



# Integrated Resources Plan

## January 2013

UPPER SAN GABRIEL VALLEY
MUNICIPAL WATER DISTRICT

REPORT PREPARED BY CDM Smith

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# Acronyms

| | |
|---|---|
| AF | acre-feet |
| AFY | acre-feet per year |
| AWT | advanced water treatment |
| CDPH | California Department of Public Health |
| cfs | cubic feet per second |
| COG | Council of Governments |
| gpcd | gallons per capita per day |
| DOF | California Department of Finance |
| DWR | California Department of Water Resources |
| EDD | California Employment Development Department |
| EPA | U.S. Environmental Protection Agency |
| FAT | full advanced treatment |
| GRIP | Groundwater Reliability Improvement Program |
| GWR | groundwater recharge |
| IPR | indirect potable reuse (for groundwater recharge) |
| IRP | Integrated Resources Plan |
| LACDPW | Los Angeles County Department of Public Works |
| LACFCD | Los Angeles County Flood Control District |
| LACSD | Los Angeles County Sanitation District |
| LTA | Long-Term Accounting (for Watermaster) |
| MF/MFR | multi-family residential |
| mgd | million gallons per day |
| MWD | Metropolitan Water District of Southern California |
| NPR | non-potable reuse |
| PERC | Potential Effective Recharge Capabilities Study |
| RO | reverse osmosis |
| RWC | recycled water contribution |
| SF/SFR | single-family residential |
| SGAG | Southern California Associations of Government |
| TMDL | total maximum daily load |
| WRP | water reclamation plant |
| WWTP | wastewater treatment plant |

# Section 1

# Introduction

The Upper San Gabriel Valley Municipal Water District (Upper District) is a wholesale water agency formed by voters in the San Gabriel Valley in 1959, under California's Municipal Water District Act. In 1963, Upper District joined the Metropolitan Water District of Southern California (MWD) in order to provide supplemental imported water to the region's local groundwater. Early in its history, Upper District played a vital role in determining water rights within the Main San Gabriel Basin (Main Basin) by acting as plaintiff in a 1973 court case. This case resulted in the creation of the Main San Gabriel Basin Watermaster (Watermaster) which was ordered by the court to administer and enforce the basin judgment for managing groundwater in the San Gabriel Valley.

Upper District does not provide direct water deliveries to residential or commercial customers, rather it provides supplemental water for groundwater recharge and some direct sales of imported water. Upper District also provides wholesale deliveries of recycled water for non-potable uses. Included in Upper District's service area are 29 member agencies (producers) that deliver water to over 900,000 residents. These customer agencies include:

- Adams Ranch Mutual Water Company
- Amarillo Mutual Water Company
- City of Arcadia
- City of Azusa
- California American Water Company
- California Domestic Water Company (wholesale)
- Champion Mutual Water Company
- City of Covina
- Covina Irrigation Company(wholesale)
- Del Rio Mutual Water Company
- East Pasadena Water Company
- City of El Monte
- City of Glendora
- Hemlock Mutual Water Company
- Golden State Water Company
- Industry Public Works
- La Puente Valley County Water District
- City of Monrovia
- Rurban Homes Mutual Water Company
- San Gabriel County Water District
- San Gabriel Valley Water Company
- City of South Pasadena
- Sterling Mutual Water Company
- Suburban Water Systems
- Sunny Slope Water Company
- Valencia Heights Water Company
- Valley County Water District
- Valley View Mutual Water Company
- City of Whittier

The Upper District is governed by five elected Directors, elected to serve 4-year terms, representing five geographic divisions within the Upper District's service area. Additionally, as a member agency of MWD, Upper District appoints one representative to sit on the MWD Board of Directors. The Upper District also has representation on both the San Gabriel Basin Water Quality Authority and Watermaster Boards.

## 1.1 Service Area Background

Upper District's service area is located in the San Gabriel Valley in Los Angeles County, and entirely overlies the Main Basin. The San Gabriel Valley was primarily agriculture until the 1950's when Southern California experienced an economic and population boom. The valley's population tripled from 1950 to 1995, and commercial and industrial activities grew substantially. As communities in the valley became built-out in the 2000's, population growth slowed to just under one percent per year. Recent growth in the valley, however, has been suppressed due to the severe economic recession that started in 2008. The unemployment rate in the region in 2013 is at double-digits and is expected to remain so for the next couple of years.

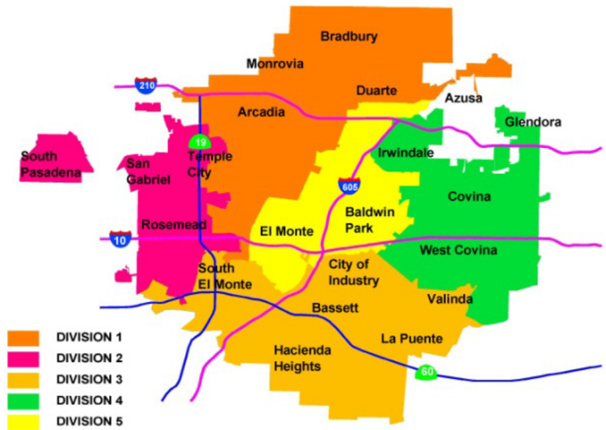


**Figure 1-1**
**Upper District's Service Area**

Upper District's service area is approximately 144 square miles and includes all or portions of the Cities of Arcadia, Azusa, Baldwin Park, Bradbury, Covina, Duarte, El Monte, Glendora, Industry, Irwindale, La Puente, Monrovia, Rosemead, San Gabriel, South El Monte, South Pasadena, Temple City, and West Covina. The service area is now largely urbanized, consisting of mainly residential, commercial and light industry.

The climate of the San Gabriel Valley is considered to be Mediterranean, with hot/dry summers and wet/cooler winters.  Average rainfall is about 18 inches, but can vary substantially from a low of 5 to a high of over  40 inches. Rainfall occurs almost entirely between the months of October through March. Summertime average temperatures are in the low 80's but can exceed 90's on very hot days. Winter temperatures average in the mid 60's.

In terms of soil type, most of the service area lies on soils that are conducive to groundwater recharge—meaning that rainfall can deep percolate into the basin.  However, as the region urbanized, roads, buildings and parking lots reduced this natural groundwater recharge. To address this, large centralized stormwater capture projects have been constructed to facilitate groundwater recharge from both native stormwater and imported water.

## 1.2 Water Supply Challenges

Imported water from MWD has been the lifeblood for much of Southern California since the 1960's. At first, MWD brought water from the Colorado River to this region, then from Northern California's Sacramento-San Joaquin Delta (Delta) through the State Water Project (SWP). During the 1990's, conflicts between California's urban, agriculture, environment interests; as well as between the Colorado River Basin States that rely on the Colorado River; began to escalate to new levels. The resulting conflicts in the Colorado River forced California to live within its state's entitlement, and significantly reduced the historical Colorado River deliveries that MWD had relied on in the past.  To make matters worse, the Colorado River Basin has just come off of an eight-year drought, the most severe measured in the 20th century. While reservoirs in that system are just starting to recover, recent droughts in the Western United States are a worrisome trend.

The Delta is of particular concern because of its ecosystem fragility and its location, which is the epicenter of where water from the SWP and the federal Central Valley Project is pumped down to central and southern California. Recent droughts and court rullings on endangered species have resulted in significantly reduced deliveries from the Delta to water users, including MWD and its member agencies. In addition, the earthen levies that protect the Delta from seawater are extremely vulnerable to seismic and extreme climatatic conditions.

By 2007, MWD's imported water and storage conditions were severely impacted by the droughts in the Colorado Basin and California, as well as court-ordered pumping restrictions in the Delta for protection of the Delta smelt (an endangered fish). As a result, MWD stopped providing groundwater replenishment deliveries (water sold at a discount off of firm imported water). In 2008, MWD's Board of Directors approved the Water Supply Allocation Plan (WSAP) to manage the limited imported water. The WSAP has 10 different shortage levels and associated actions. In 2008 and 2009, firm imported water was curtailed for the first time since 1991. It was also the first time MWD had to allocate firm imported water two years in a row. Upper District's imported allocation was approximately 31,000 acre-feet per year (AFY) for those years.

In addition to challenges with imported water reliability, groundwater levels in the Main Basin have been declining. Without a long-term, reliable source of replenishment water, more expensive reliance on MWD's firm imported water will be needed. Groundwater quality is also of concern and will require a strategy to keep groundwater production from the Main Basin reliable.

Finally, global climate change can severely impact imported and local water supplies, as well as increase water demands due to increasing temperatures and decreasing precipitation and snowpack. Studies conducted by Scripps Institute, Bureau of Reclamation, and California Department of Water Resources indicate that California and the western United States are most vulnerable

## 1.3 Purpose of Integrated Resources Plan

To address these water supply issues, Upper District has prepared an Integrated Resources Plan (IRP). IRPs are becoming more common, especially in California. IRPs examine both demand-side and supply-side options, view water more holistically and interconnected, address multiple goals, and incorporate risk and uncertainty.

Upper District's IRP explored various water supply options in terms of potential supply yield, costs, technology, water quality, and reliability. These options were bundled into several integrated alternatives (combinations of options much like a stock portfolio) that were evaluated against a set of goals and objectives for the District in order to develop a preferred strategy for meeting current and projected water demands in a reliable, cost-effective and environmentally sound manner.

Key to the success of this IRP is an adaptive management approach, whereby water supply projects can be phased in over time when needed and adapt to changing future conditions. The IRP is not a capital improvement plan, nor does it make definitive recommendations on specific projects. Rather it is a long-term road map that provides Upper District with a framework for making sound decisions. The IRP is not intended to be a static report, but more a "living" document that will be updated as future conditions unfold and become clearer.

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# Section 2
# Water Demands and Conservation

At the heart of any water supply plan is a credible water demand forecast that accounts for the major drivers in water use such as weather, housing, employment, water use efficiency, and other factors such as economy and drought.

To develop the water demand forecast for Upper District, two approaches were used. The first approach used a statistical regression analysis of historical monthly water production for Upper District's service area. This monthly production did not include groundwater export out of Upper District's service area. Rather, the production represented the total water consumed by residents and businesses within the service area. The water production included groundwater, surface diversions, imported water and recycled water. This model was used to better understand the variations in water demand from year to year due to weather, economy and drought-related mandatory restrictions.

The other approach was based on water use factors from a sample of the retail water agencies in Upper District's service area. For each category (single-family residential, multifamily residential, commercial and industrial) an aggregate average water use factor was derived for the service area total. These aggregate water use factors were then multiplied by projected demographics for the service area in order to get a total water demand forecast. The demand forecast was calibrated against actual historical water use and informed by the water production statistical model.

## 2.1 Historical Water Use

To estimate historical water use for Upper District, three sets of data were used. The first data set was actual monthly treated water deliveries from MWD for direct consumption. The second data set included estimates of monthly groundwater pumping, direct surface diversions and non-potable recycled water that were provided by Upper District's engineering consultant Stetson Engineers Inc. The third data set was a database of retail billing water use from a utility survey conducted by CDM Smith and Stetson Engineers for this project.

From fiscal year (FY) 1990 to 2000, total water use in Upper District's service area increased by 26 percent (normalized for weather), growing faster than population during the same period. From 2000 to 2012, water demand remained essentially flat due to increased water use efficiency, drought-related mandatory restrictions and a severe economic recession that started in 2008 (see Figure 2-1).

In terms of sector water use, almost 60 percent of the District's water demand is for residential use (both single-family and multifamily), while approximately 35 percent is for commercial and industrial water use (see Figure 2-2). The remaining water (~ 5 percent) is non-revenue, which includes fire protection, system flushing, and system losses and unaccounted for water.

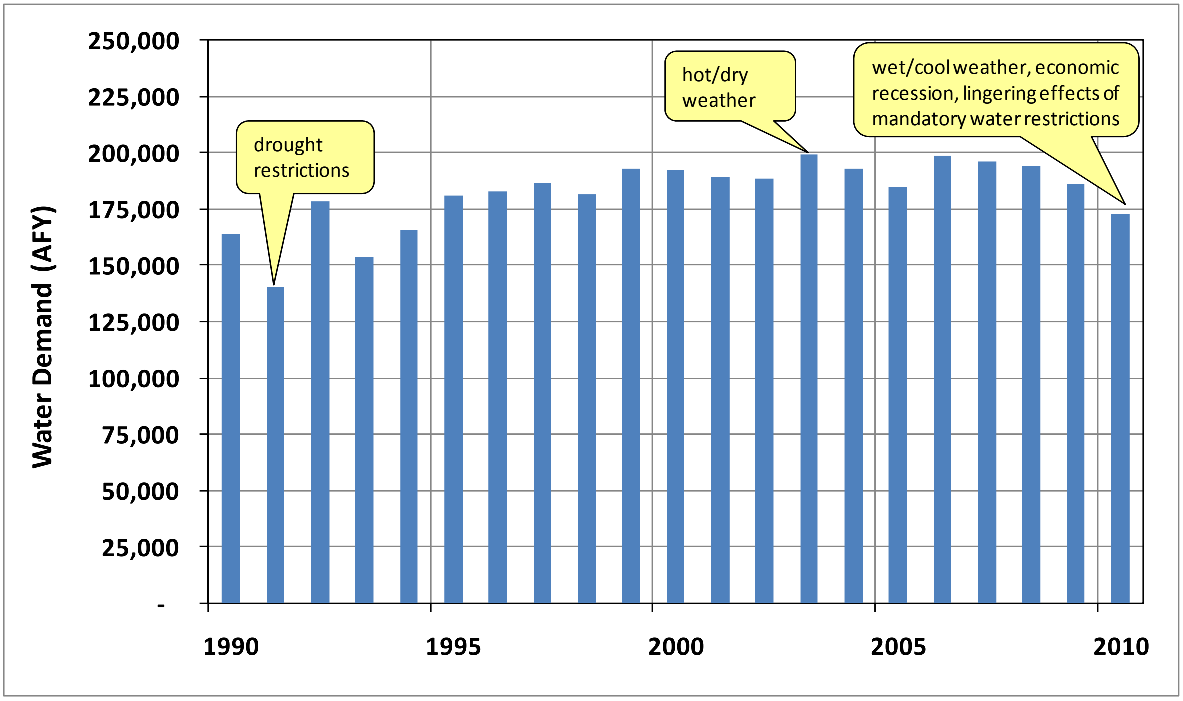


**Figure 2-1**
**Historical Water Demand in Upper District's Service Area**

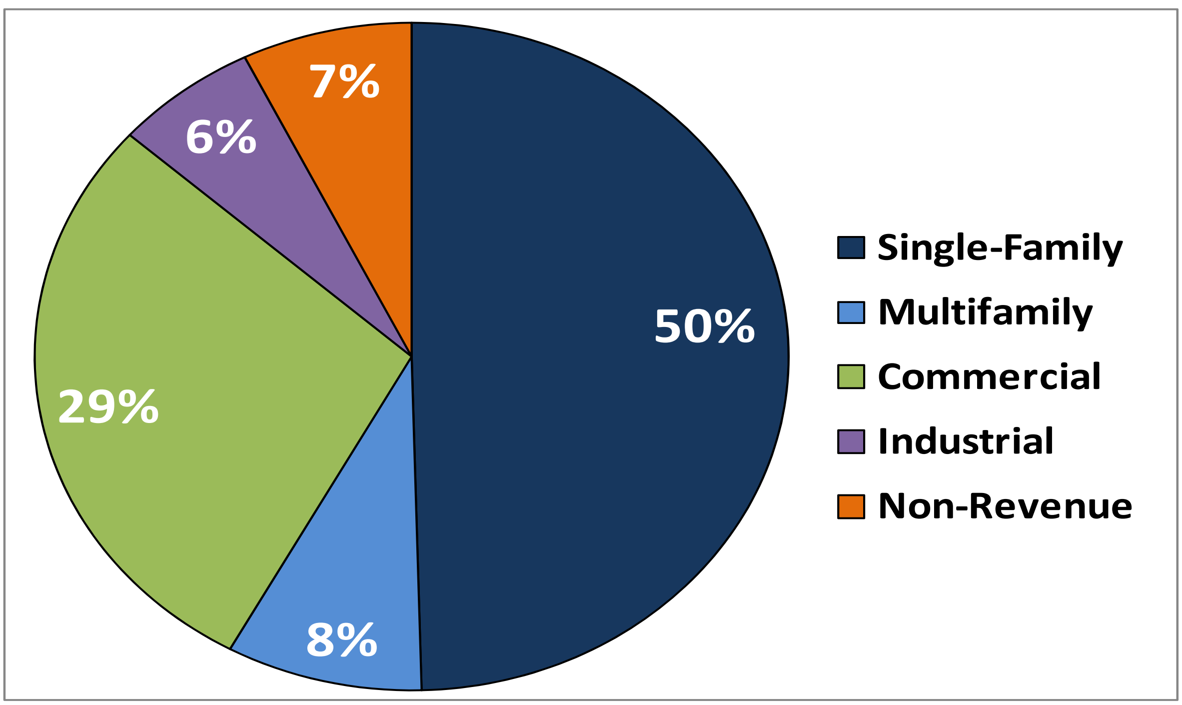


**Figure 2-2**
**Breakdown of Average Water Use for Upper District's Service Area**

In terms of seasonal use, average monthly water use was analyzed prior to the drought and economic recession. Typically, seasonal water use is anything above the minimum month (usually January or February). However, based on other empirical studies in Southern California outdoor irrigation even occurs during the minimum month. For Upper District, it was assumed that approximately 15 percent of the average water use in February (the minimum month for Upper District's service area) is for irrigation. Using this percentage, a non-seasonal (base indoor) water use was derived, representing approximately 60 percent of the annual total. To calculate seasonal water use (i.e., water used for irrigation, pool fillings, and cooling), the base indoor water use is subtracted from the total monthly water use, which is estimated to be 40 percent of the annual total. During summer months, however, seasonal water use can comprise over 53 percent of the total demand (see Figure 2-3).

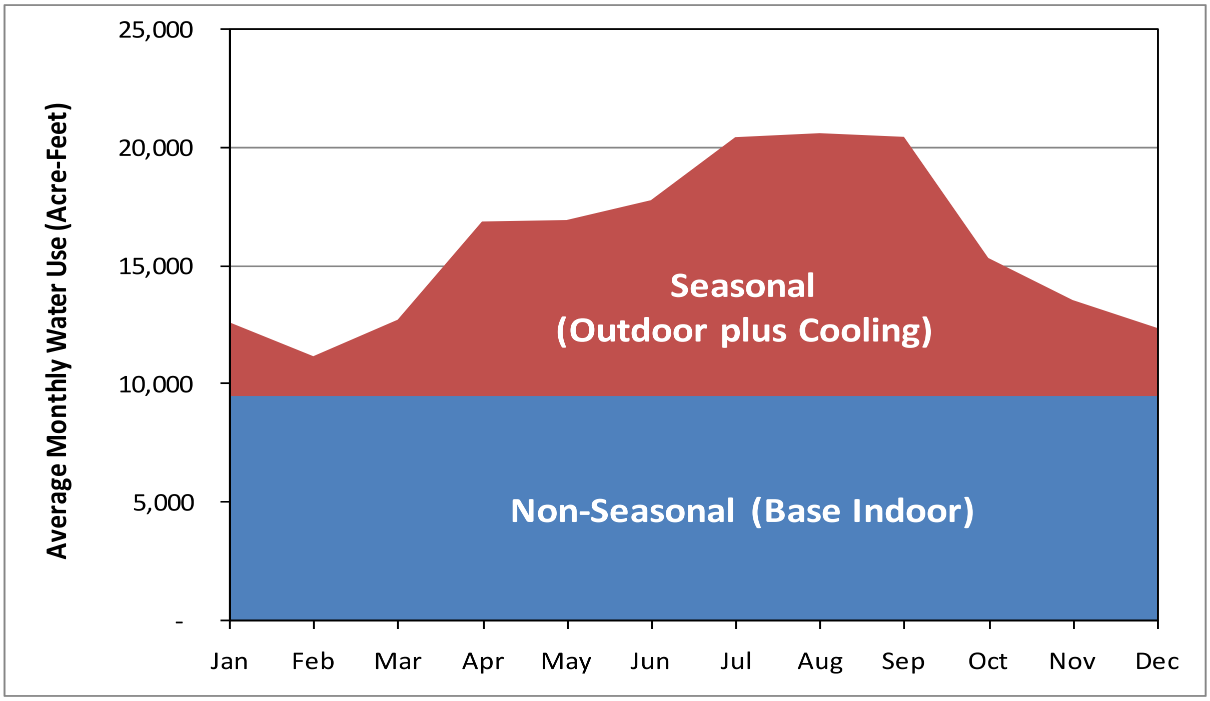


**Figure 2-3**
**Average Seasonal Water Use in Upper District's Service Area**

## 2.2 Water Production Model

To help understand past water use and better inform the water demand forecast, a multivariate statistical regression was conducted using 20 years of historical monthly water production and the following explanatory variables: population, maximum average temperature, precipitation, unemployment rate, and periods in which mandatory water use restrictions were in place. The model had an $R^2$ value of 0.91 and all of the variables were significant at the 0.001 level, indicating a good overall fit and low model error.

The model was used to explain the variability in past water use as well as to provide an assessment of why recent water demands in 2010 were 20 percent lower than in 2006-2007 (see Figure 2-4). The model verification indicated that the model was able to match historical use within 5 percent. Using the model, the difference in water demand between 2007 and 2010 could be explained. Understanding what caused the difference in variation in demands provides insights as to when and if water demands will bounce back. For example, in 1991 it took less than three years for the effects of mandatory rationing on water use behavior to dissipate. And many economists believe that double-digit unemployment will last for several more years for Los Angeles County.

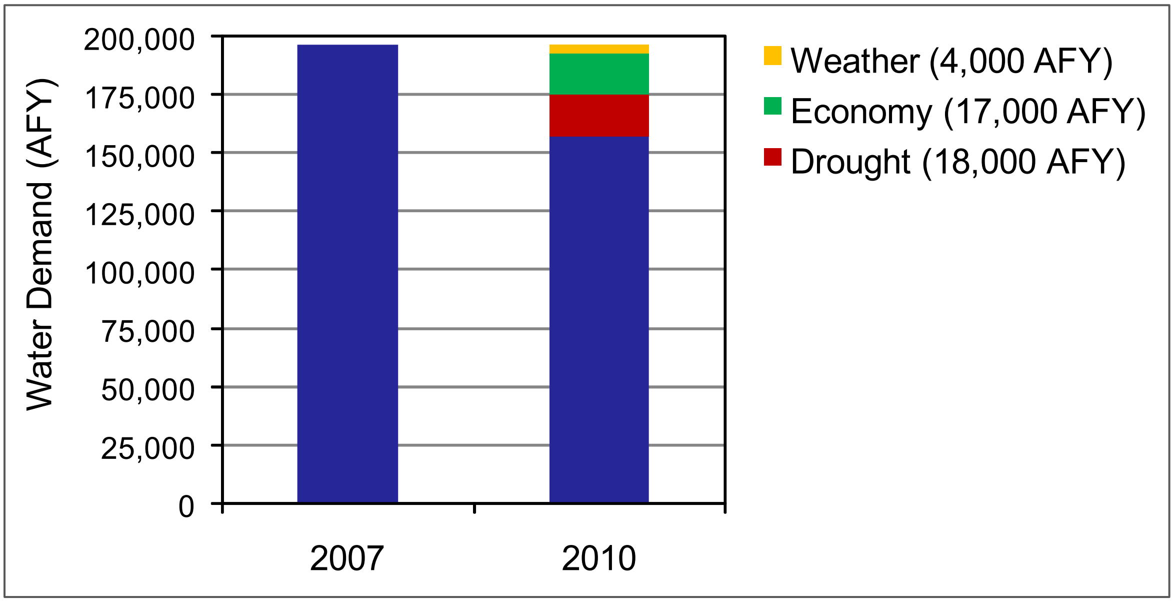


**Figure 2-4**
**Explaining Difference in Water Use Between 2007-2010 Using Statistical Model**

The figure above indicates that the economy and drought-related mandatory water use restrictions were responsible for 90 percent of the decrease in water demand between 2007 and 2010. These two factors could change for the better within 5 years based on past trends and latest economic forecasts, indicating demands could bounce back to 2007 levels in the absence of future conservation.

## 2.3 Water Demand Forecast

To forecast water demands, water use factors were generated from a sample of retail water agencies in Upper District's service area. Average billing water use data from this sample using years before the drought and economic recession were divided by associated demographic data for each utility. For example, to derive the single-family (SF) water use factor the following formula was used:

$$\text{SF Water Factor (gallons per home/day)} = \frac{\text{SF billed water use (gallons per day)}}{\text{Number of SF Households}}$$

Table 2-1 summarizes the water use factors from the utility sample, showing the range of values as well.

**Table 2-1. Water Use Factors from Sample of Retail Water Agencies in Upper District**

| Sector | Unit Use Rate (gal/unit/day) | |
|---|---|---|
| | Average Value | Range from Sample |
| Single Family Residential (per home) | 524 | 300 – 610 |
| Multifamily Residential (per home) | 260 | 200 – 500 |
| Commercial/Institutional (per employee) | 192 | 50 – 280 |
| Industrial (per employee) | 256 | 75 - 500 |

To forecast water demands, these water use factors were adjusted to reflect assumptions regarding household (HH) income and price of water. Using price and income elasticities (estimates of statistical change) from MWD's econometric demand model, these factors were adjusted net downward based on the following assumptions:

**Elasticities (estimated by MWD)[1]**

| | HH Income | Marginal Price[2] |
|---|---|---|
| Single-family Residential | 0.27 | -0.13 |
| Multifamily Residential | 0.25 | -0.11 |
| Commercial/Institutional | | -0.12 |
| Industrial | | -0.12 |

[1] An elasticity of -0.13 means that a 10% increase in price would lead to a 1.3% decrease in water demand, all other things constant.

[2] Net price elasticity, set not to double count future active water conservation.

| Influencing Factors | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 |
|---|---|---|---|---|---|---|
| % change in median household income from base | 0% | 0% | 2% | 14% | 22% | 33% |
| % change in marginal price from base | 0% | 22% | 41% | 56% | 62% | 62% |

**How Elasticities are used to modify water use factors**

Unit Use Factor $_f$ = Unit Use Factor $_c$ X

*Where:*

*Unit Use Factor = gal/home or gal/employee water use*

$f$ = future year

$c$ = current year

$\beta$ = elasticity for water use factor (price or income)

The adjusted water use factors for price and income are then multiplied by projected demographics for Upper District's service area in order to get a baseline water demand. Projected demographics were originally provided by the Southern California Association of Governments (SCAG) using the 2007 Regional Transportation Plan. These demographics were provided at a census track level and aggregated to Upper District's boundary by MWD. However, because these projections were developed prior to the recent, severe economic recession, CDM Smith adjusted downward the projections from 2015 to 2025 using recent trends from the California Department of Finance and the California Employment Development Department. Table 2-2 presents the demographic projections for Upper District, while Table 2-3 presents the baseline water demand forecast (without future conservation) by sector. The 2015 demand forecast was adjusted downward to account for the residual impacts of drought-related water restrictions.

**Table 2-2. Demographics for Upper District's Service Area**

| Sector | Units | 2015 | 2020 | 2025 | 2030 | 2035 |
|---|---|---|---|---|---|---|
| Single-family Residential | Households | 184,922 | 188,650 | 202,065 | 215,480 | 219,987 |
| Multifamily Residential | Households | 63,095 | 64,688 | 70,945 | 77,202 | 79,938 |
| Commercial/Institutional | Employment | 291,028 | 298,377 | 312,363 | 326,349 | 333,551 |
| Industrial | Employment | 44,393 | 43,300 | 42,935 | 42,570 | 41,648 |

* Based on SCAG 2007 RTP, modified by CDM Smith for years 2015-2025 to account for recent recession.

**Table 2-3. Baseline Water Demands for Upper District (AFY)**

| Sector | 2015* | 2020 | 2025 | 2030 | 2035 |
|---|---|---|---|---|---|
| Single-family Residential | 99,448 | 103,629 | 108,591 | 114,687 | 118,787 |
| Multifamily Residential | 16,902 | 17,818 | 19,237 | 20,851 | 21,990 |
| Commercial/Institutional | 57,460 | 60,138 | 59,699 | 58,862 | 56,776 |
| Industrial | 11,687 | 11,636 | 10,941 | 10,238 | 9,452 |
| Non-revenue water | 14,608 | 15,216 | 15,629 | 16,115 | 16,301 |
| Total Demand | 200,105 | 208,437 | 214,097 | 220,753 | 223,306 |

* Adjusted for recent drought impacts: unadjusted demands were lowered by 9% based on water production model described in Section 2.2.

## 2.4 Water Conservation

In the context of this IRP, water conservation is defined as being either passive or active. Passive conservation is the gain in water use efficiency that occurs because of plumbing codes and ordinances. In California, the current plumbing code requires that all new constructed homes and businesses have ultra-low flush toilets and low-flow showerheads/faucets. Also, any home or business that is remodeled has to replace old fixtures with these conserving fixtures. Los Angeles County and the state also have a model landscape ordinance requiring warm climate turf and irrigation efficiency for all new development. To account for passive conservation, CDM Smith estimated the water use efficiency of a new home/business compared to a current one. Then, using the ratio of new housing/businesses to pre-plumbing code total, plus making assumptions regarding remodeling rates, an estimate of passive conservation was calculated. In 2015, this passive conservation was estimated to be approximately 5,500 AFY, while in 2035 the passive conservation is projected to be almost 18,000 AFY.

California's SB 7-7, enacted in 2009, requires all retail water utilities to reduce their per capita water demands by 20 percent by 2020, with an interim target of 15 percent reduction by 2015. Consequences of not meeting this goal are: ineligibility for state water grants and loans (compliance as of January 1, 2016), and violation of law for administrative or judicial proceedings (after January 1, 2021). To establish a baseline per capita from which to measure compliance, several approved methods were allowed by the state. Using one of these methods, Upper District's baseline per capita water use would be 198.7 gallons per capita per day (gpcd). The 2020 target would therefore be 159.0 gpcd.

Figure 2-5 presents the water demand forecasting for the baseline, passive and 20x2020 conservation target projections. It should be noted, however, that recycled water can count towards meeting the 20x2020 conservation target. So achieving the lower demand forecast is not necessary if future recycled water is developed. Table 2-4 presents the water demand forecast by sector under passive conservation.

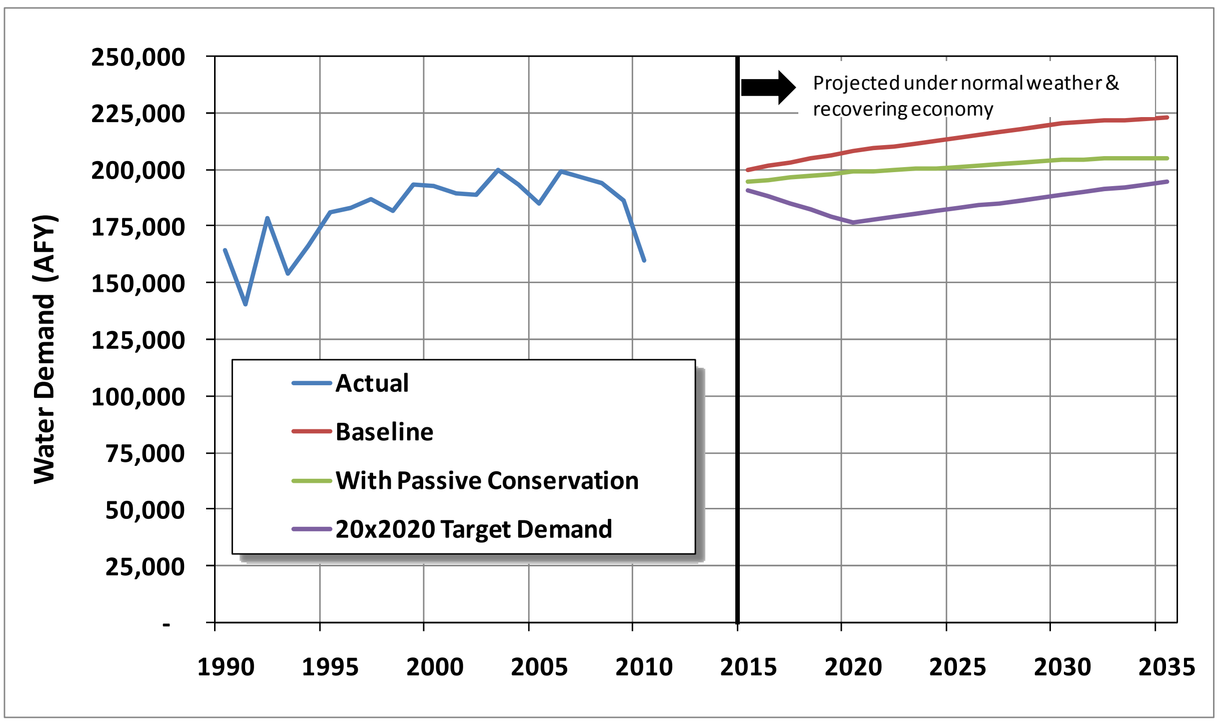


**Figure 2-5**
**Water Demand Forecast for Upper District's Service Area**

**Table 2-4. Water Demands for Upper District with Passive Water Conservation (AFY)**

| Sector | 2015* | 2020 | 2025 | 2030 | 2035 |
|---|---|---|---|---|---|
| Single-family Residential | 96,413 | 98,648 | 101,712 | 106,015 | 108,658 |
| Multifamily Residential | 16,428 | 16,975 | 18,028 | 19,269 | 20,192 |
| Commercial/Institutional | 55,848 | 57,293 | 55,947 | 54,395 | 52,135 |
| Industrial | 11,687 | 11,636 | 10,941 | 10,238 | 9,452 |
| Non-revenue water | 14,204 | 14,533 | 14,697 | 14,956 | 14,997 |
| Total Demand | 194,580 | 199,085 | 201,324 | 204,872 | 205,433 |

* Adjusted for recent drought impacts: unadjusted demands were lowered by 9% based on water production model described in Section 2.2.

## 2.4.1 Future Active Water Conservation

Unlike passive conservation which relies on codes and ordinances to drive water use efficiency, active conservation requires direct utility involvement to drive conservation. This direct involvement usually involves public education and financial incentives (such as rebates for smart irrigation devices). Upper District has had a conservation program for several years and has passed on MWD's financial incentives to its retail member agencies in order to help drive active water conservation. However, a number of factors such as the recent state law requiring 20 percent reduction in per capita water use by 2020 and the possibility of MWD reducing its financial incentives, Upper District developed a Water Use Efficiency Master Plan (WUEMP). A&N Technical Consultants (A&N) developed this master plan in order to assess the benefits and costs of various types of water conservation activities. The IRP team worked closely with A&N to coordinate efforts on both the WUEMP and IRP.

Although the purpose of the IRP is not to make specific recommendations on the types of water conservation Upper District should pursue, it does need to identify the possible broad range of conservation strategies and associated costs.

Drawing from evaluations from the WUEMP, the IRP summarized three broad levels of future active water conservation and their associated unit cost ($/AF), as shown in Table 2-5.

**Table 2-5. Active Water Conservation Strategies for IRP***

| Strategy Level | General Description | Unit Cost ($/AF) |
|---|---|---|
| Low: ~ 2,500 AFY | A continuation of current Upper District conservation activities. | $350 |
| Med: ~ 5,000 AFY | A moderate increase in Upper District conservation activities. | $420 |
| High: ~ 10,000 AFY | A significant increase in Upper District conservation activities, in both types of programs and penetration. | $450 |

* Based on evaluations from the WUEMP (A&N, 2012). See that report for a more detailed description of the types and costs of conservation activities.

# Section 3

# Existing Water Supply and Gap Analysis

The major source of water supply in Upper District's service area is pumped from the Main San Gabriel Groundwater Basin (Main Basin) by Upper District's customer agencies (or Producers). In addition to the Producers' (within Upper District) portion of the Main Basin Operating Safe Yield, several agencies have surface runoff diversion rights from the San Gabriel River or other tributaries within the watershed upstream of Whittier Narrows. These local sources of water are prioritized in meeting existing water demands. Water demands in excess of local supplies are met by supplemental sources, including recycled water for direct non-potable use, and imported water for direct potable use and for groundwater replenishment of the Main Basin. Existing water supplies described in this chapter include:

- Local Supplies: Two local supplies are used by Producers within Upper District, groundwater and surface runoff. Upper District customer agencies produce a portion of the Operating Safe Yield of the Main Basin, by well pumping. The Operating Safe Yield is the quantity of groundwater that can be produced without the need for delivery of untreated imported water to replenish the basin. In addition, several retail agencies have surface diversion water rights on the San Gabriel River or tributaries upstream of Whittier Narrows and have facilites to divert and treat surface runoff for direct delivery.

- Imported Water: Imported water sources are used for either spreading of untreated imported water for replacement of groundwater basin production in excess of Operating Safe Yield or for direct delivery of treated imported water to retail agencies supplied through connections to MWD.

- Recycled Water: Recycled water distributed to several Upper District customer agencies, through local distribution networks for direct non-potable use from two water reclamation plants; Whittier Narrows and San Jose Creek.

## 3.1 Main San Gabriel Basin Groundwater

The Main Basin is adjudicated by the Main Basin Judgment with an annual Operating Safe Yield established by the Watermaster. Watermaster annually establishes an Operating Safe Yield for the Main Basin which is then allocated to each groundwater producer based on their rights in the Basin. No restrictions on extraction quantities are required by the Judgment, but rather the Judgment is focused on establishing a methodology for annually replacing water extracted beyond the Operating Safe Yield. Pumpers extracting water in excess of their annual allocation must pay an assessment to cover the cost of obtaining Replacement Water. Replacement Water is purchased from one of three Responsible Agencies, Upper District, Three Valleys Municipal Water District, or San Gabriel Valley Municipal Water District.

The portion of the Operating Safe Yield that is allocated to pumpers that fall within the service area of each of the three Responsible Agencies is summarized in Table 3-1. Establishment of the annual Operating Safe Yield is influenced by local hydrogeologic conditions, including rainfall, storage in local reservoirs, production, runoff, and local water replenishment.

**Table 3-1. Distribution of Main Basin Allocation of Operating Safe Yield to Three Responsible Parties**

| Responsible Party | Portion of Operating Safe Yield | Allocation based on 2010-11 Operating Safe Yield of 170,000 (AFY) |
|---|---|---|
| Upper San Gabriel Valley Municipal Water District | 80% | 136,630 |
| San Gabriel Valley Municipal Water District | 11% | 17,890 |
| Three Valleys Municipal Water District | 9% | 15,480 |
| **Total** | **100%** | **170,000** |

The 39 year average Operating Safe Yield is 198,000 AFY and the 10 year average is 195,000 AFY (Figure 3-1). This average Operating Safe Yield exceeds the 1967estimate of natural safe yield in the Judgment of 152,700 AFY, most likely because of the increased centralized spreading of natural runoff. However, it should be noted that potential climate change could reduce local mountain snowpack and runoff into the San Gabriel Valley.

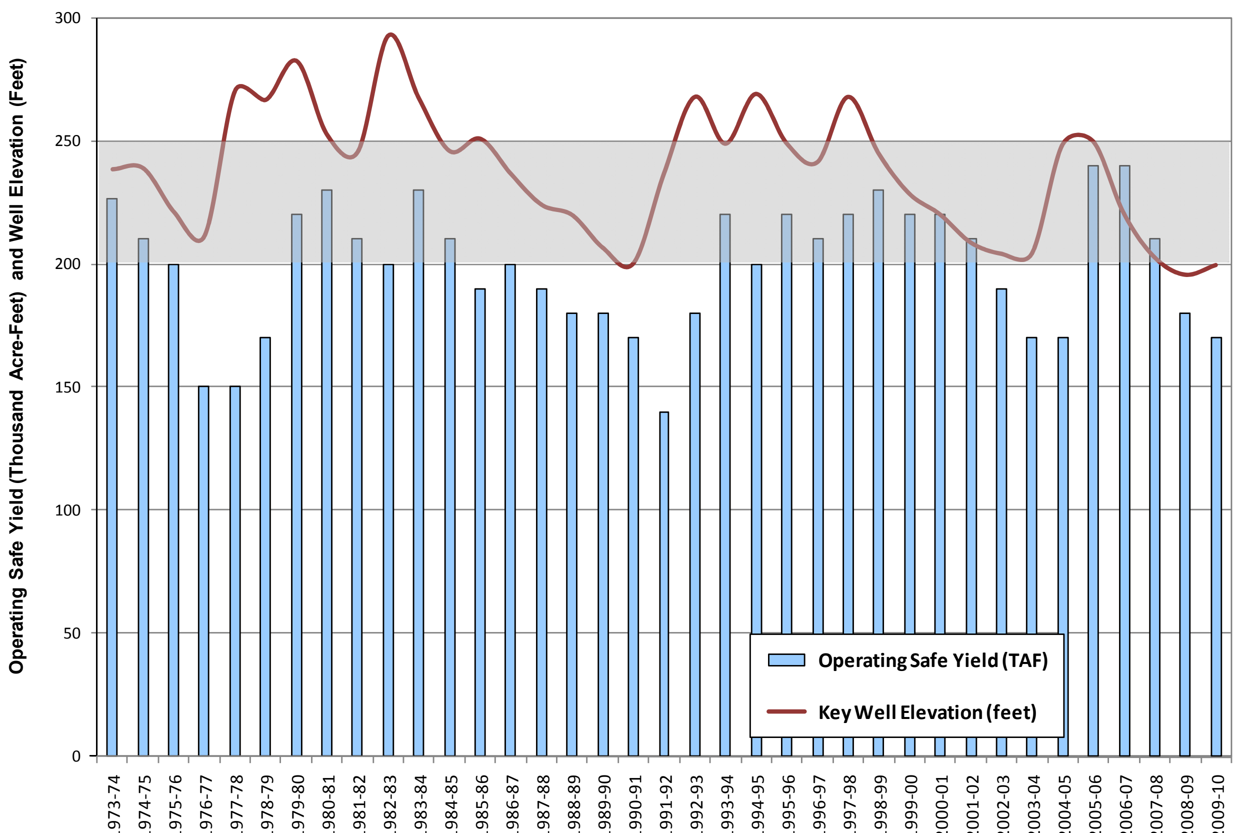


**Figure 3-1**
**Historical Operating Yield and Elevation for the Key Well in Main Basin**
**(Grey Shading Shows Target Range for Key Well Elevation)**

The Main Basin Judgment specifies that Watermaster shall spread Replacement Water, insofar as practicable, to maintain the water level at the Key Well above 200 foot elevation. Figure 3-1 shows the historical fluctuation of the Key Well elevation and illustrates that over the past 39 years, operation has generally achieved a water level elevation between 200-250 feet. In the recent wet season of 2004-05, spreading of local surface runoff increased water level at the Key Well from 200 to 250. The Main Basin had about 7,600,000 AF of water in storage when the Key Well elevation was at about 189 feet above mean sea level, The Key Well elevation has been managed to maintain water levels during extended droughts by allowing for long-term storage of spreading in excess of annual demands. Recharge of surface runoff during wet hydrologic years in excess of the Operating Safe Yield, increases storage to sustain Operating Safe Yield at usable levels during dry hydrologic years.

Surface runoff diversions from the San Gabriel River or tributaries of the watershed to Whittier Narrows are prescribed in the Main Basin Judgment. Retail agencies with rights to divert surface runoff for direct use include Cal American, Covina Irrigation, Monrovia Nursery, and Azusa Valley. The surface diversions since 2001 have averaged about 12,000 AFY. During dry years, the average is closer to 6,700 AFY.

## 3.2 Imported Water

Upper District provides imported water for groundwater replenishment to its retail agencies through purchases of water from MWD, the largest water purveyor in the State of California. Imported water supplied by MWD is conveyed from Northern California via the State Water Project (SWP) and from the Colorado River via the Colorado River Aqueduct (CRA). MWD provides Upper District with raw imported water for groundwater replenishment and treated imported water for direct delivery to retail agencies.

As stated in Section 1, there are several issues and challenges regarding imported water from MWD. These are summarized below:

- **Sacramento-San Joaquin Delta:** The Delta represents a fragile ecosystem that is at the confluence of the Sacramento and San Joaquin Rivers. It is also the point in which waters from these river systems and surface reservoirs to the north are pumped to central and southern California to meet agricultural and municipal water demands via the federal Central Valley Project and SWP. The Delta's myriad of waterways and canals weave between vast islands of land that are protected from seawater tides and storms by large earthen levees that are susceptible to failure. A break in these levees would inundate the Delta with seawater. The Delta is also home to several threatened and endangered fish species. In 2007, pumping in the Delta was restricted by court order to protect one of these fish species, the Delta Smelt. The Federal government, State of California and major water agencies relying on the Delta have begun an ambitious plan to restore the Delta and provide for a reliable water supply. This plan calls for billions of dollars in new conveyance facilities to reduce the impacts of water diversions on the natural environment. However, this plan will require voter approval for bonds as well as a financial allocation plan to share the costs of both the ecosystem restoration and new conveyance water facilities.

- **Colorado River:** While a seven state basin agreement (Quantification Settlement Agremeent) is in place, which requires California to live within its 4.4 million acre-foot entitlement for the Colorado River, prolonged droughts and over-allocation of the river are of significant concern to all Colorado River water users, including MWD.



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- **Imported Water Cost:** From 2007 to 2012, MWD's imported water costs have increased over 12 percent annually and MWD projects it's 2014 full service water rate to be 7 percent greater than its 2012 rate. Costs associated with solving the problems in the Delta will undoubtedly continue to increase future costs for MWD. The other cost issue that pertains directly to Upper District is the fact that for many of the past 7 years, MWD has not had a replenishment water rate (representing a discount off of its firm water rate). This has caused costs for groundwater replenishment of the Main Basin to increase by about 188 percent between 2007 and 2012. It is still uncertain whether a long-term replenishment rate will be re-established by MWD.

- **Climate Change:** Studies by Scripts Institute and the California Department of Water Resources (DWR) indicate that climate change can significantly impact snow melt in the Sierra Nevada mountain range, a main source of Delta water supply. Depending on the climate change scenario, imported water from the Delta may be 15 to 30 percent lower by 2050. In addition, studies by the Bureau of Reclamation indicate similar impacts for the Colorado Basin.

- **Overall Reliability:** In 2008 and 2009 MWD allocated its imported water, the first time it had to do so two years in a row. As a result, MWD is aggressively developing storage, water transfers and helping to finance local resource development in order to improve supply reliability. Through its own regional IRP, MWD has identified a long-term strategy involving core resource development and other options that can be phased in through an adaptive management approach. One key component of MWD's IRP is the assumption of significantly increased local supplies from recycled water, groundwater clean-up and potential seawater desalination.

Figure 3-2 shows the projected supply reliability of MWD's supply, assuming a Delta fix is not in place and with historical hydrology (i.e., no climate change).

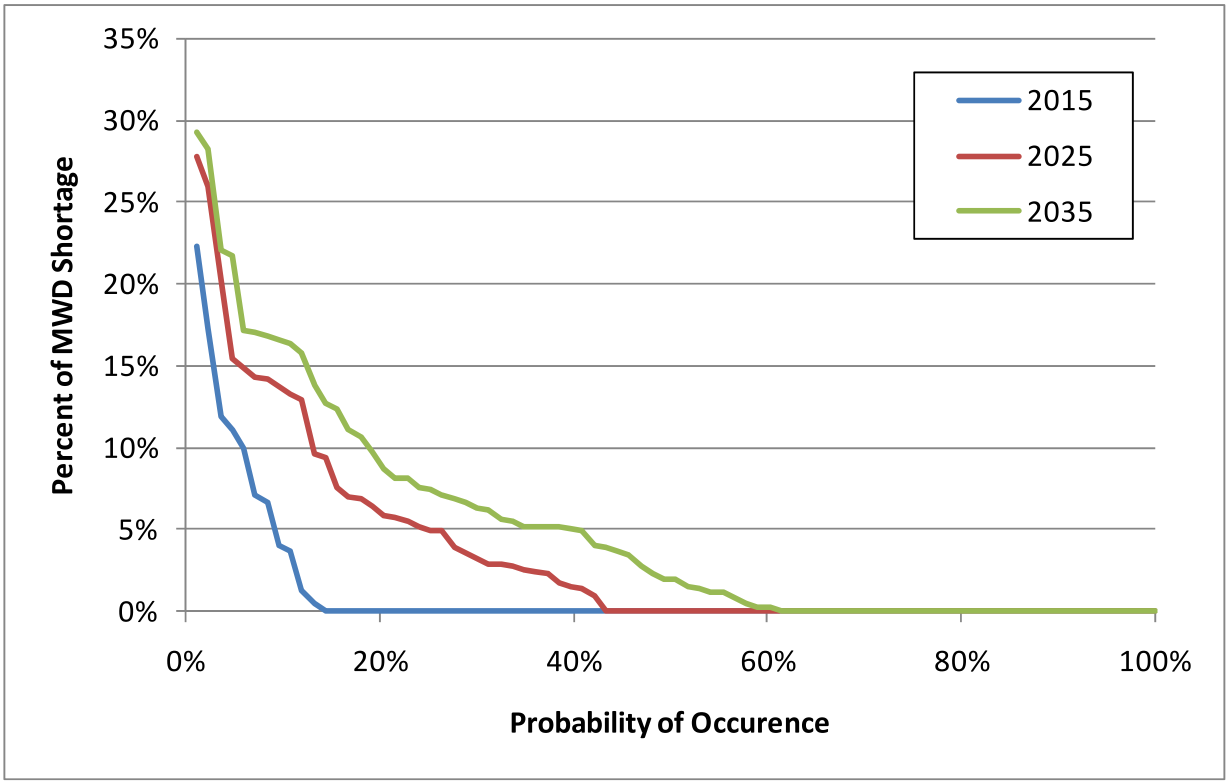



**Figure 3-2**
**MWD Imported Water in Firm Supply (Assumes No Delta Fix and No Climate Change)**
Source: Derived from data provided by MWD from 2010 IRP

What Figure 3-2 shows is that by 2035 there is a 60 percent chance that some shortage will occur in future years without a Delta fix. It also shows that by 2035 there is a 20 percent chance that a supply shortage of at least 10 percent will occur. In 2008 and 2009, a regional shortage of 10 percent triggered MWD's allocation of imported water to its member agencies. Put another way, if a Delta fix is not achieved the allocation that Upper District received in 2008 would occur 1 in 5 years (or 20 percent of the time). Climate change, while not quantified in this IRP, will only exacerbate these water shortages. For the purposes of this IRP, it was assumed that MWD will be able to essentially meet all demands for imported water 80 percent of the time, and 20 percent of the time would allocate its imported water similar to what it did in 2008.

Untreated imported water is used is used for groundwater replacement when extractions are in excess of Upper District's retail agencies' share of the Main Basin Operating Safe Yield, and for additions to long-term cyclic storage accounts. Treated imported water is provided to retail agencies as a direct delivery.

Figure 3-3 shows the historical imported water purchases made by Upper District from MWD. In general, there is substantial variability in the purchase of imported water for replacement / storage in the Main Basin, which is largely a function of hydrologic conditions.

In dry hydrologic years, the demand for imported water groundwater replacement is greatest. In wet years, local runoff is prioritized for spreading thus decreasing capacity to recharge imported water.

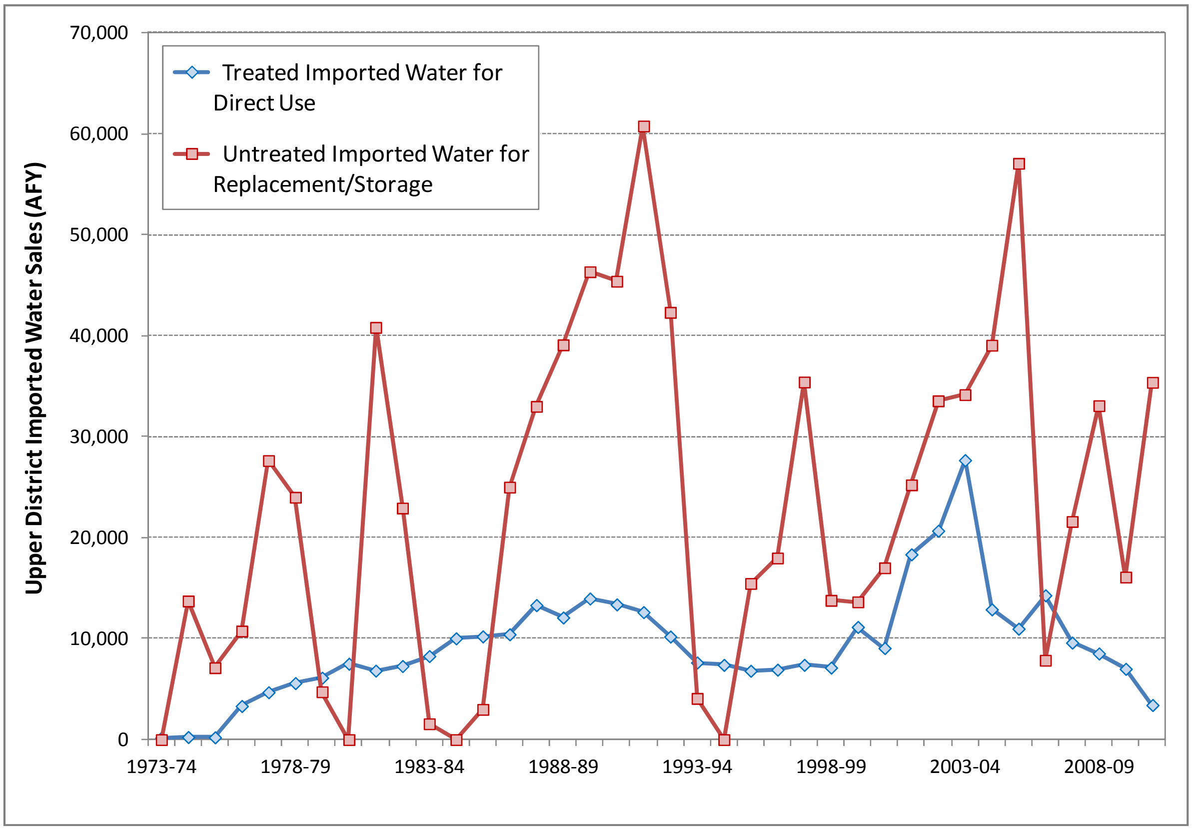



**Figure 3-3**
**Upper District's Historical Treated and Untreated Imported Water Purchases**

## 3.3 Recycled Water

Recycled water is available from two water reclamation plants in the Basin; Whittier Narrows and San Jose Creek Water Reclamation Plants (WRPs), with recent effluent quantities (average of 2010 and 2011 production) of approximately 8,800 AFY and 75,000 AFY, respectively. Both of these plants are owned and operated by the Los Angeles County Sanitation District's. A small portion of this tertiary treated effluent is used to meet non-potable demands in Upper District's service area (see Figure 3-4). In recent years Upper District has begun a Direct Use Recycled Water Program to provide recycled water via contract with its retail agencies to serve irrigation demand at facilities like schools and parks.

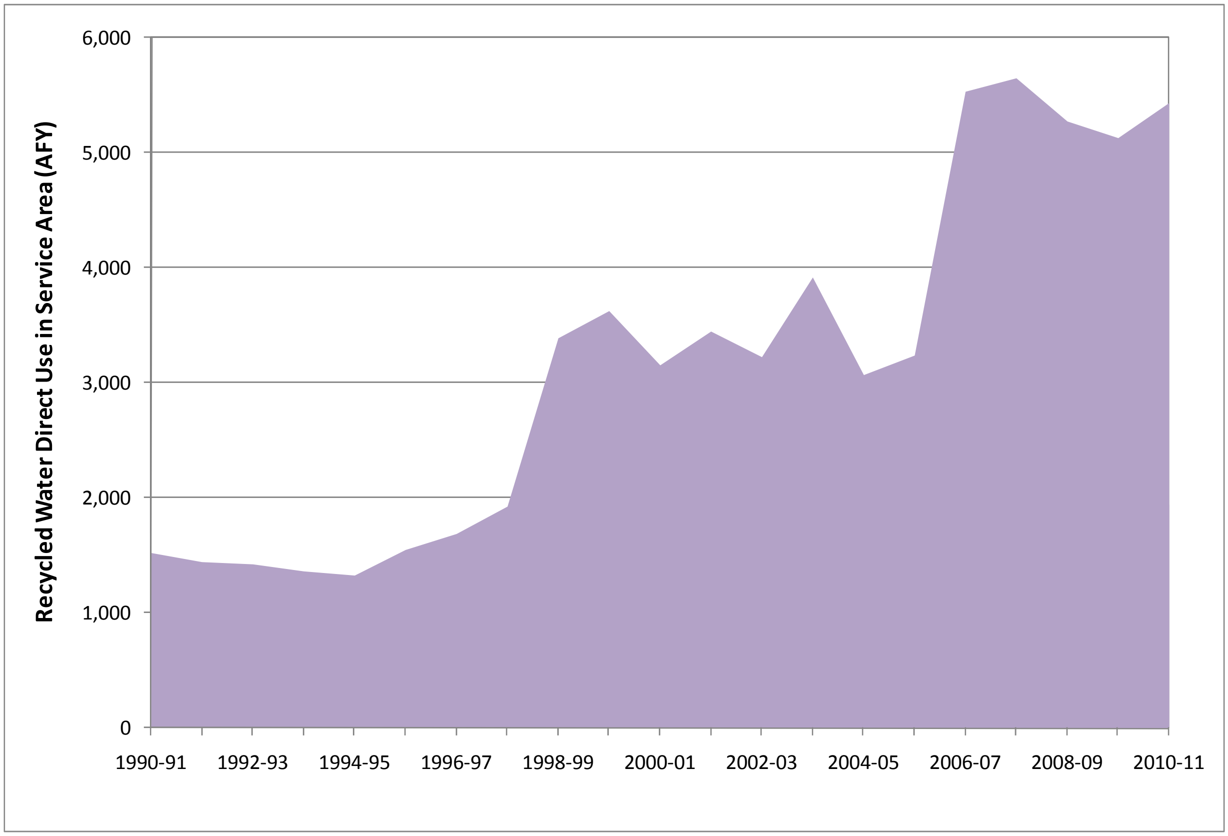



**Figure 3-4**
**Non-Potable Reuse in Upper District's Service Area**

## 3.4 Summary of Existing Water Supply

Historical water supply sources used to meet demands within Upper District's service area are shown in Figure 3-5. The predominant source of water is the natural safe yield from the Main Basin as well as local surface runoff for diversion or spreading to recharge the Main Basin.

In an average hydrologic year, supplemental supplies make up approximately 25 percent of the current supply used to meet demands in the Upper District service area. Supplemental supplies include recycled water for direct non-potable use and imported water for direct use or for replacing Main Basin pumping in excess of the Operating Safe Yield.

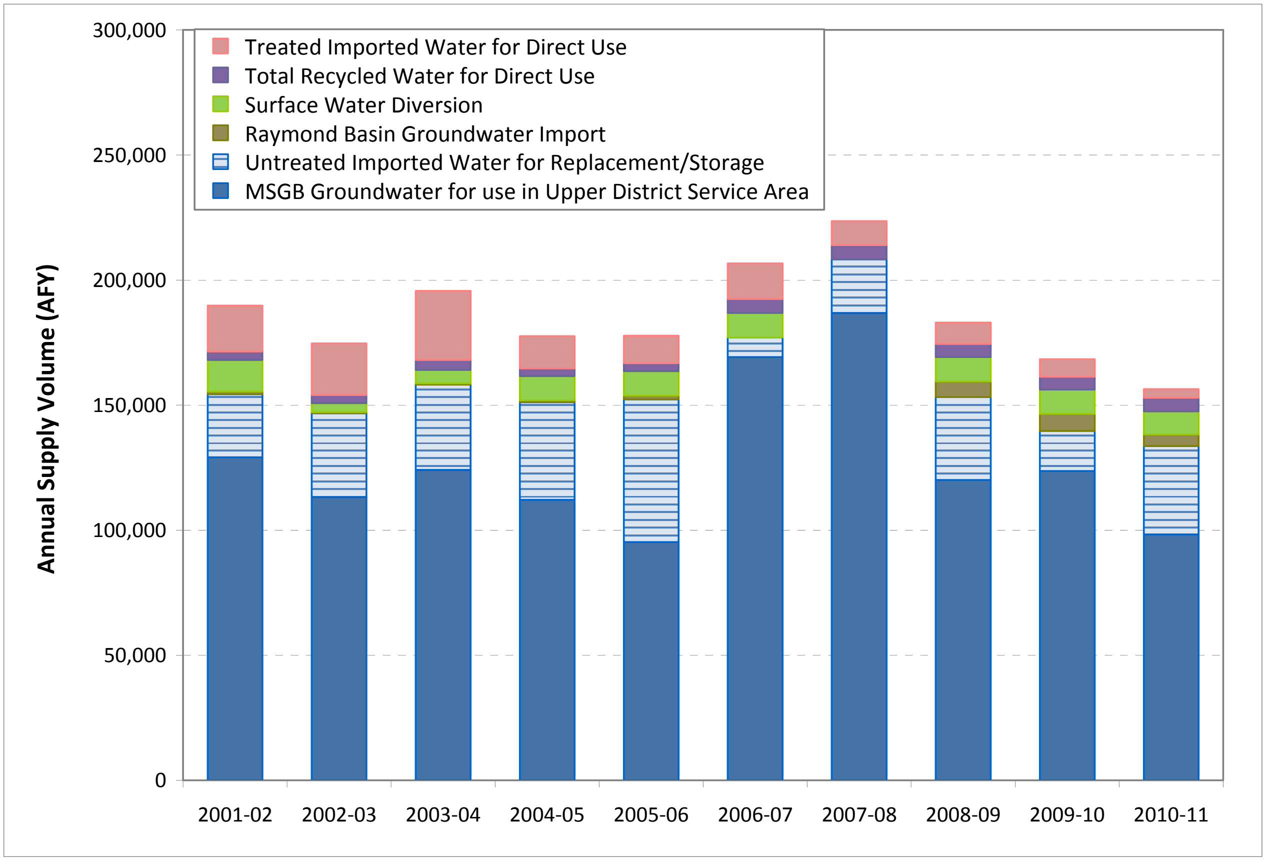



**Figure 3-5**
**Historical Water Supply Sources Used to Meet Water Demands within Upper District's Service Area**

## 3.4.1 Water Quality Issues

There are several groundwater contamination plumes throughout the Main Basin that require treatment to meet maximum contaminant level (MCL) standards for drinking water. Contaminants of concern in the Main Basin include:

- Volatile organic compounds (VOCs) which come from industrial solvents
- 1,4-dioxane, a stabilizer for chlorinated solvents
- Nitrate from use of fertilizer when the lands overlying the Basin was used for agriculture, as well as from livestock (dairies)
- Perchlorate, a solid rock fuel ingredient
- NDMA, a liquid rocket fuel ingredient
- MTBE, a gasoline additive

These contaminants are found in isolated plumes within six operable units throughout the Main Basin (Table 3-2). The ability for Upper District's retail agencies to pump groundwater from the Main Basin could be impacted without treatment. Water quality issues could also limit those strategies that rely on groundwater for conveyance, such as indirect potable reuse, stormwater capture or imported water replenishment. Substantial efforts are underway, led by the Water Quality Authority and Watermaster to maintain, upgrade and operate treatment facilities to remove these contaminants. These efforts have allowed for continued groundwater production and led to less dependence on increasingly expensive imported supplies.

**Table 3-2 Summary of Key Contaminants of Concern in Operable Units Overlying the Main Basin**

| Operable Unit[1] | TCE | PCE | CTC | 1,1-DCE | Cis-1,2-DCE | Perchlorate | NDMA | 1,2,3-TCP | 1,4-Dioxane | Chromium-6 | Nitrate |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Baldwin Park | X | X | X | | | X | X | X | X | | X |
| South El Monte | X | X | | | | X | | | X | | |
| El Monte | X | X | | | | X | | | X | X | |
| Whittier Narrows | X | X | | | | X | X | | X | | |
| Puente Valley | X | X | | X | | | | | X | | |
| Area 3 | X | X | X | | X | X | | X | | | X |

[1] Map of approximate operable units boundaries can be found in Main San Gabriel Basin Watermaster Five-Year Water Quality and Supply Plan: http://www.watermaster.org/techinfo.html

## 3.5 Gap Analysis Between Demand and Supply

In order to evaluate potential new water supplies for the IRP, an assessment of "firm" existing water supply was compared to projections of water demands in order to determine the potential gap (or water shortage). Firm existing water supply is the minimum annual supply volume expected to be available in all hydrologic year types. For this gap evaluation the following assumptions were used:

**Imported Water Supplies:**

- No Delta "fix" is implemented by 2035.
- A repeat of drought conditions in which MWD allocates imported water to Upper District, similar to 2008.
- Climate change does not impact MWD's imported water supplies within the next 25 years.

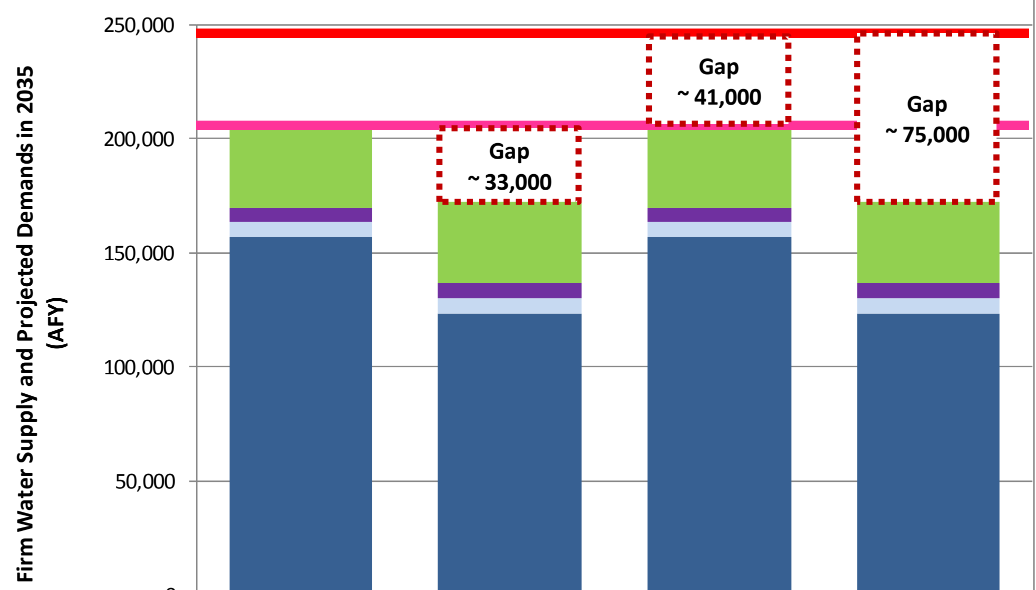
**Local Water Supplies:**

- Safe yield production of Main Basin was based on a range: with the low range being the 1967 conditions used to develop the Judgment (~152,700 AFY with ~123,600 AFY allocated to Upper District); and the high range based on the normalized average of native water produced under the Judgment from 1973 to 2010 (~195,900 AFY with ~156,700 AFY allocated to Upper District). The reason to use the 1967 conditions as a low range for safe yield production reflects the possibility that climate change could reduce the natural replenishment of the basin.
- Dry hydrologic conditions for surface water diversions.
- Groundwater quality does not limit groundwater pumping from Main Basin.

**Water Demands:**

- The low range of water demands only includes those retail-level demands within Upper District's service boundary; while the high range of water demands also includes groundwater exports from the Main Basin to meet retail water demands in Central Basin and Orange County of ~41,500 AFY (the average value since 2001).
- Water demands include passive conservation and influence of price of water and income, and existing active conservation, but do not include future active conservation.

Based on the above assumptions, a water supply gap analysis was performed comparing future water demands to existing, firm water supplies (see Figure 3-6). As shown in this figure, the gap between existing, firm water supplies and projected demands in year 2035 could range from zero to a high of 75,000 AFY, with the upper range of the gap being a proxy for potential climate change impacts. For the purpose of comparing and ranking IRP alternatives, a baseline gap assumption of approximately 33,000 AFY was used. However, because of the uncertainty in the gap, an adaptive management strategy was developed and is presented in Section 8.




| | No Gap | Baseline Gap | Med Large Gap | Large Gap |
|---|---|---|---|---|
| Allocated Firm MWD Water | 36,000 | 36,000 | 36,000 | 36,000 |
| Existing Recycled Water | 6,260 | 6,260 | 6,260 | 6,260 |
| Surface Water (dry year) | 6,600 | 6,600 | 6,600 | 6,600 |
| Groundwater (native w/o replen) | 156,700 | 123,600 | 156,700 | 123,600 |
| Retail Demands Only | 205,433 | 205,433 | 205,433 | 205,433 |
| Retail Demands Plus Exports | 246,933 | 246,933 | 246,933 | 246,933 |

**Figure 3-6**
**Range in Gap between Existing Water Supplies and Projected Water Demands for Upper District in Year 2035**

# Section 4

# IRP Process

Upper District's IRP was based on a proven planning process that explores both demand-side and supply-side options in an integrated manner in order to meet multiple objectives. The IRP also explores risk and develops an overall strategy using an adaptive management framework.

The IRP was prepared using an open, participatory process involving major stakeholders including Upper District's Board of Directors, retail agency managers (producers), Watermaster, and other regional interests. The following lists the all of the Board and stakeholder meetings and workshops for the IRP:

| Date | Meeting Group | IRP Discussion Items |
|---|---|---|
| August 2<br>2011 | Water Producers | • Project Kick-Off<br>• Goals for IRP |
| September 20<br>2011 | Board and Public | • Project Kick-Off<br>• Goals for IRP |
| January 17<br>2012 | Board and Public | • IRP Objectives (Planning Criteria)<br>• Water Demand Forecast Update |
| January 18<br>2012 | Council of Governments (COG) Group | • IRP Objectives (Planning Criteria) & Weighting<br>• Water Demand Forecast Update |
| January 19<br>2012 | Water Producers | • IRP Water Demand Forecast (Preliminary Results) |
| February 14<br>2012 | Watermaster Stormwater Capture Committee | • Update on IRP<br>• Stormwater Capture Discussion |
| February 22<br>2012 | Water Producers, COG Water Resources Working Group, San Gabriel Valley Economic Partnership | • Demand Forecast and Gap Analysis<br>• Water Supply Options<br>• Preliminary IRP Alternatives |
| May 15<br>2012 | Board and Public | • Ranking of IRP Alternatives |
| May 21<br>2012 | Water Producers | • Ranking of IRP Alternatives |

In the development of the IRP, the following terms are used:

| | |
|---|---|
| **Objectives** | Broadly stated goals of the IRP that drive the evaluation |
| **Performance Metrics** | Metrics that indicate how well objectives are being achieved |
| **Options** | Individual water supply and demand-side management projects or programs |
| **Alternatives** | Combinations of options that are evaluated against the performance metrics |

## 4.1 IRP Process

The IRP process used for Upper District is summarized in Figure 4-1. The process begins with defining the objectives and performance metrics for the IRP. Upper District's Directors developed the objectives in a board workshop, and these objectives were weighted in terms of relative importance by retail water agencies and other regional stakeholders in during a stakeholder workshop. The objectives together with the performance metrics serve as the evaluation criteria by which IRP alternatives were measured against.

Concurrent with the development of objectives, was the identification and characterization of various water supply and conservation options. These options are described in Section 2 (conservation), Section 5 (recycled water), and Section 6 (stormwater and water transfers/storage).

Because no single option can meet all of the IRP objectives, these options were combined in various ways to develop integrated alternatives. These alternatives were developed around themes such as maximize reliability or minimize cost. Then the alternatives were evaluated in terms of how well they achieved the objectives, and then ranked (presented in Section 7).

Based on the ranking of alternatives, an adaptive management approach was used to develop the IRP strategy for Upper District, which is presented in Section 8.

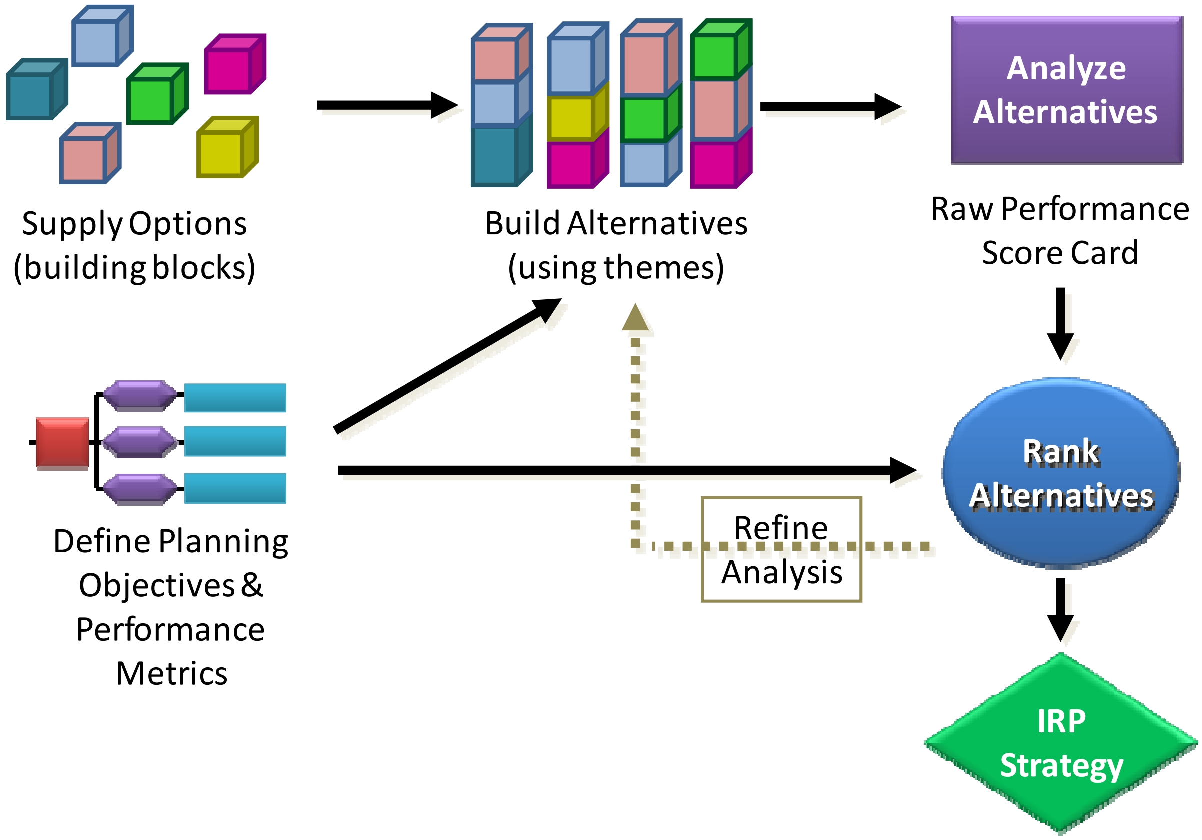



**Figure 4-1**
**IRP Process for Upper District**

## 4.2 IRP Objectives and Performance Metrics

The IRP objectives and associated performance metrics were defined by Upper District's Directors and are summarized in Table 4-1. Because not all of these objectives are equal in importance, a weighting exercise was conducted at a stakeholder workshop. Figure 4-2 summarizes the objective weights, showing both the range of weightings and the average weights for the group.

**Table 4-1. IRP Objectives and Performance Measures for Upper District**

| Objective | Performance Metric |
|---|---|
| Provide Reliable Water Supply | • Maximum water shortage in year 2035<br>• Cumulative average water shortages (2012 thru 2035)<br>• Climate change resiliency score |
| Develop Cost-Effective Solutions | • Total present value lifecycle cost<br>• Total capital costs (in $2012 dollars) |
| Increase Local Control of Supply | • A score indicating level of local control |
| Meet Water Quality Basin Goals | • A score indicating Basin water quality impacts |
| Improve Natural Environment | • Stormwater runoff managed (i.e., not going to the ocean)<br>• Greenhouse gas emissions from operations |
| Reduce Risk of Implementation | • A score indicating flexibility of alternative<br>• A score indicating permitting challenges<br>• A score indicating institutional complexity<br>• A score indicating customer acceptability |

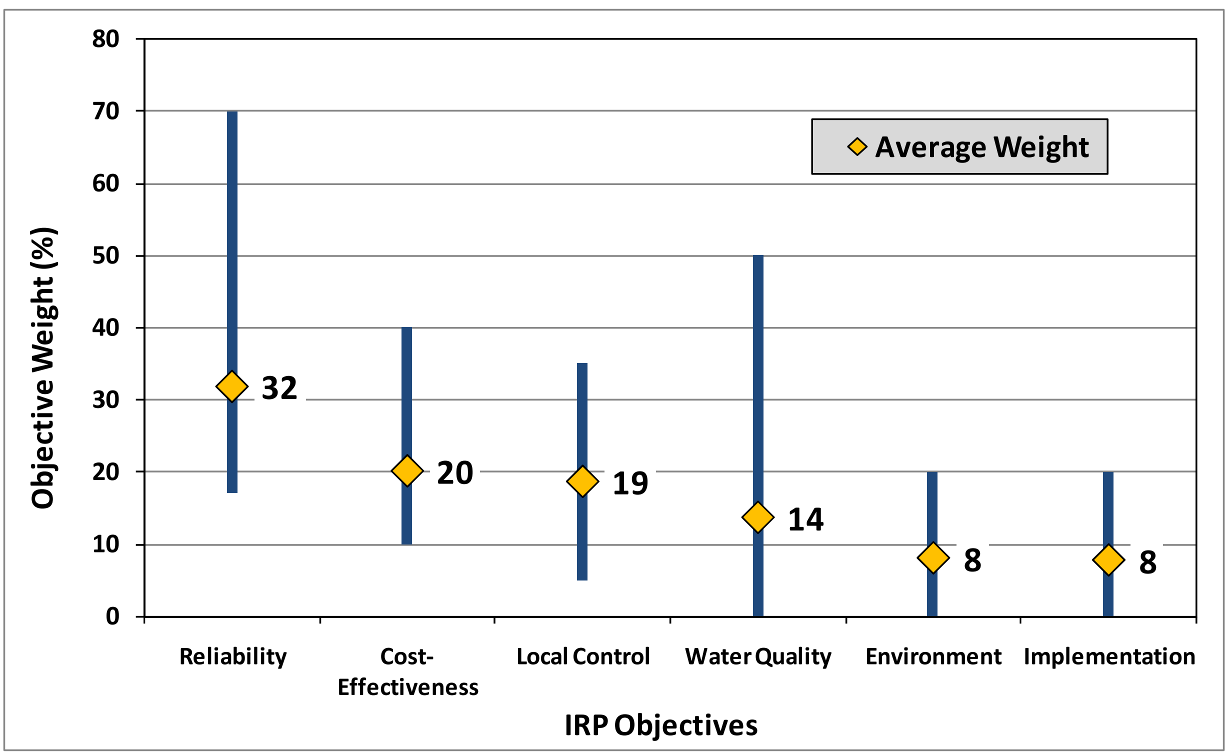



**Figure 4-2**
**Stakeholder Weights for IRP Objectives**

The weighting of objectives for Upper District indicates that *Reliability* was the most important objective, followed by *Cost-Effectiveness, Local Control* and *Water Quality*. The weighting also showed that *Reliability* and *Water Quality* had the most variation in weights as indicated by the range in blue lines in Figure 4-2. For example, at least one stakeholder felt *Water Quality* was not important at all, while at least one stakeholder thought *Water Quality's* importance was 50 percent of the total of all weights. *Reliability* had an equally large spread, with one stakeholder's weight at 18 percent, and another's at 70 percent. These spreads in objective weights were helpful in conducting sensitivity in the ranking of alternatives as described in Section 7.

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# Section 5

# Recycled Water Options

Recycled water supply options evaluated in this IRP include direct non-potable reuse (e.g. delivery of tertiary treated effluent for landscape irrigation) and indirect potable reuse (IPR), which involves treatment and/or blending for recharge of the groundwater basin, and then subsequent extraction with wells for potable use. Specific direct non-potable reuse projects are planned for implementation as part of Upper District's Direct Reuse Program, described in Section 5.1. For IPR, three alternatives are evaluated that treat wastewater from the San Jose Creek Water Reclamation Plant (SJCWRP) for spreading within the Main Basin, as described in Section 5.2.

## 5.1 Direct Non-Potable Reuse

Upper District has developed a Direct Reuse Program to use direct delivery of recycled water to serve non-potable demands, thereby offsetting reliance on imported water sources. The Direct Reuse Program began in FY 2002/03 and in FY 2011/12, Upper District recycled water deliveries were 2,084 AFY. If all planned and potential projects are implemented, the Direct Reuse Program is forecast to provide approximately 5,400 AFY.

The Direct Reuse Program is in various stages ranging from completed projects to planned and conceptual options. Recycled water supply for the Direct Reuse Program customers is obtained from the two water reclamation plants that serve the entire service area, owned and operated by the Sanitation Districts of Los Angeles County, the Whittier Narrows and San Jose Creek Water Reclamation Plants.

Table 5-1 summarizes existing, planned and potential non-potable reuse projects. At the time of the IRP preparation, several projects that were being planned are now in various stages of construction, as indicated in the table.

**Table 5-1: Summary of Existing and Potential Non-Potable Reuse with Upper District's Direct Reuse Program**

| Status | Component | Yield (AFY) |
|---|---|---|
| Existing [1] | Phase I – Rosehills | 660 |
| | Phase IIA - Whittier Narrows and Rosemead Extension | 1,570 |
| | Phase IIB - Industry Package 1 and Package 2 | 1,050 |
| | *Sub-total* | *3,280* |
| Planned and Potential (for IRP consideration) | Phase I - Rosehills Expansion | 600 |
| | Phase IIB - Industry Package 3 and Package 4 [2] | 520 |
| | Phase III - Membrane Bioreactor Treatment Plant | 500 |
| | Reuse Future Extensions of Recycled Water Program | 500 |
| | *Sub-total* | *2,120* |
| | **Total** | **5,400** |

[1] Yield shown is based on FY 2008/09 recycled water sales.

[2] At the time of the IRP analysis, these projects were planned but have since moved to construction.

## 5.2 Indirect Potable Reuse

As part of the IRP, Upper District is evaluating alternatives to use recycled water for groundwater basin replenishment—referred to as indirect potable reuse (or IPR). Building upon the work completed in the Groundwater Reliability Program (GRIP), CDM Smith developed cost estimates for several different treatment options for IPR factoring in the proposed recycled water contributions as presented in the draft California recycled water regulations (CCR Title 22 Division 4, Chapter 3, Article 5.1). The IPR project under evaluation involves delivery of recycled water from the San Jose Creek Water Reclamation Plant (SJCWRP) to the Main Basin for surface recharge to replenish the Main Basin. The options evaluated for providing treatment of the recycled water prior to recharge are:

- Advanced Water Treatment (AWT) – AWT process facilities can include Microfiltration (MF) or Ultrafiltration (UF), Reverse Osmosis (RO), Advanced Oxidation using Ultraviolet (UV) and Hydrogen Peroxide, and chemical addition for product water stabilization. AWT systems also require additional recycled water for regular membrane washing, which in the case of wastewater applications creates a waste stream that must be managed.
- Tertiary Treatment – Use of additional disinfection processes for removing suspended, colloidal, and dissolved constituents remaining after conventional secondary treatment.
- Hybrid Treatment – Some combination of Tertiary and AWT treatment systems.

IPR of up to 24,000 AFY in the Main Basin could potentially be achieved with the implementation of any of the treatment options. Since all available effluent is already treated to tertiary standards, the AWT and Hybrid Treatment options will involve construction of additional treatment facilities. For options that produce 24,000 AFY, improvements in LACSD collection system and San Jose Creek facility would also need to be made to achieve this level of IPR. For Upper District's IRP, two levels of IPR were evaluated: 10,000 AFY and 24,000 AFY.

Key to the analysis of IPR options is the allowable Recycled Water Contribution (RWC) that a potential groundwater recharge project could be permitted for operation. The California Department of Public health (CDPH) limits the amount of recycled water for groundwater recharge based on both the level of treatment and the method of recharge. In its simplest form, the RWC is defined as the volume of recycled water applied to a site divided by the sum of the recycled water volume plus diluent water (water from non-recycled sources) volume applied to the same site. Diluent water sources available to the Upper District IPR at the SFSG include imported water and stormwater runoff. Projects that use higher levels of treatment processes (e.g. AWT relative to tertiary treatment approaches) are permitted for higher RWCs. Additionally, increases to the initially permitted RWC can potentially be achieved for projects that can demonstrate consistent compliance with performance criteria. Table 5-2 shows the RWC values assumed in the Upper District IRP that are the basis for determining diluent water requirements.

**Table 5-2. Assumed Recycled Water Contribution for IPR Options**

| Period | FAT* | Tertiary |
|---|---|---|
| 2015-2020 | 75% | 20% |
| 2020-2025 | 75% | 33% |
| 2025 + | 100% | 50% |

* FAT = full advanced treatment

The IPR treatment options have different requirements for diluent water (Figure 5-1) to achieve the same annual volume of recycled water recharge in the recharge area. Stormwater or imported water for dilution are accounted in the evaluation of the IPR options, as they may increase cost or influence the other Upper District projects under consideration. Historical stormwater spreading (120-month rolling average) in the Santa Fe Spreading Grounds (SFSG) already provides the majority of the diluent water needed, leaving roughly 750 AFY of supplemental diluent supply needed to meet the 2025 projection for IPR supply (only ~3 percent of IPR potential). This could be met with imported water or it may be possible to develop synergies between projects, such as a stormwater recharge projects that provides the supplemental diluent water needed to allow implementation of IPR.

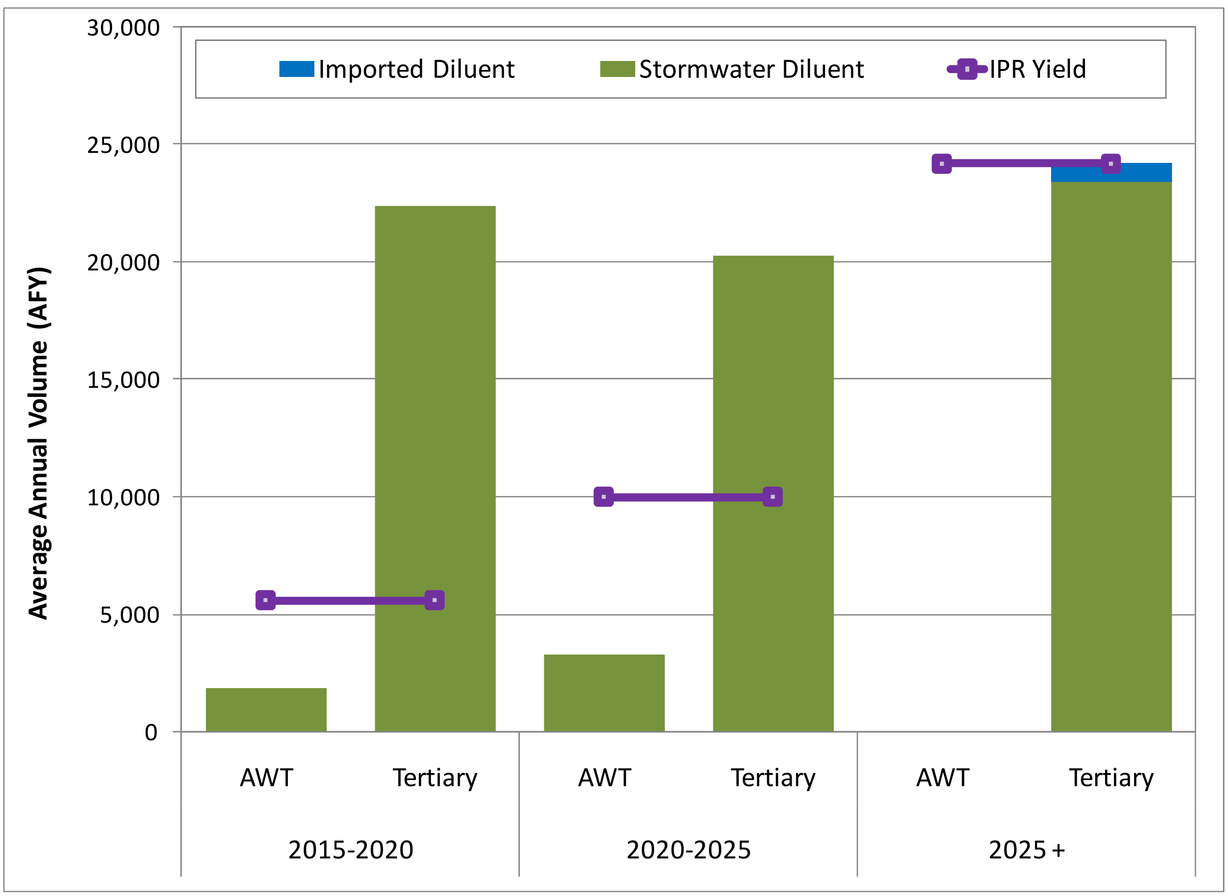


**Figure 5-1**
**IPR Recharge in SFSG and Diluent Water Requirements for each Option**

## 5.3 Recycled Water Option Costs

Capital and O&M cost estimates for most of the non-potable reuse options were provided by Upper District. CDM Smith estimated the capital and O&M costs for the membrane bioreactor treatment plant based on similar operating projects in operation. Costs for non-potable reuse projects are summarized in Table 5-3.

**Table 5-3. Estimated Costs for Non-Potable Reuse Recycled Water Options**

| Cost | Capital Cost ($) | Annual O&M ($/yr) |
|---|---|---|
| Phase IIB - Industry Package 3 | $2,200,000 | $90,000 |
| Phase IIB - Industry Package 4 | $3,000,000 | $60,000 |
| Phase III - Membrane Bioreactor Treatment Plant | $8,000,000 | $230,000 |
| Reuse Future Extensions of Recycled Water Program | $10,000,000 | $100,000 |
| **Total** | **$23,200,000** | **$480,000** |

Table 5-4 summarizes estimated capital costs for the two IPR options; tertiary treatment and full advanced treatment (FAT). These estimates are based on scaling down original estimates in the GRIP for the 10,000 AFY yields. The annual O&M cost estimates are summarized by project components and were derived from the cost curves for various project components provided in GRIP. In addition, costs were estimated for a hybrid IPR option involving a smaller AWT plant (14 MGD) for blending with tertiary treated water. This hybrid AWT plant was sized to provide sufficient capacity to reduce the TDS from tertiary effluent (~580 mg/L) to a concentration low enough to meet water quality objectives (450 mg/L)for the Main Basin. Also, a reduced amount of tertiary recycled water utilized in the hybrid option would ensure that the historical surface runoff spreading in SFSG be sufficient to meet the RWC target without any supplemental diluent water requirements.

Table 5-5 presents the O&M costs for the different treatment options, based on scaling the costs from the GRIP study as well as accounting for the draft Recycled Water Contributions.



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**Table 5-4. Estimated Capital Costs for Indirect Potable Reuse Recycled Water Options for 10,000 AFY of Supply Yield**

| Cost[1] | Tertiary Treatment | Full Advanced Treatment (FAT) | Hybrid (Tertiary/AWT) |
|---|---|---|---|
| Sewer Diversions [2] | | | |
| Route media filter backwash to plant influent | n/a | $100,000 | $100,000 |
| Re-route sewers in the vicinity of the Pomona WRP to SJCWRP | n/a | $1,500,000 | |
| EQ Basin [3] | $24,200,000 | $32,000,000 | $28,900,000 |
| AWT Facilities Excluding Brine Discharge | n/a | $99,000,000 | $58,000,000 |
| AWT Brine Discharge | n/a | $47,000,000 | $28,000,000 |
| Conveyance to SFSG | | | |
| Pipeline from SJCWRP to SFSG | $53,800,000 | $53,800,000 | $53,800,000 |
| Pump Station from SJCWRP to SFSG | $5,100,000 | $5,110,000 | $5,110,000 |
| **Total** | **$83,000,000** | **$239,000,000** | **$174,000,000** |

[1] All costs are in 2011 dollars, unless noted otherwise. Costs are based on cost curves included in *Grip Alternatives Analysis Final Report*, RMC, June 2011. Appendix B.

[2] Assumes 14,600 AFY is available at SJCWRP. The remaining recycled water is achieved by recovering washwater and re-routing sewers. The remaining recycled water needed for tertiary treatment can be obtained with minimal costs, but the excess recycled water needed for the FAT option require capital investments.

[3] Assumes EQ basin capacity required is 20% of recycled water supply, plus backwash supply required for FAT options.

**Table 5-5. Estimated O&M Costs for Indirect Potable Reuse Recycled Water Options for 10,000 AFY of Supply Yield**

| Cost[1] | Tertiary Treatment | Full Advanced Treatment (FAT) | Hybrid (Tertiary/AWT) |
|---|---|---|---|
| Tertiary Water Purchase [2] | $3,020,000 | $1,850,000 | $1,500,000 |
| Imported Water Purchase [3] | $702,000 | n/a | n/a |
| EQ Basin [4] | $111,000 | $147,000 | $133,000 |
| AWT Facilities Excluding Brine Discharge | n/a | $20,400,000 | $12,000,000 |
| AWT Brine Discharge | n/a | $1,770,000 | $1,040,000 |
| Conveyance to SFSG | | | |
| Pipeline from SJCWRP to SFSG | $237,000 | $237,000 | $237,000 |
| Pump Station from SJCWRP to SFSG | $3,220,000 | $3,220,000 | $3,220,000 |
| Groundwater Recovery [5] | $2,420,000 | $2,420,000 | $2,420,000 |
| Total | $9,700,000 | $30,000,000 | $20,500,000 |

[1] All costs are in 2011 dollars, unless noted otherwise. Costs are based on cost curves included in *Grip Alternatives Analysis Final Report*, RMC, June 2011. Appendix B.
[2] Assumes “floor” rate tertiary effluent price of $105/AF for FAT and hybrid options and “ceiling” rate tertiary effluent purchase price of $315/AFY for no advanced treatment option.
[3] Assumes $936/AF of imported water purchase cost.
[4] Assumes O&M cost for EQ basin is approximately 0.5% of construction cost.
[5] Assumes $100/AF for groundwater recovery.

To approximate the annual cost of water from each of these options, the estimated capital costs were amortized over thirty years with an assumed interest rate of five percent. This cost is added to the annual O&M cost for the proposed recycled water facilities to determine the total annualized cost for both non-potable and indirect potable reuse projects. Comparing these annualized costs, including capital and O&M, with the estimated average annual yields, the unit cost of water in unit cost ($/AF) is approximated (see Figure 5-2).



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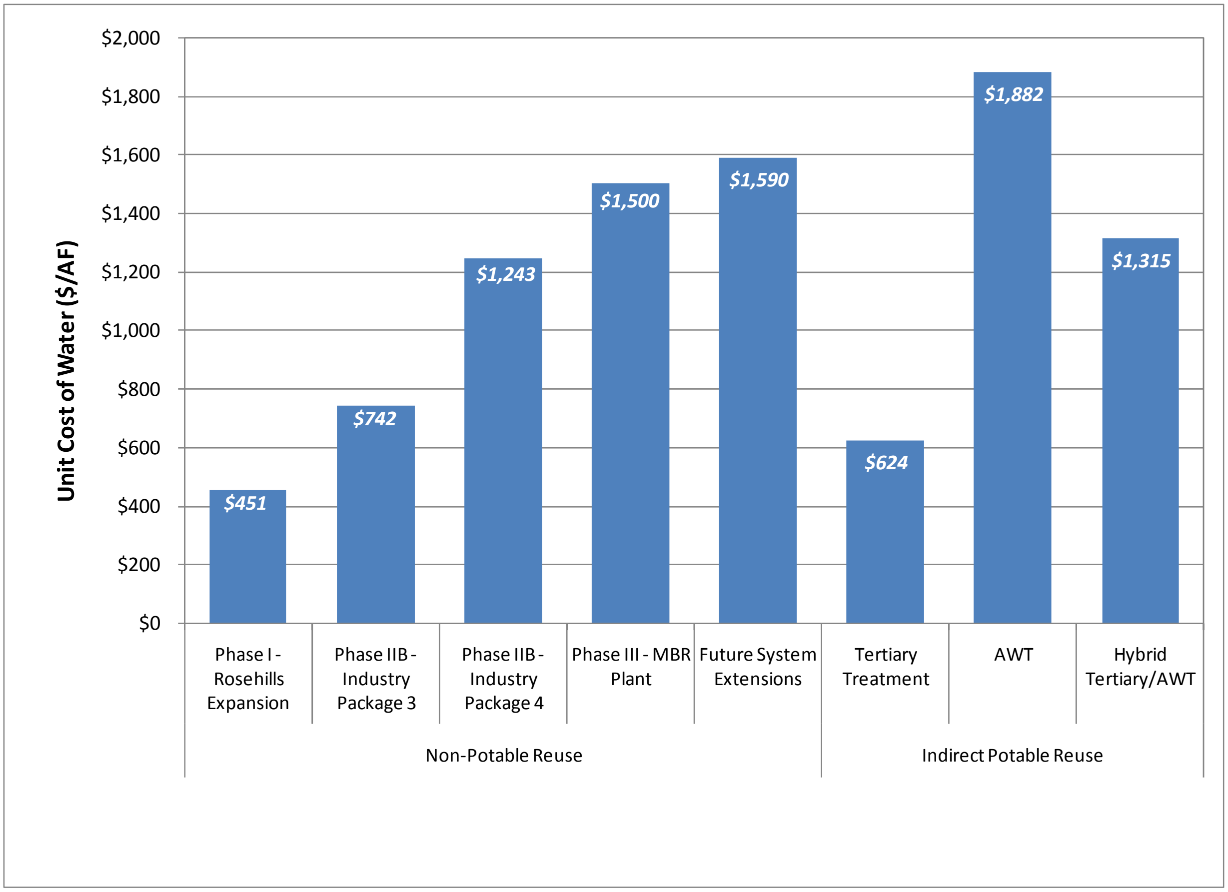


**Figure 5-2**
**Estimated Unit Cost of Water for Recycled Water Options for the IRP**

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# Section 6

# Stormwater and Water Transfers/Storage Options

Stormwater harvesting options evaluated in this IRP include centralized (i.e. regional) and decentralized (i.e. lot level) project types. Specific centralized stormwater projects identified in the Potential Effective Recharge Capabilities (PERC) Study (Stetson Engineers, 2007) were evaluated, as described in Section 6.1. Decentralized options were evaluated for implementation by considering three methods on a typical parcel and then extrapolating over areas not upstream of one of the evaluated centralized options, as described in Section 6.2. Water transfers and storage options are discussed in Section 6.4.

## 6.1 Centralized Stormwater Options

The Los Angeles County Flood Control District (LACFCD) owns and operates a series of dams and spreading basins to conserve (i.e. reduce outflows to ocean) stormwater runoff in the San Gabriel River and Rio Hondo watersheds by diverting runoff into facilities that provide storage and recharge underlying groundwater basins. In 1985, the responsibilities and authority vested with LACFCD were transferred to the Los Angeles County Department of Public Works (LACDPW), with the Watershed Management Division having the role of planning and policy and the Flood Management and Water Resources Divisions having the role of maintenance and operations. The IRP evaluated options to enhance existing facilities or construct new facilities to increase recharge of stormwater in the Main Basin. In 2011, the Watermaster's Stormwater Capture Ad Hoc Committee completed a Summary of Potential Stormwater Projects for Main Basin recharge, which was based upon findings of the second (1995) and third (2007) updates to the PERC study (Stetson Engineers, 2011). Of the thirteen projects described in this summary report, Ad Hoc committee selected five , which are evaluated in the IRP, including:

- Miller Pit
- Olive Pit
- Walnut Creek Spreading Basin
- Buena Vista Spreading Basin
- Peck Road Spreading Basin

### 6.1.1 Long Beach Judgment

The Long Beach Judgment, approved in 1964, provides for the accounting of runoff in the San Gabriel River and Rio Hondo, to ensure equitable volumes of water are available to entities downstream (Lower Area, overlying the Central groundwater basin) of Whittier Narrows. Per the Long Beach Judgment, recharge of stormwater runoff is accounted for to help satisfy water entitlements for downstream recharge in the Central groundwater basin. The San Gabriel River Watermaster determines annual volumes and useable water and Lower Area entitlement (function of preceding 10-yr rainfall) to compute annual debits or credits for the Upper Area to the Lower Area as well as long term accrued credits or debits. The San Gabriel River Watermaster also performs a long-term accounting (LTA) after each 15 to 25-year period when average rainfall is between 18-19 inches. The LTA adjusts accrued credits or debits to account for differences between Lower Area entitlement during the LTA period and Usable Water actually received by Lower Area during the LTA period.

Figure 6-1 shows useable water deliveries from Upper Area to Lower Area, annual Lower Area entitlement, and accrued credits over the second and third LTA periods. Over these LTA periods, the Upper Area has accrued a credit of approximately 150,000 AFY. The first LTA period (1963-1979) was excluded from the IRP analysis because, at that time, overall urban development in the watershed was substantially lower than current levels, resulting in lower imperviousness and less surface flow at Whittier Narrows.

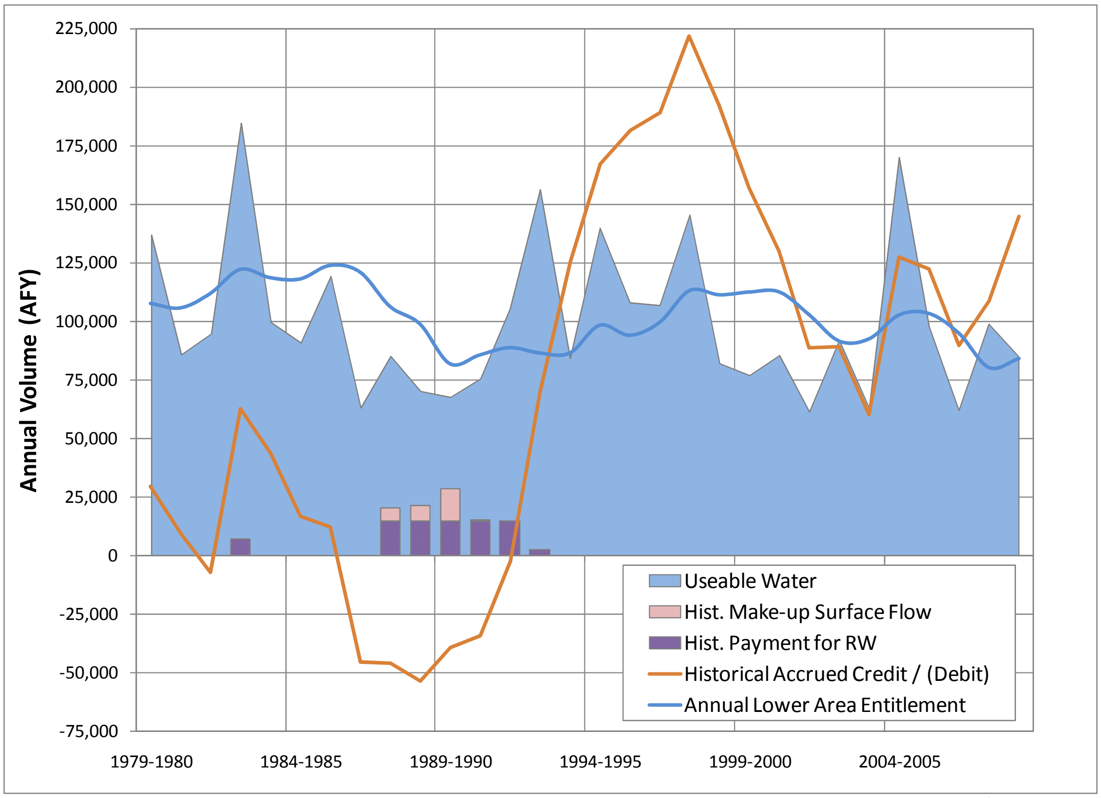


**Figure 6-1**
**Summary of Upper Area Water Deliveries to meet Lower Area Entitlements for Second and Third Long-Term Accounting Periods**

Not all surface flow passing though Whittier Narrows is considered usable and therefore effecting the determination of whether the Upper Area delivered sufficient water to meet the Lower Area entitlement in a given water year. The portion of surface flow generated in the Upper Area that flows out of the Montebello forebay (assumed lost to the Pacific Ocean) is referred to as 'unusable surface flow'. Unusable surface flow consists of runoff in the San Gabriel River or Rio Hondo that is too turbid for recharge or exceeds the diversion/storage capacity of the Rio Hondo Spreading Grounds (RHSG) or San Gabriel Spreading Grounds (SGSG). Since unusable surface flow is not accounted for in meeting the Lower Area entitlement, capture and recharge of this volume in the Upper Area would not reduce Usable Water. Unusable surface flow is highly variable due to rainfall patterns, with volumes ranging from < 10,000 AFY to over 400,000 AFY. In a median year, approximately 15,000 AFY of unusable surface flow is lost to the Pacific Ocean. For the Upper District IRP, new Main Basin recharge with stormwater was determined using two different runoff capture approaches; with and without limiting Upper Area stormwater capture to unusable surface flow, as defined in the Long Beach Judgment.

### 6.1.2 Centralized Stormwater Projects

Figure 6-2 provides a schematic of stormwater drainage showing the location of proposed projects for centralized stormwater capture. Two different types of centralized stormwater capture and recharge were evaluated in the Upper District IRP, including:

- Diversion into new deep replenishment basins, with Miller and Olive Pits as two proposed projects, shown as orange filled squares in Figure 6-2.
- Enhancement of existing spreading basins to provide additional off-site recharge capacity, with Peck Road, Walnut Creek, and Buena Vista Spreading Basins (SBs), shown as red outlined features associated with existing facilities. Off-site recharge involves the temporary detention of additional surface runoff in an existing facility for conveyance to a secondary recharge area. For the Buena Vista SB project, a new deep replenishment basin within United Rock Pit 3 would also be constructed to receive the runoff captured for recharge. For the Peck Road and Walnut SB projects, secondary off-site recharge occurs within the channel bottom following the storm event.

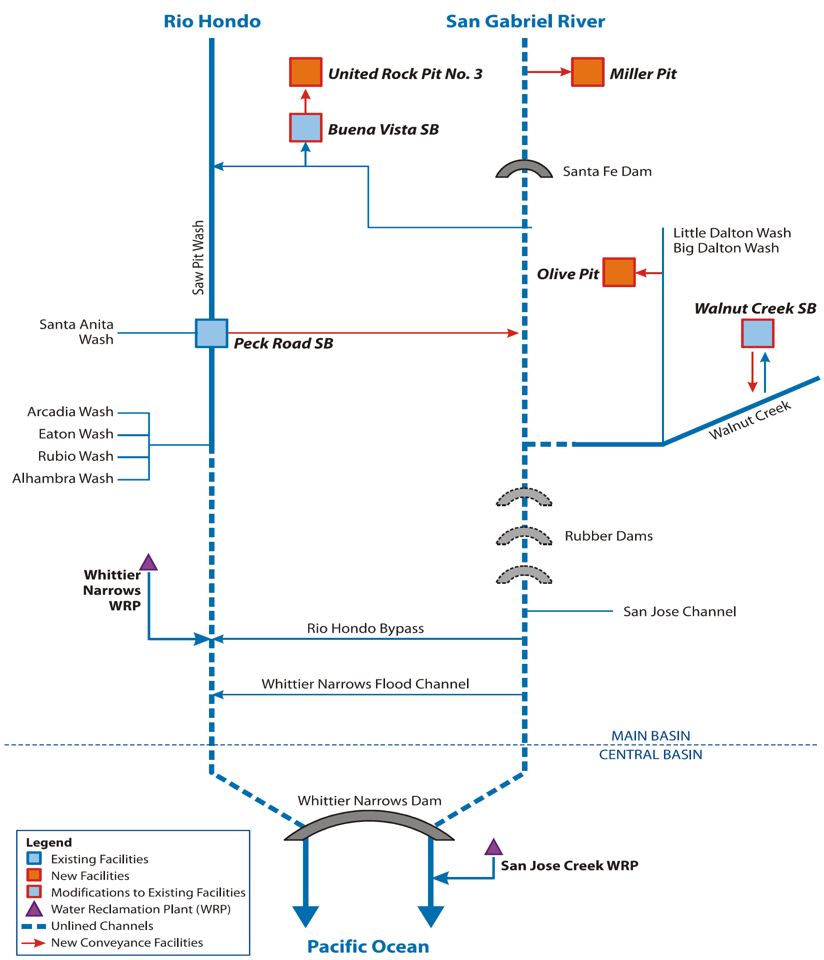


**Figure 6-2**
**Schematic of Drainage and Proposed Centralized Stormwater Harvesting Projects**

Miller and Olive Pits are existing deep pits, which could be used for groundwater replenishment. Miller Pit would capture runoff from the San Gabriel River at I-210, upstream of the Santa Fe Dam and Olive Pit would capture runoff from Dalton Wash downstream of Azusa Canyon Road. Key parameters used in the analysis of stormwater capture potential at Miller and Olive Pits include diversion, storage, and recharge capacities (Table 6-1). For Miller Pit, the San Gabriel River downstream of Santa Fe Dam provides recharge capacity within the channel bottom, thus modeled inflows to Miller Pit representing new Main Basin groundwater recharge was limited to days when flow downstream of the Santa Fe Dam (E281) exceeded 50 cfs, a rough estimate of the natural channel bottom recharge capacity for surface runoff downstream of the Santa Fe Dam.

**Table 6-1. Summary of Proposed Improvements at Existing Spreading Basins**

| Project | Within Basin | | | Off-site Recharge | | Potential Inflow Data Source (LA County Flow Gauge ID) |
|---|---|---|---|---|---|---|
| | Storage (AF) | Recharge Rate (ft/day) [1] | Diversion (cfs) | Type | Pumping / Recharge (cfs) | |
| Miller Pit | 850 | 2.0 | 50-100 [2] | n/a | n/a | San Gabriel River below Santa Fe Dam (E281) |
| Olive Pit | 1,150 | 1.0 | 50-100 [2] | n/a | n/a | Dalton Wash at Merced Ave (F274) |
| Peck Road Spreading Basin | 3,350 | 0.1 - 2.0 | n/a | Channel Bottom | 50 | Sawpit Wash below Live Oak Ave (F194) plus Santa Anita Wash at Longden Ave (F193) |
| Walnut Spreading Basin | 170 | 0.3 - 2.2 | 150 | Channel Bottom | 20 | Walnut Creek below Puddingstone (F40) plus 1.25 times Arcadia Wash below Grande Ave (F317) |
| Buena Vista Spreading Basin | 200 | 0.1 - 2.0 | 2,900 | United Rock Pit 3 | 25 | Santa Fe Diversion Channel (F280) plus 0.18 times Arcadia Wash below Grande Ave (F317) |

[1] Recharge rate varies with hydrologic year type.

[2] Diversion rate estimated to provide effective stormwater capture while avoiding oversizing facilities beyond a point of diminishing returns.

The projects at Peck Road and Walnut Spreading Basins involve construction of a pump station and conveyance to move water detained during a storm event to unlined channel segments after flow in the receiving channel recedes to below the natural recharge capacity of the channel bottom. For Peck Road Spreading Basin, the project includes conveyance pipeline to bring the detained water east from the Rio Hondo drainage-shed to the San Gabriel River. The project proposed for the Buena Vista Spreading Basin involves a new pump station to move stormwater captured from Buena Vista Channel and Santa Fe Diversion Channel to a new groundwater replenishment basin within United Rock Pit 3. Table 6-1 summarizes the key sizing criteria for pumping, conveyance and off-site recharge. Rio Hondo upstream of Whittier Narrows Dam provides recharge capacity within the channel/basin bottom, thus modeled inflows to Peck Road and Buena Vista Spreading Basins representing new Main Basin groundwater recharge was limited to days when flow in the unlined segment of Rio Hondo was greater than 50 cfs.

It should be noted that there are several environmental and water quality issues that will need to be resolved before implementation of any of these centralized stormwater projects. For example, during the development of Upper District's IRP, the U.S. Fish and Wildlife Service established two critical habitat designations for endangered/threatened species, the Santa Ana sucker and southwestern willow flycatcher. Both of these habitat designations are in areas that compete with flood control and stormwater capture operations in the watershed. In addition, water quality regulatory requirements and potential liabilities for additional stormwater capture projects will have to be considered on a case-by-case basis.

### 6.1.3 Estimate of Centralized Stormwater Yield

A stormwater capture analysis was developed to estimate potential for increased recharge of the Main Basin with addition of new projects. The analysis involved testing the impact of additional storage and recharge capacity on historical daily hydrologic data from drainage areas upstream of the proposed project locations. Daily water balance simulations computed total potential Main Basin recharge and potential recharge of runoff otherwise lost to the Pacific Ocean (i.e. unusable surface flow). Figure 6-3 shows the daily evaluation steps, including specific flow data thresholds, implemented to determine potential recharge of available 'unusable surface flow' in one of the five centralized stormwater projects.

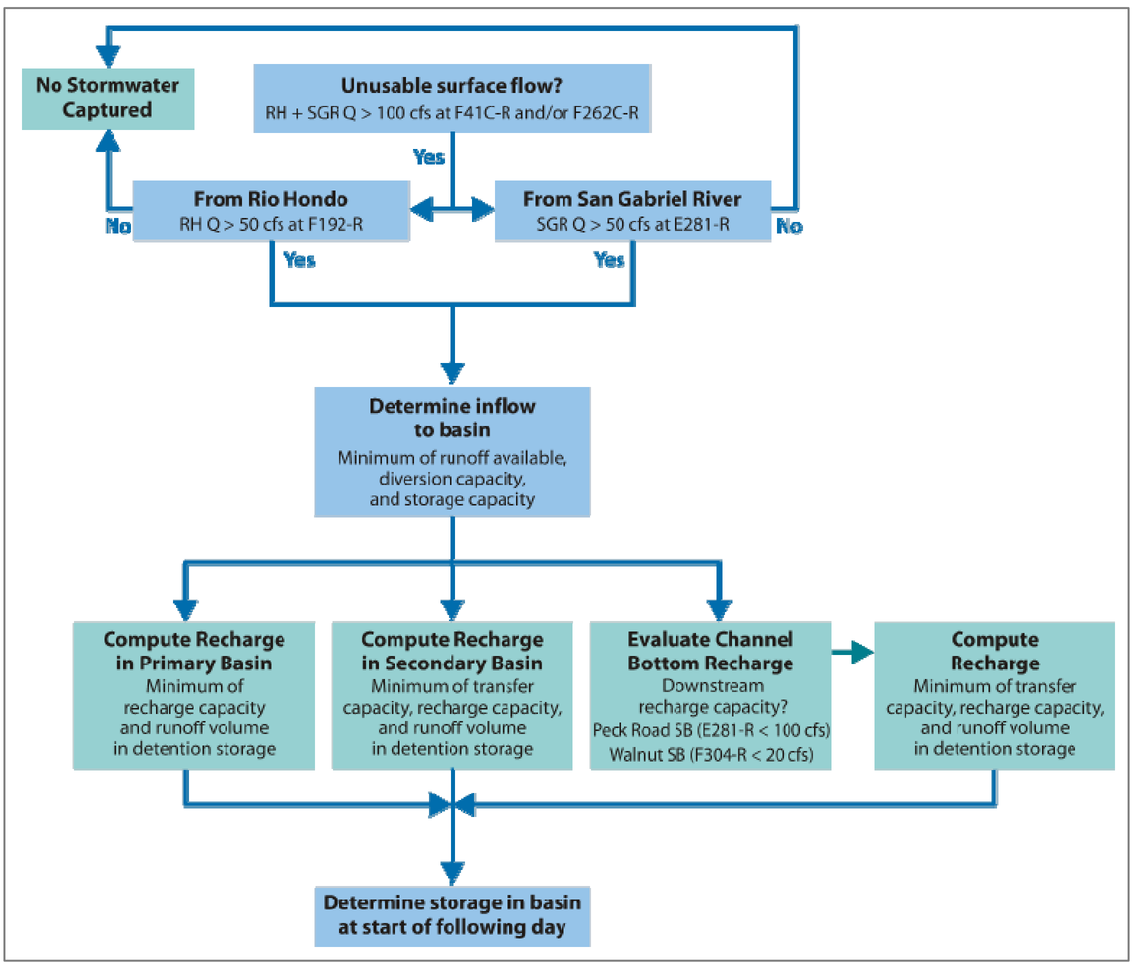


**Figure 6-3**
**Flowchart for Computing the Potential Capture and Recharge of 'Unusable Surface Flow' in each of the Centralized Stormwater Projects**

For several implementation scenarios of one or more projects, as shown in Table 6-2, results were aggregated to annual volumes for use in evaluating long-term yield. In some cases recharge limitations caused combinations of projects to have a lower yield than the sum of projects if implemented individually. Centralized stormwater recharge has large year-to-year fluctuations in recharge potential, which could be dampened by long-term storage in the Main Basin. Generally, the analysis showed long-term average annual recharge potential could provide significant new groundwater recharge relative to the gap between current supplies and projected water demand.

**Table 6-2. Average Annual Estimates of Main Basin Recharge from both Total Potential and 'Unusable' (Otherwise Lost to Ocean) Volumes for each Centralized Stormwater Capture Scenario**

| Scenario | Portion of Potential Main Basin Recharge Otherwise Lost to Pacific Ocean (AFY) |
|---|---|
| All Projects | 5,298 |
| Diversion from Walnut, Buena Vista, and Peck Road SBs | 2,263 |
| Miller Pit | 1,290 |
| Diversion from Walnut SB | 484 |
| Olive Pit | 2,329 |
| Diversion from Buena Vista SB | 696 |
| Diversion from Peck Road SB | 1,318 |
| Miller Pit + Olive Pit | 3,603 |
| Diversion from Walnut and Peck Road SBs | 1,678 |

## 6.2 Decentralized Stormwater Options

Decentralized stormwater options in the Upper district were evaluated for residential and commercial parcels. By reducing runoff from parcels, the captured water can be utilized to offset non-potable water demands or increase recharge to the underlying Main Basin. An ancillary benefit of decentralized stormwater options is a reduction in pollutant loading and conveyance of polluted stormwater to receiving water bodies. Select subwatersheds of the San Gabriel River watershed within the Upper District boundaries were evaluated for implementation of decentralized stormwater options including Alhambra, Arcadia, Dalton, Eaton, Rubio, San Jose, and Walnut Creek (Figure 6-4). Other subwatersheds were not evaluated as it was assumed centralized stormwater options would address these areas.

### 6.2.1 Decentralized Stormwater Projects

Three decentralized stormwater options were evaluated, including

- Single-family residential (SFR) rain barrels - Rain barrels are barrels installed to capture runoff from rooftops by redirecting runoff from downspouts to the barrels. Collected water is later used for non-potable demands, such as irrigation. Typically, rain barrels have hose spigots to allow for irrigation use of the collected water.

- SFR bioretention areas - Bioretention areas, also known as residential rain gardens, receive water from redirected rooftop runoff. Bioretention areas have the benefit of reducing offsite runoff, providing aesthetic benefits to the parcel, and providing groundwater recharge in areas underlain by more permeable soils..

- Commercial cisterns - Commercial cisterns operate in a similar manner to rain barrels, but at a larger scale. Rooftop runoff is redirected to the cisterns and used at a later time for non-potable demands. Cisterns can be located above ground or below ground and may require pumps to adequately deliver the collected water into existing irrigation systems.

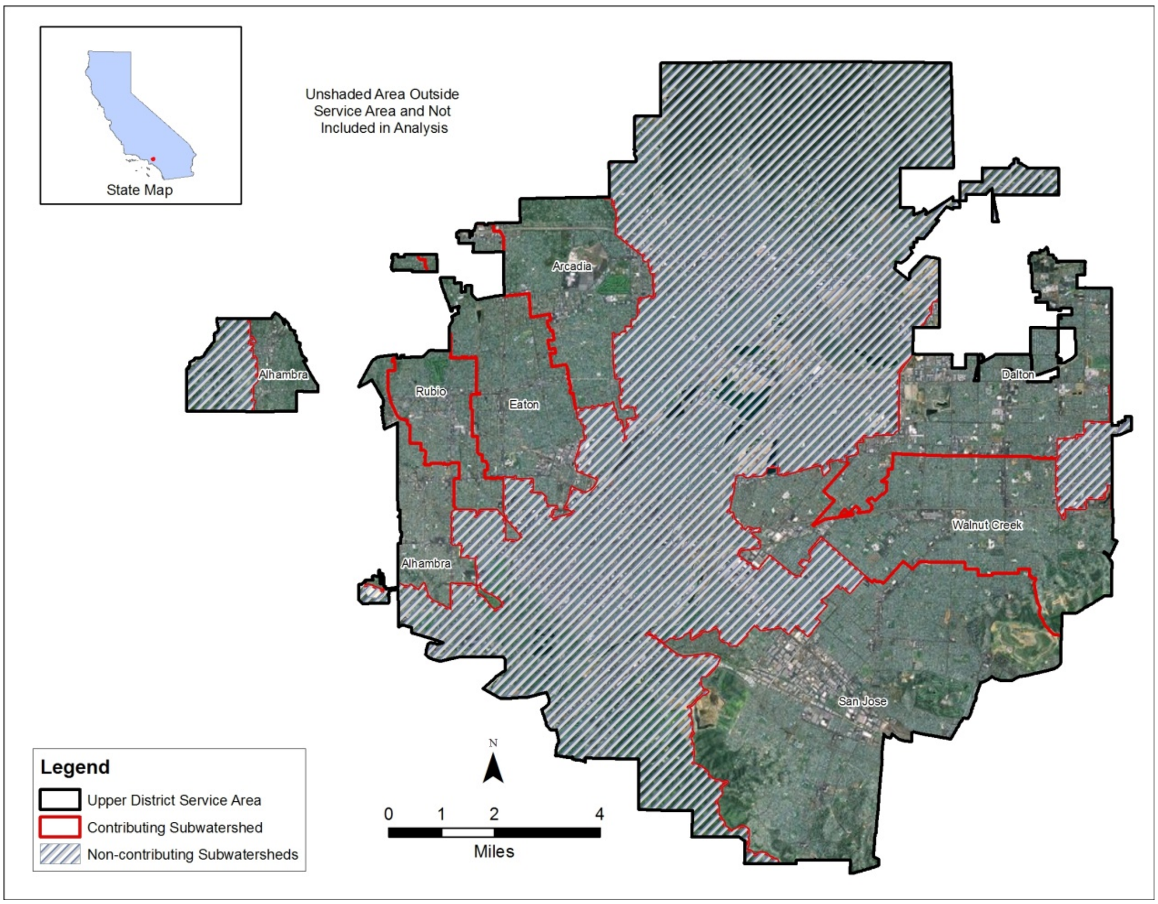


**Figure 6-4**
**San Gabriel River Watershed Areas within Upper District Service used for Decentralized Stormwater Options**

Projects that capture and recharge onsite runoff, SFR bioretention areas, differ from those that involve capture and subsequent use for onsite irrigation, SFR rain barrels and commercial cisterns. The former requires recovery of new recharge water from the underlying aquifer with groundwater wells, while the latter provides a direct offset of water demand. Evaluation of these options was completed for a typical installation on a median size SFR or commercial parcel, and then results were extrapolated over portions of the service area. The following sections summarize the analyses used to assess the potential water yield from these decentralized stormwater project types.

### 6.2.2 Estimate of Stormwater Yield

Estimates of yield for a representative SFR and commercial parcel with typical installation of the proposed projects involved development of a continuous simulation model of daily runoff volume capture and recharge or onsite irrigation. Daily rainfall and evapotranspiration data were obtained from nearby meteorological stations to develop the yield estimates. Table 6-3 provides the design criteria and assumptions used to estimate yield, and the averaged results from the three decentralized stormwater project types.

**Table 6-3. Design Criteria, Assumptions, and Yield Estimates for Decentralized Stormwater Project Options**

| Parameter | SFR Bioretention | SFR Rain Barrel | Commercial Cistern |
|---|---|---|---|
| Total Number of Parcels | 168,000 | 168,000 | 700 [1] |
| Total Implementation Rate | 30% | 30% | 100% |
| Median Parcel Size (sf) | 6,500 | 6,500 | 70,000 |
| Median Rooftop Area (sf) | 1,600 | 1,600 | 13,000 |
| Median Parcel Imperviousness | 35% | 35% | 80% |
| Irrigated Landscape Area (sf) | n/a | 4,000 | 12,600 |
| Storage Capacity (gal) | 1,300 | 200 | 3,000 |
| SFR Bioretention Bottom Area (sf) | 100 | n/a | n/a |
| SFR Bioretention Design Percolation Rate (in/hr) | 0.25 | n/a | n/a |
| Annual Yield for Subject Area (AFY) | 2,371 | 425 | 66 |
| Percent of Irrigation Demand | n/a | 3% | 11% |
| Average # of Days with Irrigation | n/a | 35 | 67 |
| Percent of Runoff Capture | 51% | 14% | 18% |

[1] Number of existing commercial parcels that are greater than 1 acre and have buildings on site within

For the SFR rain barrels and commercial cistern project types, only the runoff from the roof area is captured; therefore, it was assumed that all rainfall is effectively captured until the storage capacity is filled. The rate of drawdown of the stored runoff is computed as a function of daily onsite irrigation demand, computed as specified in the Statewide Model Water Efficient Landscape Ordinance. Figure 6-5 shows results of the continuous simulation model for a 1-month period including several storms that filled a rain barrel and then the drawdown of stored runoff water during dry periods between storm events. As expected, the yield was constrained by the different seasonality of runoff volume and irrigation demand (Figure 6-6).

For SFR bioretention, runoff form the entire parcel area is estimated using a runoff coefficient to account for abstraction of rainfall and percolation over pervious areas upstream of the project. Sizing of the SFR bioretention area involved application of local stormwater design criteria, including a design storm depth of 0.75 inches, standard specifications for planting media depth and porosity, allowable ponding, and average underlying soil permeability for the region (Table 6-3).

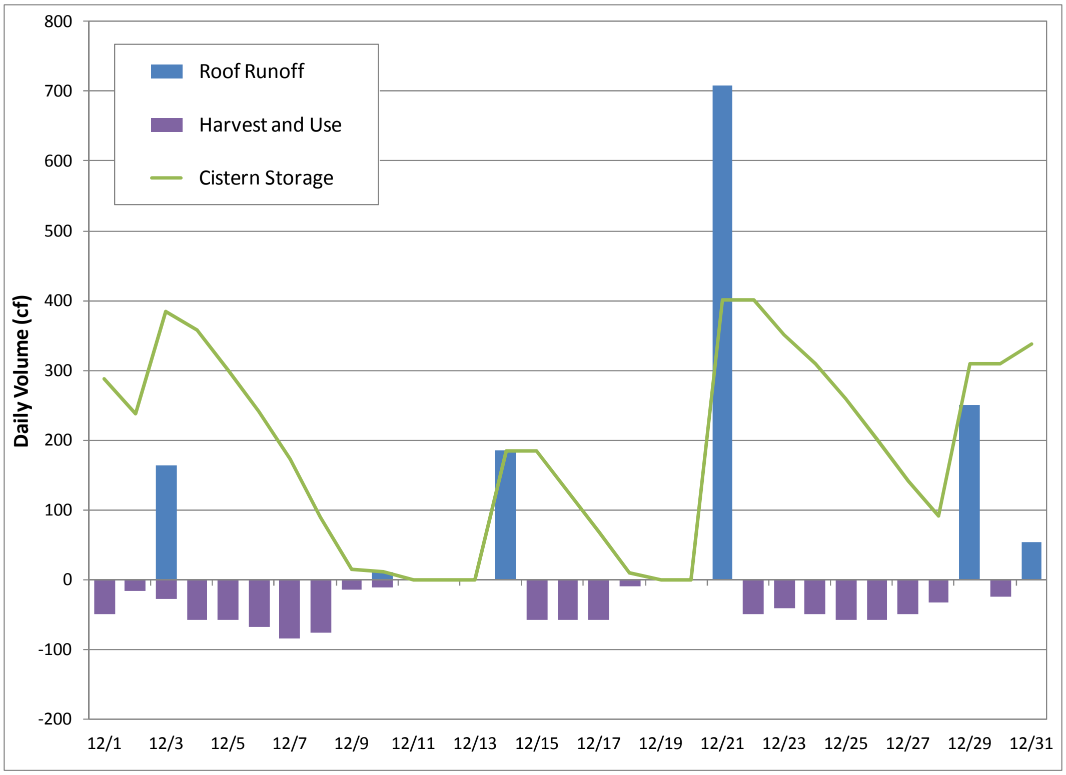


**Figure 6-5**
**Extraction of 1-month of Runoff Volume, Storage, and Onsite Irrigation Use for a Typical Commercial Cistern Stormwater Project**

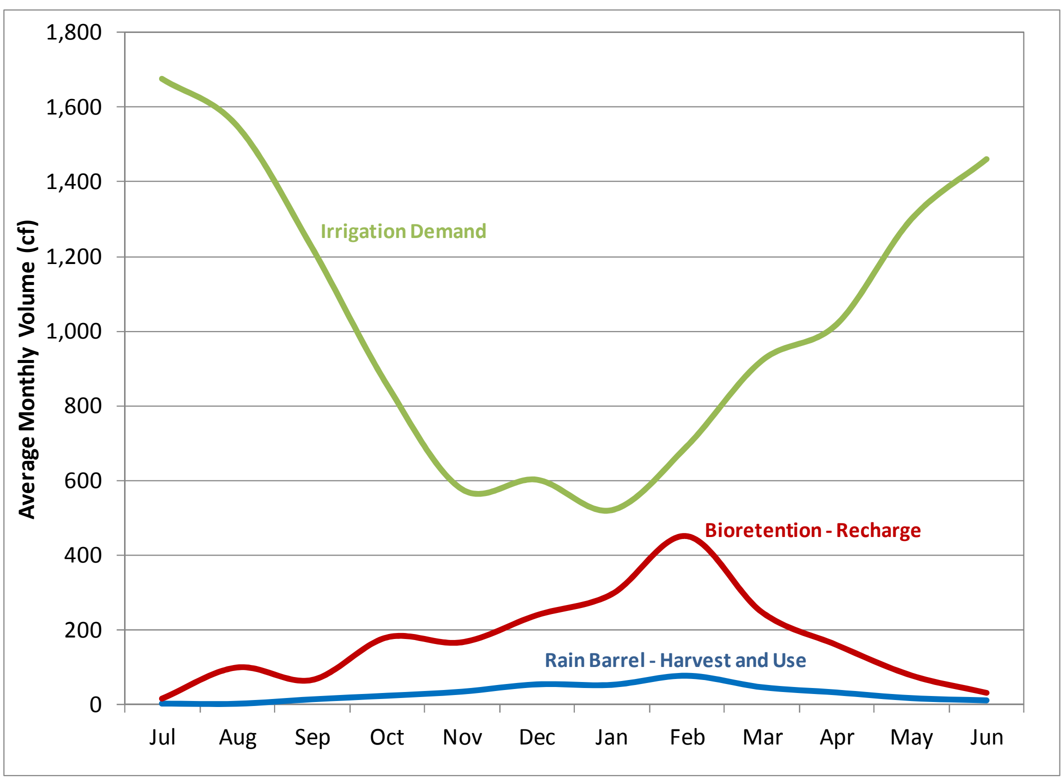


**Figure 6-6**
**Average Monthly Yield from Decentralized SFR Stormwater Project Options**

## 6.3 Stormwater Option Costs

Cost estimates were developed by CDM Smith using data from the PERC Study, supplemented by CDM Smith contractors evaluation, for the five centralized and three decentralized stormwater project options evaluated for the Upper District IRP. For the centralized stormwater options, detailed takeoff estimates were prepared for capital costs, which are summarized in Table 6-4. These capital costs consist of earthwork and construction of new diversion, pumping, or conveyance facilities. These costs can vary significantly depending on the final conceptual design of the proposed project. Table 6-5 summarizes estimated capital costs for the decentralized project types, which involve extrapolation of estimated cost for a typical project on a median SFR or commercial parcel over approximately 50,000 SFR and 670 commercial parcels in the subject area.

**Table 6-4. Estimated Costs for Centralized Stormwater Options**

| Cost | Miller Pit | Olive Pit | Peck Road SB | Walnut SB | Buena Vista SB |
|---|---|---|---|---|---|
| Earthwork | $ 610,000 | $ 1,300,000 | n/a | $ 200,000 | $ 210,000 |
| Concrete | $ 60,000 | $ 60,000 | n/a | n/a | $ 60,000 |
| Pipelines | $ 830,000 | $ 260,000 | $ 2,900,000 | $ 50,000 | $ 190,000 |
| Pump Station | n/a | n/a | $ 820,000 | $ 490,000 | $ 700,000 |
| Rubber Dam | n/a | $ 1,000,000 | n/a | n/a | n/a |
| Admin / Permits / Contingency | $ 1,070,000 | $ 1,780,000 | $ 2,610,000 | $ 520,000 | $ 800,000 |
| Total | $ 2,570,000 | $ 4,300,000 | $ 6,330,000 | $ 1,260,000 | $ 1,960,000 |

**Table 6-5. Estimated Costs for Decentralized Stormwater Options**

| Cost | SFR Bioretention | SFR Rain Barrel | Commercial Cistern |
|---|---|---|---|
| Equipment [1] | $ 1,200 | $ 400 | $ 1,500 |
| Installation [2] | | $ 100 | $ 1,400 |
| Total (per parcel) | $ 1,200 | $ 500 | $ 2,900 |
| Total (Extrapolated) | $ 60.5 million | $25.2 million | $ 2.0 million |

[1] Rain barrel cost from http://www.cleanairgardening.com; Bioretention cost from http://www.millcreekwatershed.org/assets/files/howto.pdf; Commercial cistern and pump cost from http://www.thetanksource.com.

[2] Installation costs for rain barrels and cisterns estimated from *Los Angeles Integrated Resources Plan, Facilities Plan, Volume 3: Runoff Management*; CH:CDM, July, 2004.

To approximate the cost of water from each of these options, the estimated capital costs were amortized over thirty years with an assumed interest rate of five percent. Also, annual cost to operate and maintain (O&M) the proposed stormwater facilities was assumed to be three percent of the total capital cost for both centralized and decentralized projects. Comparing these annualized costs, including capital and O&M, with the estimated average annual yields, the unit cost of water in $/AFY is approximated (Figure 6-7).

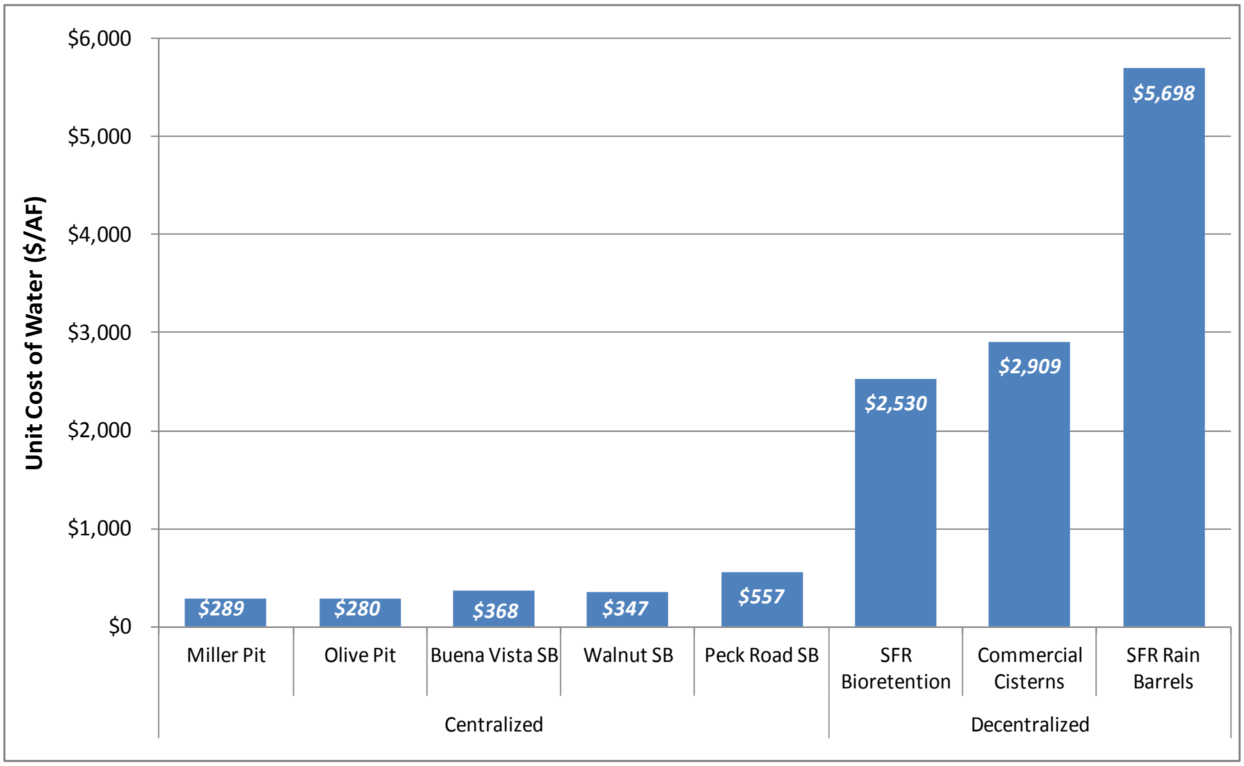


**Figure 6-7**
**Estimated Unit Cost of Water for each Stormwater Project Evaluated in the Upper District IRP**

## 6.4 Water Transfers/Storage

For the purpose of the IRP, a generic water transfer/storage option was developed. This could be a proxy for several different programs such as a wet year storage program in which Upper District buys or contracts long-term for water during wet hydrologic years from the Central Valley, Kern-Friant system, or a number of groundwater banks such as Arvin-Edison. It could also represent purchase of MWD replenishment water if that program is re-instated.

Given the MWD water supply reliability analysis presented in Section 3, Upper District's need for new water supplies is not required every year. In fact, in most years there will likely be enough water to meet water demands in the service area. But approximately 20 percent of the time, there is an expected gap between future demands and existing, firm water supplies. Because of this, and because Upper District and its retail agencies have access to a large groundwater basin for storage, wet-year water transfers can be very cost-effective. Wet-year transfers are generally less costly and more reliable because of reduced stress on the Delta and lower SWP/CVP system demands. The wet-year transfer water would be stored in the Main Basin for later use during dry years and droughts. The key, however, is to keep this water in the Basin for long-term storage.

The cost assumptions for the IRP for this water transfer include the following components: (1) purchase price of water; (2) wheeling charges to be paid to MWD for use of their system to move the water; and (3) extraction, or groundwater pumping costs when the water is used. Table 6-6 presents these water transfer costs.

**Table 6-6. Summary of Assumed Water Transfer/Storage Cost**

| Cost Category | Unit Cost[1] $/AF |
|---|---|
| Water Transfer Purchase Price | $195 |
| MWD System Access Charge | $217 |
| MWD Water Stewardship Charge | $43 |
| MWD Power Charge | $136 |
| **Total** | **$591** |

[1] All costs in 2012 dollars.

# Section 7

# Alternatives Evaluation

The conservation and water supply options that were described in Sections 2, 5, and 6 were characterized in terms of potential benefits to provide insights into how they might be combined into alternatives. Besides cost and supply yield, which are presented in Sections 2, 5 and 6, the following benefits were assessed for each of the major option categories:

- **Drought Proof** – indicates how well an option is resilient against droughts. Those options that are dependent on surface water will have greater hydrologic variability and therefore be more prone to droughts.
- **Climate Change** – indicates how well an option is resilient against climate change. While surface water will be more vulnerable to climate change, groundwater that is recharged by mountain snowpack can also be affected by climate change.
- **Basin Water Quality (WQ)** – indicates how well an option improves basin water quality, specifically salinity.
- **20x2020 Goal** – indicates if an option will help meet the state's required reduction of per capita water use of 20 percent by 2020.
- **Flexible** – indicates the option's flexibility in terms of phased implementation or incrementally utilized.
- Total Maximum Daily Load (TMDL) – indicates if the option helps the region meet TMDL requirements for discharges of stormwater into receiving waters.

For each of these benefits, the options were assessed using a simple, relative scoring (see Figure 7-1).

| Option Category | Benefits | | | | | |
|---|---|---|---|---|---|---|
| | Drought Proof | Climate Change | Basin WQ | 20x2020 Goal | Flexible | TMDL Benefits |
| Indirect Potable Reuse (tertiary/blend) | ● | ● | ◒ | ● | ◒ | ○ |
| Indirect Potable Reuse (FAT*) | ● | ● | ● | ● | ○ | ○ |
| Non-Potable Recycled Water | ◒ | ● | ○ | ● | ◒ | ○ |
| Centralized Stormwater Capture | ● | ◒ | ● | ○ | ● | ● |
| Decentralized Stormwater Capture | ◒ | ◒ | ○ | ○ | ◒ | ● |
| Water Transfers/GW Storage | ◒ | ◒ | ◒ | ○ | ● | ○ |
| MWD Imported Water | ○ | ○ | ◒ | ○ | ● | ○ |
| New Water Conservation | ● | ● | ○ | ● | ◒ | ○ |

* Full advanced treatment

● – Strong benefit
◒ – Moderate benefit
○ – Little to no benefit

**Figure 7-1**
**Benefits of Different Options**

What this characterization indicates is no option provides all of the benefits that are needed in this IRP in terms of reliability, water quality, meeting California's 20x202 conservation goals, being flexible and providing total maximum daily load (TMDL) benefits. Therefore, alternatives (combinations of various options) were defined and analyzed against the planning objectives using the IRP process described in Section 4.

## 7.1 Definition of Alternatives

To help define the IRP alternatives, themes were used. Some themes were designed to push a particular option in order to see how that strategy would perform. This was useful to see trade-offs between these alternatives. Two alternatives, however, were designed to be hybrid mixes using the insights gained from the options assessment summarized in Figure 7-1. In the end, the following 6 alternatives were defined:

1. **Maximize Reuse** — Maximizes recycled water, both non-potable and indirect potable options
2. **Maximize "Green"** — Maximizes options that have minimal impacts on environment
3. **Maximize Reliability** — Maximizes options that have high reliability elements
4. **Maximize Flexibility** — Maximize options that are the most flexible in implementation and operations
5. **Balanced Mix A** — A hybrid alternative with balanced options, with a focus on cost-effectiveness
6. **Balanced Mix B** — A hybrid alternative with balanced options, with a focus on permitting

Table 7-1 presents these 6 alternatives and the options included in them.

**Table 7-1 Options Included in Each IRP Alternative**

| | Alternatives (Yields in Acre-Feet) | | | | | |
|---|---|---|---|---|---|---|
| Options | Alternative 1 Max Reuse | Alternative 2 Max "Green" | Alternative 3 Max Reliability | Alternative 4 Max Flexibility | Alternative 5 Balanced Mix A | Alternative 6 Balanced Mix B |
| Indirect Potable Reuse (tertiary/blend) | 10,000 | | | | 10,000 | |
| Indirect Potable Reuse (AWT*) | 14,000 | | 24,000 | | | 10,000 |
| Non Potable Recycled Water | 1,520 | 520 | 1,520 | 1,020 | 1,020 | 520 |
| Centralized Stormwater Capture | | 5,300 | 5,300 | 5,300 | 5,300 | 5,300 |
| Decentralized Stormwater Capture | | 1,700 | | | 200 | |
| Conservation (level 1) | 2,500 | | 2,113 | | | |
| Conservation (level 2) | | | | 5,000 | 5,000 | 7,500 |
| Conservation (level 3) | | 10,000 | | | | |
| Water Transfers/Storage | | 10,000 | | 10,000 | 11,413 | 9,613 |
| MWD Drought Penalty Purchase | | | | 5,000 | | |
| **Sub-total New Options** | **28,020** | **27,520** | **32,933** | **26,320** | **32,933** | **32,933** |

* AWT = Advanced water treatment.



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## 7.2 Evaluation of Alternatives

The alternatives in Table 7-1 were evaluated against performance metrics presented in Table 4-1 (Section 4). To evaluate the reliability and cost of the alternatives, a mass balance simulation was conducted using the time series from 2012 to 2035. Both average year and drought year conditions were simulated. Average year simulations were used for lifecycle cost analysis, while drought year conditions were used for assessing supply reliability (see Appendix G for an example simulation for Alternative 5). In addition to the reliability and cost performance metrics, other metrics where developed. Greenhouse gas emissions (expressed in metric tons/acre-foot) were estimated based on energy requirements for each option in the alternatives. Runoff managed (expressed as acre-foot) was estimated by accounting for the reduction of stormwater discharged to the ocean. The other performance metrics (climate change, local control, water quality, flexibility, permitting, institutional, and customer) were based on a qualitative "score" of 1 to 5, where 5 equals best performance. This qualitative assessment was based on other IRPs in Southern California, as well as input from Upper District staff and best engineering judgment. Table 7-2 summarizes all of the performance metrics for all of the alternatives.

**Table 7-2 Performance Metrics for Alternatives**

| Objective | Performance Metric | Alternative 1 Max Reuse | Alternative 2 Max "Green" | Alternative 3 Max Reliability | Alternative 4 Max Flexibility | Alternative 5 Balanced Mix A | Alternative 6 Balanced Mix B |
|---|---|---|---|---|---|---|---|
| Reliability | 2035 Max Shortage (AFY) | 4,913 | 5,413 | 0 | 6,613 | 0 | 0 |
| | Cumulative Av Shortage (AF) | 5,611 | 2,601 | 3,402 | 3,587 | 0 | 0 |
| | Climate Change Score | 5.0 | 3.5 | 5.0 | 2.0 | 4.0 | 4.0 |
| Cost | PV Total Cost ($ M) | $1,272 | $1,152 | $1,415 | $1,141 | $1,128 | $1,479 |
| | 2012 Total Capital Cost ($ M) | $197 | $27 | $284 | $35 | $91 | $189 |
| Local Control | Local Control Score | 5.0 | 3.0 | 5.0 | 2.0 | 4.0 | 4.0 |
| Water Quality | Water Quality Score | 4.0 | 3.0 | 5.0 | 2.5 | 3.5 | 4.5 |
| Environmental | Greenhouse Gas (MT/Year) | 20,406 | 5,187 | 25,013 | 5,659 | 10,601 | 16,338 |
| | Runoff Managed (AFY) | 0 | 7,000 | 5,300 | 5,300 | 5,500 | 5,300 |
| Implementation | Flexibility Score | 1.0 | 4.5 | 1.0 | 5.0 | 3.5 | 3.5 |
| | Permitting Score | 3.0 | 3.5 | 4.0 | 5.0 | 3.0 | 4.5 |
| | Institutional Score | 3.5 | 2.0 | 3.0 | 3.0 | 4.0 | 4.0 |
| | Customer Score | 2.5 | 4.5 | 4.0 | 5.0 | 3.0 | 5.0 |

AFY = acre-feet/year; AF = acre-feet; $ M = millions of dollars; MT = metric tons.

For all "Scores" 1 = worst performance, 5 = best performance.

These performance metrics were input into a decision software tool called Criterium Decision Plus (CDP), developed by InfoHarvest, Inc. This industry-standard decision software is used to standardize different metrics (quantitative and qualitative) and incorporate criteria weighting in order to score and rank alternatives. The software uses a technique called multi-attribute rating that is described in Figure 7-2 and below.

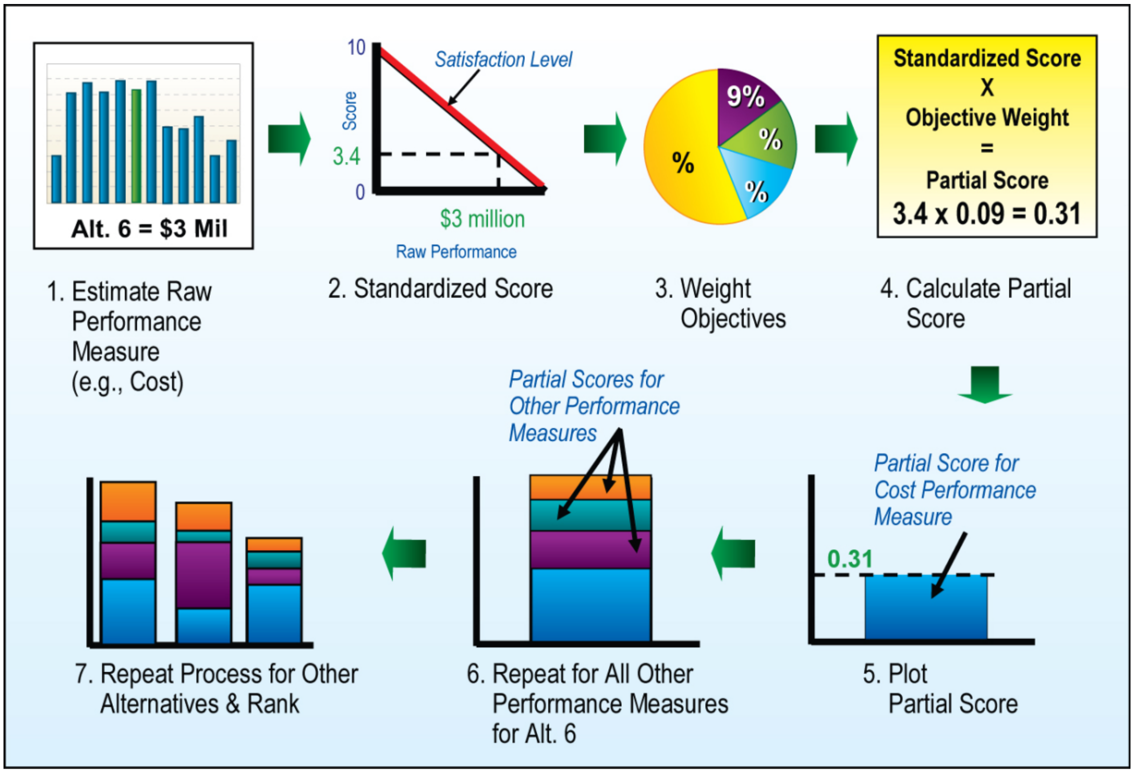



**Figure 7-2**
**Multi-Attribute Rating Technique Used by CDP Software to Rank Alternatives**

Multi-attribute rating uses 7 steps to score and rank alternatives. In step 1, raw performance for all of the alternatives is compared for a given criteria (in this case cost). Step 2 standardizes the performance into a score from 0 to 10. In this example, Alt 6's cost performance is fairly expensive so it's standardized score is fairly low (e.g., 3.4 out of 10). This step is important because performance is measured in different units (i.e., cost in dollars, reliability in AFY). Step 3 assigns weights to the objective and Step 4 calculates are partial score for a given alternative based on the multiplication of the standardized score (Step 2) and weight (Step 3). The partial score is plotted (Step 5), and then the whole process is repeated for a given alternative for all of the other performance measures (Step 6). This creates a total score that can then be compared to other alternatives. Steps 1-6 are repeated for all alternatives and compared so they can be ranked (Step 7). This process is powerful because it not only ranks alternatives but clearly shows trade-offs.

Figure 7-3 presents the ranking of Upper District's IRP alternatives using the average stakeholder objective weights presented in Figure 4-2 (Section 4).

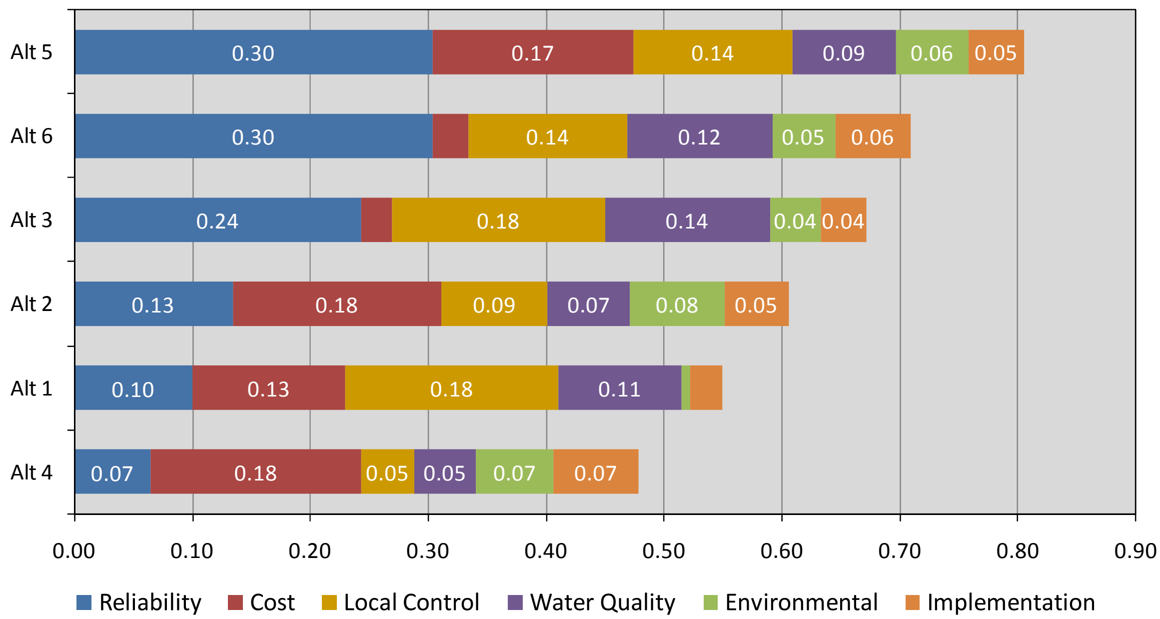



**Figure 7-3**
**Ranking of IRP Alternatives Using Average Stakeholder Objective Weights**

Based on average stakeholder weights for the objectives (shown as different color bar segments), Alternative 5 clearly ranks highest overall. It has the best score for reliability (partial scores are shown in white text on the bars), and the second best scores for cost and local control. It also has good scores for water quality and environmental. Its only mediocre score is in implementation—mainly as it relies on tertiary treatment (plus adequate blend water) for groundwater recharge of recycled water. Alternative 6 ranks 2nd, while Alternative 4 ranks last.

In order to test the robustness of this ranking, several sensitivities were conducted by altering the weights between the objectives: (1) all objectives are equally weighted, at ~17 percent each; (2) water quality is given a super weight of 40 percent, while all other objectives are given a weight of 12 percent each; and (3) cost is given a super weight of 40 percent, while all other objectives are given a weight of 12 percent each. Figure 7-4 presents the ranking of alternatives for the base ranking (using stakeholder weights) and for the three sensitivities.

Figure 7-4 indicates that Alternative 5 ranks 1st three out of four scenarios, and only when water quality is given a super weight does it rank 3rd. Alternative 6, which uses full advanced treatment for groundwater recharge of recycled water, ranks 2nd two out of four scenarios and only ranks 1st when water quality is given a super weight. However, when cost is given a super weight Alternative 6 ranks 5th (second-to-last). All other alternatives never rank 1st and rarely are consistent in their ranking of 2nd or 3rd places. This sensitivity analysis indicates that the evaluation and ranking of alternatives is fairly robust.

| | Rankings | | | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **1** | **2** | **3** | **4** | **5** | **6** |
| Stakeholder Weights | Alt 5 | Alt 6 | Alt 3 | Alt 2 | Alt 1 | Alt 4 |
| Equal Weights | Alt 5 | Alt 6 | Alt 2 | Alt 3 | Alt 4 | Alt 1 |
| Water Quality Weight | Alt 6 | Alt 3 | Alt 5 | Alt 2 | Alt 1 | Alt 4 |
| Cost Weight | Alt 5 | Alt 2 | Alt4 | Alt 1 | Alt 6 | Alt 3 |

*Most frequent highest ranking alternative*

*Most frequent second highest ranking alternative*

**Figure 7-4**
**Sensitivity in Alternative Rankings**

Figure 7-5 presents the resource mix for Alternative 5 compared to the status quo in year 2035, assuming no Delta fix and a repeat of a drought. Alternative 5 would cut Upper District's reliance on imported water in half, compared to the status quo approach. Alternative 6 would have similar reduced reliance on imported water. In fact, both Alternative 5 and 6 have significant merit as long-term strategies for Upper District. As such, Section 8 presents specific recommendations using an adaptive management approach based on the options included in both of the high-ranking alternatives.

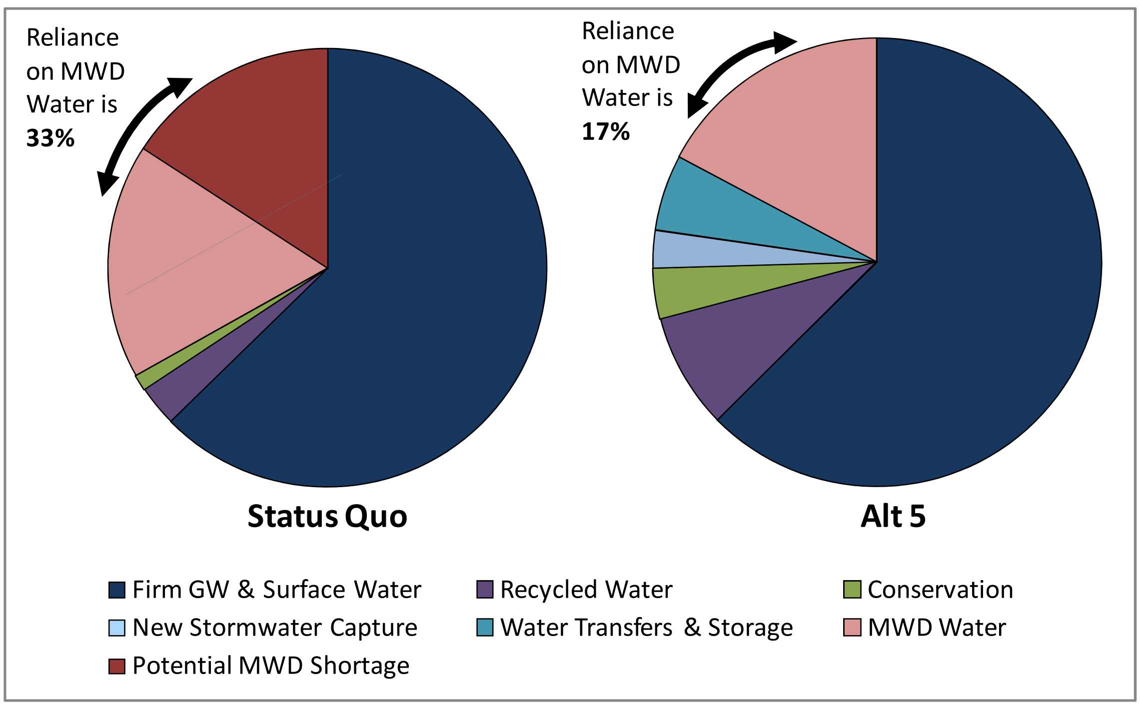



**Figure 7-5**
**Resource Mix for Alternative 5 Compared to Status Quo in Year 2035 during a Drought**

# Section 8

# Adaptive Management and Recommendations

The comprehensive evaluation of alternatives presented in Section 7 concluded that Alternatives 5 and 6 were most frequently the highest ranking alternatives, even under sensitivity analyses. These alternatives compare and contrast in the following ways:

| Options Included | Alternative 5 | Alternative 6 |
| --- | --- | --- |
| Conservation | 5,000 AFY | 7,500 AFY |
| Centralized Stormwater Capture | 5,300 AFY | 5,300 AFY |
| Decentralized Stormwater Capture | 200 AFY | -- |
| Water Transfers/Storage | 11,400 AFY | 9,600 AFY |
| Non-Potable Recycled Water | 1,200 AFY | 520 AFY |
| Indirect Potable Reuse (GW Recharge) | 10,000 AFY* | 10,000 AFY ** |

* Tertiary with blend

** Full Advanced Treatment

While both alternatives offer full reliability through 2035, even without a Delta fix, they do so in slightly different ways. The main difference is the treatment for indirect potable reuse. Alternative 5 relies on tertiary treatment with sufficient blend of native stormwater to meet California draft recycled water regulations, while Alternative 6 relies on full advanced treatment (FAT). FAT is substantially more expensive both in initial capital cost and in annual O&M costs. For instance, Alternative 6 has a capital cost that is more than double that of Alternative 5, $189 million vs. $91 million. Upper District is currently working closely with WateReuse and Los Angeles County Sanitation District to conduct research to identify the most appropriate treatment technology. Alternatives 5 and 6 also differ in how California's 20x2020 conservation goal is achieved. Alternative 5 puts more emphasis on meeting the conservation goal through recycled water, while Alternative 6 puts more emphasis on water conservation to meet the goal.

Despite the differences between the alternatives, they are not incompatible. In fact, they can build off of each other depending on the outcome of several factors. For example, a significant cost for the indirect potable reuse is the conveyance pipeline from the SJCWRP to LACPW spreading grounds. This pipeline would be needed regardless of the treatment selected. If Upper District is not successful with securing regulatory and customer approval for tertiary treatment with blend water it can proceed with AWT without losing any investment in the pipeline. Also, there is the possibility of a hybrid between the two treatment alternatives. For example, the first 5,000 to 10,000 AFY could be tertiary treatment with blended stormwater, then if needed advanced water treatment could be used for additional phases. Several other agencies in Southern California are exploring this hybrid treatment for its cost-effectiveness and water quality objectives.

## 8.1 Adaptive Management

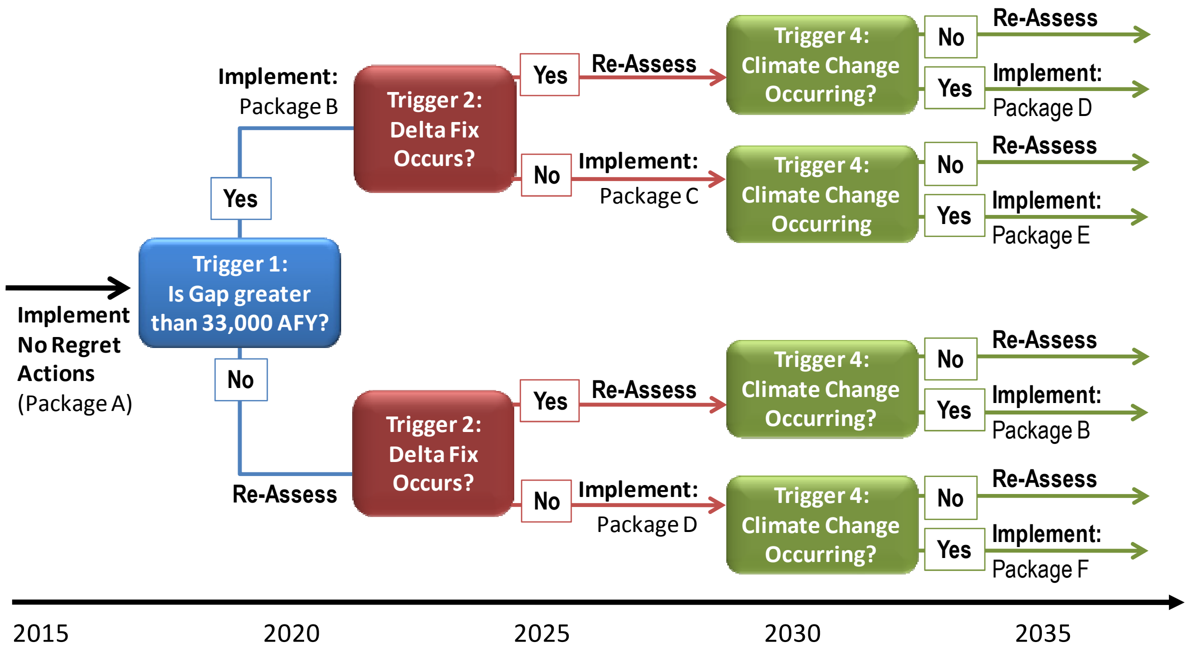
Because of the uncertainty in the size of the potential gap between existing water supplies and projected water demands, an adaptive management strategy was developed for Upper District's IRP. Adaptive management is a process in which different future scenarios are defined. Risk triggers are then identified that serve as branches of a decision tree. For each trigger, outcomes are predicted, and for each outcome, actions are identified. Adaptive management also identifies no or low regret actions that will produce benefits under most or all outcomes of the future. This approach results in a "living" document that can be revisited and updated as the future unfolds.

For the context of Upper District's IRP, no or low regret actions represent the implementation of those projects that are necessary for meeting regulatory and/or other state requirements (such as meeting the 20x2020 conservation goal), those projects that have a unit cost ($/AF) that is projected to be lower than MWD's imported water cost for Upper District, and those actions which provide the necessary foundation to move forward with long-term actions (such as studies and design).

Based on the IRP evaluations, the following options are considered no or low regrets:

- Expanding active water conservation to an annual total of 5,000 AFY
- Implementing up to 1,200 AFY of the most cost-effective non-potable reuse projects
- Implementing up to 5,300 AFY of centralized stormwater capture
- Conducting regulatory investigations and design services for indirect potable reuse

These no or low regret actions should occur within the next 5 years. Beyond these short-term actions, Upper District's adaptive management strategy for the IRP is shown in Figure 8-1.




| | |
|---|---|
| Package A: | active water conservation (5,000 AFY); non-potable reuse (1,200 AFY); centralized stormwater (5,300 AFY) |
| Package B: | indirect potable reuse (10,000 AFY) |
| Package C: | additional phase of indirect potable reuse (14,000 AFY); water transfers (11,400 AFY); additional active water conservation (2,500 AFY) |
| Package D: | indirect potable reuse (10,000 AFY); water transfers (11,400 AFY); decentralized stormwater (200 AFY) |
| Package E: | additional stormwater capture (5,000 AFY); additional water transfers (20,000 AFY) |
| Package F: | additional stormwater capture (5,000 AFY) |

**Figure 8-1**
**Adaptive Management Strategy for Upper District's IRP**



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## 8.2 Recommendations

Based on the evaluation of alternatives and adaptive management strategy, the following recommendations for Upper District's IRP are:

1. Develop financing plan and CIP for IRP implementation—working closely with retail water agencies, and partner agencies such as Watermaster, Los Angeles County Flood Control District, Los Angeles County Sanitation District, and U.S. Army Corps of Engineers;

2. Conduct regulatory review and preliminary design for indirect potable reuse treatment options;

3. Working closely with partner agencies, implement the following options between now and 2017:

   - Active conservation, as recommended in Water Use Efficiency Master Plan

   - Planned non-potable recycled water projects

   - Centralized stormwater capture projects; and

4. Re-Assess demands and supplies per the adaptive management framework presented in Figure 8-1, and if necessary implement other options of the IRP strategy such as indirect potable reuse, water transfers, and additional stormwater capture.

It is also recommended that Upper District update the IRP and risk triggers every 5 years, in conjunction with its preparation of the Urban Water Management Plan.

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