existing PWD wells to maintain existing pumping capacity and enable greater pumping during dry years. Based on the current capacity versus earliest recorded capacity described in the 2020 Well Rehabilitation Prioritization Program Report, repair, rehabilitation and replacement of all wells described could potentially increase pumping capacity to 16 mgd. While implementation of this option would improve the resilience of the production wells, this option by itself would only maintain baseline pumping capacity but not increase groundwater supplies. This option would need to be paired with another groundwater supply project to increase access to additional groundwater supplies.

Assuming five wells are replaced, capital costs are approximately $35,000,000, and rehabilitation of wells (considered O&M) would cost approximately $1,340,000, for a total cost of $36,340,000 in 2022 dollars.

4.2.3 Local Surface Water Options

As described in Chapter 3, PWD and LCID have water rights to divert 5,500 AFY from Littlerock Creek. The first 13 cfs of Littlerock Creek flows are available to LCID, and any flow above 13 cfs is split between the two districts, with 75 percent going to PWD and 25 percent going to LCID. The potential for increasing local surface water supplies to PWD is described in the following sections.

4.2.3.1 Palmdale Ditch Enhancements (Option 6)

The Palmdale Ditch is a 7.2-mile long part earthen and part concrete-lined open ditch that conveys water from Littlerock Dam Reservoir to Lake Palmdale. It is estimated that up to 25 percent of water supplies are lost due to evaporation and seepage from the ditch. This option would replace the open ditch with a pipeline to reduce losses, and increase flow capacity from 25 cfs to 60 cfs to divert more water from the Littlerock Dam Reservoir. This would allow PWD to increase the average diversion closer to 5,500 AF/Y. The option is estimated to yield up to 1,500 AFY in losses alone.

Palmdale Ditch Enhancements would have a capital cost of approximately $18,100,000 in 2022 dollars. O&M costs are assumed to be no more than the current cost of O&M, and therefore are not included. The annual water supply cost of $508 per AF in 2022 dollars includes the cost to treat the water at Leslie O. Carter WTP and assuming capital cost is financed at 3% over 30 years. In total, this option is estimated to cost approximately $1,100 per AF.

4.2.3.2 Sediment Removal at Littlerock Reservoir (Option 7)

Littlerock Reservoir is a man-made feature formed by the impoundment of water by the Littlerock Dam. The initial design capacity of Littlerock Reservoir was 4,300 AF; however, this capacity was substantially reduced to approximately 1,600 AF because of the deposition of sediment behind Littlerock Dam. In 1992, the height of Littlerock Dam was raised to restore storage capacity to 3,500 AF. Since then, sedimentation has reduced storage capacity by 600 to 700 AF, thus limiting an equivalent amount of local supply storage. Sediment removal activities currently underway are assumed to increase reservoir capacity by approximately 200 AF, increasing capacity from 2,874 AF to 3,074 AF. This option would also restore the capacity of the Littlerock Reservoir to 3,583 AF through the removal of 1,165,000 net cubic yards of sediment accumulated behind the Littlerock Dam. As a result, reservoir capacity would be additionally increased by approximately 500 AF (from 3,074 AF to 3,583 AF). The additional supply available for diversions will depend on the number of times the reservoir fills per year and is assumed to be a minimum of 500 AFY.

Sediment Removal at Littlerock Reservoir would cost approximately $40-45 per cubic yard of sediment removed, for a total cost of $52,000,000. There are no O&M costs associated with this option. The annual cost of $5,800 per AF in 2022 dollars includes the cost to treat the water at Leslie O. Carter WTP.

4.2.4 Recharge/Banking Options

PWD is actively looking at potential options to increase the storage of wet year water supplies as they become available for use in dry years. The following sections summarize potential options for recharge/banking water both within and outside of the Antelope Valley.

4.2.4.1 External Imported Water Storage (Option 8)

Under this option, PWD would store excess SWP supplies during wet years in an existing groundwater bank outside the Antelope Valley, such as the Semitropic Water Bank. During dry or drought periods when imported water supplies are limited or insufficient, this stored water would then be conveyed back into the California Aqueduct and diverted to Lake Palmdale for treatment and use. For planning purposes, this option assumes that up to 15,000 AF of external storage would be available for groundwater banking. As described in Chapter 3, the use of these banked imported supplies would provide PWD with an additional 39 percent imported water return flow credit. While implementing this option would provide imported water storage for use during dry years, this option by itself would not increase water supplies. This option would need to be paired with another supply project, such as Options 1-3 presented above, to increase access to additional water supplies.

Assuming a 10,000 AFY take capacity and 40,000 AF storage capacity, the Internal Imported Water Storage option would have a capital cost of approximately $88,000,000 (assuming $2,200 per AF of storage space) and an O&M cost of $90,300 per year. In addition, storage, extraction and power cost for pumping is estimated at $206 per AF.

4.2.4.2 Internal Imported Water Storage (Option 9)

Similar to Option 8, this option would store excess SWP supplies during wet years in an existing groundwater bank within the Antelope Valley, such as at the High Desert Water Bank or other AVEK banking facility, or store water in PWD-controlled recharge areas such as Big Rock Creek. If stored in the High Desert Water Bank or other AVEK banking facility, the stored water would then be pumped back into the California Aqueduct and diverted to Lake Palmdale for use during dry or drought periods when imported water supplies are limited or insufficient. If stored in a PWD-controlled facility such as Big Rock Creek, PWD would need to construct new wells to pump the banked water and connect to the existing distribution system. Water banked in the Basin is subject to a 10 percent leave-behind requirement, as stipulated by the AV Watermaster Rules and Regulations and storage agreements. Like with Option 8, this option would need to be combined with another supply project, such as Options 1-3, to provide additional water supplies.

Assuming a 10,000 AFY take capacity and 40,000 AF storage capacity, the External Imported Water Storage option would have a capital cost of approximately $88,000,000 (assuming $2,200 per AF storage capacity) and an O&M cost of $90,300 per year. In addition, storage, extraction and power cost for pumping is estimated at $206 per AF.

4.2.4.3 Internal Imported Water Storage via Upper Amargosa Water Bank (Option 10)

Completed in 2019, the Upper Amargosa Creek Recharge project was a joint effort between PWD, the City of Palmdale, AVEK, and Los Angeles County Waterworks District 40 to convey water from the California Aqueduct to a series of recharge ponds and replenish the Basin. PWD currently has a right to recharge 1,378 AFY into the Upper Amargosa Creek Recharge Project. Under this option, PWD would maximize its 25% share of recharge capacity and store excess SWP supplies during wet years in the Upper Amargosa Water Bank. PWD would construct new wells to pump the banked water and connect to the existing distribution system for use during dry or drought periods. Per the storage agreement, water banked in the years in the Upper Amargosa Water Bank is subject to a 10 percent leave-behind requirement. Like with Options 8 and

9, this option would need to be combined with another supply project, such as Options 1-3, to provide additional water supplies.

The Internal Imported Water Storage via Upper Amargosa Water Bank option would have a capital cost of approximately $14,000,000 for construction of new wells to produce the stored water and an O&M cost of $465,000 per year, assuming a pumping rate of 2,000 AFY during dry years (i.e., 3 out of 10 years).

4.2.5 Recycled Water Options

PWD has signed an agreement to purchase 5,325 AFY of tertiary effluent from PWRP, owned and operated by LACSD. PWD considered both potable and nonpotable reuse options for this tertiary effluent. As stated in the introduction to **Section 4.2**, nonpotable reuse options (Option 11) were screened out because demand for nonpotable supplies is not anticipated to increase substantially in the region. Direct potable reuse options (Option 12) were also screened out because of the increased complexity and cost associated with additional treatment, monitoring, and reporting, among other requirements. The following sections summarize the two indirect potable reuse options remaining for recycled water use.

4.2.5.1 Recycled Water Augmentation at Palmdale Lake (Option 13)

With Option 13, PWD would construct an Advanced Water Purification Facility (AWPF) near the PWRP. Tertiary effluent from PWRP would be sent to the AWPF for advanced treatment, consisting of low-pressure Membrane Filtration (MF), reverse osmosis (RO), and an advanced oxidation process (AOP). The advanced treated water would be conveyed to Palmdale Lake and retained for at least 60 days before being sent to the Leslie O. Carter WTP for potable use. While the Leslie O. Carter WTP has a treatment capacity of 30 mgd, this option would limit the maximum flow to the Leslie O. Carter WTP to 22.8 mgd to ensure that the water has a hydraulic retention time of a minimum 60 days. This option would provide an average of 5,000 AFY of surface water for augmentation at Palmdale Lake, assuming a brine loss of up to 15 percent.

The Recycled Water Augmentation at Palmdale Lake option would have a capital cost of approximately $119,700,000 and an O&M cost of $4,900,000 per year. Costs also include $500 per AF to treat the water at Leslie O. Carter WTP. In total, this option is estimated to cost approximately $2,200 per AF.

4.2.5.2 Recycled Water Injection (Option 14)

Similar to Option 13, PWD would construct an AWPF near the PWRP. Tertiary effluent from PWRP would then be conveyed to AWPF for advanced treatment, consisting of MF, RO, and AOP. The product water treated at the AWPF would then be directly injected into the Basin via an injection well. Assuming a brine loss of up to 15 percent, this indirect potable reuse project would yield an average 5,000 AFY for groundwater recharge (PWD, 2021b). In addition, it's assumed that PWD would be subject to a 10 percent leave-behind requirement by the watermaster, resulting in approximately 4,500 AFY of supply available for pumping. This option would require drilling and equipping of approximately 5 new wells to extract the recharged water, as well as a pipeline to convey the water to PWD's distribution system.

The Recycled Water Augmentation at Palmdale Lake option would have a capital cost of approximately $138,600,000, which includes the construction of 5 wells at $7,000,000 per well, and an O&M cost of $6,000,000 per year. In total, this option is estimated to cost approximately $2,600 per AF.

4.2.6 Demand Management Options

The options presented in **Section 1** through **Section 4.2.5** all increase water supply or storage to meet future demand. In this section, demand management options focus on reducing the demand for water by improving water use efficiency and reducing water waste rather than increasing supply availability. The potential for demand management within PWD's service area is described in the following section.

4.2.6.1 Conservation (Option 15)

California Senate Bill (SB) 606 and Assembly Bill (AB) 1668, collectively known as the Water Conservation and Efficiency Bills, require urban water suppliers to establish water use targets by 2022 and develop plans to achieve those targets by 2025. The bills also establish new water use efficiency standards and water loss reporting requirements. Under this option, PWD would implement conservation measures to reduce potable water demand by 1,400 AFY by 2025 and meet the SB 606/AB 1668 requirements. It is assumed that this option will be required in every alternative portfolio analyzed in Chapter 5.

There would be no capital or O&M costs associated with the implementation of this option.

5. ALTERNATIVE DESCRIPTIONS AND EVALUATION

The purpose of this SWRP is to facilitate robust decision-making when implementing projects that aim to meet future service area demands. The following sections describe the development and evaluation process used to identify a preferred alternative to guide future project implementation. The alternatives development and evaluation process is shown in **Figure 5-1** and described in greater detail in the following sections.

Figure 5-1: Alternatives Development and Evaluation Process

5.1 Alternatives Development

The central component of this SWRP evaluation is the alternatives, each of which are comprised of a group of options presented in Chapter 4. There are multiple methods and approaches to assembling alternatives using the options. The alternatives were developed and differentiated by their use of unique combinations of water resource types such as imported water, groundwater, local surface water, and recycled water. Different combinations of supply types were then coupled with storage options, additional production, distribution, and other elements were added to each alternative to reflect PWD's water system and resources future. This process resulted in eleven alternatives, summarized in **Table 5-1**. The eleven alternatives were developed and evaluated based on the ability to meet complex water resources challenges and achieve SWRP goals.

Table 5-1: Alternatives Summary

Alternative	Focus
1. Imported Water	Internal banking
2. Imported Water	External banking
3. Recycled Water	Groundwater injection
4. Recycled Water	Surface water augmentation
5. Hybrid Imported Water/Recycled Water	Imported water external banking, recycled water injection
6. Hybrid Imported Water/Recycled Water	Imported water internal banking, recycled water surface water augmentation
7. Hybrid Surface Water/Recycled Water	Surface water enhancement, recycled water injection
8. Hybrid Groundwater/Recycled Water	Groundwater rights, recycled water injection
9. Hybrid Imported Water/Recycled Water	Imported water internal banking, recycled water injection
10. Hybrid Recycled Water	Recycled water injection, recycled water surface water augmentation
11. Hybrid Groundwater/Recycled Water/ Surface Water	Groundwater rights, recycled water injection, surface water enhancement

Each alternative has a unique combination of supply, production, and storage options. Once combined, individual alternatives were modified as needed to remove redundancies, refine supply volumes and optimize infrastructure. For example, an alternative that relies heavily on imported water will not include distribution, storage and other components associated with producing more local supply. All alternatives include supply and production options that are required by regulations (e.g., conservation to comply with SB 606/AB 1668) or that are required to maintain baseline supplies (e.g., well rehabilitation and/or replacement). As discussed in Chapter 4, none of the alternatives include nonpotable or direct potable reuse due to demand and regulatory constraints. In addition, all alternatives assume that well rehabilitation and/or replacements of existing wells and conservation efforts would continue. A summary of options to be implemented under each alternative is provided in **Table 5-2**. A more detailed description of each alternative, including the projected water supply shortage frequency and depth of unmet demand, is provided in the following sections.

Table 5-2: Options and Alternatives Summary

Options	Alternative										
	1	2	3	4	5	6	7	8	9	10	11
1. Imported Water, Tier 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Imported Water, Tier 2	✓	✓		✓	✓				✓		
3. Imported Water, Tier 3	✓	✓									
4. Purchase of Antelope Valley Basin Rights								✓			✓
5. Well Rehabilitation and/or Replacements of Existing Wells	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6. Palmdale Ditch Enhancements							✓				✓
7. Sediment Removal at Littlerock Reservoir							✓				
8. External Imported Water Storage		✓			✓						
9. Internal Imported Water Storage	✓					✓			✓		
10. Internal Imported Water Storage via Upper Amargosa Water Bank	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11. Nonpotable Reuse											
12 Direct Potable Reuse											
13. Indirect Potable Reuse – Recycled Water Augmentation at Palmdale Lake				✓		✓				✓	
14. Indirect Potable Reuse – Recycled Water Injection			✓		✓		✓	✓	✓	✓	✓
15. Conservation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

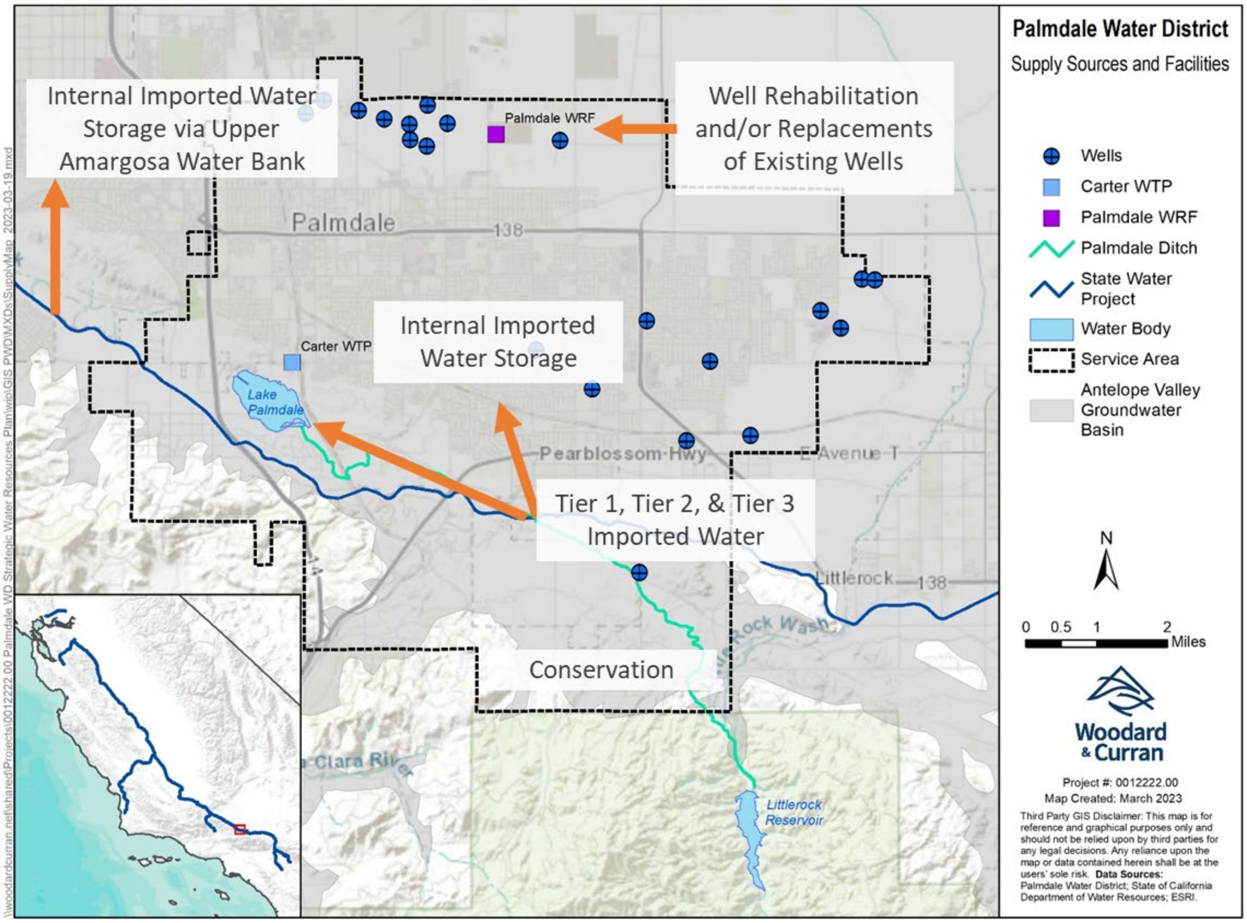
5.1.1 Alternative 1 – Imported Water (Internal Banking)

Alternative 1 focuses on maximizing imported water supplies and developing additional storage capacity within the Antelope Valley Basin (Basin) to store surplus imported water when it becomes available in wet years for use in dry or drought periods. Under this alternative, PWD would maximize the use of Tier 1 (Article 21) imported water, and purchase or lease up to 10,600 AFY Tier 2 and Tier 3 imported water Table A allocations. Imported water not used directly would be stored in local banking facilities, including an AVEK Water Bank and the Upper Amargosa Water Project. This includes up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project and up to 12,000 AFY of imported water stored in an

Antelope Valley water bank. In addition, unused groundwater would be carried over as storage in the Basin. Any water stored in an Antelope Valley Water Bank is assumed to primarily be pumped back into the aqueduct, though it's also possible to exchange water stored for groundwater. Up to 61,000 AF would be stored in the Antelope Valley via the Antelope Valley Water Bank, the Upper Amargosa Water Project and groundwater carryover. Two new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-2**. **Figure 5-3** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12 below**.

Figure 5-2: Alternative 1 Facility Locations



Project #: 0012222.00
Map Created: March 2023
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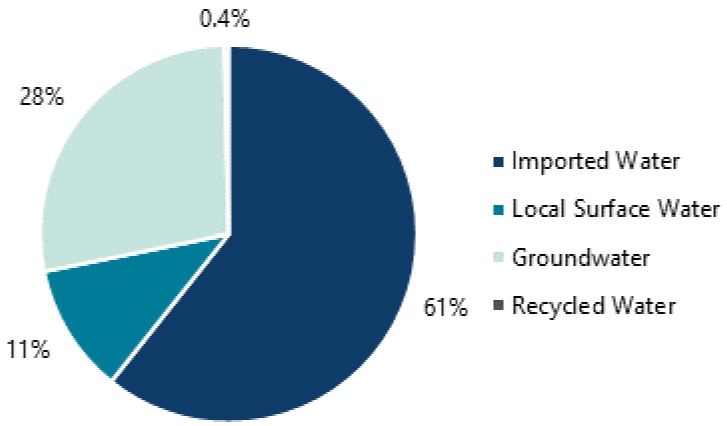
Figure 5-3: Alternative 1 Average Annual Supply Portfolio (2050)



5.1.2 Alternative 2 – Imported Water (External Banking)

Alternative 2 focuses maximizing imported water supplies and developing additional storage capacity outside the Antelope Valley to store surplus imported water when it becomes available in wet years for use in dry or drought periods. PWD would negotiate a storage agreement with an external bank, such as the Semitropic Water Bank, to store imported water supplies. Under this alternative, PWD would purchase and store up to 24,000 AF of Tier 1, Tier 2, and Tier 3 imported water supplies in a water bank outside of the Antelope Valley. PWD would also store up to 40,000 AF of imported water and groundwater carryover in the Basin. This includes up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project. Two new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-4**. **Figure 5-5** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12** below.

Figure 5-4: Alternative 2 Facility Locations

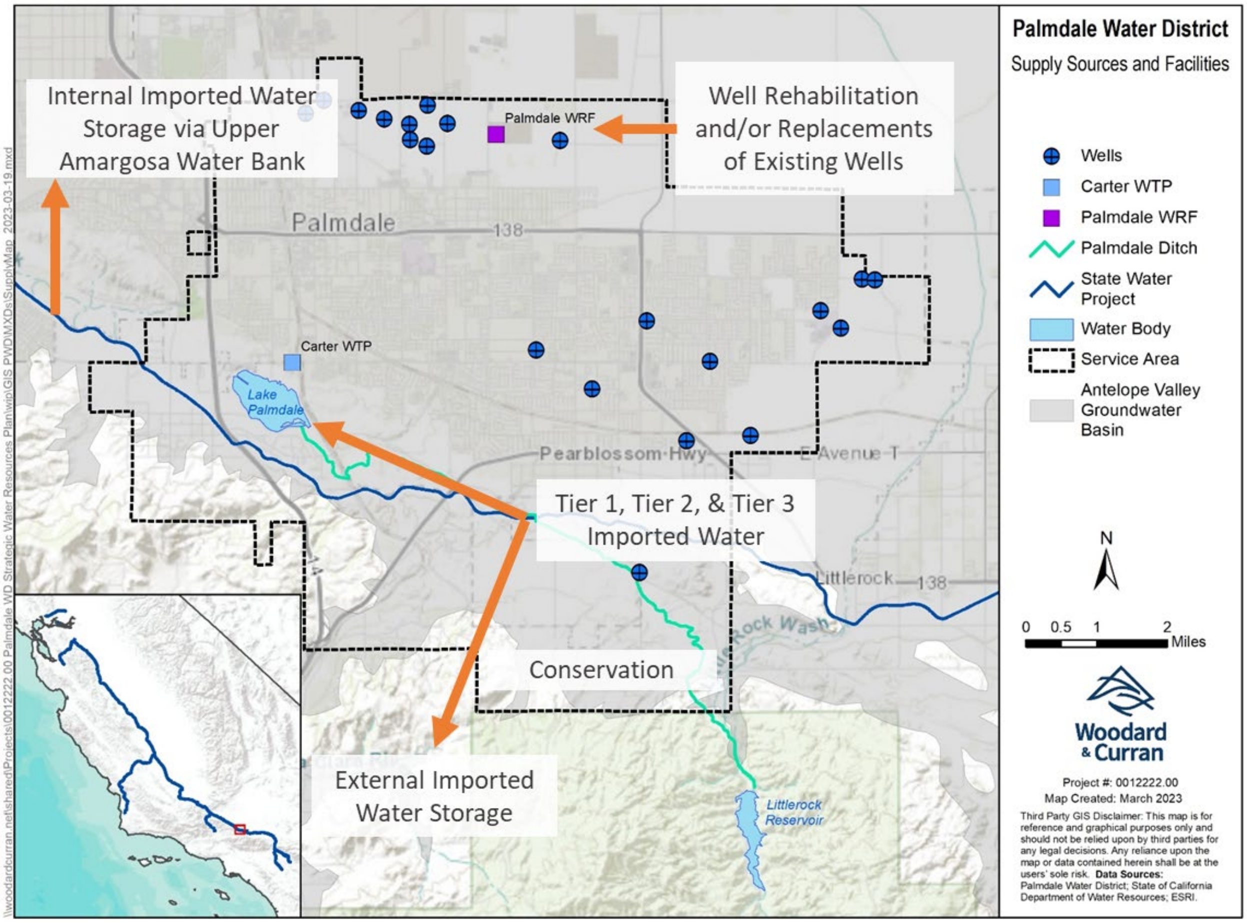


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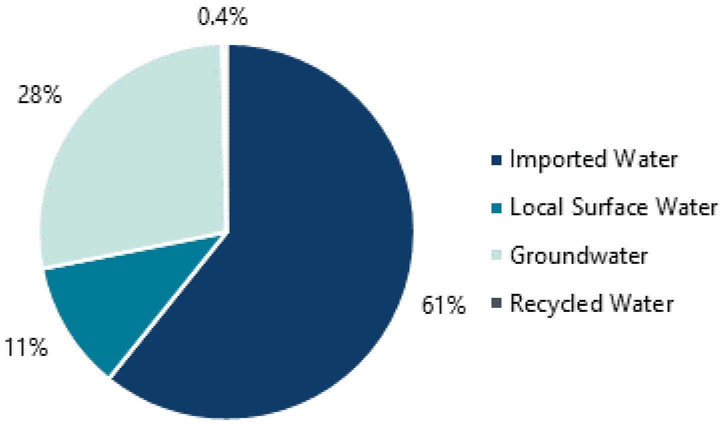
Figure 5-5: Alternative 2 Average Annual Supply Portfolio (2050)



5.1.3 Alternative 3 – Recycled Water (Groundwater Injection)

Alternative 3 focuses on increasing local water supply reliability by recharging recycled water supplies to augment existing groundwater supplies in the Basin. Under this alternative, PWD would inject 4,500 AFY of recycled water supplies into the Basin annually. PWD would also store up to 32,500 AF of Tier 1 imported water, recycled water, and groundwater carryover in the Basin. This includes up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project. Seven new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-6**. **Figure 5-7** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12 below**.

Figure 5-6: Alternative 3 Facility Locations

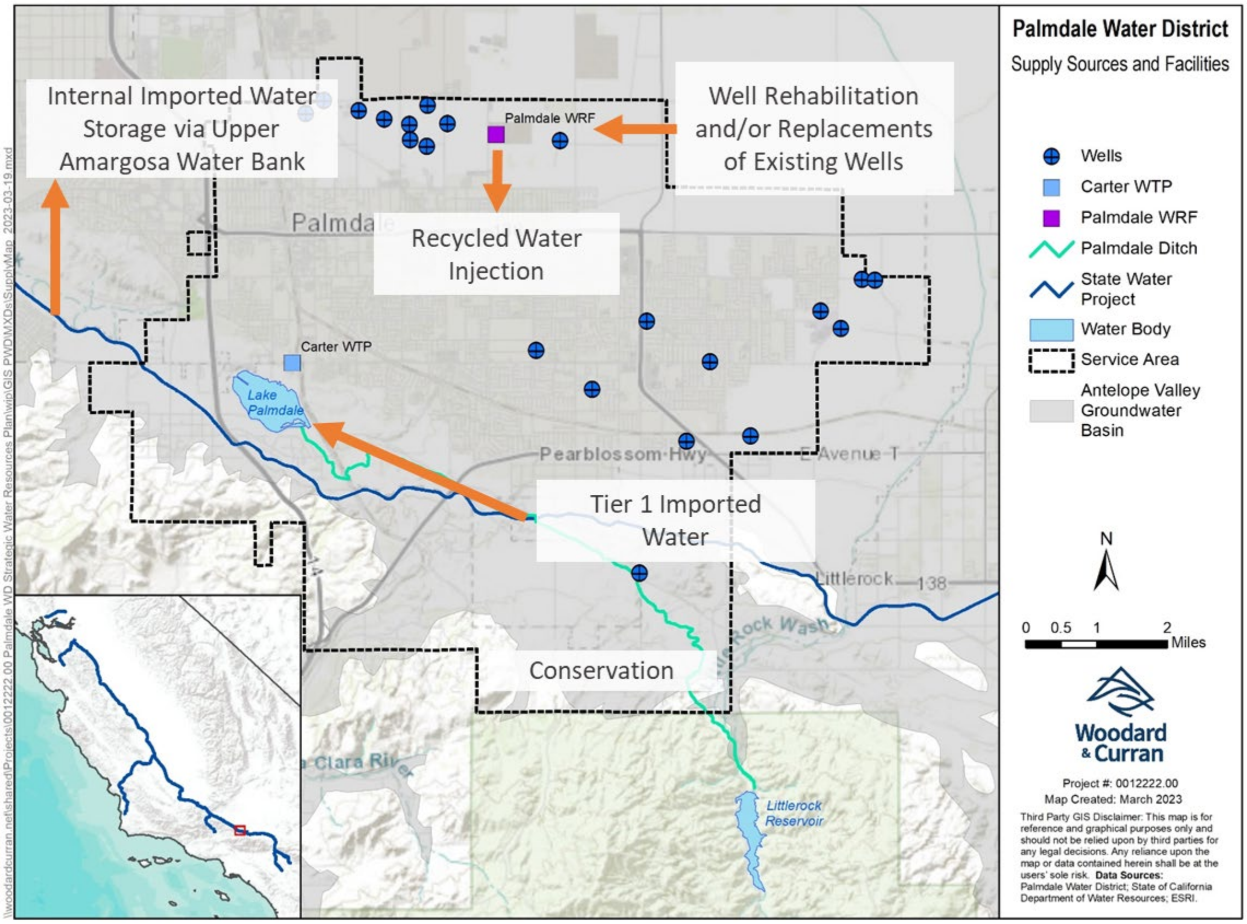


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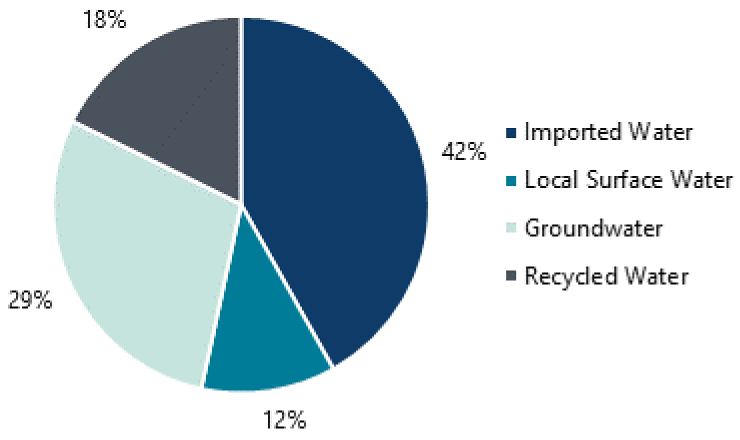
Figure 5-7: Alternative 3 Average Annual Supply Portfolio (2050)



5.1.4 Alternative 4 – Recycled Water (Surface Water Augmentation)

Alternative 4 focuses on increasing local water supply reliability by conveying recycled water supplies into Lake Palmdale. Under this alternative, 5,000 AF of recycled water supplies would be diverted to Lake Palmdale annually to augment surface water supplies. PWD would also store up to 29,000 AF of Tier 1 and Tier 2 imported water supplies as well as groundwater carryover in the Basin. This includes up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project. Two new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-8**. **Figure 5-9** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12** below.

Figure 5-8: Alternative 4 Facility Locations

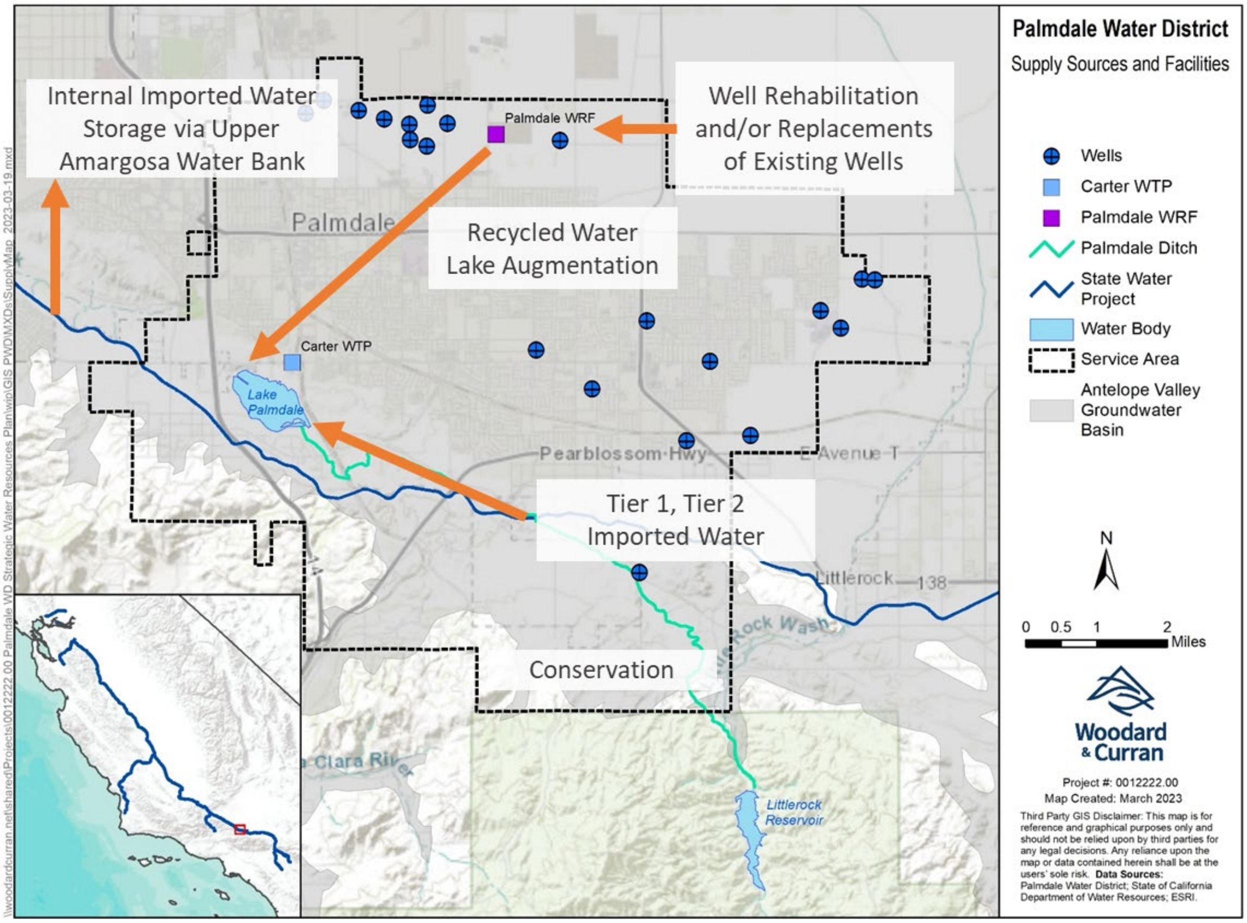
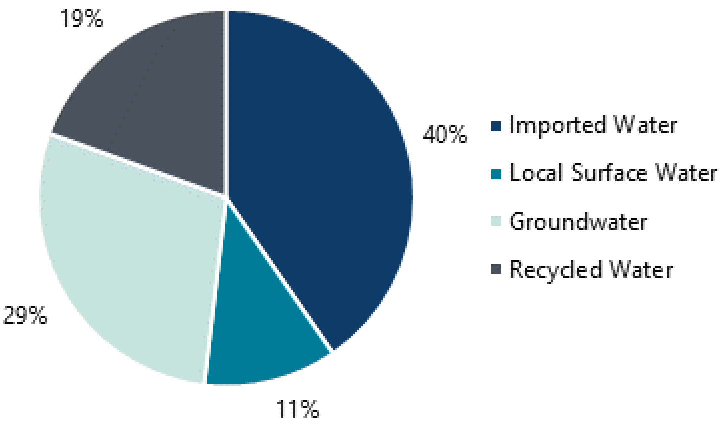


Figure 5-9: Alternative 4 Average Annual Supply Portfolio (2050)



5.1.5 Alternative 5 – Hybrid Imported Water/Recycled Water (External Banking and Recycled Water Injection)

Alternative 5 focuses on maximizing imported water supplies and developing additional storage capacity outside the Antelope Valley to store surplus imported water when it becomes available in wet years, as well as recharging recycled water supplies to augment existing groundwater supplies in the Basin. Under this alternative, PWD would store up to approximately 9,200 AF of Tier 1 and Tier 2 imported water supplies in the Semitropic Water Bank. PWD would also inject 5,000 AF of recycled water supplies into the Basin annually. It's assumed that 10% of the recharged recycled water (500 AFY) would be left in the basin to improve basin health. In addition, it's assumed that PWD would store up to 33,000 AF of imported water, recycled water, and unused groundwater in the Basin. This includes up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project. Seven new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-10**. **Figure 5-11** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12 below**.

Figure 5-10: Alternative 5 Facility Locations

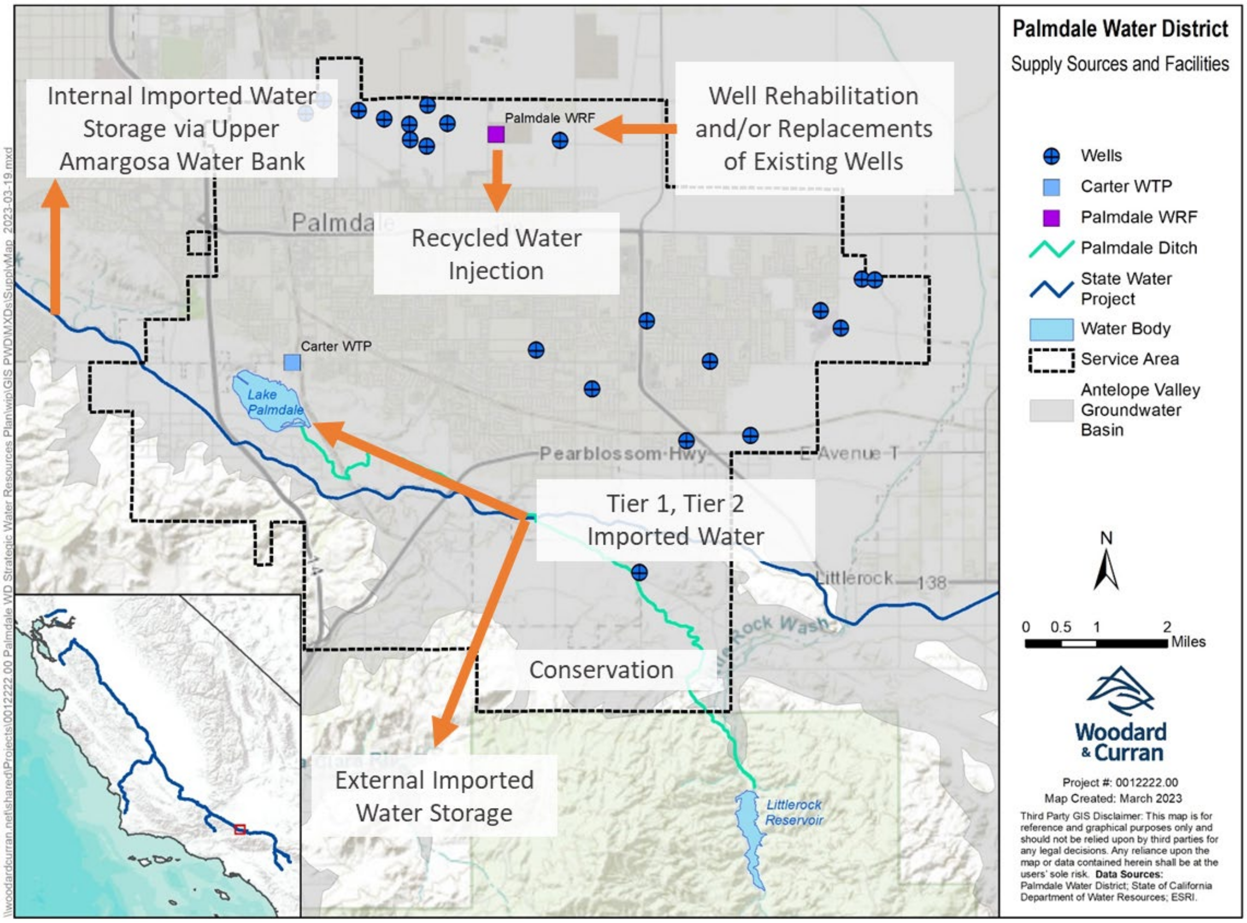


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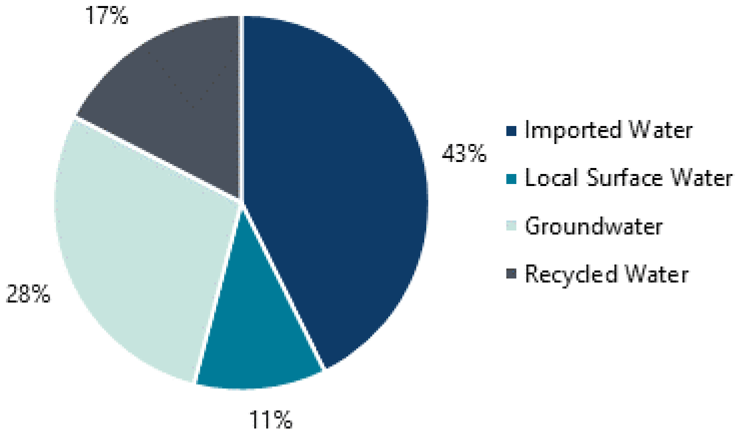
Figure 5-11: Alternative 5 Average Annual Supply Portfolio (2050)



5.1.6 Alternative 6 – Hybrid Imported Water/Recycled Water (Internal Banking and Surface Water Augmentation)

Alternative 6 focuses on maximizing imported water supplies and developing additional storage capacity within the Basin to store surplus imported water when it becomes available in wet years, as well as increasing local water supply reliability by conveying recycled water supplies into Lake Palmdale. Under this alternative, approximately 5,000 AFY of recycled water supplies would be transported to Lake Palmdale to augment surface water supplies. PWD would also store up to 25,000 AF of Tier 1 imported water and unused groundwater in the Basin. This includes up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project and up to 7,800 AFY of imported water stored in an Antelope Valley Water Bank. Any water stored in an Antelope Valley Water Bank is assumed to primarily be pumped back into the aqueduct, though it’s also possible to exchange stored water for pumped groundwater. Two new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-12**. **Figure 5-13** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12** below.

Figure 5-12: Alternative 6 Facility Locations

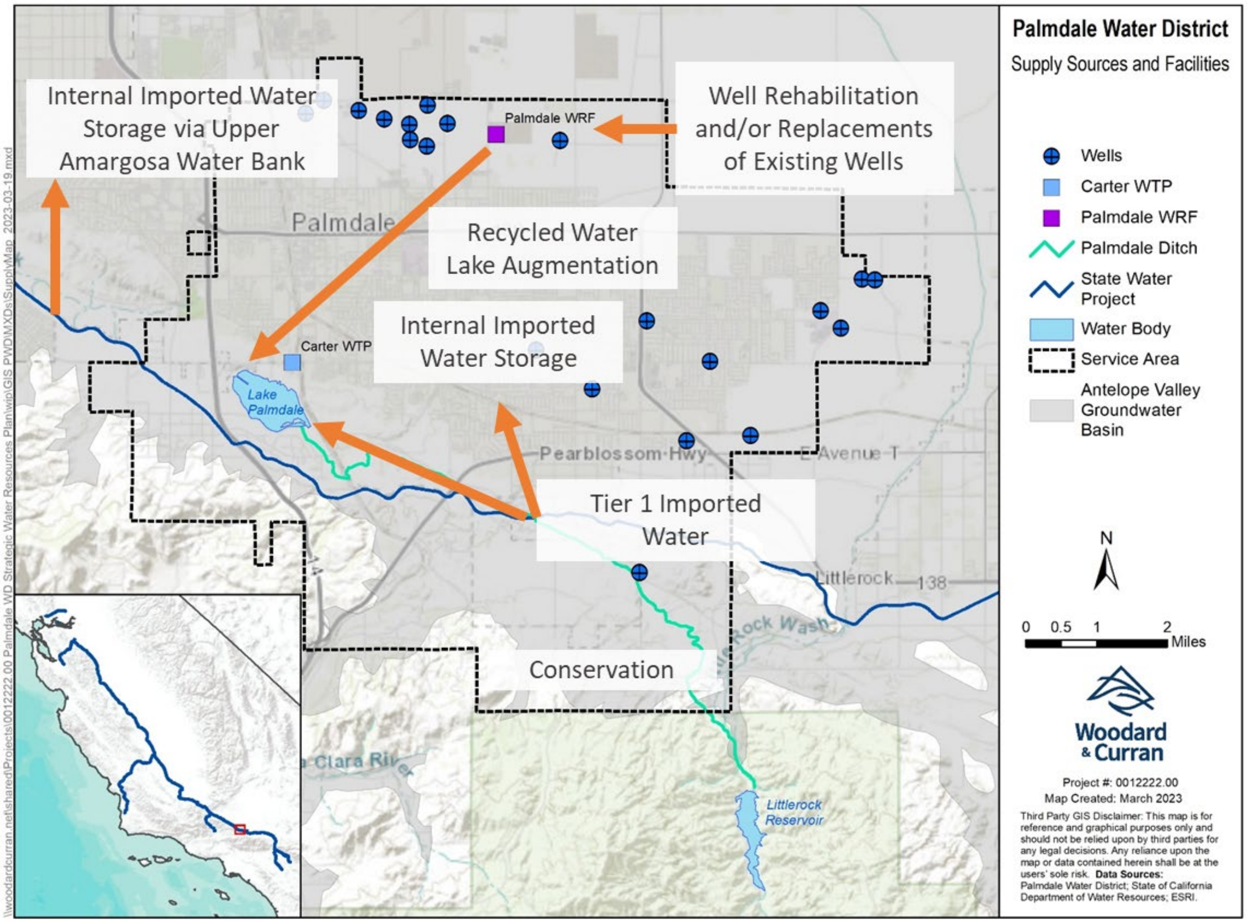
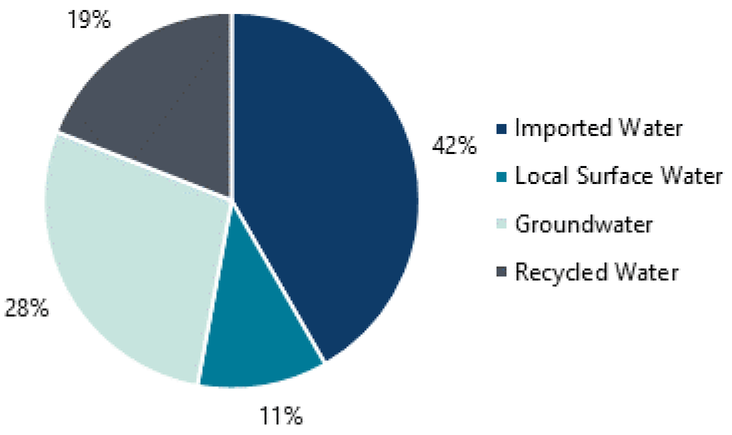


Figure 5-13: Alternative 6 Average Annual Supply Portfolio (2050)



5.1.7 Alternative 7 – Hybrid Surface Water/Recycled Water

Alternative 7 focuses on increasing local water supply reliability by maximizing local surface water supplies and recharging recycled water supplies to augment existing groundwater supplies in the Basin. Under this alternative, PWD would implement Palmdale Ditch enhancements to reduce conveyance losses, as well as restore capacity at Littlerock Reservoir. The Palmdale Ditch enhancements and restored capacity of Littlerock Reservoir would result in an average increase of 2,000 AFY of local surface water. In addition, PWD would store up to 30,000 AF of Tier 1 imported water, recycled water, and groundwater carryover in the Basin. This includes up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project and 5,000 AFY of recycled water supplies recharged into the Basin annually. It's assumed that 10% of the recharged recycled water (500 AFY) would be left in the basin to improve basin health. Seven new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-14**. **Figure 5-15** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12** below.

Figure 5-14: Alternative 7 Facility Locations

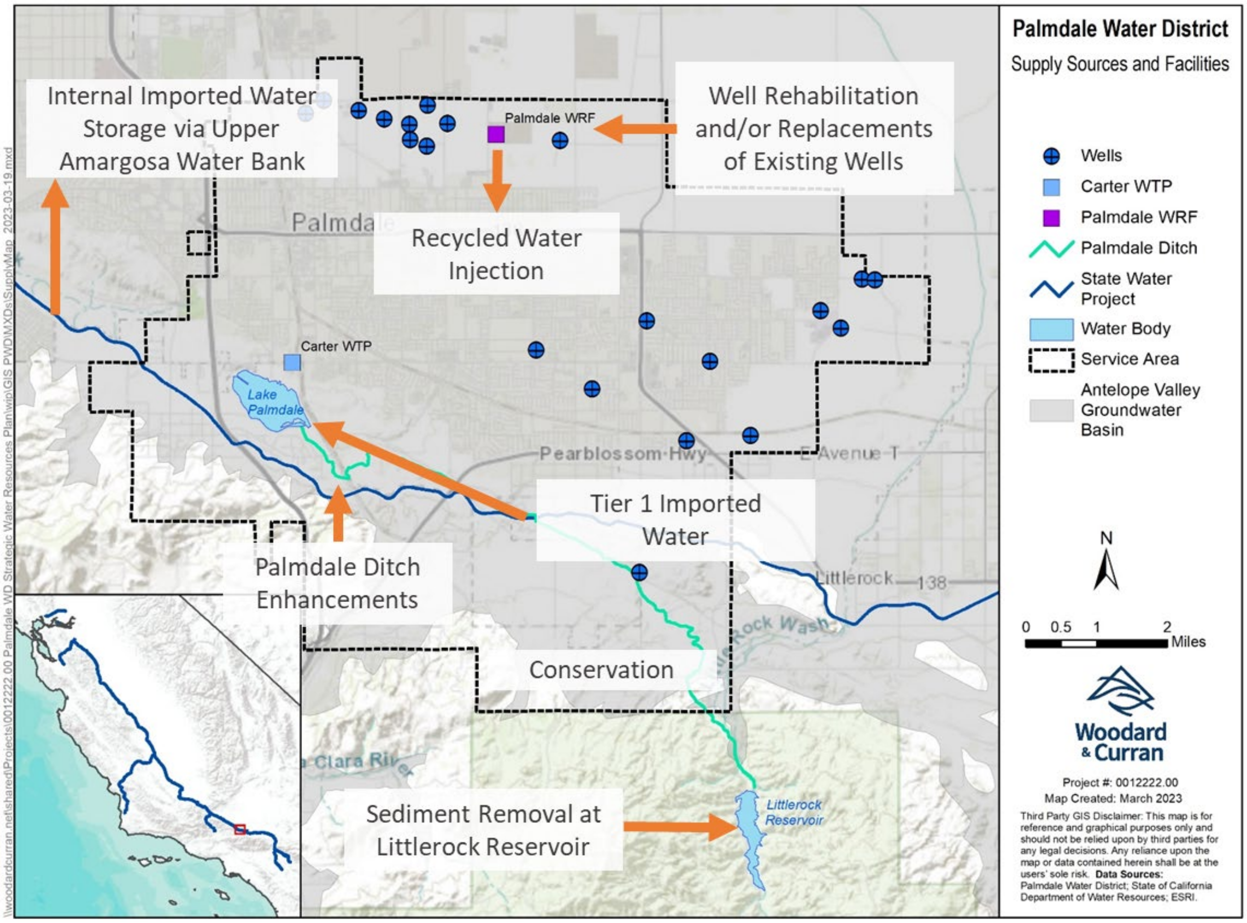
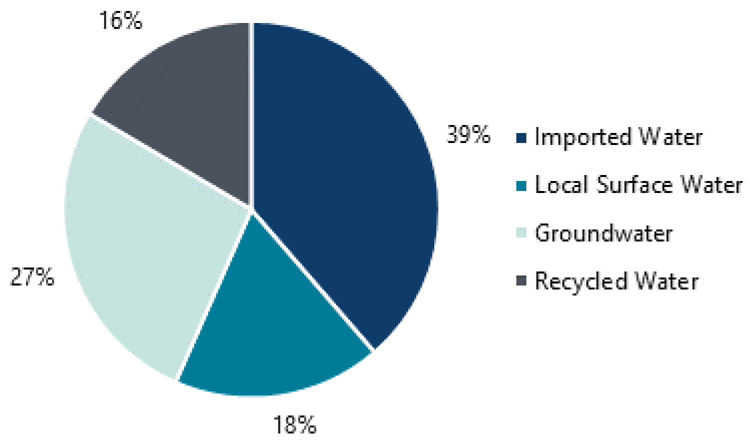


Figure 5-15: Alternative 7 Average Annual Supply Portfolio (2050)



5.1.8 Alternative 8 – Hybrid Groundwater/Recycled Water

Alternative 8 focuses on increasing local water supply reliability by recharging recycled water supplies and purchasing groundwater production rights to augment existing groundwater supplies. Under this alternative, PWD would store up to 32,000 AF of Tier 1 imported water, recycled water, and groundwater carryover in the Basin. Groundwater production rights would be enhanced through the purchase of 2,000 AFY of production rights from other groundwater users in the Basin. In addition, PWD would recharge up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project and 5,000 AFY of recycled water supplies recharged into the Basin annually. It's assumed that recycled water recharge would require a 10% leave-behind to improve the health of the Basin. Seven new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-16**. **Figure 5-17** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12** below.

Figure 5-16: Alternative 8 Facility Locations

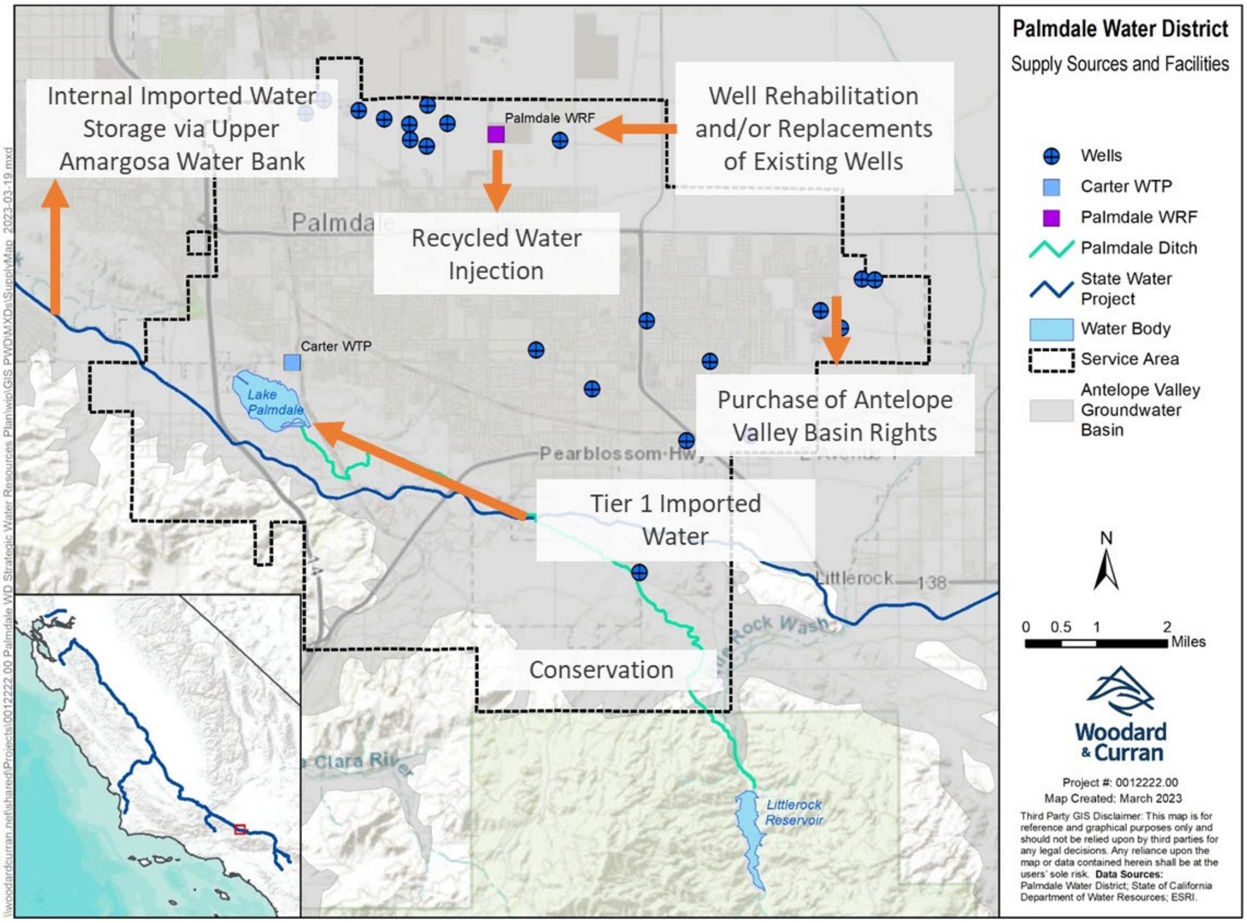
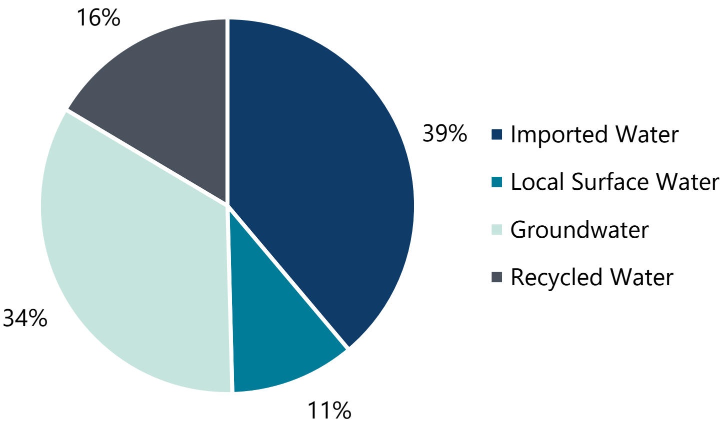


Figure 5-17: Alternative 8 Average Annual Supply Portfolio (2050)



5.1.9 Alternative 9 – Hybrid Imported Water/Recycled Water

Alternative 9 focuses on maximizing imported water supplies and developing additional storage within the Basin to store surplus imported water when it becomes available in wet years, as well as increasing local water supply reliability by augmenting groundwater supplies with recycled water supplies. Under this alternative, PWD would store up to 17,300 AF of Tier 1 and Tier 2 imported water in an internal water bank in the Antelope Valley. Any water stored in an Antelope Valley Water Bank is assumed to primarily be pumped back into the aqueduct, though it's also possible to exchange water stored for groundwater. In addition to storage in an internal water bank, this alternative assumes up to 31,000 AF of storage in the Antelope Valley Basin via imported recharge at the Upper Amargosa Water Project, recycled water injection and groundwater carryover. Seven new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-18**. **Figure 5-19** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12** below.

Figure 5-18: Alternative 9 Facility Locations

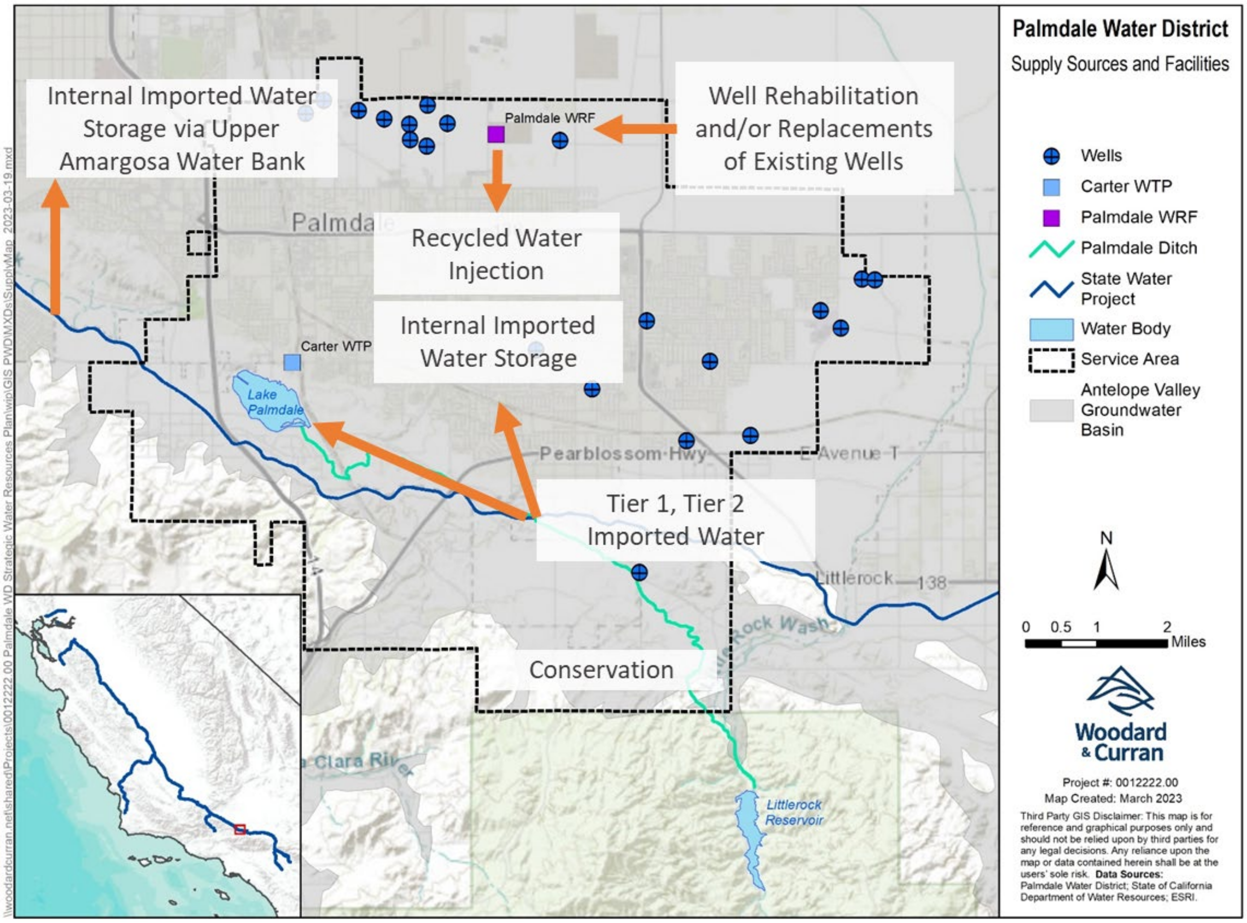
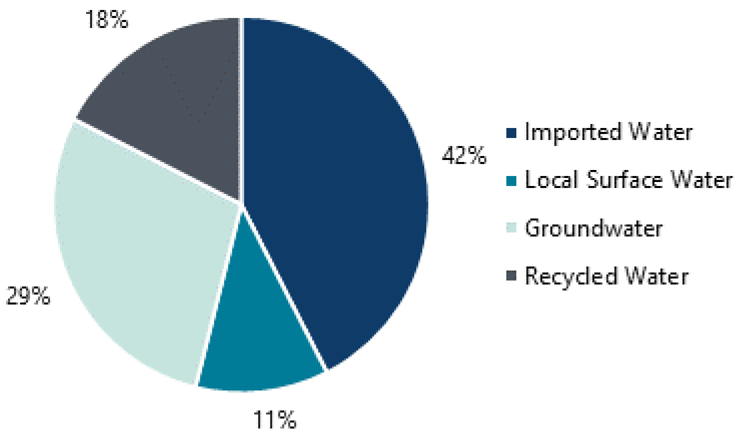


Figure 5-19: Alternative 9 Average Annual Supply Portfolio (2050)



5.1.10 Alternative 10 – Recycled Water Injection and Surface Water Augmentation

Alternative 10 focuses on increasing local water supply reliability by recharging half of the recycled water supplies into the Basin and diverting the other half into Lake Palmdale. On average, approximately 2,500 AF of recycled water supplies would be transported to Lake Palmdale, and 2,500 AF of recycled water supplies would be injected into the Basin annually. PWD would store up to 28,000 AF of Tier 1 imported water, recycled water, and groundwater carryover in the Basin. This includes the 2,500 AFY of recycled water supplies recharged into the Basin, as well as up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project. It's assumed that 10% of the recharged recycled water (500 AFY) would be left in the basin to improve basin health. Five new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program.

A map of the potential components under this Alternative is shown in **Figure 5-20**. **Figure 5-21** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12** below.

Figure 5-20: Alternative 10 Facility Locations

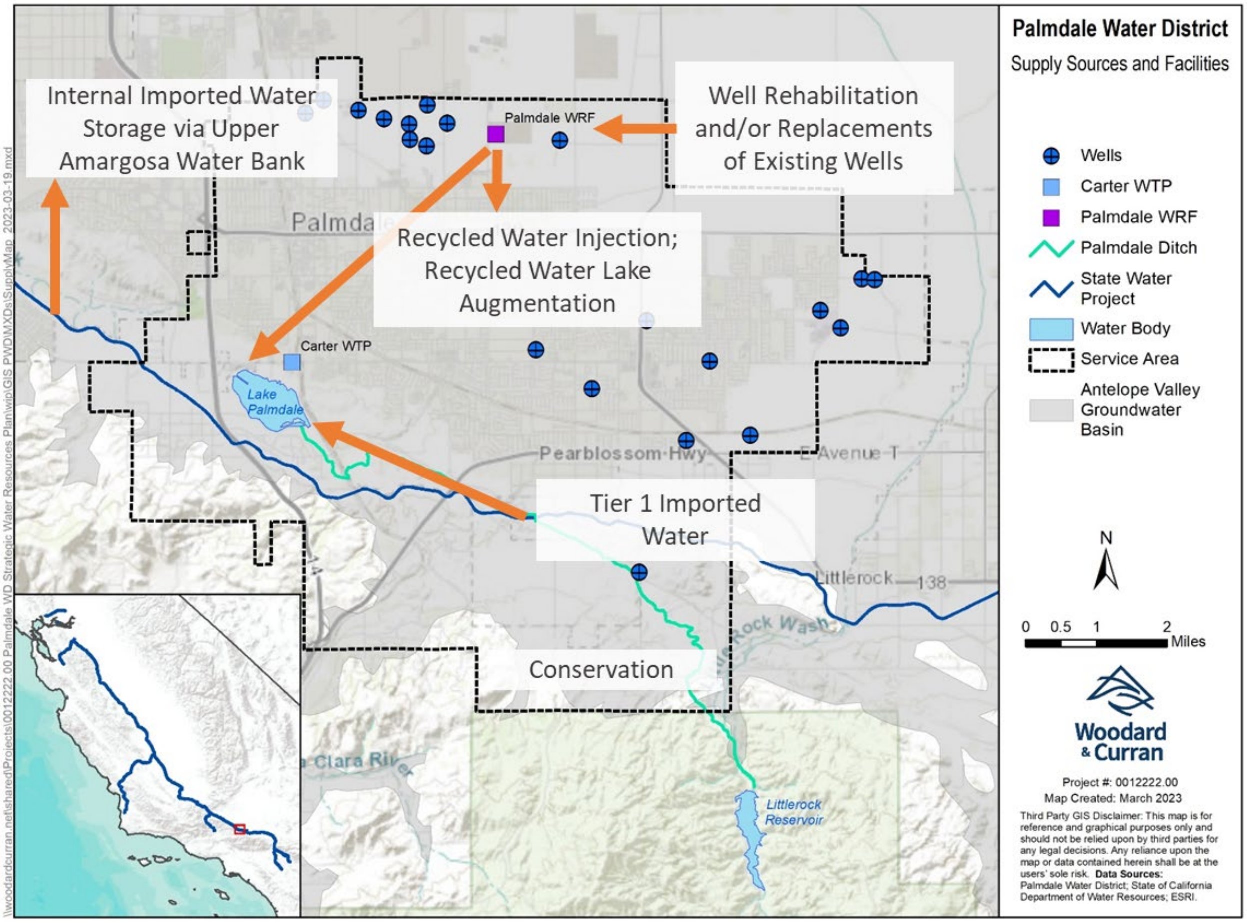
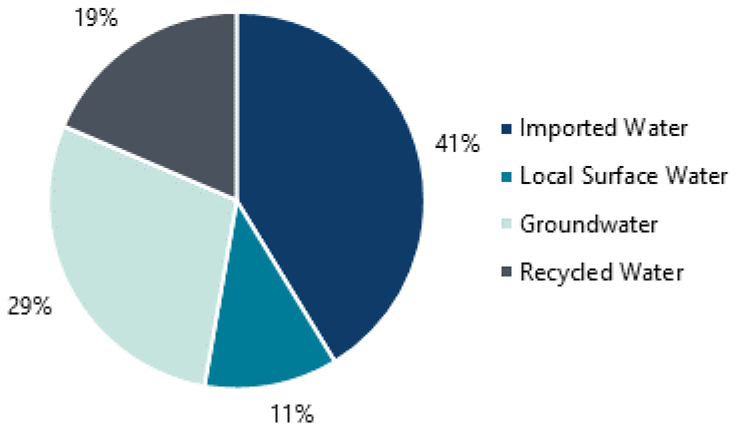


Figure 5-21: Alternative 10 Average Annual Supply Portfolio (2050)



5.1.11 Alternative 11 – Hybrid Groundwater/Recycled Water/Surface Water

Alternative 11 focuses on increasing local water supply reliability by recharging recycled water supplies, maximizing local water supplies, and purchasing groundwater production rights to augment existing groundwater supplies. Under this alternative, PWD would store up to 32,500 AF of Tier 1 imported water, recycled water, and groundwater carryover in the Basin. This includes 5,000 AFY of recycled water supplies recharged into the Basin as well as up to 1,600 AFY of imported water recharged via the Upper Amargosa Water Project. PWD would purchase 1,000 AFY of groundwater production rights from other pumpers in the Basin. Seven new wells are assumed to be needed to pump the stored water in the Basin (assuming a capacity of 1.7 mgd per well), in addition to five well replacements identified in the Well Rehabilitation Program. In addition, PWD would implement Palmdale Ditch enhancements to reduce conveyance losses and increase local water supply, resulting in an average increase of 1,500 AFY of local surface water.

A map of the potential components under this Alternative is shown in **Figure 5-22**. **Figure 5-23** shows, on average, the amount and type of supply that will be used under this alternative to meet demand in 2050. The projected water supply shortage frequency and depth of unmet demand is summarized in **Section 5.1.12** below.

Figure 5-22: Alternative 11 Facility Locations

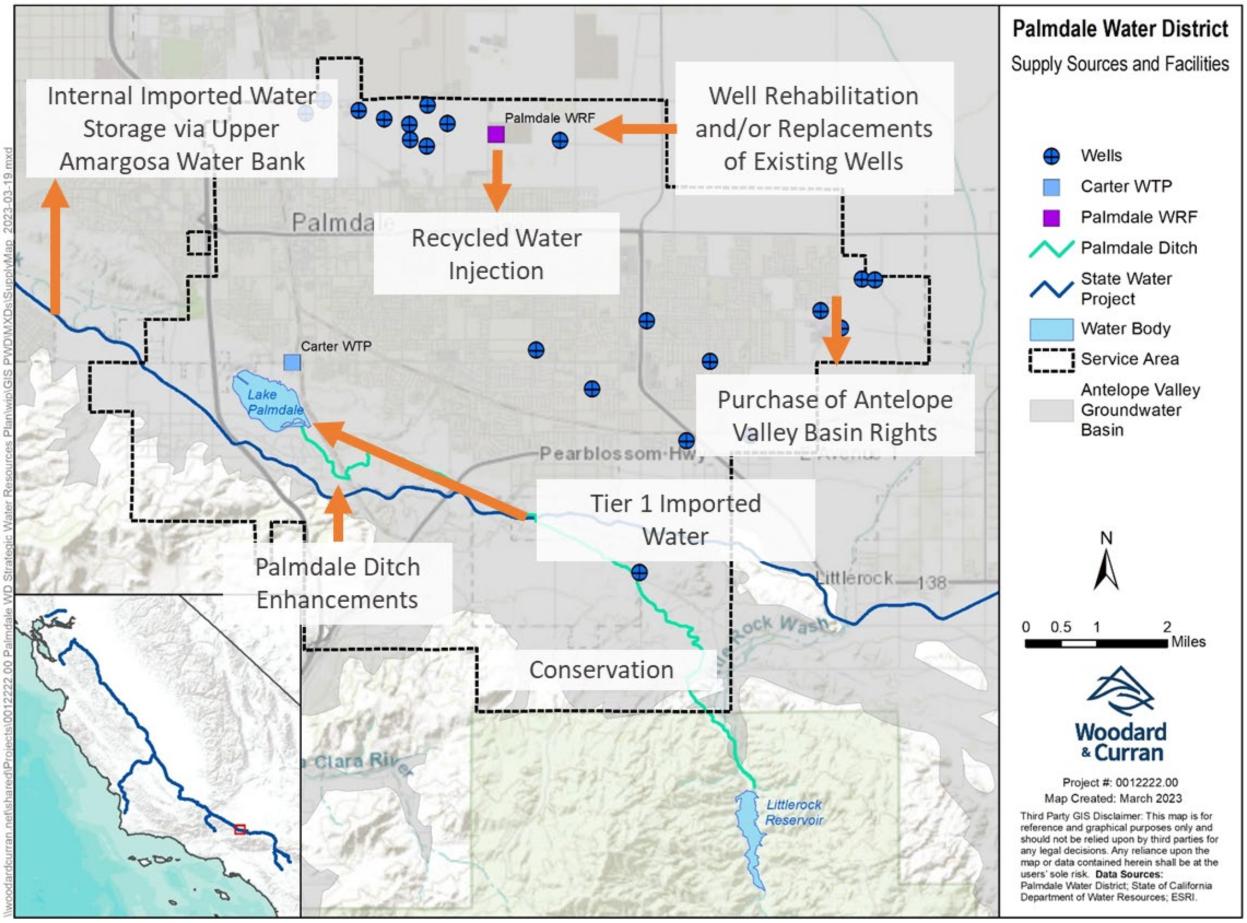


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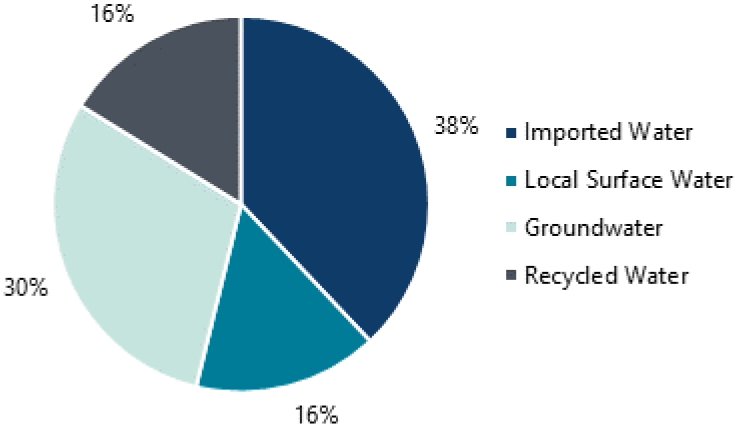
Figure 5-23: Alternative 11 Average Annual Supply Portfolio (2050)



5.1.12 Summary of Water Supply Shortages and Unmet Demands

A summary of water supply shortages and unmet demands in 2050 under each alternative is shown in **Table 5-3** as modeled using the WEAP model. As shown below, Alternative 1 (Imported Water (Internal Banking)) and Alternative 2 (Imported Water (External Banking)) experience the highest unmet demand, followed by Alternative 4 (Recycled Water (Surface Water Augmentation)) and Alternative 6 (Hybrid Imported/Recycled Water (Internal Banking and Surface Water Augmentation)). Alternative 8 (Hybrid Groundwater/Recycled Water) and Alternative 11 (Hybrid Groundwater/Recycled Water/Surface Water) experienced the lowest unmet demand in terms of both frequency and depth. In general, alternatives that maximize local storage and recycled water use performed the best in terms of reliability.

Table 5-3: Summary of Water Supply Shortages and Unmet Demands (2050 Demand)

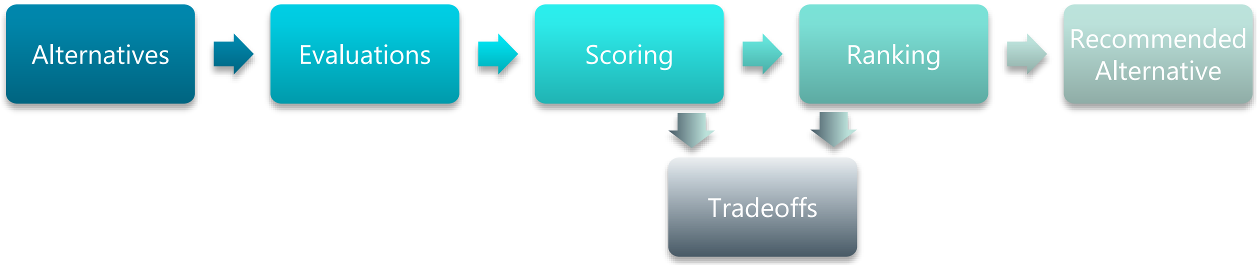
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9	Alt 10	Alt 11
Frequency of unmet demand during droughts	94%	94%	27%	85%	26%	74%	27%	6%	20%	59%	3%
Average unmet demand during droughts (AFY)	2,000	2,400	650	2,300	620	2,000	510	9	450	1,400	5
Frequency of unmet demand (above 20%)	4%	6%	0%	2%	0%	2%	0%	0%	0%	0%	0%
Average depth of unmet demand (over 20%)	5,600	5,800	0[1]	5,400	01	5,400	0[1]	0[1]	0[1]	0[1]	0[1]
Maximum unmet demand (AFY)	6,000	6,100	2,300	5,500	2,400	5,500	2,200	95	2,300	3,700	80

1. Shortages experienced under these alternatives do not exceed 20% of demand in any year.

5.2 Alternatives Evaluation

A multi-criteria evaluation method was used to compare the alternatives' ability to meet the objectives of this SWRP. Essential to this multi-criteria evaluation method is defining criteria and metrics to assess each alternative. The multi-criteria evaluation method uses alternative analysis results and accounts for the relative importance of the criteria to compute an aggregated final performance score. Alternatives can then be compared to make planning decisions. **Figure 5-24** provides an overall evaluation process showing each of the steps, from forming alternatives through evaluation and selection of the preferred portfolio, as described in the following sections.

Figure 5-24: Alternative Evaluation Process



5.2.1 Evaluation Criteria

In applying a multi-criteria evaluation method, the number of criteria need to be manageable, and criteria need to adhere to some basic principles. Criteria need to exhibit the following traits:

- **Understandable –** Decision-makers need to know what is being measured.
- **Quantifiable by quantitative or qualitative methods –** At least one metric needs to be established for each criterion. If no quantitative method is feasible to score a portfolio, a qualitative scale based on objective information needs to be established.
- **Non-redundant –** Each criterion and metric need to measure a distinct element of the alternative.

Table 5-4 shows the evaluation criteria and associated metrics that were developed based on the various objectives established for this SWRP and defined in Chapter 1. The evaluation criteria are both quantitative and qualitative. For the purposes of this SWRP, all criteria are considered equally important for most decision-makers and are therefore equally weighed to evaluate the alternatives.

Table 5-4: Evaluation Criteria

Criteria	Metric	Points			
Quantitative		*1 point*	*0.75 points*	*0.50 points*	*0.25 points*
Drought Reliability – Frequency	Likelihood of experiencing of shortage of 20% or more in 2050	No shortage	1% to 5%	5% to 10%	Over 10%
Drought Reliability – Depth	Average depth of shortage in 2050	Less than 3%	3% to 8%	9% to 15%	Over 15%
Emergency Imported Water Outage Reliability	Shortage depth during a 12-month SWP water outage (2050 demand)	Under 10% shortage	10% to 20% shortage	20% to 30% shortage	Shortage of 30% or above
Cost Efficiency	Unit cost, including capital, O&M, and water purchase cost, for new supplies and facilities	Under $3,200/AF	$3,200/AF to $3,700/AF	$3,700/AF to $4,200/AF	Over $4,200/AF
Water Quality	Loading of TDS applied to the Basin	Under 2,020 tons TDS (less than 15% increase over baseline)	2,020 to 2,100 tons TDS (15% to 20% increase over baseline)	2,100 to 2,280 tons TDS (20% to 30% increase over baseline)	Over 2,280 tons TDS (more than 30% increase over baseline)
Qualitative		*1 point*	*0.67 points*		*0.33 points*
Institutional Independence	Institutional independence (i.e., PWD control)	PWD control of assets	Regional control of assets		External control of assets
Sustainability	Stewardship of facilities, groundwater basins and/or reservoirs	Improves stewardship of facilities and groundwater basins and reservoirs	Improves stewardship of facilities or groundwater basins or reservoirs		Does not improve stewardship
Funding Potential	Eligibility for funding programs	Current/known funding programs	Assumed future funding programs		Limited funding likely

Criteria	Metric	Points		
Implementability	Ease of completing environmental documentation and regulatory/permitting compliance Phasing potential and adaptability	Environmental and permitting expected to be less complicated and high phasing potential	Environmental and permitting expected to be somewhat complicated or high phasing potential	Environmental and permitting expected to be more complicated

5.2.2 Alternative Evaluation

The evaluation results are most helpful to decision-makers when they highlight the differences between alternatives in their ability to meet SWRP objectives. This section presents the evaluation results based on each alternative's overall ability to achieve objectives established during the planning period.

5.2.2.1 Drought Reliability – Frequency

Drought Reliability – Frequency quantitatively evaluated for each of the supply alternatives on its anticipated reliability in drought conditions. This evaluation considered the potential likelihood of shortages in 2050. This criterion was calculated as the percentage of years experiencing a shortage that exceeds 20% of demand for each supply alternative.

In general, groundwater and recycled water supplies tend to be less vulnerable to drought conditions than imported and local surface water supplies. As a result, alternatives that incorporate recycled water injection into the Basin reduced the potential likelihood of shortages during drought conditions. These alternatives tended to score higher than alternatives that did not incorporate recycled water injection.

Table 5-5: Drought Reliability – Frequency Evaluation Results

Alternative	Drought Reliability – Frequency (percent of years experiencing shortage exceeding 20% of demand)	Points
1. Imported Water (Internal Banking)	4%	0.75
2. Imported Water (External Banking)	5%	0.75
3. Recycled Water (Groundwater Injection)	0%	1.00
4. Recycled Water (Surface Water Augmentation)	2%	0.75
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	0%	1.00
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	2%	0.75
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	0%	1.00
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	0%	1.00
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	0%	1.00
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	0%	1.00
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	0%	1.00

5.2.2.2 Drought Reliability – Depth

Drought Reliability – Depth quantitatively evaluated for each of the supply alternatives on its anticipated reliability in drought conditions. This evaluation considered the average depth of shortage during droughts in 2050. This criterion was calculated as the AFY of shortage for each supply alternative during droughts.

As previously mentioned, groundwater and recycled water supplies are generally less susceptible to drought impacts compared to local surface water supplies and imported water supplies. Furthermore, diverse water supply portfolios tend to also be more resilient to drought conditions. Therefore, hybrid alternatives that incorporate recycled water injection into the Basin have the potential to decrease the average shortage depth during drought conditions. These alternatives have generally scored higher than those that do not include diverse portfolios with recycled water injection.

Table 5-6: Drought Reliability – Depth Evaluation Results

Alternative	Drought Reliability – Depth (average depth of demand during drought years as the percent of demand)	Points
1. Imported Water (Internal Banking)	8% of demand	0.75
2. Imported Water (External Banking)	9% of demand	0.50
3. Recycled Water (Groundwater Injection)	3% of demand	0.75
4. Recycled Water (Surface Water Augmentation)	9% of demand	0.50
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	2% of demand	1.00
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	8% of demand	0.75
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	2% of demand	1.00
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	no shortage	1.00
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	2% of demand	1.00
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	6% of demand	0.75
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	no shortage	1.00

5.2.2.3 Emergency Imported Water Outage Reliability

Emergency Imported Water Outage Reliability quantitatively evaluated each of the supply alternatives on its ability to meet water demands in the event a catastrophic event disrupts imported water availability. This evaluation considered the water supply shortage depth during a 12-month SWP water outage. This criterion was calculated as a percentage of shortage for each supply alternative based on the 2050 water demand.

Alternatives that are heavily reliant on imported water supplies are more vulnerable to shortages in the event a catastrophic event disrupts the SWP conveyance infrastructure, resulting in an imported water outage. Consequently, alternatives that are less dependent on imported water supplies scored higher because they are generally more resilient to emergency imported water outages.

Table 5-7: Emergency Imported Water Outage Reliability Evaluation Results

Alternative	Emergency Imported Water Outage Reliability (shortage depth during a 12-month imported water outage as percent of demand)	Points
1. Imported Water (Internal Banking)	23% of demand	0.50
2. Imported Water (External Banking)	24% of demand	0.50
3. Recycled Water (Groundwater Injection)	9% of demand	1.00
4. Recycled Water (Surface Water Augmentation)	13% of demand	0.75
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	9% of demand	1.00
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	15% of demand	0.75
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	8% of demand	1.00
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	0% of demand	1.00
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	9% of demand	1.00
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	12% of demand	0.75
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	0% of demand	1.00

5.2.2.4 Cost Efficiency

Cost Efficiency quantitatively evaluated each of the supply alternatives on cost efficiency measured as the total cost needed to produce an average (across the combined supply sources) unit of supply in AFY. The total cost to implement each alternative was estimated by annualizing any individual costs to purchase water, capital costs to build necessary facilities, as well as operational and maintenance (O&M) costs associated with any existing and new facilities required for the alternative to function. The combined unit costs were spread across the average annual volume of supply to calculate the average present value unit cost ($/AF) for each alternative.

Table 5-8: Cost Efficiency Evaluation Results

Alternative	Unit Cost ($/AF)[1]	Points
1. Imported Water (Internal Banking)	$3,400	0.75
2. Imported Water (External Banking)	$3,400	0.75
3. Recycled Water (Groundwater Injection)	$3,700	0.75
4. Recycled Water (Surface Water Augmentation)	$3,300	0.75
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	$4,600	0.25
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	$4,200	0.50
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	$3,300	0.75
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	$3,100	1.00
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	$3,600	0.75
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	$3,600	0.75
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	$2,900	1.00

1. Unit costs include the capital and O&M costs for all projects described in the alternatives description above. For example, Alternative 3: Recycled Water (Groundwater Injection) includes the costs for AV Pure Water, conveyance of imported water to the Amargosa Water Bank recharge facilities, and new wells required to produce any stored water.

5.2.2.5 Water Quality

Water Quality quantitatively evaluated each of the supply alternatives on the overall water quality associated with each alternative's supply mix. This was estimated by calculating the total amount of salts (total dissolved solids [TDS]) delivered into the service area by each alternative's supply mix. The total anticipated TDS loading to the groundwater basin was calculated in tons per year for each supply alternative and compared to the baseline scenario.

Advanced treated water and imported water supplies both introduce additional TDS into the Basin. Tertiary effluent from the PWRP has an average TDS concentration of 471 milligrams per liter (mg/L). Advanced treatment is assumed to reduce TDS concentrations by more than 95 percent, resulting in an estimated concentration of 24 mg/L (PWD, 2022). TDS concentrations for imported water from the SWP are significantly higher, estimated at approximately 300 mg/L (PWD, 2021a). As a result, alternatives that focus on maximizing local surface water and groundwater supplies scored the highest because they do not introduce a new source of TDS into the Basin. Alternatives that focus on recycled water scored higher than alternatives that primarily rely on imported water supply, particularly alternatives with internal imported water storage, because they introduce less TDS into the Basin.

Table 5-9: Water Quality Evaluation Results

Alternative	Water Quality (TDS loading in tons/yr)	Points
1. Imported Water (Internal Banking)	2,740 tons/yr	0.25
2. Imported Water (External Banking)	2,570 tons/yr	0.25
3. Recycled Water (Groundwater Injection)	2,000 tons/yr	1.00
4. Recycled Water (Surface Water Augmentation)	2,110 tons/yr	0.50
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	2,130 tons/yr	0.50
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	2,250 tons/yr	0.50
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	2,000 tons/yr	1.00
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	2,000 tons/yr	1.00
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	2,450 tons/yr	0.25
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	2,200 tons/yr	0.50
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	2,000 tons/yr	1.00

5.2.2.6 Institutional Independence

Institutional Independence qualitatively evaluated each of the supply alternatives on the level of dependence on non-PWD entities. Considerations included control over the facilities required for implementation and supplies generated. Alternatives with components such as external banking that involve outside agencies are dependent upon those agencies for success.

In general, PWD has greater control over local water supplies such as recycled water, groundwater, and local surface water, and less control over external water supplies such as imported water. As a result, alternatives that maximize local water supplies directly managed by PWD scored the highest. Alternatives that rely on imported water supplies and external imported water storage tended to score the lowest.

Table 5-10: Institutional Independence Evaluation Results

Alternative	Institutional Independence (based on reliance on other agencies)	Points
1. Imported Water (Internal Banking)	Banking agreement with AVEK (within region) Imported water purchase agreements	0.67
2. Imported Water (External Banking)	Banking agreement outside the region Imported water purchase agreements	0.33
3. Recycled Water (Groundwater Injection)	No reliance on new partnerships or agreements	1.00
4. Recycled Water (Surface Water Augmentation)	No reliance on new partnerships or agreements	1.00
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	Banking agreement outside the region	0.33
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	Banking agreement with AVEK (within the region)	0.67
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	No reliance on new partnerships or agreements	1.00
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	No reliance on new partnerships or agreements	1.00
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	Banking agreement with AVEK (within region)	0.67
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	No reliance on new partnerships or agreements	1.00
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	No reliance on new partnerships or agreements	1.00

5.2.2.7 Sustainability

Sustainability qualitatively evaluated each of the supply alternatives on the stewardship of facilities, groundwater basins, and reservoirs. Considerations included the ability to replenish local resources or improve the condition of existing resources.

Alternatives that improve local resource conditions by enhancing PWD’s infrastructure, such as the Palmdale Ditch and Littlerock Reservoir, tended to score higher under this criterion. Alternatives that do not have an impact on local facilities, basins, or reservoirs, such as alternatives that primarily focus on increasing imported water supplies and rely on external banking, tended to score lower.

Table 5-11: Sustainability Evaluation Results

Alternative	Sustainability (based on stewardship of facilities, groundwater basins and/or reservoirs)	Points
1. Imported Water (Internal Banking)	Improves stewardship of groundwater basin	0.67
2. Imported Water (External Banking)	Doesn't improve stewardship of facilities, groundwater basins and/or reservoirs	0.33
3. Recycled Water (Groundwater Injection)	Improves stewardship of groundwater basin	0.67
4. Recycled Water (Surface Water Augmentation)	Improves stewardship of facilities (Carter WTP)	0.67
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	Improves stewardship of groundwater basin	0.67
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	Improves stewardship of facilities (Carter WTP)	0.67
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	Improves stewardship of reservoirs and groundwater basin and Carter WTP	1.00
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	Improves stewardship of Carter WTP and groundwater basin	0.67
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	Improves stewardship of groundwater basin	0.67
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	Improves stewardship of Carter WTP and groundwater basin	0.67
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	Improves stewardship of Carter WTP, Palmdale Ditch and groundwater basin	1.00

5.2.2.8 Funding Potential

Funding Potential qualitatively evaluated each of the supply alternatives on the eligibility and competitiveness for common water supply funding sources. The evaluation of fundability considered State and federal funding programs such as Drinking Water State Revolving Fund (SRF), Clean Water SRF, Sustainable Groundwater Management, Title XVI Water Reclamation and Reuse, WaterSmart, and other known sources of funding.

Over the past few years, funding programs have focused on maximizing local water supplies to reduce reliance on imported water supplies. As a result, integrated alternatives that include options to maximize groundwater, recycled water, and/or local surface water supplies tend to be more competitive for funding, and therefore score higher, than alternatives that primarily focus on increasing imported water supplies.

Table 5-12: Funding Potential Evaluation Results

Alternative	Funding Potential (based on known and potential funding opportunities)	Points
1. Imported Water (Internal Banking)	Potential future funding for local water bank development	0.67
2. Imported Water (External Banking)	Low potential for future funding	0.33
3. Recycled Water (Groundwater Injection)	Current/known funding programs (recycled water)	1.00
4. Recycled Water (Surface Water Augmentation)	Current/known funding programs (recycled water)	1.00
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	Current/known funding programs (recycled water)	1.00
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	Current/known funding programs (recycled water)	1.00
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	Current/known funding programs (recycled water)	1.00
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	Current/known funding programs (recycled water)	1.00
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	Current/known funding programs (recycled water)	1.00
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	Current/known funding programs (recycled water)	1.00
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	Current/known funding programs (recycled water)	1.00

5.2.2.9 Implementability

Implementability qualitatively evaluated each of the supply alternatives on the ease of implementation. Considerations included ease of completing environmental documentation and regulatory and permitting compliance requirements associated with accessing, producing, and conveying the supply mix within each alternative. This criterion also evaluated the supply alternatives' phasing potential and adaptability to uncertainty, such as changes in demand trends, hydrology and supply availability, facility needs and costs, regulations, and decision-maker priorities.

Table 5-13: Implementability Evaluation Results

Alternative	Implementability (based on permitting requirements and phasing potential)	Points
1. Imported Water (Internal Banking)	Uncomplicated environmental permitting, but low phasing potential	0.67
2. Imported Water (External Banking)	Uncomplicated environmental permitting, but low phasing potential	0.67
3. Recycled Water (Groundwater Injection)	Less complicated permitting and environmental docs required for RW injection, low phasing potential	0.67
4. Recycled Water (Surface Water Augmentation)	More complicated permitting and environmental docs req'd for lake augmentation with RW, low phasing potential	0.33
5. Hybrid Imported Water/ Recycled Water (External Banking, Recycled Water Injection)	Less complicated permitting and environmental docs req'd for RW injection, and potential for phasing	1.00
6. Hybrid Imported Water/Recycled Water (Internal Banking, Surface Water Augmentation)	More complicated permitting and environmental docs req'd for lake augmentation with RW, but with potential for phasing	0.67
7. Hybrid Surface Water/Recycled Water (Surface Water Enhancement, Recycled Water Injection)	More complicated permitting & environmental docs req'd for removing sediment from Littlerock Reservoir due to existing habitat, but with potential for phasing	0.67
8. Hybrid Groundwater/ Recycled Water (Groundwater Rights, Recycled Water Injection)	Less complicated permitting and environmental docs req'd for RW injection, and potential for phasing	1.00
9. Hybrid Imported Water/Recycled Water (Internal Banking, Recycled Water Injection)	Less complicated permitting and environmental docs req'd for RW injection, and potential for phasing	1.00
10. Hybrid Recycled Water (Recycled Water Injection, Surface Water Augmentation)	More complicated permitting and environmental docs req'd for lake augmentation with	0.67

Alternative	Implementability (based on permitting requirements and phasing potential)	Points
	RW, but with potential for phasing	
11. Hybrid Groundwater/ Recycled Water/ Surface Water (Groundwater rights, Recycled Water Injection, Palmdale Ditch Enhancement)	Less complicated permitting and environmental docs req'd for RW injection, and potential for phasing	1.00

5.2.3 Alternative Summary Scores

Table 5-14 shows the summary of the scores for each alternative under each of the nine evaluation criteria. In each case the points contained in the table above are multiplied by the criteria weight for each criterion. With all criteria weighted equally, the differences between alternatives depend on which one is more balanced and higher ranked in more areas. **Section 5.3** below incorporates the evaluation criteria results and identifies a preferred alternative.

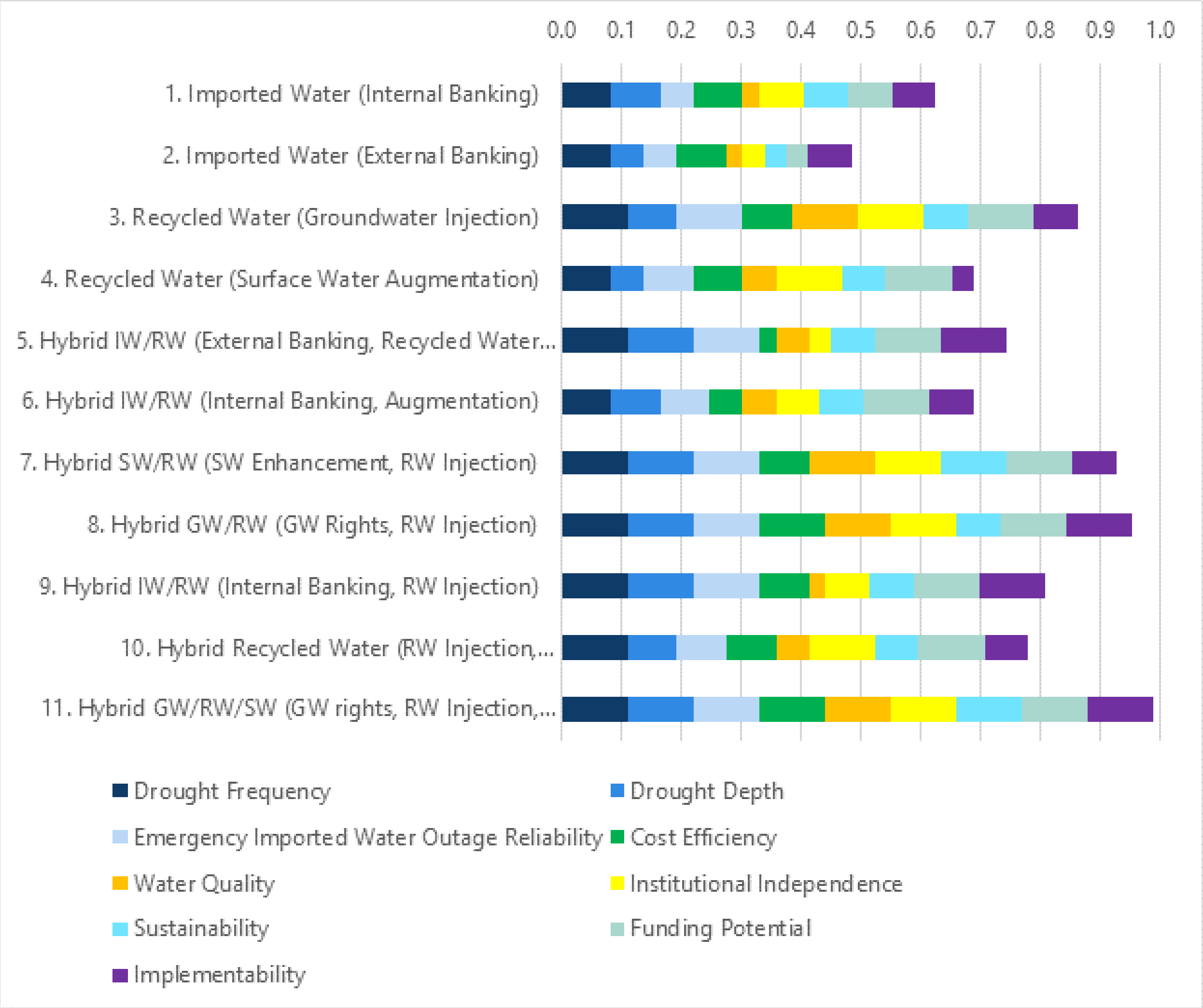
Table 5-14: Alternative Evaluation Weighted Scores

	Criteria Weight	1. Imported Water *Internal banking*	2. Imported Water *External banking*	3. Recycled Water *Groundwater injection*	4. Recycled Water *Surface water augmentation*	5. Hybrid Imported Water/ Recycled Water *Imported water external banking, recycled water injection*	6. Hybrid Imported Water/Recycled Water *Imported water internal banking, recycled water surface water augmentation*	7. Hybrid Surface Water/Recycled Water *Surface water enhancement, recycled water injection*	8. Hybrid Groundwater/ Recycled Water *Groundwater rights, recycled water injection*	9. Hybrid Imported Water/Recycled Water *Imported water internal banking, recycled water injection*	10. Hybrid Recycled Water *Recycled water injection, recycled water surface water augmentation*	11. Hybrid Groundwater/ Recycled Water/Surface Water *Groundwater rights, recycled water injection, Palmdale Ditch enhancement*
Drought Reliability – Frequency	11.1%	0.08	0.08	0.11	0.08	0.11	0.08	0.11	0.11	0.11	0.11	0.11
Drought Reliability – Depth	11.1%	0.08	0.06	0.08	0.06	0.11	0.08	0.11	0.11	0.11	0.08	0.11
Emergency Imported Water Outage Reliability	11.1%	0.06	0.06	0.11	0.08	0.11	0.08	0.11	0.11	0.11	0.08	0.11
Cost Efficiency	11.1%	0.08	0.08	0.08	0.08	0.03	0.06	0.08	0.11	0.08	0.08	0.11
Water Quality	11.1%	0.03	0.03	0.11	0.06	0.06	0.06	0.11	0.11	0.03	0.06	0.11
Institutional Independence	11.1%	0.07	0.04	0.11	0.11	0.04	0.07	0.11	0.11	0.07	0.11	0.11
Sustainability	11.1%	0.07	0.04	0.07	0.07	0.07	0.07	0.11	0.07	0.07	0.07	0.11
Funding potential	11.1%	0.07	0.04	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Implementability	11.1%	0.07	0.07	0.07	0.04	0.11	0.07	0.07	0.11	0.11	0.07	0.11
Total Weighted Score		**0.62**	**0.49**	**0.86**	**0.69**	**0.74**	**0.69**	**0.93**	**0.95**	**0.81**	**0.78**	**0.99**

5.3 Alternative Ranking Results and Selection of Preferred Alternative

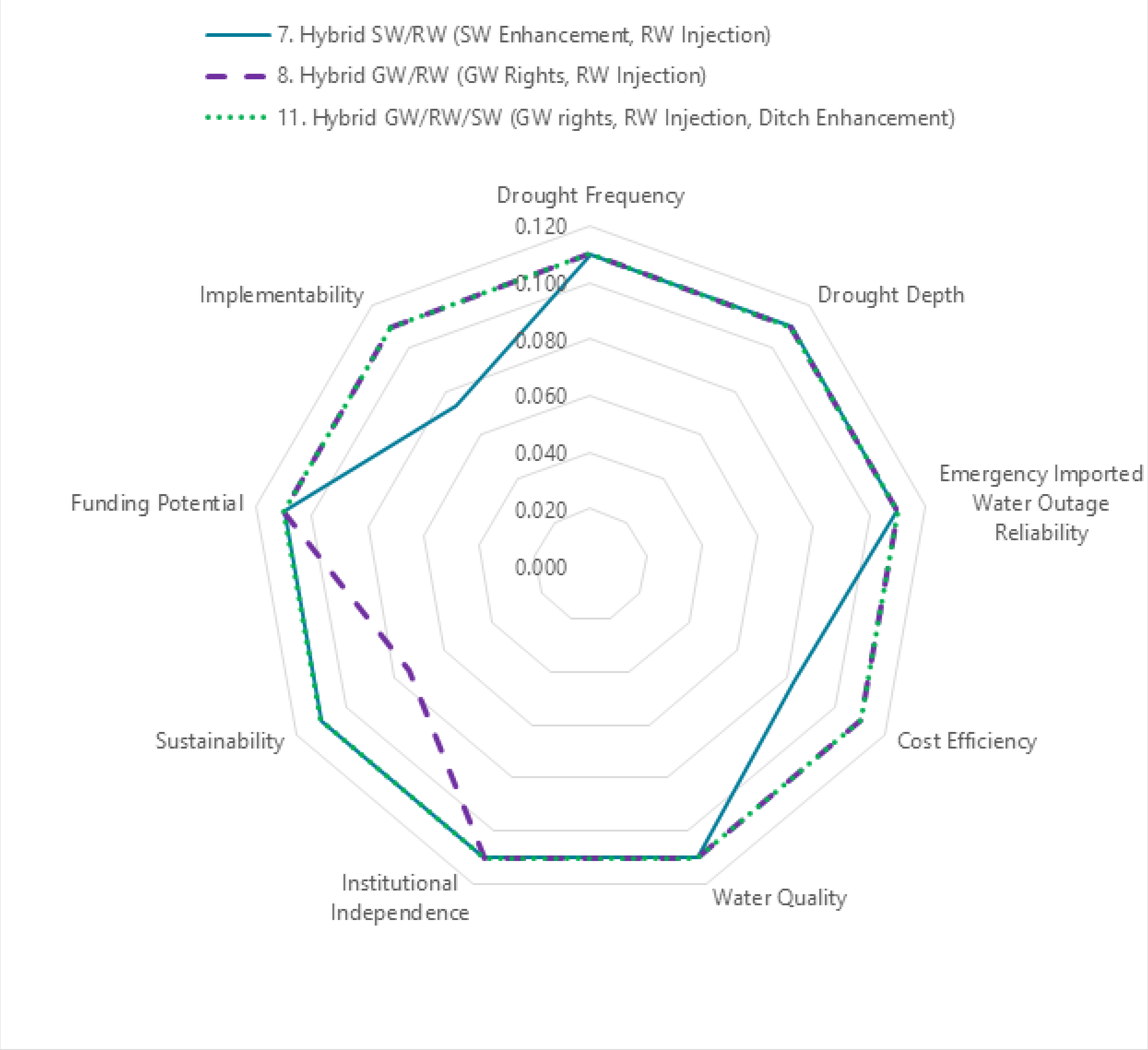
Figure 5-25 compares summarizes the performance for each alternative based on the results presented in **Table 5-14**. Alternatives that primarily rely on imported water, particularly alternatives 1 and 2, are noticeably lower in overall scoring relative to the other hybrid alternatives. The lack of diversity in these portfolios makes these alternatives susceptible to drought impacts, emergency imported water outages, and water quality degradation. These alternatives also provide less institutional independence and are less sustainable and have lower funding potential. Another notable result is that the hybrid alternatives tend to be the highest scoring. Hybrid alternatives that incorporate local water supply development, such as alternatives 3, 7, 8 and 11, rely on water supplies that are less susceptible to drought impacts and emergency imported water outages, provide greater institutional independence, and have greater funding potential. These alternatives also have less potential to impact water quality in the Basin.

Figure 5-25: Alternatives Scores



The SWRP process included the evaluation of results internally with PWD staff to interpret these multi-criteria evaluation results. For a planning project with the importance and relevance of the SWRP, an aggregated numerical index from quantitative analysis cannot dictate a final decision alone, even though it represents an invaluable parameter for decision-making. To facilitate decision-making, the top three scoring alternatives were compared as part of a tradeoff analysis to present and discuss the pros and cons of the alternatives. Figure 5-26 plots the scores of Alternatives 7, 8 and 11 on a radar-style chart with a criteria on each axis, with better scores plotted on the outer rings. As shown in the chart, these three alternatives score similarly under most criteria, including drought frequency, drought depth, emergency imported water outage reliability, cost efficiency, water quality and institutional independence. Alternative 7 scores slightly lower under implementability due to the increased permitting requirements needed for the option to increase sediment removal in Littlerock Reservoir. Alternative 8 scores slightly lower under sustainability due to having less options that would improve stewardship of local surface water resources. Therefore, Alternative 11 scored equal to or better in all categories as compared to Alternatives 7 and 8.

Figure 5-26: Evaluation Comparison for Alternatives 7, 8 and 11



Overall, Alternative 11 ranks the highest relative to the other alternatives, and is therefore, the preferred alternative in this SWRP. The implementation and financing plan for this preferred alternative are described in the following chapters.

5.4 Analysis of Preferred Alternative with Delta Conveyance Project

The California Department of Water Resources (DWR) has been working to improve SWP infrastructure used to convey water through the Sacramento-San Joaquin Delta (Delta) from the Bay area to Southern California. The proposed Delta Conveyance Project will develop new infrastructure facilities in the Delta to guard against disruptions caused by sea level rise, the hydrologic effects of climate change and seismic threats.

The proposed Delta Conveyance Project, as identified in the Draft Environmental Impact Report (EIR) (DWR, 2022a), is projected to increase Delta water exports, including an increase of 13% of Table A deliveries in an average hydrologic year and 23% increase of Table A deliveries in dry and critical water years under existing (2020 hydrology) conditions. Article 21 deliveries are projected to increase by 254% in an average year and 3% in dry and critical years under existing (2020 hydrology) conditions. Under 2040 hydrology conditions, Table A deliveries are projected to increase by 16% in an average year and by 35% in dry and critical years. Article 21 deliveries are projected to increase by 185% in an average hydrologic year and *decrease* by 22% in dry and critical years under 2040 hydrology conditions.

The reliability of supply was modeled with the expected changes in Table A and Article 21 deliveries due to the Delta Conveyance Project under the baseline scenario and with the preferred alternative, the results of which are shown in **Table 5-15.** The improved reliability from the Delta Conveyance Project is projected to decrease the frequency and depth of unmet demand in both the baseline and preferred alternative. However, there are still significant benefits in the reduction of unmet demand in the preferred alternative as compared to the Baseline.

Table 5-15: Summary of Unmet Demand Under with and without Delta Conveyance Project (2050 Demand)

	Without Delta Conveyance Project		With Delta Conveyance Project	
	Baseline	Preferred Alternative	Baseline	Preferred Alternative
Frequency of unmet demand during droughts	26%	3%	21%	1%
Average unmet demand during droughts (AFY)	6,700	5	5,500	2
Frequency of unmet demand (above 20%)	28%	0%	22%	0%
Average depth of unmet demand (for years of unmet demand over 20%)	7,900	0	7,300	0
Maximum unmet demand (AFY)	10,400	80	9,600	75

6. IMPLEMENTATION

6.1 Preferred Alternative Summary

The preferred alternative selected through the SWRP process is one which maximizes local supplies and facilities to meet future growth and increases storage of water in the Antelope Valley Basin to meet demands during times of imported water shortage. The preferred alternative includes the following strategies:

- Maximize current Table A water usage
- Maximize beneficial use of recycled water through implementation of Pure Water Antelope Valley (AV)
- Store imported water in the Antelope Valley Basin via the Upper Amargosa Creek Project
- Store recycled water in the Antelope Valley Basin via injection
- Maintain storage capacity in Littlerock Reservoir through sediment removal
- Improve Palmdale Ditch to reduce water loss
- Add additional pumping capacity to access stored water during times of shortage
- Continue active conservation programs

The water supply targets for the preferred alternative are shown in **Table 6-1**.

Table 6-1: Water Supply Targets for the Preferred Alternative

Water Supply Element	Current	Target for 2050
Supply Volumes (average)		
Imported Water - Potable - Recharge	 6,400 AFY 0 AFY	 9,600 AFY[1] 1,200 AFY[1]
Groundwater Pumping	8,000 AFY	11,200 AFY
Littlerock Reservoir	3,000 AFY	4,500 AFY
Recycled Water - Non-potable - Recharge via injection	 100 AFY 0 AFY	 100 AFY 5,000 AFY
Facility Capacities		
Leslie O. Carter WTP (Carter WTP)	35 mgd	35 mgd
Pure Water Treatment	0 mgd	5 mgd
Injection Wells	0 mgd	4.5 mgd
Production Wells	9.8 mgd	32 mgd
Water Storage in Antelope Valley Basin	0 AF	32,500 AF

2. Actual volume of imported water used will vary significantly depending on Table A allocations. In years of lower imported water availability, it's assumed that pumping will be increased to meet demands.

6.2 Implementation Plan

This implementation plan outlines elements to be considered as PWD moves forward with implementing the preferred alternative, including:

- Articulating the objectives to be achieved with each water resources strategy
- Identifying what activities need to take place to achieve those objectives and when they need to be implemented
- Identify what decisions need to be made and when to commit PWD resources
- Summarize the costs associated with these activities and decisions
- Identify what uncertainties may impact implementation

This implementation plan is designed to serve as a guide for PWD as it proceeds with developing new water resource capabilities. The strategies addressed include the following elements:

- Imported water
- Groundwater
- Recycled water
- Littlerock Reservoir
- Conservation

6.2.1 Imported Water

PWD's strategic objectives for managing imported water are:

- Support projects and initiatives that increase the resilience of State Water Project Supplies
- Increase storage of SWP supplies in the Antelope Valley Basin
- Maximize use of existing imported water supplies

To achieve these strategic objectives, PWD will pursue the following strategies:

1. **Support State Water Project System Management and Operation:** The planning, operation, and management of the SWP system is continuing to evolve as plans and contingencies are made for conveyance improvement to the Delta, new surface storage, and changes to water exchange/transfer policy and oversight. It is incumbent on PWD to be closely involved in discussions and decisions that may affect either the reliability or cost of imported water to PWD.

2. **Bank Imported Water in Antelope Valley Basin Storage Projects:** The State Water Project is expected to continue to have fluctuations in the amount of water available to State Water Contractors, and even experience greater fluctuations as climate change impacts hydrology. To take advantage of increased volumes of imported water in wet years, PWD should take advantage of imported water recharge projects in the Antelope Valley Basin to store imported water for use in dry years.

3. **Maintain Flexibility for Future Surface Water Treatment:** While the recommended strategy utilizes groundwater pumping to meet future delivery needs rather than surface water treatment, PWD should nevertheless maintain its ability to implement water treatment in the future. This

capability may be needed due to changes in water quality regulations, deterioration in imported water quality, or a possible future shift in PWD’s water resource strategy for other reasons.

6.2.2 Groundwater

PWD’s strategic objective for managing and developing groundwater are:

- Be able to pump stored water to meet demands during imported water shortages
- Establish and operate recharge facilities to offset proposed pumping increases
- Leverage excess stored water to generate capital for PWD projects
- Increase PWD’s groundwater production rights

To achieve these strategic objectives, PWD will pursue the following strategies:

1. **Maintain existing pumping capacity:** PWD should proceed with the rehabilitation and replacement of its wells as recommended in the 2020 Well Rehabilitation Prioritization Program to maintain current pumping capacity.
2. **Install new production and injection wells:** PWD should proceed with installing additional well capacity to both meet demand growth and pump stored water during years when SWP allocations are low. To offset increased production, PWD should proceed with installing injection wells to be used for the injection of purified water from the Pure Water AV advanced water treatment plant.
3. **Pursue an agreement(s) with the Watermaster to store water long-term in the Antelope Valley Basin:** The recommended strategy relies on storage of sufficient water in the Antelope Valley Basin to meet years of imported water shortage. Given that these shortages can last for multiple years, it will be necessary to develop an agreement(s) with the Watermaster to allow for multiple-year storage of up to 32,000 AF of water in the basin.
4. **Continue Support of Antelope Valley Basin Storage Projects:** Historically, PWD has had sufficient supplies to meet demands, even during years of drought. As demand increases, meeting demand during periods of shortage will require PWD to store water. PWD should continue to support the development of water banking in the Antelope Valley Basin, and store excess imported water available in wet years for use during droughts or imported water outages.
5. **Purchase additional groundwater rights:** While recharge of recycled and imported water will help to offset pumping capacity in the near- and mid-term, in the long-term PWD may need to purchase additional groundwater rights to meet demand growth. PWD should pursue opportunities in the future to purchase groundwater rights from other producers in the Basin.

6.2.3 Recycled Water

PWD’s strategic objective for managing and developing recycled water are:

- Maximize the use of recycled water within PWD’s service area to limit the need for more imported water

- Obtain funding and partnerships to offset the cost of Pure Water AV

To achieve these strategic objectives, PWD will pursue the following strategies:

1. **Continue design, pilot testing and construction of an advanced water treatment facility**: PWD has been working towards implementation of an advanced water treatment project for recycled water for several years, and is currently in the pilot testing phase. PWD should continue with this work with the goal of constructing a full-scale facility to augment water supplies in the service area.
2. **Pursue funding and partnership opportunities for Pure Water AV:** PWD intends to pursue grant and State Revolving Fund (SRF) loan funding to help offset the construction cost of Pure Water AV. In addition, it may be possible to partner with other agencies to construct a larger advanced treatment facility that will help reduce the unit cost of advanced treated water.

6.2.4 Littlerock Reservoir

PWD's strategic objective for managing local surface water are:

- Continue Littlerock Reservoir sediment removal activities
- Improve Palmdale Ditch to reduce water loss

To achieve these strategic objectives, PWD will pursue the following strategies:

1. **Remove sediment from Littlerock Reservoir to maintain current capacity:** PWD's ongoing sediment removal activities have allowed for the maintenance of the current reservoir storage capacity. PWD should continue with these efforts to remove the approximately 38,000 cubic yards of annual sedimentation every one to two years, depending on sediment inflow to the reservoir.
2. **Enclose Palmdale Ditch:** Obtain funding assistance from the U.S. Bureau of Reclamation and other sources to convert the unlined, open portions of Palmdale Ditch to a closed pipeline. PWD should move forward with this project to prevent future water loss due to seepage and evapotranspiration and increase the yield from Littlerock Reservoir.

6.2.5 Conservation

PWD's strategic conservation objectives:

- Continue to expand conservation efforts on a regular basis (e.g. every 3-5 years), attracting outside funding to help expand programs
- Maintain and update policies as needed to reduce water waste and preserve PWD's ability to achieve sufficient conservation savings in the event of a water shortage emergency
- Achieve conservation objectives set by the State as part of Assembly Bill (AB) 1668 and Senate Bill (SB) 606

To achieve these strategic objectives, PWD will pursue the following strategies:

1. **Continue to Monitor and Report Effectiveness of Conservation Programs:** PWD should continue to track and report conservation savings on an annual basis, including tracking the installation of conservation devices (both from passive and active programs) and the penetration and results of other programs. By tracking and reporting this information, PWD will be able to accomplish a number of things including: evaluate the effectiveness of programs so that resources can be better targeted, develop a conservation track record for use when pursuing grant funds, and benchmark progress as compared to other water districts.

2. **Regularly Review and Coordinate PWD and City of Palmdale Ordinances and Policies:** The City of Palmdale is an active partner with PWD in conservation efforts and has implemented its own measures to save water at its parks and other facilities. In addition, the City has taken a lead role in creating land use ordinances that restrict outdoor landscaping to reduce water consumption. PWD has also developed a water budget rate structure that incorporates water use targets. PWD should regularly review with the City its conservation targets and programs to identify areas where the City and PWD can work together to produce more effective measures, messaging and enforcement of conservation ordinances.

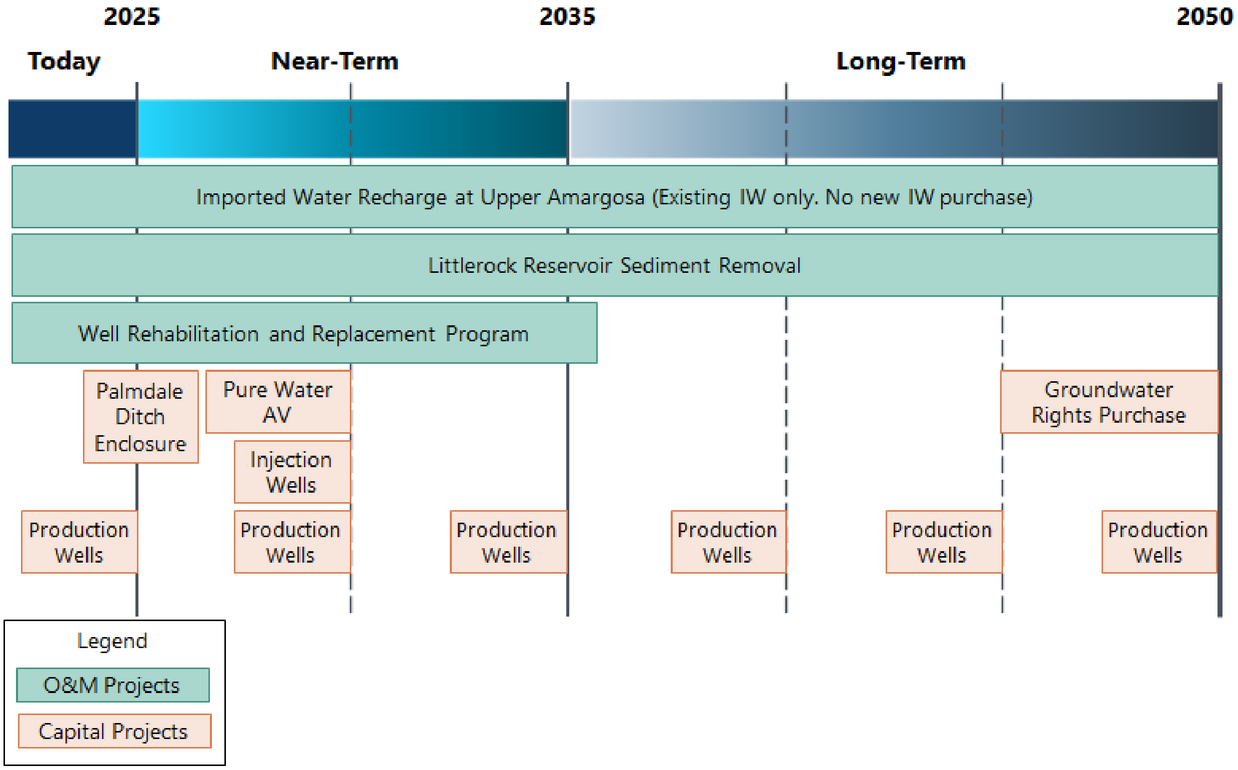
3. **Coordinate Communications with Other Antelope Valley Water Purveyors:** PWD, working through the Antelope Valley Integrated Regional Water Management (IRWM) Program or other collective forum, should coordinate its conservation efforts with others to make sure messaging, materials, effectiveness reporting and other communication efforts are consistent and supportive of each other’s programs.

4. **Pursue Grant Funding to Improve Program Cost Effectiveness:** To expand implementation by improving cost effectiveness, PWD should routinely pursue grant funding for conservation programs that are regularly offered through the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR). By developing a consistent program and demonstrated track record, PWD will be able to establish a positive relationship with these potential funding agencies as new grant funds become available.

6.3 Implementation Schedule

The proposed schedule for project implementation is shown in **Figure 6-1**, and is divided into O&M and capital projects. Projects that will maintain current facilities or won’t require capital outlay are designated as O&M projects, while new facilities that will require capital outlay are designated as capital projects. In the near-term, PWD will continue to recharge imported water at the Upper Amargosa Creek Project, continue to remove sediment to maintain capacity at Littlerock Reservoir, and will implement the well rehabilitation and replacement program. It’s assumed that the Palmdale Ditch enclosure and Pure Water AV projects will be implemented in the near-term, along with necessary injection and production wells to produce stored water. Given that significant capital projects will be implemented in the near-term, additional new supply from groundwater rights purchases and new production wells are not expected to be required until the end of the planning period (2045 to 2050).

Figure 6-1: Implementation Schedule



6.4 Projected Costs

Projected costs for implementing the preferred alternative according to the above schedule are shown in **Table 6-2**. Capital costs reflect the latest planning-level costs available for each project in 2022 dollars. O&M costs reflect the estimated annual O&M for each project in 2022 dollars, once the project has been implemented. Total costs reflect the total capital and O&M cost for the overall planning period which extends from 2025 to 2050. It should be noted that capital costs do not reflect awarded or potential grant or loan funding. Potential project funding will be discussed in the next chapter.

Table 6-2: Preferred Alternative Projected Costs for the Planning Period (2025 to 2050)

Project	Capital[1] (2022 dollars)	O&M[2] (2022 dollars)
Maintenance of Existing Supply Reliability and Facilities		
Imported Water Recharge at Upper Amargosa Creek	$14 million	$466,000/year
Littlerock Reservoir Sediment Removal	$0	$1,900,000 every other year
Well R/R Program	$49 million (well replacement)	$1.34 million (total for well repair and rehabilitation)
Palmdale Ditch Enclosure	$18.1 million	$4,400/year
New Supply Projects		
Pure Water AV (including advanced treatment plant, injection wells and production wells)	$152.6 million	$6,120,000/year
Groundwater Rights Purchase (includes rights and new wells)	$29.5 million	$410,000/year
Total Net Present Value[3]	**$169.8 million**	**$36.7 million/year**

1. Capital costs do not include grant funding that has already been awarded.
2. O&M costs are escalated to account for changes in the cost of power, materials and chemicals at the following rates: imported water conveyance is escalated at an average of 2%, Carter WTP treatment escalated at 3.3%, groundwater pumping escalated at 4.1%, other O&M costs escalated at 2.6%. Sources: PWD 2019 rate study and DWR Bulletin 132-22 Appendix B.
3. Assumes a 3% rate over the 25-year implementation. Does not consider funding and financing costs.

6.5 Adaptive Management

Implementation of the SWRP will be a long-term process and is expected to face uncertainty in the future. While the SWRP was developed under certain assumptions that account somewhat for uncertainty, conditions may change and alter how the SWRP is implemented. The preferred alternative was developed based on the current understanding of projected conditions and should be adaptable to future conditions.

PWD will apply an adaptive management approach as a tool to ensure successful implementation of the SWRP. Adaptive management is a flexible management strategy that employs monitoring and experience to inform decision making in the face of uncertainty. Adaptive management will allow PWD to periodically assess how internal and external conditions have changed and determine if and how implementation should change to achieve SWRP goals and objectives. **Table 6-3** provides a listing uncertainties and potential impacts that may influence the way the SWRP is implemented, as well as responses that PWD may take to address the uncertainties.

Table 6-3: Uncertainties, Potential Impacts and Responses

Uncertainties	Potential Impacts	Responses
Population Growth	Population in PWD's service area is expected to grow	Continue to monitor growth in population to determine if growth is higher or lower than expected and adjust the timing acquisition of new groundwater rights until projected demand reaches needed levels.
Delta Conveyance Project	The Delta Conveyance Project (DCP) will increase SWP reliability but also increase costs.	Support for SWP improvements is necessary to maintain reliability. Continue to monitor the status of the DCP and expected costs for Delta improvements.
Climate Change	Climate change may reduce reliability of imported supplies, create more variability in local precipitation and increase demand due to increasing temperatures.	Pursue strategies to increase local supply sources and increase local storage of supplies.
Water Quality Regulations	Federal and State drinking water quality regulations change over time and new regulations may reduce the availability of PWD groundwater supplies.	Continue to monitor upcoming drinking water quality regulations as compared to local supply quality.
Availability of Grant Funding	PWD plans to offset the costs of some capital projects with grant funding, but funding program availability varies from year to year.	Tracking funding programs to ensure that PWD is positioned to apply for funding as it becomes available and that the timing aligns with project implementation.
Consumer behavior and device penetration	Conservation effectiveness is directly related to consumer behavior and penetration of conservation devices. However, both are difficult to predict without a long local track record and thus are difficult to rely upon.	Take a measured approach to developing a conservation program, monitoring performance on a regular basis to make program adjustments.

As part of developing this SWRP, tools were developed that can inform implementation of the preferred alternative, including the following:

- **Demand Forecast Tool** – The demand forecast spreadsheet tool can be used to project demands for different demand sectors based on selected growth and unit factors. Should growth not follow projections, the spreadsheet tool can be updated to reflect changes and provide updated demand forecasts.
- **WEAP systems model -** The WEAP systems model simulates PWD's supply and production to account for uncertainty and risk of future water supplies and helps to evaluate the ability to meet future needs. Should reliability of supplies or major system changes occur, the WEAP model can be updated to reflect these changes and provide updated reliability projections.
- **Integrated Planning Tool –** The integrated planning tool serves as an options and alternatives database that allows for the building and evaluation of alternatives. Should PWD need to revise alternatives in the future, the tools allow for changes or new alternatives to be created and scored.

7. FINANCING PLAN

The purpose of the financing plan for the SWRP is to clarify the principles by which PWD will use to guide future financing measures needed to implement the plan and to outline a proposed funding strategy.

7.1.1 SWRP Financing Principles

The costs associated with implementing the SWRP are significantly higher than the costs to develop the current PWD system. As such, it is important to develop a set of guiding principles for PWD to use to ensure an equitable and appropriate allocation of costs.

For this SWRP, the proposed financing principles are:

- New customers establishing new connections must pay for new supplies and the infrastructure to deliver those supplies.
- Current and future customers must pay for reliability of current supply up to budgeted allotments for indoor and outdoor usage. This would include the costs to maintain Littlerock Reservoir, rehabilitate and replace existing wells, PWD's share of improvements to the Delta, and improvements needed to meet water quality standards.
- Those customers choosing to use more than their allotment will be responsible to fund higher cost water reliability projects including conservation and recycling.
- Current and future customers are to pay for all O&M costs
- Property owners pay fixed costs for the State Water Project
- Other system enhancements need to be able to pay for themselves without subsidy from other revenue sources.
- Financing strategy needs to provide for supply reliability assuming no future development or delayed future development.

7.1.2 Financing Options

PWD has the following financing options available to fund improvements recommended in the SWRP. These options are:

- **Capital Improvement Fee - Water Supply**: Currently PWD assesses a Capital Improvement Fee (CIF) connection fee with infrastructure and water supply components that is designed to pay for new distribution system infrastructure and water supplies based on the project's requirements.
- **Water Rates**: Water rates are designed to produce revenues to cover a variety of costs and encourage efficient water use through indoor and outdoor allocations or water budgets. These include ongoing operation and maintenance costs to deliver water, administrative costs, conservation costs and the cost to obtain supplemental water supplies to maintain system reliability, and the costs to meet new water quality requirements. Water rates are also used to provide funds to various reserve accounts and to help fund debt repayment.

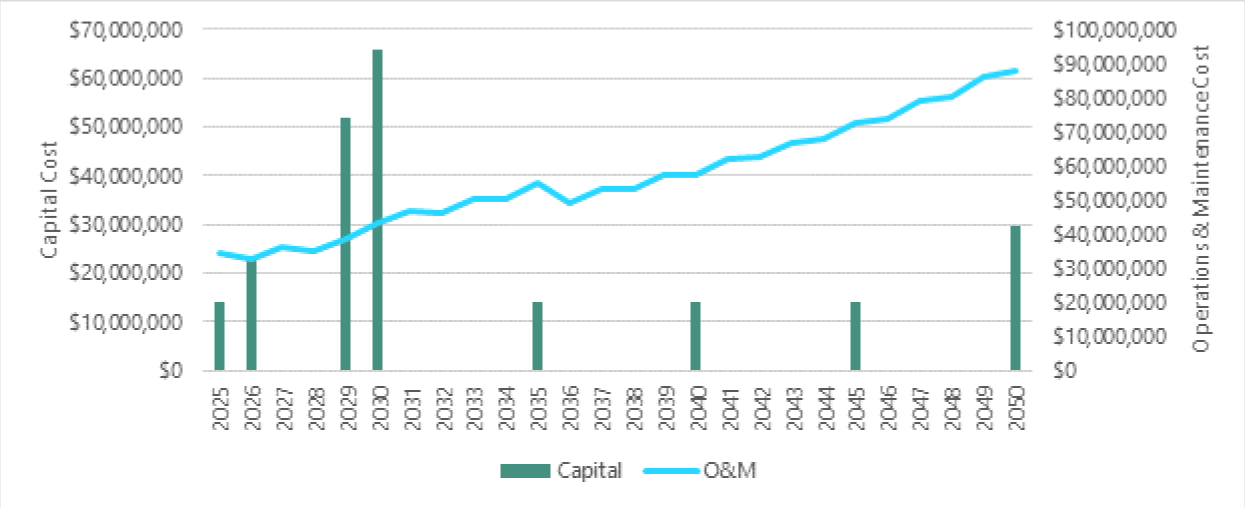
- **Municipal Debt**: Municipal debt instruments (bonds, certificates of participation, etc.) are commonly used to finance major capital projects. Terms generally range from 5 to 30 years with low to moderate interest rates depending upon PWD's credit rating at the time.
- **State Revolving Fund (SRF) Loan**: The USEPA provides states with funding for the SRF loan program to provide low-interest loans for clean water improvement (i.e. wastewater) and drinking water programs. Historically, loans for the drinking water program are limited to low-income communities facing public health threats to their water supplies and thus is not a likely source of funding for PWD's SWRP. However, loans (and occasionally grants) are available from the clean water program for water recycling projects.
- **Property Tax Assessment**: Property tax assessments can be used to help cover the fixed costs associated with water supply facilities. Currently, PWD utilizes a tax assessment as authorized by the State to fund fixed costs associated with the State Water Project. The assessment could be used to fund PWD's portion of the fixed costs associated with modifications to the Delta or new storage projects implemented by DWR to improve the reliability of the SWP.
- **Grants**: Grants are made available through various State, Federal, and non-profit organizations to provide funding for specific programs. At the State level, grants are generally made available through voter-approved initiatives or through grants from the Federal government funneled through State agencies. Meanwhile, grants at the federal level are made through legislative appropriation to federal agencies such as the USEPA, the USBR and the USACE. In general, grants are highly competitive and should not be considered reliable sources of funding for long-term planning. That said, PWD should actively pursue grants to fund multiple elements of this SWRP including conservation, water recycling, and groundwater storage.
- **Partnership Opportunities**: Partnership opportunities on groundwater storage and recycled water should be explored as potential ways to help finance projects. Potential partners may include both parties within the Antelope Valley (e.g. AVEK, City of Palmdale, and Waterworks District No. 40) as well as parties outside (e.g. Metropolitan Water District, Los Angeles Department of Water and Power). However, given the specific nature of these opportunities, these will need to be approached on an opportunistic basis and are not assumed as part of the financing plan for the SWRP.

In PWD's setting, because the majority of the water supply need is expected to be driven by new development, the most appropriate financing mechanisms for PWD to rely upon are water supply connection fees, municipal and SRF loans, and water rates. While PWD should aggressively pursue grants, and possibly consider using a property tax assessment to fund additional fixed costs, neither of these will be significant to cause a substantial change in financing approach.

7.2 Projected Cash Flow Requirements

Projected cash flows for the preferred alternative are illustrated in **Figure 7-1** below. These costs include the cost of production to meet existing demand plus new demand. It is important to note that the bulk of capital expenditure occurs over the next 10 years. In addition, O&M costs experiences a dip after 2035 due to the assumption that imported water lease agreements are not renewed.

Figure 7-1: Project Capital Outlays and O&M Costs for the Preferred Alternative



7.3 Financing Strategies

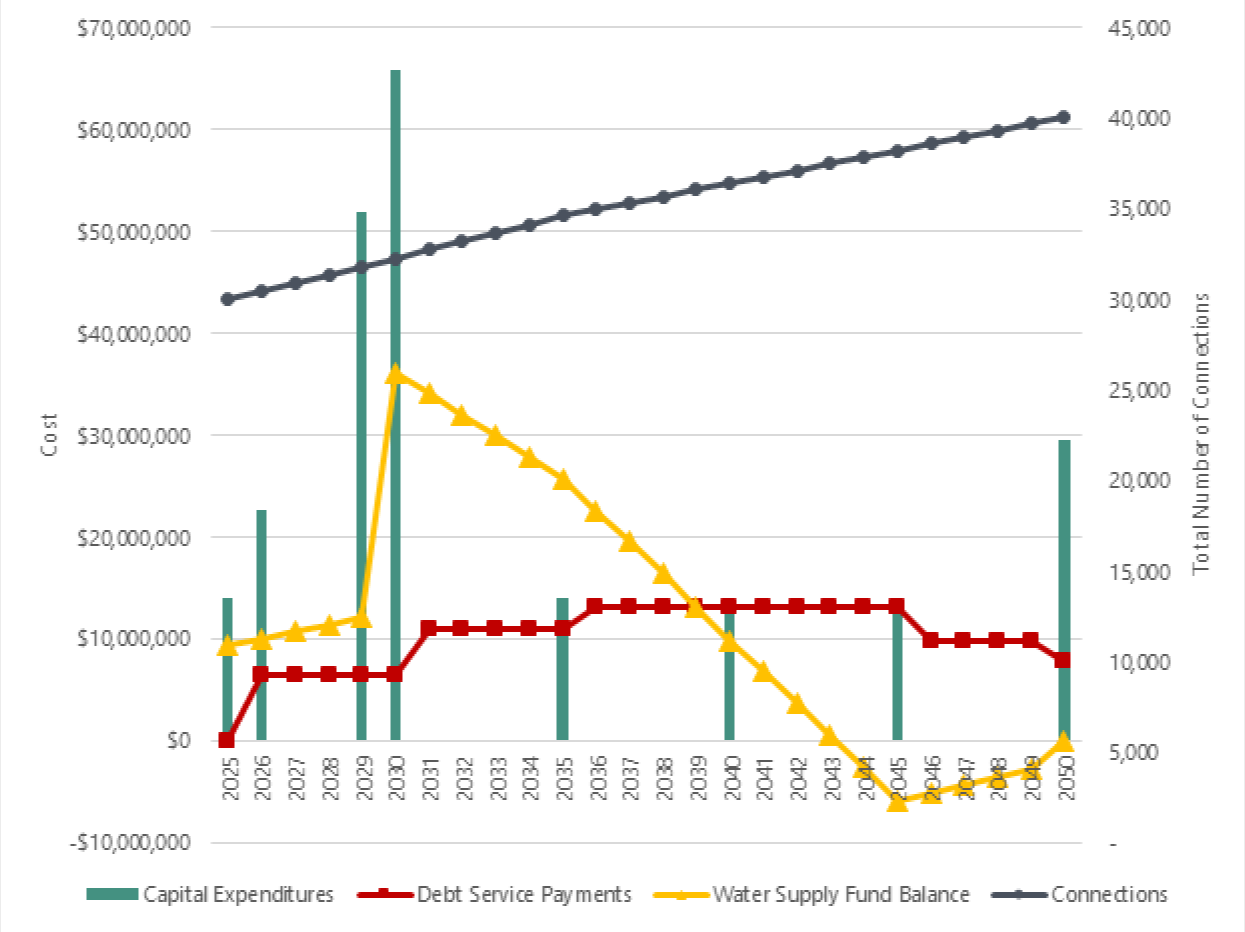
This section outlines proposed financing strategies for the preferred alternative.

7.3.1 Capital Improvement Fee - Water Supply

The analysis below has been used to identify at what level water supply connection fees should be set to recover capital and financing costs with the development of new water supplies. The results of this evaluation indicate that a water supply connection fee of approximately $37,500 per acre-foot would be needed to fund the capital and debt service costs through 2050. The relationship between capital costs, debt service, connection fees and growth in connections is illustrated below in **Figure 7-2**. The connection fee was set such that a Water Supply Fund would achieve a near-zero balance by 2050.

For planning purposes, this analysis was designed to identify an appropriate connection fee. It should be noted that the precise mixture of debt to cash expenditures for capital outlays shown in **Figure 7-2** has not been optimized to ensure that the water supply fund balance is always positive and sufficient to meet debt coverage ratio requirements (generally 150% of annual debt service).

Figure 7-2: Relationship Between Number of Connections and Financing Elements for Strategy

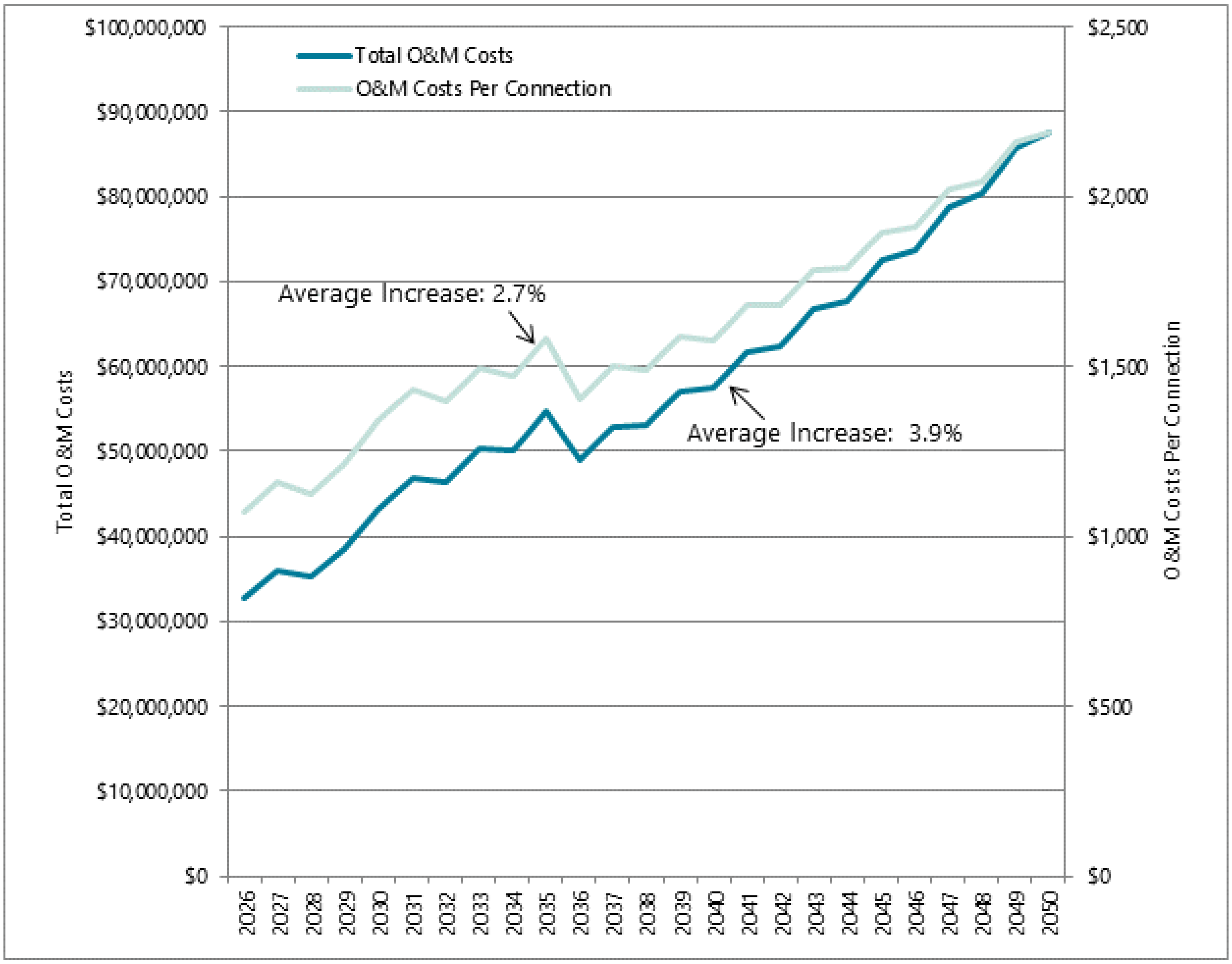


7.3.2 Water Rates

The SWRP presumes that water rates will be used to cover ongoing O&M costs associated with new supplies as well as existing O&M costs. For the SWRP, an analysis was performed to examine the O&M costs to evaluate the projected annual cost increase and the increase in cost per connection. The analysis did not attempt to determine what future water rates should be but rather if the expected increase in O&M costs were reasonable and could be expected to be covered by reasonable rate increases.

Figure 7-3 below illustrates projected average O&M costs (in 2022 dollars) from 2025 to 2050 and projected costs per connection. Results show that while O&M costs increase on average at 3.9% annually, the cost per connection increases on average 2.7% annually.

Figure 7-3: Projected O&M Costs



7.4 Financing Plan Summary

To summarize, the recommended financing strategy for the SWRP involves the following steps:

- Implement a water supply connection fee of $37,500 per acre-foot and escalated every year by the rate of inflation.
- Use a combination of municipal debt financing, SRF loans, and collected water supply connection fees to fund capital projects identified in the SWRP.
- Continue to maintain current approach to setting water rates to cover O&M expenses associated with the SWRP.
- Further evaluate using property tax assessment(s) to fund potential future fixed costs associated with system improvements such as the well rehabilitation program and imported water reliability improvements. It should be noted that this may require voter approval as required by Proposition 218.

- Track and pursue grant opportunities for conservation, water recycling, and groundwater storage projects.
- Further evaluate partnership opportunities and engage with potential partners for recycling and groundwater storage projects as these projects evolve.

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APPENDIX A: WEAP MODEL ASSUMPTIONS

WEAP Model Assumptions

Imported Water

- Adjusted to incorporate climate change based on 2021 DWR Delivery Capability Report modeling results
- Further adjustments made to SWP Table A deliveries to reflect the average the last 10-years of deliveries to PWD (9,200 AFY)
- Diversion to Lake Palmdale (capacity = 30 cfs)
- Butte Water assumed to end in 2035
- LCID transfer assumed to end in 2035 (75% of Allocation)

Groundwater

- Pumping rights (2,770 AFY) and federal reserve (1,430 AFY) consistent with the Antelope Valley Basin Judgment. Safe Yield will be reassessed in 2032 and the change will reflect using the established protocol outlined in the Judgement. Currently, it is 82,300 native and 110,000 AF with return flows.
- Natural inflows adjusted to incorporate climate change based on DWR SGMA climate change factors to estimate reductions in groundwater availability due to climate change
- Imported water return credits: 39% of water imported by PWD
- Unused groundwater can be carried over to future years
- Includes banking to the Upper Amargosa Creek Recharge Project in years where imported water is available (PWD has a right to recharge 1,378 AF annually into the Upper Amargosa Creek Recharge Project with 10% leave-behind)
- Maximum annual pumping is 11,000 AF (approximately 9.8 mgd)

Littlerock Creek and Reservoir

- Historical inflow adjusted to incorporate climate change based on DWR SGMA climate change factors for streamflow
- 500 AF minimum water level maintained in Littlerock Reservoir through Labor Day, then use anyway we want afterward.
- Diversion to Lake Palmdale via Palmdale Ditch (capacity = 25 cfs, assumes 25% loss)
- Evaporation rate at the reservoir is equal to historical average

Lake Palmdale and Carter WTP

- Lake Palmdale capacity = 4,130 AF (assumed to maintain 3812 AF until Oct 1)
- Diversion to Carter WTP (capacity = 35 mgd)
- Carter WTP assumed to be shutdown 6 weeks of the year starting in December
- Evaporation rate at the reservoir is equal to historical average

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