Chapter 5.1 Water Supply

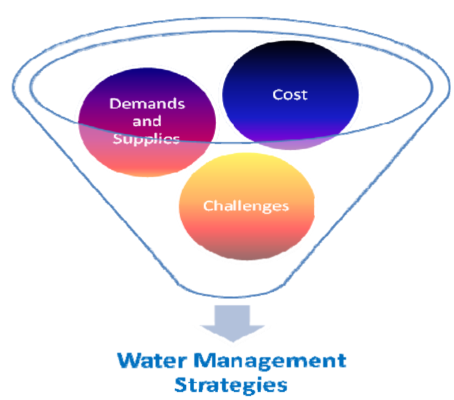
Introduction

The climate and geography of the State of California present a unique challenge to the management and delivery of water. While most of the State's precipitation falls on the northern portion of the State, most of California's population resides in the semi-arid, southern portion of the state. Water is diverted, stored, and then transferred from the water-rich north to the more arid central and southern sections of the state through the California State Water Project (SWP), the Central Valley Project, and the Los Angeles Aqueduct.

In addition to the projects that transport water from the north to the south, the southern coastal area relies on water imported through Metropolitan Water District of Southern California's (MWDSC) Colorado River Aqueduct (CRA). The U.S. Bureau of Reclamation and seven basin states manage the Colorado River (CR) system under the authority of the Secretary of the Interior and for the benefit of seven "basin states". Over-allocation of this resource, along with a U.S Supreme Court Decision (*Arizona v. California, 1964*) and population and economic growth, led to the recent California "4.4 Plan" and Quantification Settlement Agreement (QSA). The QSA limits California's share of the CR Supply to 4.4 million acre-feet (maf). As a result of these actions, MWDSC's supply from the CR was significantly reduced, especially during extended dry periods.

In the past, a buffer supply was developed by constructing new facilities such as dams and/or aqueducts to provide supply for future growth. Today, the gap between supply and demand has closed and increasing emphasis is placed on conservation and development of local supplies. Building new facilities is costly and such projects face strict environmental review before they can be approved. This has caused California to seek more creative and sustainable solutions to water resource management.

The Santa Ana River Watershed (Watershed) lies in semi-arid southern California. Like many other areas, the Watershed is carefully evaluating water supplies and demands and seeking creative, cost-effective strategies to provide a reliable water supply into the future. Water supply reliability will be challenged by state droughts, droughts on the CR, the vulnerability of the Sacramento-San Joaquin River Bay-Delta, and the threat of climate change. Designing a diverse and flexible water resource management system that can meet these challenges will help to ensure water reliability and a sustainable and vibrant economy for the Watershed.

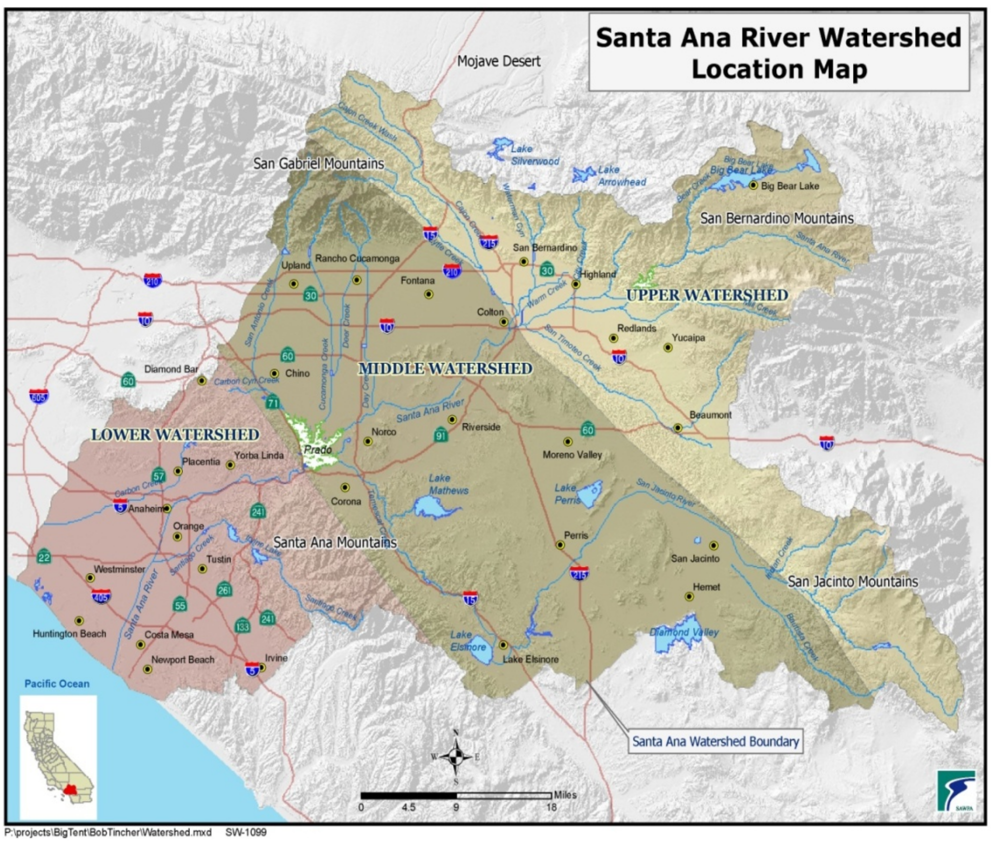


The *One Water One Watershed* (OWOW) collaborative process has facilitated the discussion of water management and sustainability throughout the Watershed. The key objective for water supply reliability is a cost-effective and diverse water supply and water storage portfolio that makes better use of existing facilities and supplies; improves overall water use efficiency; achieves a practical level of inter-connections and redundancy; and optimizes water storage for use during drought periods. This section of the plan focuses on how to maintain a robust and reliable water supply within the watershed.

Current Conditions

There are five principal wholesale agencies that form SAWPA and manage roughly one-fifth of the water supplies within the Watershed, both local and imported. In addition to these regional water agencies, the Watershed also contains portions of four counties represented, as well as retail and wholesale water agencies. For purposes of this report, the analysis has been organized by three general areas: Upper Watershed, Middle Watershed, and Lower Watershed. These areas are subsets of ONE WATERSHED (**Figure 5.1-1**). The regional water agencies within each general area are described below.

Figure 5.1-1 Watershed Areas



Upper Watershed

San Bernardino Valley Municipal Water District (Valley District) is a State Water Contractor and provides imported water from the SWP to local retail agencies in its 325 square mile service area to supplement and enhance groundwater resources. Valley District's service area generally includes the cities and communities of San Bernardino, Colton, Loma Linda, Redlands, Rialto, Bloomington, Highland, Grand Terrace, and Yucaipa. Valley District is a member agency of the Santa Ana Watershed Project Authority (SAWPA).

San Gorgonio Pass Water Agency (SGPWA) is a State Water Contractor, and provides imported water from the SWP to local retail agencies in its 225 square mile service area to supplement and enhance groundwater resources. SGPWA's Service area includes Calimesa, Beaumont, Banning, Cherry Valley, Cabazon, and Morongo Indian Reservation. The SGPWA service area straddles the Watershed, with its western two-thirds in the watershed and eastern one-third in the Whitewater River watershed.

Middle Watershed

Eastern Municipal Water District (EMWD) is a member agency of MWDSC and provides both water and sewer service throughout its 555 square mile service area. Major communities include Moreno Valley, Hemet, San Jacinto, Perris, Sun City, Menifee, Winchester, and parts of Temecula, and Murrieta. In addition to retail customers, EMWD wholesales water through seven local water agencies. EMWD is a member agency of SAWPA.

Western Municipal Water District (WMWD) is a member agency of MWDSC and provides water service throughout its 510 square mile service area in western Riverside County. Within its boundaries lie the communities of Jurupa, Rubidoux, Riverside, Norco, Corona, Elsinore Valley, and parts of Temecula. WMWD serves imported water directly to customers who are located in the unincorporated and non-water bearing areas around Lake Mathews and portions of the City of Riverside. Ten wholesale customers are served by WMWD with both CR and SWP water. WMWD is a member agency of SAWPA.

Inland Empire Utilities Agency (IEUA) is a member agency of MWDSC and provides water and sewer services to a 242 square mile area in the western portion of San Bernardino County. Within its boundaries lie the Cities of Chino, Chino Hills, Fontana, Montclair, Ontario, Rancho Cucamonga, and Upland. IEUA is a member agency of SAWPA. IEUA also is completely within the boundaries of the Chino Basin Watermaster.

Chino Basin Watermaster (Watermaster) is a consensus-based organization facilitating the development and utilization of the Chino Groundwater Basin. The Watermaster consists of various entities pumping water from the Basin including cities, water districts, water companies, agricultural, commercial, and other private concerns. The Watermaster's mission is "to manage the Chino Groundwater Basin in the most beneficial manner and to equitably administer and enforce the provisions of the Chino Basin Watermaster Judgment", Case No. RCV 51010 (formerly Case No. SCV 164327).

Lower Watershed

Orange County Water District (OCWD) manages groundwater within its 355 square mile service area. Within its boundaries lie the Cities of Anaheim, Buena Park, Costa Mesa, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, Irvine, La Palma, Los Alamitos, Newport Beach, Orange, Placentia, Santa Ana, Seal Beach, Stanton, Tustin, Villa Park, Westminster, and Yorba Linda. OCWD recharges the groundwater basin with surface water flows from the Santa Ana River (SAR) and Santiago Creek, recycled water from the OCWD Groundwater Replenishment System, and imported water which is purchased from the Municipal Water District of Orange County. OCWD is a member agency of SAWPA.

Municipal Water District of Orange County (MWDOC) is a member agency of MWDSC and sells imported water to 29 retail water agencies and cities in north and south Orange County. MWDOC also sells water to OCWD. MWDOC also straddles the Watershed, with its northernmost portion being in the Watershed and its southern portion being outside of the Watershed.

Within each of these regional agencies, there are a number of retail water agencies. For purposes of brevity, these local agencies have not been individually listed in this report. However, these agencies did provide invaluable input into the OWOW process.

Water Demand and Sources

The total water demand for the Watershed is the summation of the water demand projections from each of the regional water agencies. Most of these demand projections were obtained from the most recently published *Urban Water Management Plan(s)* (UWMP), *Water Master Plan(s)*, or similar report(s). These regional projections include the demand of the local retail water agencies within each regional agency. There are some retail agencies that overlay more than one regional agency. In these cases, the retail agency's demand would be split between the regional agencies to avoid any double-counting.

The Urban Water Management Planning Act (Act) requires that planning projections be evaluated over at least a 20 year period. Most of the agencies within the Watershed projected their demands for a 25 year period ending in 2030. This report provides the actual water demands for 2005 along with the water demand projections through 2030.

Water demands within the Watershed are met through a combination of both local and imported water supplies. Local resources include precipitation in the form of snow pack, surface flow and groundwater. Imported resources for the Watershed are primarily from the CRA and the SWP.

Figure 5.1-2 Resources Used to Meet 2005 Demand

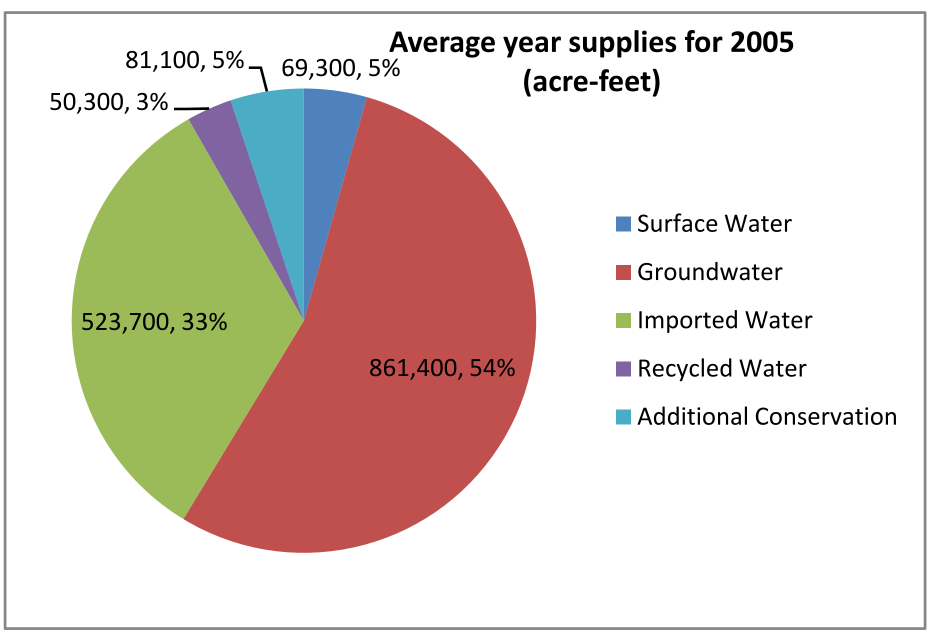
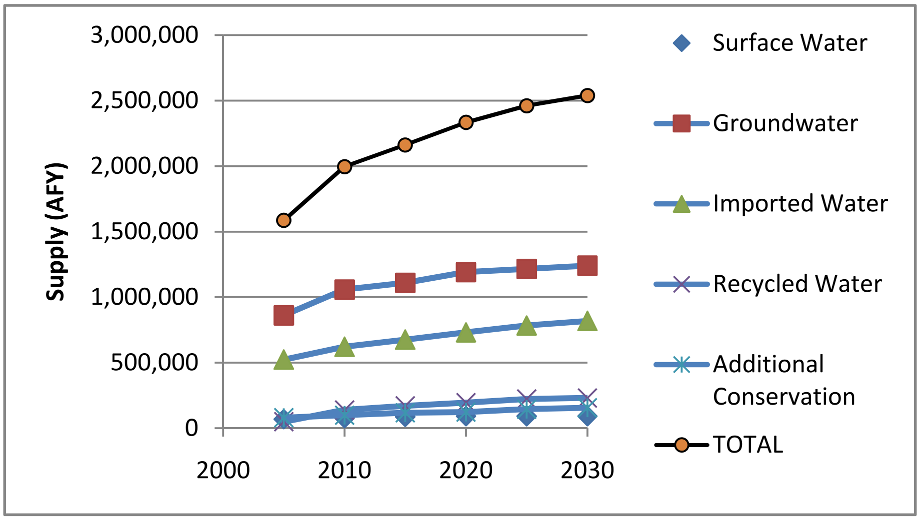


Figure 5.1-2 shows the resources used to meet 2005 demand in the Watershed. Altogether, local resources (groundwater, surface water and recycled water) met approximately two-thirds of the demand. The remaining one-third of demand was met with imported water from the SWP and the CRA.

The following chart and table presents the projected water supply mix through 2030 for the region for an average year. Overall water supply is expected to increase from 1,585,800 AFY in 2005 to 2,539,400 AFY in 2030. This represents an increase of 54% over the 25-year period, or average annual increase of 1.7%.



The rate at which the supply of different sources will increase varies from 1.1-1.2% per year for surface water, groundwater, and imported water, which can be considered "traditional" sources of water, to 2.9% for additional conservation and 7.5% for recycled water. These projections, if materialized, imply a gradual shift toward more sustainable water sources.

Supplies to Meet Ultimate Demands - Santa Ana River Watershed

Average Year Supplies (acre-feet per year)

Year	Surface Water	Groundwater	Imported Water	Recycled Water	Additional Conservation	TOTAL
2005	69,300	861,400	523,700	50,300	81,100	1,585,800
2010	77,200	986,200	708,200	211,700	99,700	2,083,000
2015	87,200	1,037,900	691,900	242,900	119,100	2,179,000
2020	92,000	1,119,500	704,800	267,400	123,900	2,307,600
2025	92,000	1,143,900	704,800	295,400	147,600	2,383,700
2030	92,000	1,172,500	704,800	303,300	164,400	2,437,000
Average annual change	1.1%	1.2%	1.2%	7.5%	2.9%	1.7%

The following table presents projected supplies under a multi-year drought scenario. Similar to the average year scenario, total supplies will increase by 1.8% per year, albeit from a slighter lower base (1,573,600 AFY vs 1,585,800 AFY). The most notable difference is a lower growth in supplies from less drought-tolerant sources, such as surface and imported water, coupled with a higher increase in groundwater use and a significant increase in conservation.

Multi-year Drought Supplies (acre-feet per year)

Year	Surface Water	Groundwater	Imported Water	Recycled Water	Additional Conservation	TOTAL
2005	53,900	866,100	513,900	56,900	82,900	1,573,700
2010	55,000	1,018,900	600,900	217,900	131,300	2,024,000
2015	59,500	1,046,000	637,600	245,300	159,100	2,147,500
2020	59,500	1,164,900	632,400	269,800	186,500	2,313,100
2025	64,500	1,195,900	626,400	298,000	216,000	2,400,800
2030	64,500	1,232,500	622,300	305,900	246,700	2,471,900
Average annual change	0.7%	1.4%	0.8%	7.0%	4.5%	1.8%

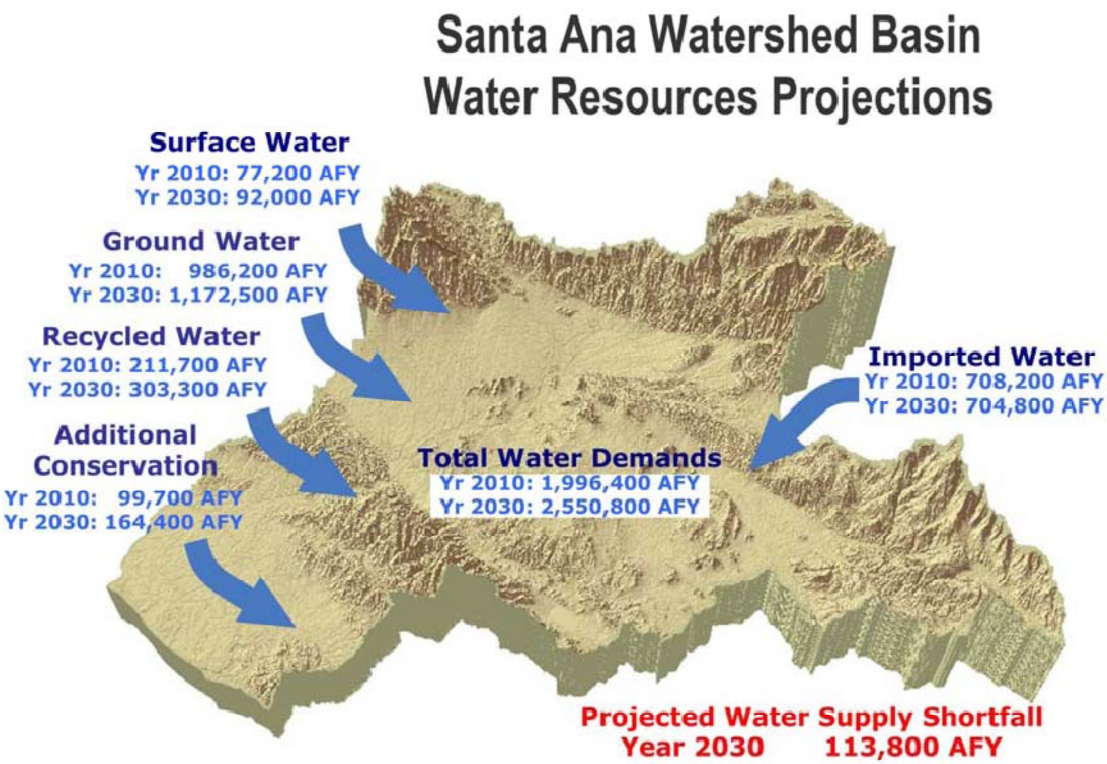
Finally, the next table shows the supply under a multi-year drought scenario. Similar to the single-year drought scenario, there would be a significant increase in recycled water and additional conservation, combined with a net decline in the supply of surface water and in total supply.

Single Year Drought Supplies(acre-feet per year)

Year	Surface Water	Groundwater	Imported Water	Recycled Water	Additional Conservation	TOTAL
2005	46,000	874,600	512,100	56,900	85,900	1,575,500
2010	37,100	1,045,700	694,600	214,000	119,700	2,111,100
2015	37,100	1,103,500	743,800	245,300	141,800	2,271,500
2020	37,100	1,222,300	732,500	269,800	159,100	2,420,800
2025	42,100	1,241,700	718,800	298,000	190,200	2,490,800
2030	42,100	1,265,600	707,000	305,900	218,600	2,539,200
Average annual change	-0.3%	1.5%	1.3%	7.0%	3.8%	1.9%

Figure 5.1-3 shows anticipated water supplies to the Watershed for 2010 and 2030. A supply shortfall of 113,800 AFY is anticipated if no action is taken to develop sustainable sources.

Figure 5.1-3 Anticipated Water Supplies to the Watershed for 2010-2030



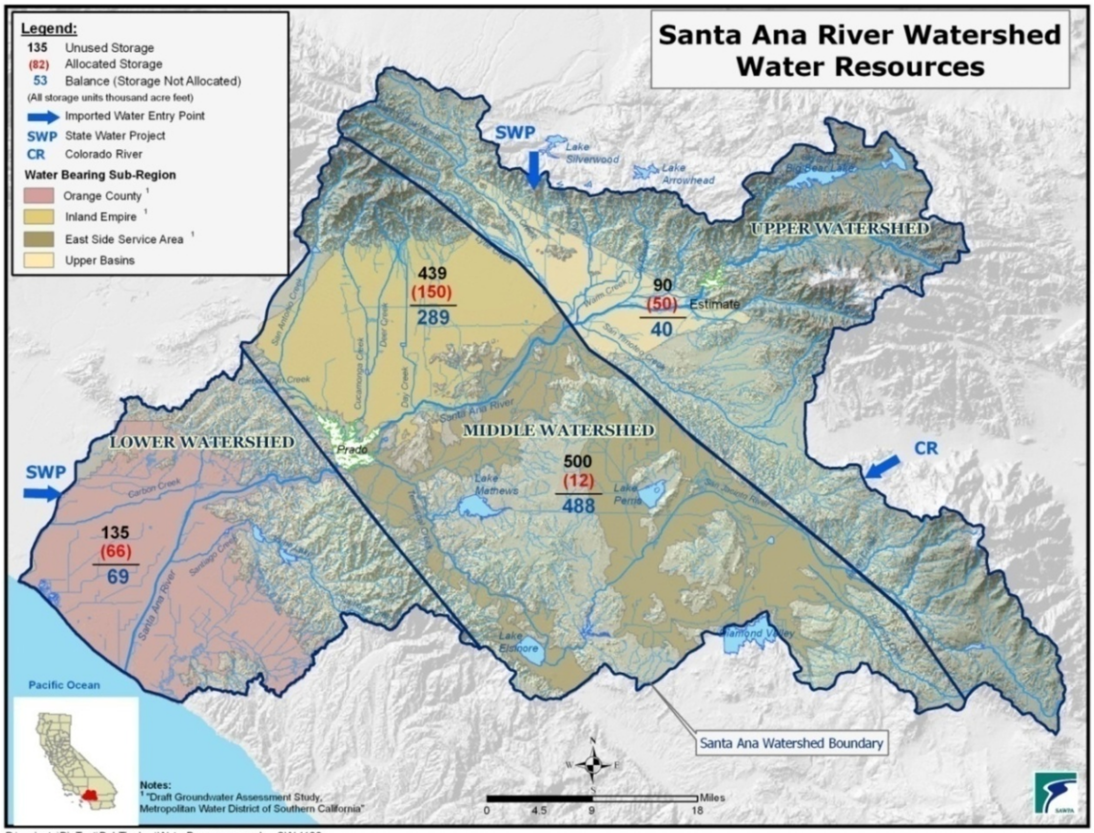
Local Water

Groundwater

The underground pore space between soil granules provides a location to store water, referred to as groundwater, which can be later extracted using wells. This underground storage space functions essentially like a series of underground reservoirs. These underground reservoirs, or basins, range from a few hundred to over one thousand feet in thickness. Basins upstream from Prado Dam underlie about 1,200 square miles of the Watershed, while basins downstream from Prado Dam underlie about 400 square miles of the Watershed. Nearly all of the basins within the watershed have a calculated "safe yield" which was calculated using past hydrology and assumes that past hydrology will repeat itself. The safe yield is the amount of water that can be annually pumped from a basin on a permanent basis without emptying the basin.

In general, the Watershed relies heavily on the groundwater basins for both storage and water supply. **Figure 5.1-4** generally shows the larger groundwater basins within the Watershed along with any available storage capacity (individual basins and sub-basins have been omitted for clarity). These basins provide storage space for local and imported water supplies that can be used during droughts or other shortages.

Figure 5.1-4 Groundwater Resources within the Watershed (Thousand acre-feet)



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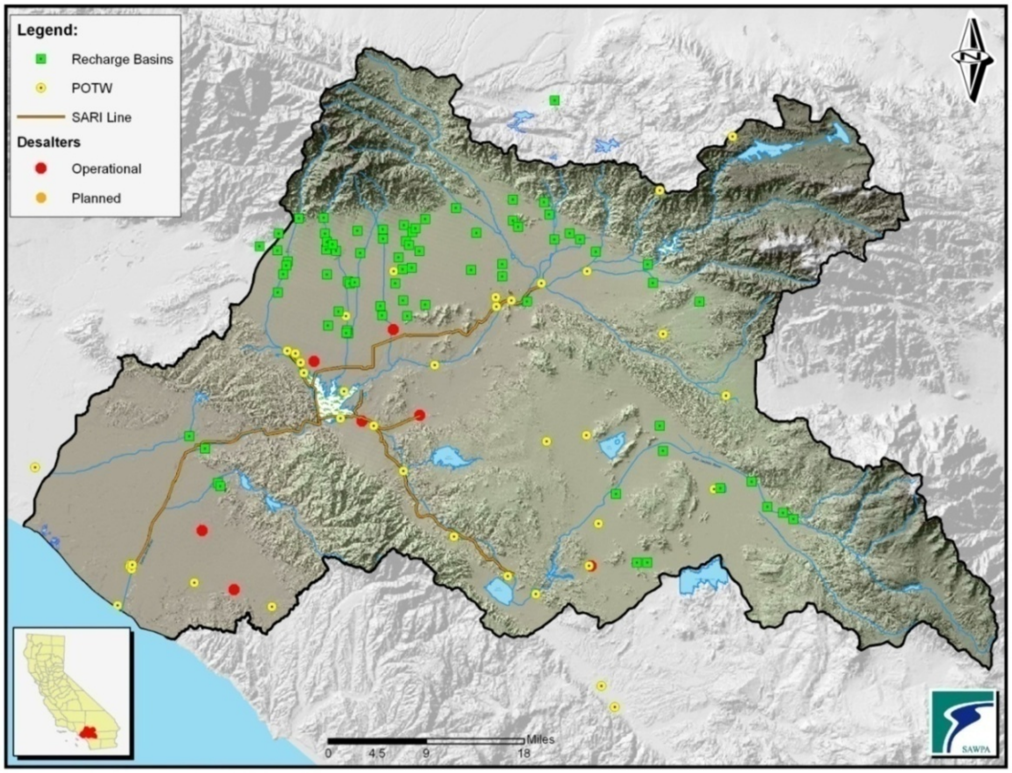
As mentioned above, the amount of water produced from these underground basins is limited to the safe yield of the basin. However, the yield of these basins can be increased by artificial replenishment.

Artificial replenishment involves storing additional water in the basin(s), over and above the natural replenishment. The most common type of artificial replenishment is "spreading" water into open "pits", or basins, and allowing it to soak into the ground down to the "water table". Another commonly used method is called "in-lieu" replenishment. This method involves replacing groundwater with another source of water. This corresponding reduction in groundwater pumping results in less water being removed from the basin which effectively acts to replenish the groundwater supply. Finally, the most costly method of artificial replenishment is to inject the water into the basin using an injection well(s). Of the various methods available for artificial recharge, spreading basins are the most economical and the most common throughout the Watershed. **Figure 5.1-5** shows the locations of spreading basins in the Upper, Middle and Lower Watershed.

Figure 5.1-5 Artificial Recharge Basins and Desalters



One challenge to groundwater supplies in the Watershed is "contamination", by total dissolved solids (TDS or salinity) and nitrates. These salts accumulate mostly through use and evaporation, but also are introduced to the water supply by way of agricultural fertilizers and septic tanks. Further, other forms of contamination found in the Watershed are TCE, PCE (commonly used solvents) and Perchlorate (fertilizer, fireworks and explosives). All these forms of contamination must be removed using various treatment methods before it can be introduced into the water supply system.

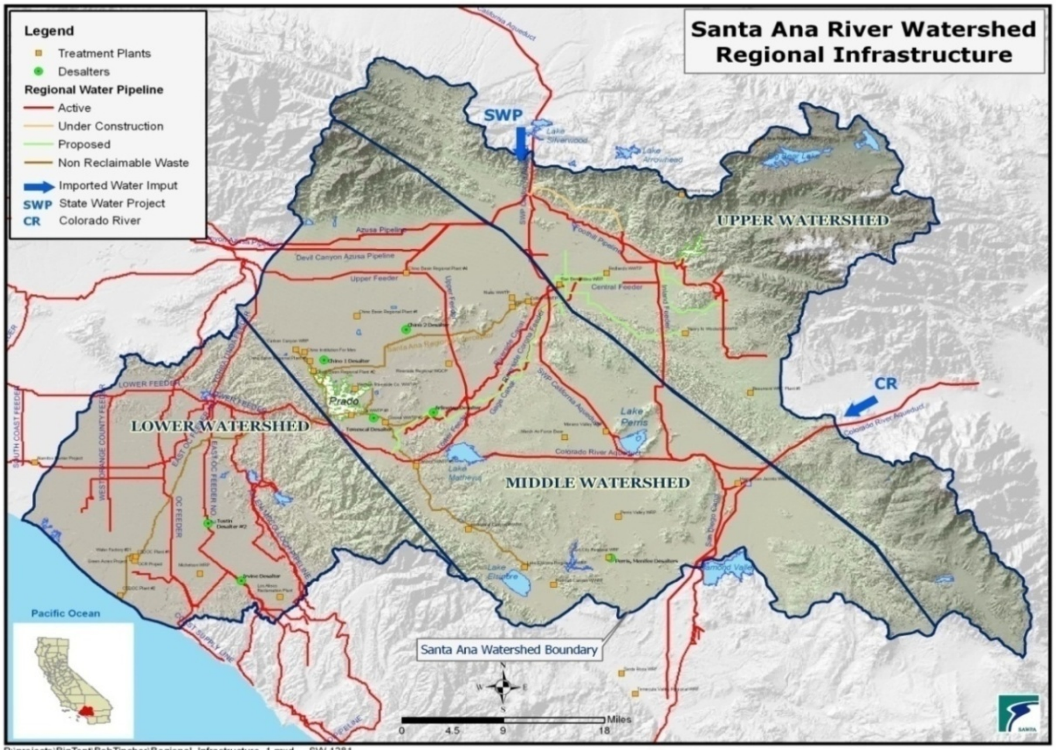
Local Surface Water

In 2005, the amount of local surface water from rivers and streams that was diverted and used accounted for approximately 5% of the total water supply. Local surface water is largely seasonal, meaning that most of the water comes in the "wet" or rainy season, and is dramatically reduced in the "dry" season to snowmelt, natural springs, and treated wastewater flows. Facilities, such as dams and flood control detention basins divert and slow storm runoff providing some additional groundwater replenishment. However, in the Upper Watershed, only a fraction of storm runoff is being diverted and used as surface water. In other portions of the Watershed, the exact opposite is true. Much of the runoff from the Upper and Middle Watershed is captured by the U.S. Army Corps of Engineers' Prado Dam and later is used by the Lower Watershed. A similar opportunity is available in the Upper Watershed at the U.S. Army Corps of Engineers Seven Oaks Dam.

Imported Water

In 2005, the CR and the SWP met approximately one-third of the demand. Water is imported into the area by MWDSC (SWP and CR), SGPWA (SWP) and Valley District (SWP). **Figure 5.1-6** shows the regional infrastructure and the entry points for the SWP and the CR.

Figure 5.1-6 Regional Infrastructure within the Watershed



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As shown on **Figure 5.1-6**, there are significant regional pipelines (48 inch diameter and larger) and surface storage reservoirs in the Watershed. These pipelines provide opportunities for water transfers, especially in an emergency situation. **Table 5.1-1** provides a list of surface water reservoirs in the Watershed and their capacities.

Table 5.1-1 Surface Water Reservoir Capacities

Reservoir	Capacity (acre-feet)
Lake Arrowhead	48,000
Big Bear Lake	73,000
Diamond Valley Reservoir	800,000
Lake Elsinore	45,000
Canyon Lake	12,000
Lake Mathews	178,500
Lake Perris	120,000
Prado Dam	Flood control and conservation
Seven Oaks Dam	Flood control (conservation pending)
Lake Silverwood	74,970
Irvine Lake	25,000

Evaluate Water Supply Reliability

The first step toward evaluating the water supply reliability for the Watershed was to establish the criteria by which it would be measured. To maintain consistency with existing State of California requirements, it was decided to evaluate the Watershed using the scenarios given in the Act. These scenarios are summarized in **Table 5.1-2**.

Table 5.1-2 Water Supply Reliability Scenarios Provided in the Act

Scenario	Description
Average conditions[1]	What are the water supply reliability vulnerabilities given average supplies to the region?
Single year drought[1]	What are the water supply reliability vulnerabilities given a single year of drought?
Multi-year drought[1]	What are the water supply reliability vulnerabilities given a multi-year drought?
50% reduction in imported water supplies[1]	What are the water supply reliability vulnerabilities if the Watershed loses 50% of imported water supplies?
Catastrophic Interruption[1]	What are the water supply reliability vulnerabilities if a catastrophic interruption occurs due to an earthquake or other disaster?

In addition to the above scenarios, **Table 5.1-3** provides a list of additional scenarios developed as part of the OWOW process. Collectively, **Tables 5.1-2** and **5.1-3** provide a complete list of the evaluated scenarios.

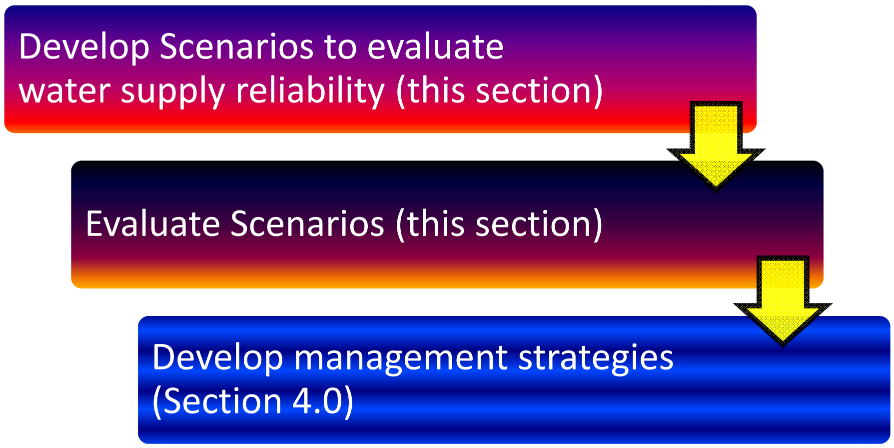
Table 5.1-3 Additional Water Supply Reliability Scenarios Evaluated as part of the OWOW Process

Scenario	Description
Flow restrictions in the Sacramento-San Joaquin Delta	How is water supply reliability affected by the current flow restrictions in the Delta as presented in the Draft 2007 SWP Reliability Report?
Climate Change	What are the water supply reliability vulnerabilities given the assumed effects of climate change as presented in the Draft 2007 State Water Project Reliability Report?
Zebra and/or Quagga Mussels	What are the water supply reliability vulnerabilities of the Zebra Mussel and/or the Quagga Mussel were to infiltrate the SWP?
Sediment Transport	How does sediment transport at Seven Oaks Dam and/or Prado Dam affect water supply reliability?
Wildfire	How does the threat of wildfire affect water supply reliability?
Channel Armoring	How does channel armoring in the SAR affect water supply reliability?
Water quality degradation	How does water quality degradation affect water supply reliability?
Terrorism	How does terrorism affect water supply reliability?

[1] Scenario presented in the Urban Water Management Planning Act.

All of the scenarios pose a threat to water supply reliability. The evaluation consisted of analyzing anticipated water supplies for each of these scenarios to determine if they are adequate to meet the anticipated demands. If anticipated demands are less than anticipated supplies, the system is deemed reliable. If anticipated demands are greater than anticipated supplies, water management strategies will need to be developed to offset these deficits. **Figure 5.1-7** provides an overview of the evaluation process.

Figure 5.1-7. Overview of the Water Supply Reliability Evaluation Process



The scenarios analyzed in this document represent a “snapshot” in time. As new challenges and constraints to water supply reliability are identified, they will require evaluation.

Evaluate Water Supply Reliability Scenarios

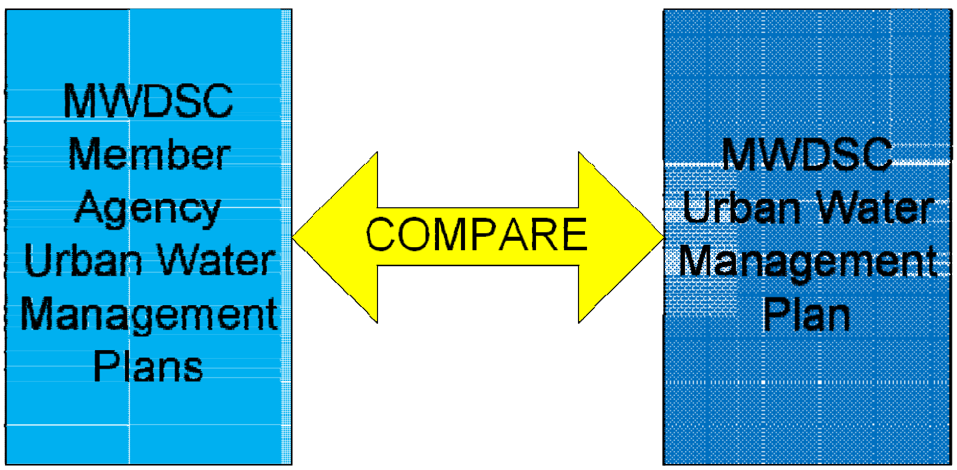
Nearly all of the water agencies within the Watershed are required to evaluate their water supply reliability every five years and publish the results in an UWMP. Because the OWOW process is evaluating many of the same scenarios that are evaluated in these UWMPs, the evaluation of these scenarios for the watershed consisted of compiling and analyzing the existing UWMP data. Certain assumptions also were used in the evaluation and are included in **Table 5.1-4**. The supplies that were included in the various UWMPs included groundwater, surface water, recycled water and imported water.

Table 5.1-4 Assumptions Used for Evaluation of Water Supply Reliability

Item	Assumptions
Groundwater	Limited to the “safe yield” of each basin.
Imported Water	The following documents were used to estimate the anticipated deliveries of imported water given average, single year drought and multi-year drought hydrological conditions: State Water Project Delivery Reliability Report, 2005 The Metropolitan Water District of Southern California Urban Water Management, November, 2005 supplemented with data from MWDSC.

The three hydrologic scenarios evaluated as part of the OWOW process are the same scenarios evaluated in UWMPs throughout the Watershed. As each agency that prepared an UWMP is responsible for determining that supplies are adequate to meet demands, the analysis for this report simply could be a summation of the individual UWMP results. However, a different methodology was used to analyze and provide some verification of the planning numbers in the UWMPs. First, realizing that the UWMP values for surface water and groundwater are based upon long-term averages, the analysis could be simplified by assuming these values are "fixed". The same assumption also can be applied to recycled water. Given these simplifying assumptions, the only water source that could be analyzed was imported water.

Figure 5.1-8 Evaluation of the MWDSC Imported Water Supplies Involved a Comparison of the Member Agencies' UWMPs to the MWDSC UWMP



There are three agencies that import water into the Watershed: 1) Valley District, 2) SGPWA, and 3) MWDSC. Of the three, MWDSC provides nearly 90% of the imported water into the Watershed. However, the MWDSC UWMP does not break the imported water demand down by member agency. Therefore, the MWDSC UWMP and the member agency UWMPs could not be easily compared. MWDSC estimated that about 24% of their total imported water deliveries serve the OWOW area. Using this figure, the total amount of MWDSC imported supplies could be estimated for the OWOW area and then compared to the amount of imported water shown in their member agencies UWMPs.

Average Year (Benchmark)

Averages can be somewhat useful in simplifying the evaluation of data sets, such as water supplies, which have significant fluctuations. Evaluating average water supplies can also be used as a benchmark for comparison purposes. This scenario evaluates the water supply reliability for the watershed by comparing average water supplies to projected demands.

To evaluate this scenario, water supply data for the "average year" scenario was compiled from the various UWMPs. This data essentially provides the planned water sources given "average" hydrologic conditions. **Figure 5.1-9** summarizes the data and shows that local water sources meet almost 68% of the demand with about 32% coming from imported water. Although "additional conservation" is not really a supply, it has been presented as a supply to highlight the fact that the water agencies will require additional conservation, over and above that which already is occurring to meet the demands into the future. **Figure 5.1-10** shows that projected imported water supplies will be greater than demands through 2015, but likely will be inadequate to meet projected demand beginning in 2025. After the year 2025, demands will continue to exceed supplies until the deficit reaches about 90,000 AF in 2030. About 17,500 AF of the deficit is expected to occur in the SGPWA[2]. The remainder of the deficit will occur in the Middle and Lower Watershed.

Figure 5.1-9 Comparison of Total Demand (by source) versus the Projected Supply

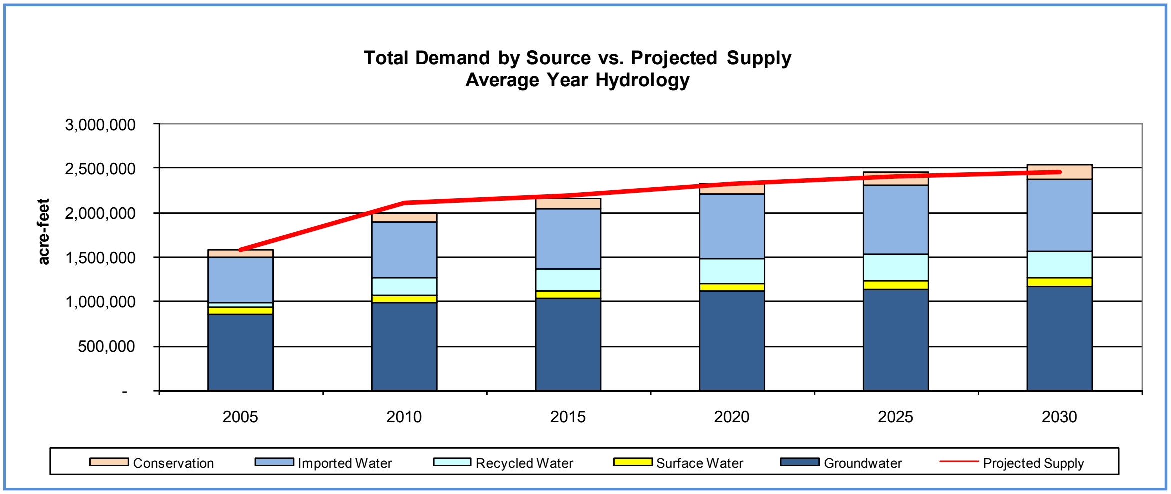
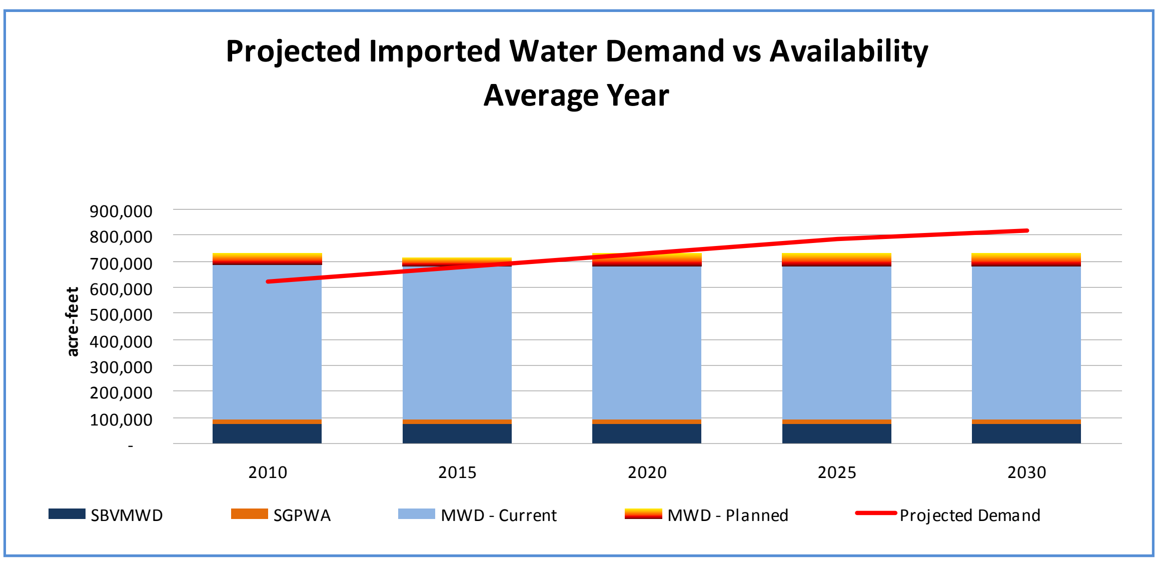


Figure 5.1-10 Imported Water Demand versus Availability for Average Hydrologic Conditions



2 Upper SAR Watershed Integrated Regional Water Management Plan, Table 3-12, November 2007, pg. 3-20.

Given average hydrologic conditions, the Watershed will not be able to meet its needs beginning in 2020. By 2030, the deficit is expected to reach about 90,000 AF annually. Approximately 17,500 AF of the deficit is expected to occur in the SGPWA, with the remainder occurring in the Middle and Lower Watershed. Water management strategies to overcome this deficit are provided in the *Management Strategies to Improve Water Supply Reliability* section.

Single-Year Drought

To evaluate this scenario, water supply data for the "single year drought" scenario was compiled from the various UWMPs. This data essentially provides the planned water sources given a single year of drought. **Figure 5.1-11** summarizes the UWMP data and shows that local water sources meet about 75% of the demand with about 25% coming from imported water. The figure also shows a surplus during a single year drought. This overall surplus is partly due to the method of analysis used to estimate the amount of imported water supplies and demands, but also is due to MWDSC storage programs. These programs store water in wet years for later delivery in drought years. Although there may be an overall surplus, the SGPWA projects a shortage of 27,000 AF in a single year of drought.

Figure 5.1-11 Anticipated Demand (by source) versus Projected Supply for a Single Year of Drought

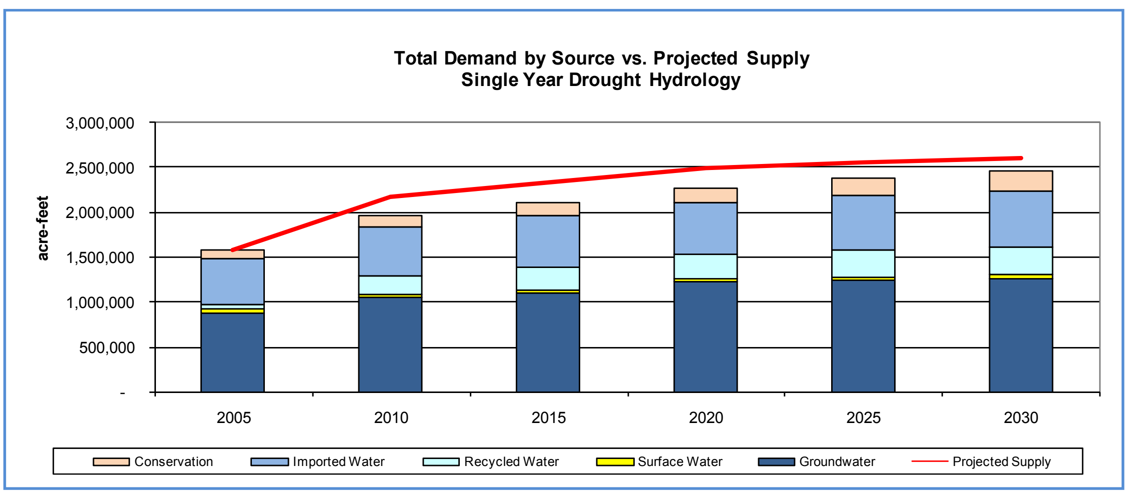
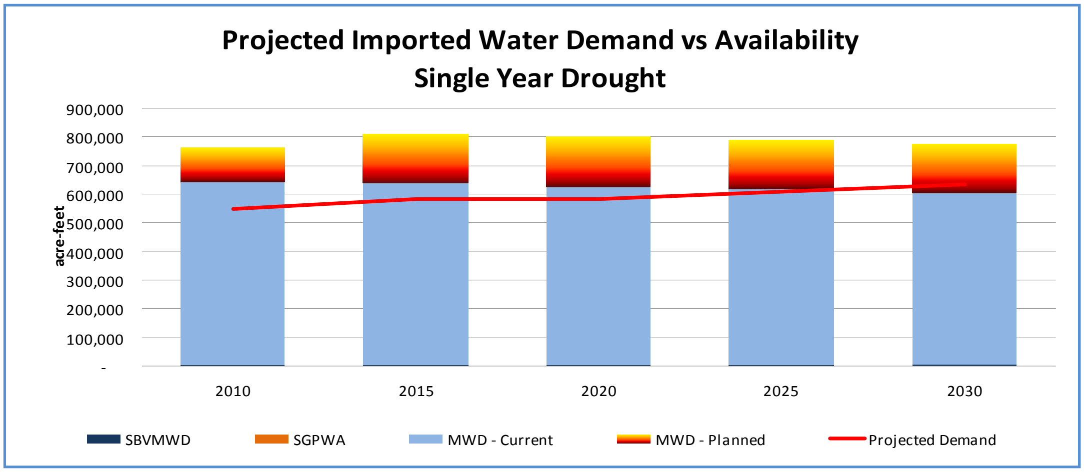


Figure 5.1-12 summarizes the projected demand versus supply of imported water given a single year of drought. In a single year drought, DWR estimates that the SWP will only be able to deliver about 5% of its capacity. This effectively means that the SWP is almost completely shut off during a single year drought. However, despite the extremely low estimated delivery from the SWP in a single drought year, the Watershed is still estimated to have enough imported water due to MWDSC storage programs (although the chart shows a surplus, that "surplus" water would likely be used in another part of the MWDSC service area). As stated above, although there may be an overall surplus in the Watershed, the SGPWA is projecting a shortage of 27,000 AF in a single year of drought.

Given a single year of drought, the Watershed will have an overall surplus of water due mostly to MWDSC storage programs. However, although he overall Watershed is projected to have a surplus, SGPWA is projecting a 27,000 AF deficit during a single year of drought. Water management strategies to overcome this deficit are provided in the *Management Strategies to Improve Water Supply Reliability* section.

Figure 5.1-12 Projected Imported Water Demand versus Availability in a Single Year of Drought



Multi-Year Drought

This scenario evaluates the water supply reliability for the Watershed assuming a multi-year drought. The MWDSC UWMP analyzes a three year drought (1990-92). DWR analyzes a four year drought in their Reliability Report (1931-34).

To evaluate this scenario, water supply data for the "multi-year drought" scenario was compiled from the various UWMPs. This data essentially provides the water sources they plan to use given a multi-year drought. **Figure 5.1-13** summarizes the UWMP data and shows that they plan to have local water sources meet about 73% of the demand with 27% coming from imported water.

Figure 5.1-13 Projected Demands (by anticipated source) versus Projected Supply during a Multi-Year Drought

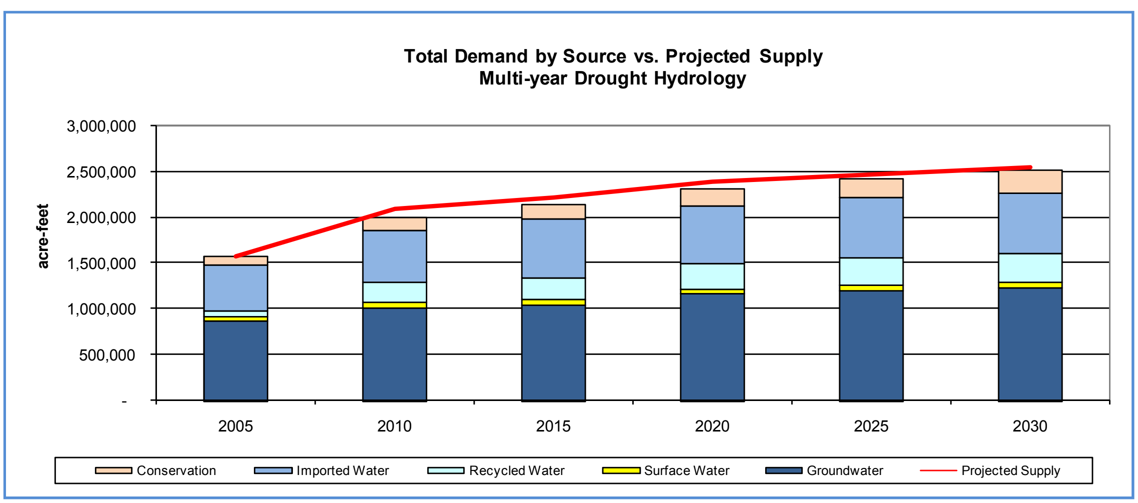
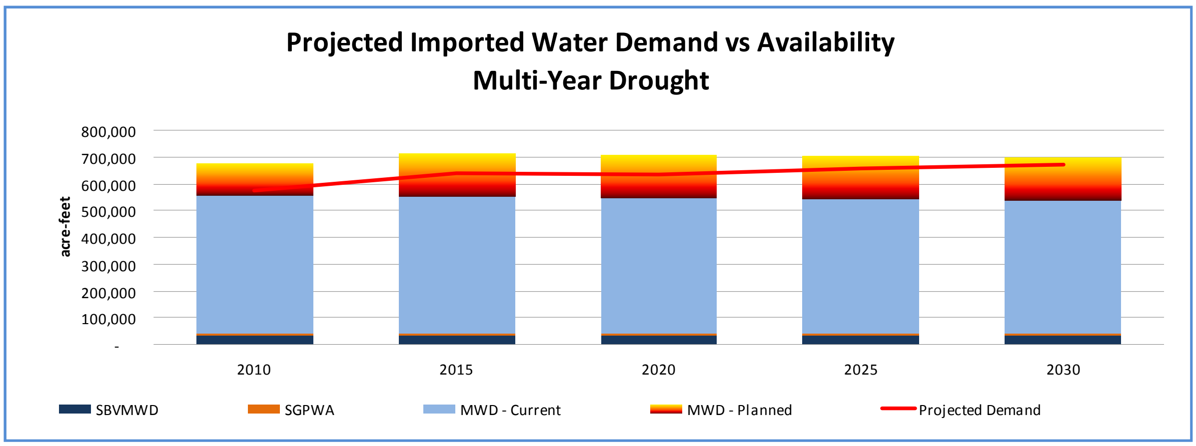


Figure 5.1-14 summarizes the projected need versus supply of imported water given a multi-year drought. In a multi-year drought, DWR estimates that they will only be able to deliver about 38% of the total capability on the SWP. However, despite the low estimated delivery from the SWP in a multi-year drought, the Watershed is still estimated to have a surplus in imported water due to MWDSC storage programs. Although there may be an overall surplus in the Watershed, SGPWA is projecting a shortage of 24,000 AF in a multi-year drought.[3]

The Watershed will be able to meet its needs during a multi-year drought due mostly to the storage programs implemented by MWDSC. However, despite this overall surplus, SGPWA is expecting a deficit of about 24,000 AF during a multi-year drought. Water management strategies to overcome this deficit are provided in the *Management Strategies to Improve Water Supply Reliability* section.

Figure 5.1-14 Projected Imported Water Need versus Availability for a Multi-Year Drought



Evaluate a Short-term 50% Reduction in Imported Water Supplies

One of the scenarios water agencies must evaluate as part of their UWMP is a 50% reduction in supplies. To maintain consistency with this requirement, it was decided to evaluate a 50% reduction in imported water supplies for the Watershed. However, both a single year drought and multi-year drought result in greater reductions in imported water supplies than 50%. Therefore, any strategies that are implemented to overcome the drought scenarios also will overcome this scenario.

As both the single-year drought and multi-year drought scenarios result in reductions of imported water greater than 50%, any management strategies implemented to overcome those scenarios also will overcome this scenario.

[3] Upper Santa Ana River Watershed Integrated Regional Water Management Plan, Table 3-12, November 2007, pg. 3-20.

Evaluate a Catastrophic Interruption in Water Supplies

The water system that serves both local and imported water to the watershed is made up of a variety of facilities including pipes, canals, and levees that are all susceptible to damage or failure from a catastrophic event. The catastrophic events that were evaluated as part of the OWOW process are earthquake, Delta levee failure, power failure, wildfire, and terrorism. While catastrophic events may not be avoided entirely, measures can be developed and set in place to minimize the interruption to water service following a catastrophic event. These measures include: assessing the vulnerability of systems, quantifying available resources, determining optimal use of resources, increasing the flexibility of distribution systems, increasing regional coordination and establishing repair priorities.

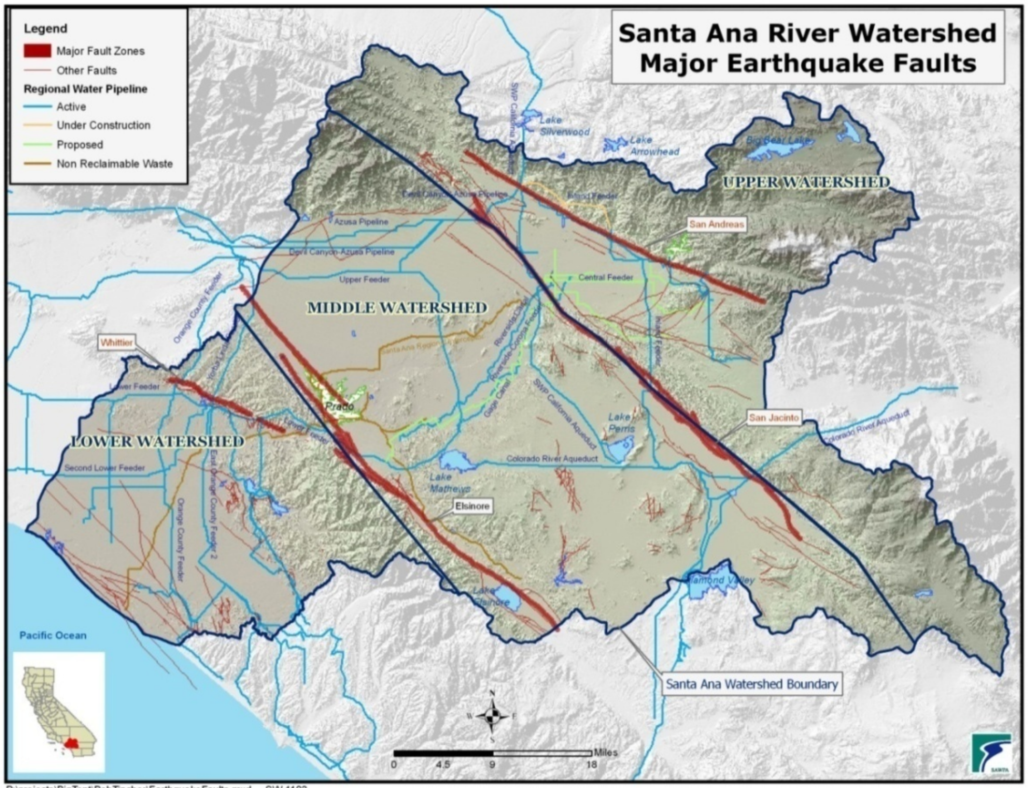
Evaluate the Effect of an Earthquake on Water Supplies

The Watershed is located within a seismically active region of southern California. As shown on **Figure 5.1-15**, six active major earthquake faults and a number of smaller faults extend through the Watershed. As shown on **Table 5.1-5**, a seismic event along one of the major active faults within the Watershed could result in an earthquake in the range of magnitude 6.0 to 8.0 on the Richter Scale.

Table 5.1-5 Estimated Maximum Richter Magnitude for Various Faults in the

Fault	Maximum Magnitude
San Andreas	8.0
San Jacinto	7.5
Elsinore	6.8
Chino	6.5
Whittier	6.8
Peralta Hills	6.6
Puente Hills	7.5
Newport/Inglewood	6.9

Figure 5.1-15 Major Earthquake Faults in the Watershed



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Depending on the intensity of the earthquake and location of the epicenter, catastrophic damage and interruptions of water service could occur throughout the Watershed. Regional water conveyance systems, including the CRA; the Upper, Lower and Coastal Feeder Systems; as well as the East Branch of the California Aqueduct (a.k.a Foothill Pipeline) could sustain significant damage from a major earthquake that would interrupt the delivery of imported water supplies to the Watershed. It also would make it difficult to transport water regionally within the Watershed. Additionally, damage could occur to local water transmission systems operated by retail water agencies within the Watershed, such as the Gage Canal, Riverside Canal, and the Riverside 42-inch and 48-inch pipelines. In addition to the potential damage to transmission facilities, damage also could occur to groundwater pumping facilities, water storage facilities, and water treatment plants as a result of seismic shaking impacts and/or from liquefaction impacts in areas that have high groundwater tables.

Based upon past seismic events, it is assumed that the impacts of a seismic event will be short-term. Due to the uncertainty tied to seismic events (magnitude, epicenter, etc.), it is not possible to determine the exact impact of a seismic event on water supply. However, the Watershed can implement strategies that will better prepare the Watershed for such an event. These strategies are provided in the *Management Strategies to Improve Water Supply Reliability* section.

Evaluate a Delta Levee Failure on Water Supplies

The California Delta is a region where two of California's largest rivers, the Sacramento River and the San Joaquin River meet. The Sacramento-San Joaquin Delta is the hub of the State's water supply system. About two-thirds of all California residents and millions of acres of irrigated farmland rely on the Delta for water from the SWP and the Federal Central Valley Project. The structural integrity of the delta levee system is vital to maintain water supplies to southern

California. However, the Delta levee system is aging and a considerable amount of the land along the Delta levee system has subsided below sea level. The earthen levees are subject to risk from earthquakes, flooding and salt water intrusion. Catastrophic damage sustained by the levees would result in interruptions to SWP supplies to the Watershed due mostly to saltwater intrusion.

A Delta levee failure would reduce deliveries on the SWP for 15 to 27 months[4] depending on the severity of the failure. Assuming the duration of this catastrophic event is limited to 15 months, it is very similar to the effects of a single year drought in which SWP supplies are assumed to be reduced to 5%. Thus, the strategies that are implemented to offset the effects of a single year drought would be helpful for a Delta Levee failure. These strategies are provided in the *Management Strategies to Improve Water Supply Reliability* section. Assuming a 27 month repair period, the effects of this catastrophic interruption would be very similar to a multi-year drought. Thus, the strategies that are implemented to offset the effects of a multi-year drought also would be helpful to offset this event. Should the levee failure(s) occur after a drought period when stored water supplies are severely depleted, other emergency strategies would need to be implemented, such as extreme conservation.

Evaluate a Power Failure on Water Supplies

Power failure can occur as isolated incidents or as part of larger event such as a regional power grid failure caused by a catastrophic event. During a large-scale power failure, water conveyance systems, water treatments plants, and ground water pumping wells could cease to operate.

Most power officials believe that under a scenario when only a portion of the regional power grid fails, the loss of power should not extend beyond 24 hours. However, under a scenario where all three grids of the North American Grid fail, the loss of power could extend for days. Depending on how much of the grid is lost and the length of time it takes to repair, the loss of power could have a profound impact on water delivery.

Power failure likely would have a short-term impact on water supply reliability. Due to the uncertainty of this scenario, it is not possible to determine the exact impact. However, the same strategies that will help to prepare for an earthquake will help prepare for such an event. These strategies are provided in the *Management Strategies to Improve Water Supply Reliability* section.

Evaluate Wildfire on Water Supplies

Wildfire can damage water delivery facilities or the power infrastructure used by water facilities. In addition, the loss of vegetation resulting from a wildfire can change runoff patterns, increase sediment, and reduce water storage. There also are potential water quality concerns associated with ash falling into surface reservoirs, which could overwhelm filtration plants as turbidities increase by orders of magnitude.

The effects of wildfire likely will have a short-term impact on water supply. Possible effects are loss of vegetation, change in runoff patterns, increased sedimentation, reduced natural water storage, and ash falling into surface reservoirs. Due to the uncertainty of this scenario, it is not possible to

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[4] Resource Management Associates, Inc., *Delta Levees Seismic Risk Assessment Modeling 30 and 50 Breach Scenarios*, March 2005, p. 15.

determine the exact impacts. However, the same strategies that will help to prepare for an earthquake will help prepare for such an event. These strategies are provided in the *Management Strategies to Improve Water Supply Reliability* section.

Evaluate the Effects of Terrorism on Water Supplies

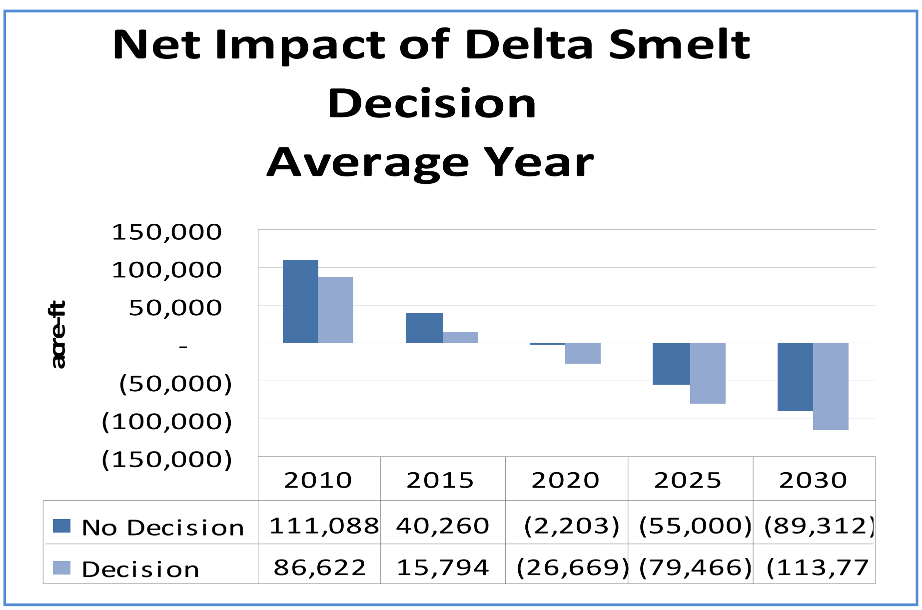
There is always a possibility that water infrastructure could be targeted by terrorists. Water agencies have responded to this potential threat by reducing public access to water infrastructure or even the information about infrastructure. They have also responded by increasing security measures at their facilities.

The effects of a terrorist attack likely will cause short-term reduction in water supply reliability. Due to the uncertainty of this scenario, it is not possible to determine the exact impacts. However, the same strategies that will help to prepare for an earthquake will help prepare for such an event. These strategies are provided in Management *Strategies to Improve Water Supply Reliability.*

Evaluate Delta Flow Restrictions on Water Supplies

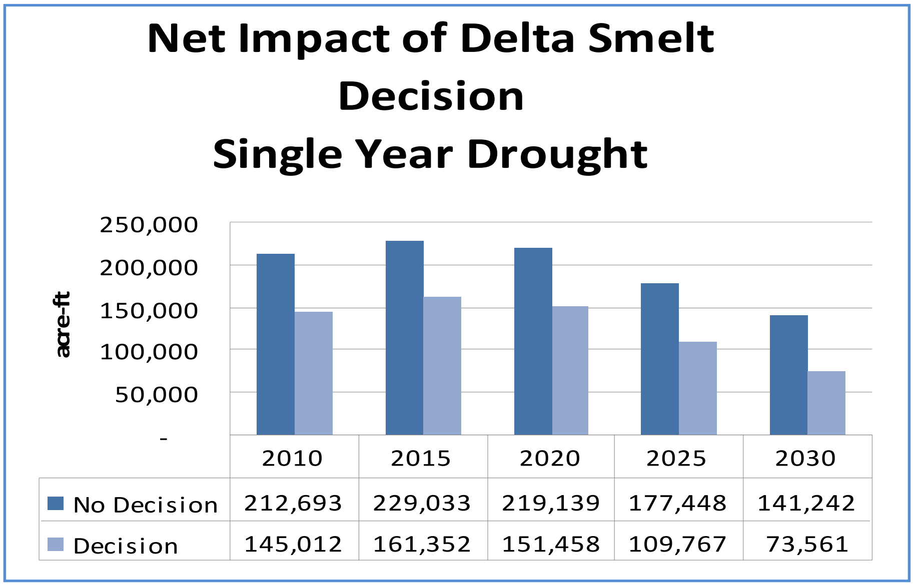
In 2007, the federal court ordered "interim" operating rules to protect a small fish called the delta smelt. This scenario evaluates the impacts of this interim decision if it were to become permanent. DWR has analyzed the long-term impacts of these interim operating rules on SWP deliveries in The State Water Project Delivery Reliability Report 2007 (2007 Report)[5]. **Figures 5.1-16, 5.1-17,** and **5.1-18** show the net overall impact of this decision on the Watershed given average hydrology, a single year of drought or a multi-year drought. In these figures, a positive number indicates a "surplus" and a negative number indicates a "deficit".

Figure 5.1-16 Net Impact of Delta Smelt Decision on the Water Budget for the Watershed given Average Hydrologic Conditions



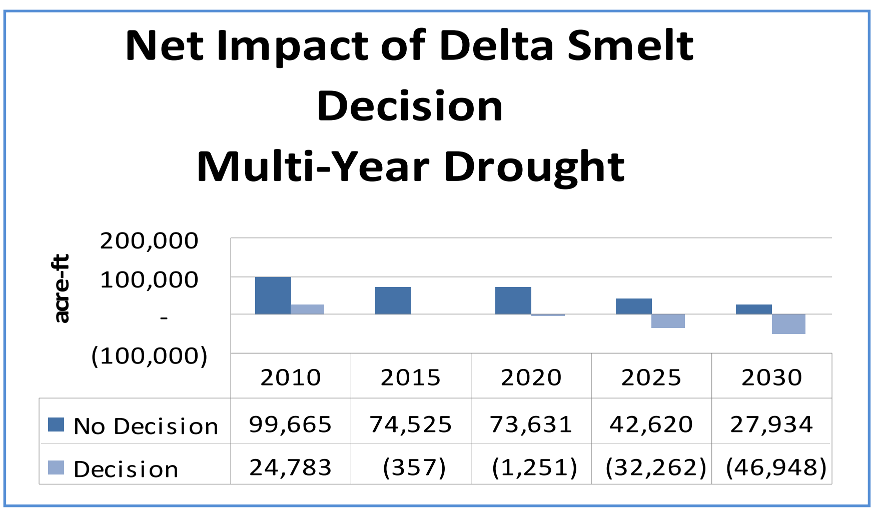
5 The State Water Project Delivery Reliability Report 2007, pp. 42 – 49.

Figure 5.1-17 Net Impact of Delta Smelt Decision on the Water Budget for the Watershed given a Single Year of Drought



Should the Delta Smelt Decision remain permanent, it will have a negative impact on water supply reliability within the Watershed. Strategies to help overcome this deficit are included in the *Management Strategies to Improve Water Supply Reliability* section.

Figure 5.1-18 Net Impact of Delta Smelt Decision on the Water Budget for the Watershed given a Multi-Year Drought



Evaluate Climate Change on Water Supplies

Temperature data suggest that California's climate is getting warmer. This phenomenon is being referred to as "Climate Change". Climate change could have an impact on water supply reliability. Potential impacts include reduction in snow pack, changes in the timing and amount of runoff, changes in the frequency and magnitude of extreme storm events, increased watershed vegetation demands due to higher evapotranspiration rates, changes in future agriculture and urban water demands, changes in sea level rise, and increased potential for salt water intrusion to the Sacramento-San Joaquin Delta and groundwater basins near the coast.

Presently, the extent of climate change impacts is uncertain. DWR has analyzed the long-term impacts of climate change on SWP deliveries in their 2007 The State Water Project Delivery Reliability Report (2007 Report)[6]. The results of the climate change analysis actually result in an increase in reliability when compared to the analysis without climate change[7]. Since it does not result in lower reliability like other scenarios analyzed in the OWOW process, it is not analyzed in this report.

Although current analysis is suggesting that climate change may not have a long-term impact on imported water supplies, there is still much uncertainty regarding this phenomenon. Realizing that this phenomenon could have long-term impacts on water supply reliability and that the exact effects are unknown, the Watershed may want to consider implementing a "contingency factor" as a management strategy. For example, a contingency factor of 10% would mean that future water supplies must exceed calculated demands by at least 10% to cover any unknown effects of climate change.

Evaluate the Impact of Quagga and/or Zebra Mussels on Water Supplies

Quagga Mussels and the closely related Zebra Mussels are small shellfish, usually less than half inch in size that can live and reproduce in pipes. When they do, they clog water systems and intake pipes causing hundreds of millions of dollars in maintenance and/or damage costs annually. Once they are established, they are very difficult to eradicate. The Quagga Mussel has been discovered in Lake Mead, the CRA, and a local reservoir in San Diego County. There is concern that Quagga Mussels could become more widespread and migrate into the watershed through untreated water pipelines or larvae carried by boats and watercraft vehicles.

Mussels can clog pipelines. Strategies to help prevent impacts from this invasive species will be provided in the *Management Strategies to Improve Water Supply Reliability* section.

Evaluate the Effects of Santa Ana River Channel Armoring and Sediment Transport

The SAR is a productive recharge "facility" that helps replenish the Watershed's groundwater basins. The transport and deposition of sediment along the SAR is critical to maintaining existing groundwater recharge capacity. A sandy river bottom allows surface water to percolate easily into the groundwater basin and maximizes recharge rates. If this process is interrupted, the amount of recharge can be reduced.

The transport and disposition of sand within the SAR is interrupted when it is trapped by both the Seven Oaks Dam and Prado Dam. Seven Oaks Dam traps sediment at the base of the San Bernardino Mountains while Prado Dam traps sediment just upstream of Orange County. This entrapment of the sand causes negative impacts on the recharge capacity of the riverbed.

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[6] State of California, The Resources Agency Department of Water Resources, The State Water Project Reliability Report 2007, August 2008, pg. 49.
[7] State of California, The Resources Agency Department of Water Resources, The State Water Project Reliability Report 2007, August 2008, compare Table 6.4 and Table 6.13.

In addition, as the sand washes away and no longer is being replaced by sand from upstream, the river bottom gradually transitions from a “soft” bottom to a coarser bottom that includes heavier material such as gravel and cobbles. The gravel and cobbles eventually interlock with fine sediments and form an “armored” layer. This process is referred to as “channel armoring,” which can reduce the recharge rate of the river. A Groundwater Recharge Study prepared by OCWD estimates that the armoring of the SAR has resulted in a loss of percolation of about 1% per year. With a long-term degradation of recharge rates, longer stretches of the river would be needed to recharge the same amount of water that is recharged today or some other kind of mitigation would be required.

Additionally, sediment loading behind the two dams can reduce surface water storage volumes. The continued build up of sediment behind the dams will reduce the overall storage capacity of the dams, which will, in turn, reduce the amount of storm flow that can be temporarily stored and released for groundwater recharge.

Channel armoring could reduce recharge rates along the SAR. Sediment transport could reduce storage volumes behind Prado Dam and Seven Oaks Dam thereby reducing the amount of stormwater that can be captured and used.

Evaluate the Effects of Water Quality Degradation on Water Supplies

Water supply reliability in the Watershed can be improved by reinstating local water resources that have been avoided due to poor water quality. For example, some groundwater basins in the Watershed have been impacted by high concentrations of salts. In the past, rather than pump and treat this poorer quality water, many groundwater producers chose to replace it with another source(s) of water that did not require treatment. This same approach also has been used in groundwater basins that were polluted by volatile, organic compounds and other contaminants. If, instead, these local resources were to be treated and used, they effectively would become “new” sources of water within the Watershed which would act to increase water supply reliability. Water supply reliability can be increased if water resources that were avoided in the past due to poorer water quality are, instead, treated and utilized.

Table 5.1-6 Summary of Water Supply Reliability Scenarios

Short-term Impacts	Long-term Impacts
Catastrophic Interruption	Average Hydrologic Conditions
Earthquake[1]	
Power outage[1]	Single-year Drought Hydrologic Conditions
Mussels[1]	
Wildfire[1]	Multi-year Drought Hydrologic Conditions
Water quality degradation	
Terrorism[1]	Climate Change[1]
	Sediment Transport[1]

1 Actual effects uncertain.

Summary of Evaluation Results

The water supply reliability scenarios that were evaluated as part of this analysis can really be broken into two general categories, short-term impacts and long-term impacts. **Table 5.1-6** summarizes the two general categories. Those in the short-term category are difficult to quantify. Those in the long-term category are more easily quantified except for climate change, sediment transport and channel armoring which are still under investigation.

A summary of the evaluation results for the average, single year drought and multi-year drought scenarios is included in **Table 5.1-7.** The *Management Strategies to Improve Water Supply Reliability* section presents various management strategies that can be used to offset any projected shortfall(s). The shortfall will primarily occur in the Upper Watershed.

Table 5.1-7 Summary of Evaluation Results with and without the "Interim" Delta Smelt Decision

Year	Average		Single Year Drought		Multi-Year Drought	
	No Decision	Smelt Decision	No Decision	Smelt Decision	No Decision	Smelt Decision
2010	111,088	86,622	212,693	145,012	99,665	24,783
2015	40,260	15,794	229,033	161,352	74,525	(357)
2020	(2,203)	(26,669)	219,139	151,458	73,631	(1,251)
2025	(55,000)	(79,466)	177,448	109,767	42,620	(32,262)
2030	(89,312)	(113,778)	141,242	73,561	27,934	(46,948)

Management Strategies to Improve Water Supply Reliability

Reliability Goal

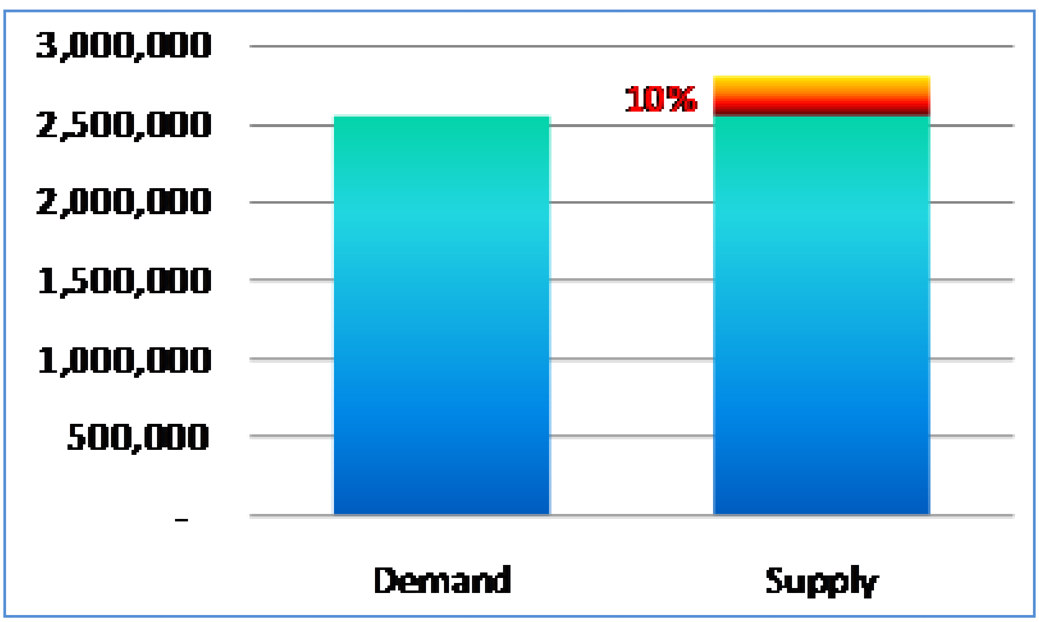
As shown in the *Evaluate Water Supply Reliability* section, the Watershed will experience an estimated deficit between supplies and demand. **Table 5.1-8** summarizes the calculated deficits for each scenario.

Table 5.1-8 Calculated Deficits based on Scenario

Scenario	Calculated Deficit
Average	114,000
Single-year drought	0
Multi-year drought	47,000
Maximum deficit	**114,000**

In addition to the above calculated deficits, there are also many uncertainties including the unknowns of future weather, the effects of climate change and any legal restrictions that could be placed on water supplies such as those restrictions placed on the State Water Project as part of the "Delta Smelt Decision". One way to prepare for these uncertainties is to develop "extra" water supply options to exceed the projected demand by a certain amount, or "contingency factor". For the OWOW process, the contingency factor was established at 10% (**Figure 5.1-19**) of the overall water budget for the watershed, or 255,000 acre-ft. The summation of the contingency amount and the maximum calculated deficit provide an overall "reliability goal" of 369,000 acre-ft above the maximum projected demand.

Figure 5.1-19 To Help Overcome Uncertainty, a 10% Contingency Factor was Established



Management Strategies

To achieve the reliability goal of 369,000 AF, the following water management strategies were developed:

Reduce Demand

- Increase water use efficiency

Optimize Imported Water

- Increase utilization of imported water
- Improve reliability of imported water

Develop new sources of supply

- Capture more stormwater
- Increase the use of recycled water
- Import treated wastewater from outside the watershed
- Desalt the Pacific Ocean

Increase storage

- Increase surface water storage
- Increase groundwater storage
- Increase water banking

Implement emergency measures

- Local emergency plans
- Mutual Aid
- System interconnections
- Extraordinary conservation

Each of the above strategies will be developed in more detail within this section.

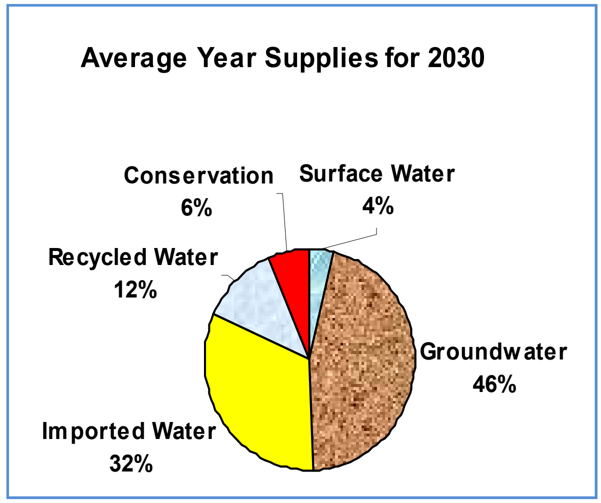
Strategies that Reduce Demand

The term "Demand management" generally is used to describe any strategy that reduces the demand for drinking water. The two main demand management strategies used in the watershed are recycled water and water use efficiency (formerly water conservation). With regard to water conservation, there are a variety of programs that have been implemented throughout the Watershed. See the Water Use Efficiency Section for an explanation of the current programs.
With regard to water recycling, the watershed, as a whole, is fairly efficient. Flows discharged in the upper and middle watershed are almost entirely re-used downstream. See the Recycled Water Section for an explanation of the current programs.

Governor's 20% reduction by 2020:

<u>*Estimated benefit: 50,000 AF*</u>

On February 28, 2008, Governor Schwarzenegger wrote to leadership of the California State Senate, outlining key elements of a comprehensive solution to problems in the Sacramento-San Joaquin Delta. The first element on the Governor's list was "a plan to achieve a 20 percent reduction in per capita water use statewide by 2020." While many of the details are still being developed, it is generally understood that the 20 percent goal can be achieved by any combination of water conservation and water recycling. Based on the water budget information for 2030, 18% of the water budget for the Watershed will be met by conservation and water recycling. Therefore, to achieve this goal, the Watershed will have to increase conservation and recycling by at least two percent, or 50,000 AF.



Water Use Efficiency (Water Conservation)

<u>Estimated benefit (over and above the 20 percent reduction by 2020 program instituted by the Governor):</u>

Water use efficiency is comprised of any technology or change in public behavior that results in lower per capita water use. Some of the water use efficiency programs in the Santa Ana River Region include financial incentives for consumers who implement new water efficient technologies, as well as public education regarding the various ways that water use can be reduced around their homes or businesses. The water budget data compiled for the OWOW process includes estimated figures for water use efficiency. However, the Water Use Efficiency Pillar estimates that these figures could increase by implementing the programs mentioned in the Water Use Efficiency Section.

The Water Use Efficiency Pillar has identified several high-priority water use efficiency strategies for further development and some that could be implemented immediately (see Water Use Efficiency Section 5.4). One of the proposed strategies is to promote the development and enforcement of water use efficiency legislation at the local, State and Federal levels. Such legislation would require new development (residential and commercial) within the Watershed to implement water use efficiency technologies. In addition to legislation, more work needs to be done to educate and encourage the public to make more efficient use of their water resources. "Tiered" water rates, which reward those who use less water, also are recommended throughout the Watershed.

Another way to save water is to reduce one of the only measurable "losses" in the Watershed, evapotranspiration. Evapotranspiration is the combined water loss associated with evaporation and transpiration. Evaporation is the movement of water to the air from the land surface and water bodies. Transpiration is the movement of water into plants and the subsequent loss of water as vapor through its leaves.

The losses associated with evaporation might be reduced by developing and implementing specific programs to increase the amount of shaded area such as planting trees or constructing shade structures. However, more analysis will be required to determine whether or not the increased water use by any new shade trees would offset any potential decrease in evaporation associated with their shade. Provided this strategy is effective, it would be most appropriate in the areas of the Watershed with the highest evaporation rates, namely the upper and middle Watershed.

The losses associated with transpiration could be reduced by developing and implementing specific programs which remove plants with higher transpiration rates such as turf grass and Arundo, wherever practical.

The *Water Use Efficiency* section of this report provides more detailed plans and programs for water use efficiency in the Watershed.

Optimize Imported Water Strategies

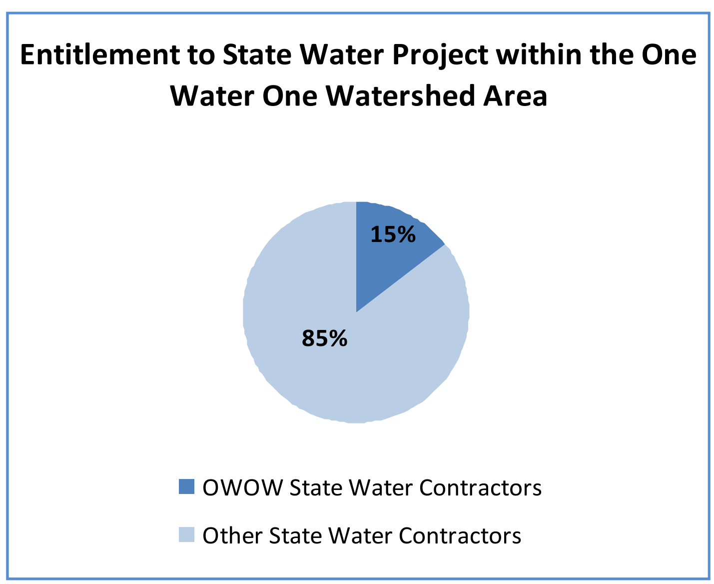
As seen in the *Evaluate Water Supply Reliability* section, the Watershed is dependent upon imported water to meet one-third of its needs into the future. However, the reliability of this source of water has proven to be less certain, at times, due to unforeseen circumstances such as the "Delta Smelt Decision" in 2007. This historic decision resulted in one of the single largest court-ordered SWP delivery reductions in state history to protect the endangered Sacramento/San Joaquin Delta smelt (fish). As a result of this and other problems in the Delta, the SWP operates below its delivery capacity. However, the Watershed may be able to implement strategies that could help offset the various uncertainties, and possibly even increase the amount of imported water available to the Watershed.

"Base Load" off of imported water

<u>Estimated benefit: 70,000 AF annually</u>

To help improve operations through the Delta, the Governor of the State of California formed the *Delta Blue Ribbon Panel* (Panel). The Panel has made recommendations that would improve operations through the Delta. One such recommendation involves the implementation of a new delivery pattern that is the opposite of the current delivery pattern. The current delivery pattern is to import less water in wet years due to lower demands and abundant local supplies and to import more water during dry years when demands are high. The current delivery pattern has resulted in unused imported water during wet years and more extreme water conservation measures during dry years when imported water is not readily available. The proposed delivery pattern would take more imported water when it is available

Figure 5.1-20 OWOW Portion of the SWP



during wet years. **Figure 5.1-21** shows that nearly 10 MAF of imported water from the SWP went unused since 1990[8], or approximately 470,000 AFY. Assuming the Watershed were able to make use of this water in a wet year and that it would get approximately 15%[9] (**Figure 5.1-20**) of the water, the overall yield of the SWP for the Watershed could be increased by as much as 70,000 AFY. It also is worthy to note that this simplified analysis does not include unused supplies from the CR system. Although this system is fully subscribed, there also may be wet years when undelivered water from the CR system also could be available.

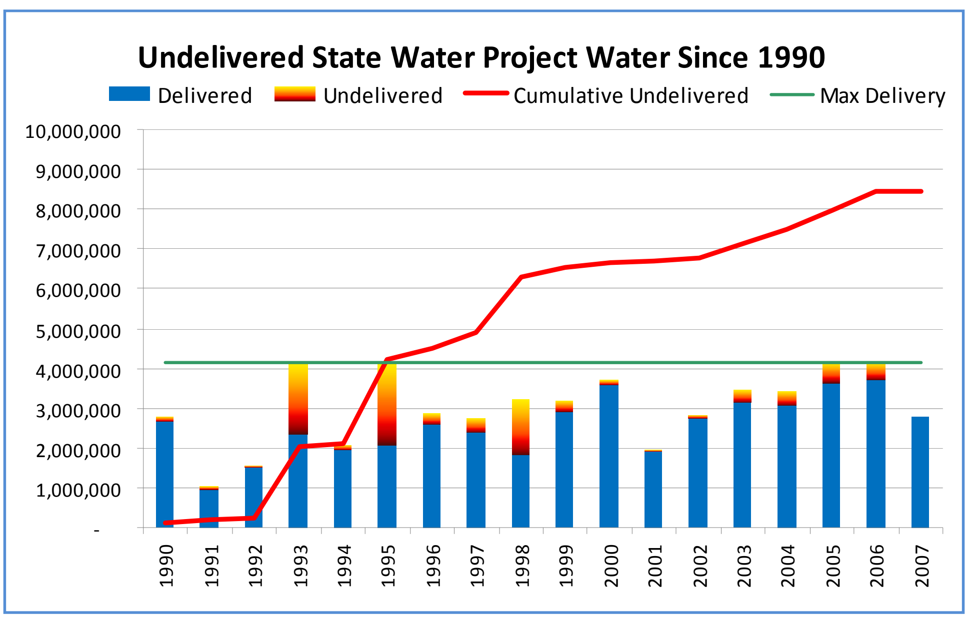
This strategy has been labeled "base loading off of imported water" because the general concept involves utilizing all imported water sources first. Since the current delivery pattern is to reduce the amount of imported water during wet years, nearly all of the water imported in a wet year can be viewed as additional yield. This strategy also could result in a change in cash flow. In wet years, more money would be spent on imported water. However, this increase in negative cash flow likely would be offset by a savings in dry years when water agencies are not forced to purchase water on the "open market" due to shortages of imported water. These open market purchases can be orders of magnitude higher than the cost of imported water.

To evaluate the feasibility of this concept, a simplified evaluation was performed to determine what facilities would be required, if any, to implement this strategy. The evaluation consisted of answering the following questions:

How much imported water can the Watershed currently put to use during a wet year? In the future?

Can the Watershed rely almost entirely on groundwater during dry years when there is less imported water available?

Figure 5.1-21 Undelivered SWP Water since 1990



[8] 1990 was the first year the Department of Water Resources had the facilities available to deliver 100% of State Water Project entitlement.
[9] Approximate State Water Project entitlement for the watershed as a percentage.

Below, **Figure 5.1-22** summarizes the answer to the first question of how much wet year imported water can be put to use currently and into the future. As seen in this figure, the watershed is not currently able to utilize all of its wet year entitlement. However, utilizing facilities that are already planned to be implemented, the watershed will be able to utilize all wet year water in the future.

This strategy assumes that the increased yield of imported water will result in more stored groundwater through artificial recharge and in lieu recharge. Therefore, the full benefit will not be realized unless there are adequate facilities to extract and deliver the stored water during drought periods.

Figure 5.1-2 The Amount of Imported Water the Watershed can put to Use in a Wet Year

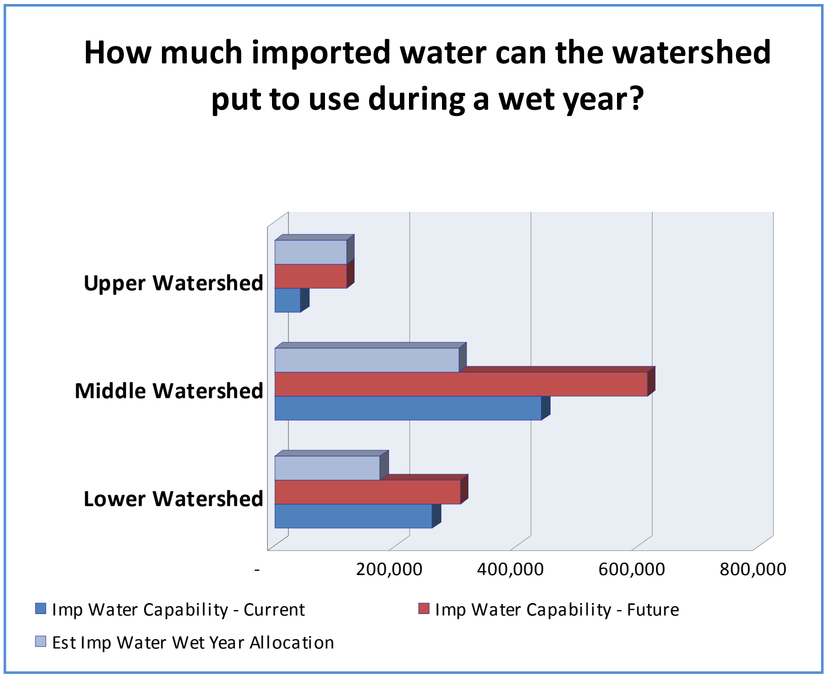
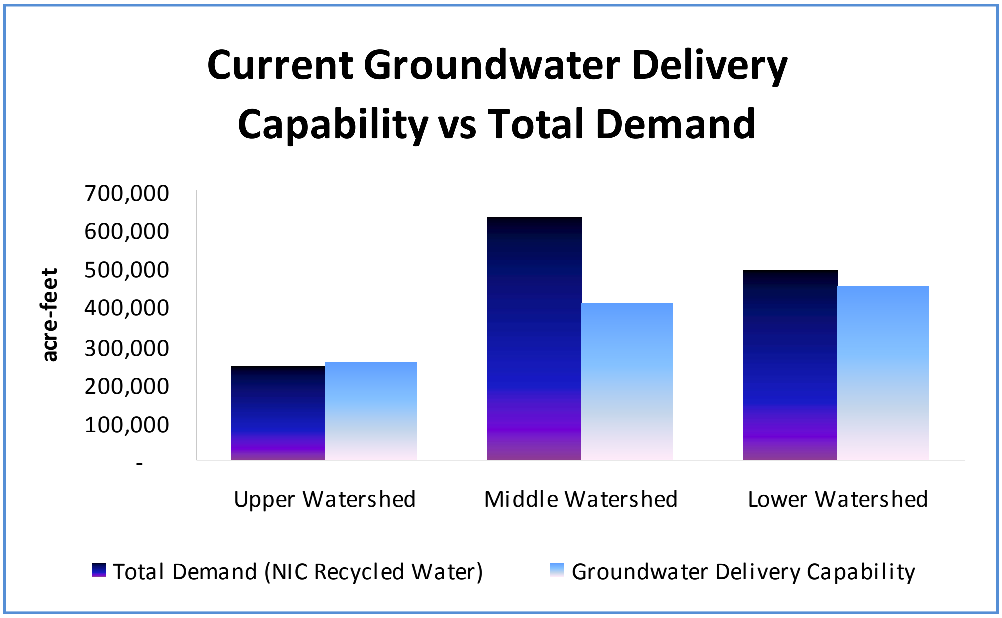


Figure 5.1-23 shows that the Upper and Lower Watershed currently have the groundwater delivery capability to meet demands during a drought year when imported water is less available. However, the Middle Watershed does not currently have the groundwater delivery capability to fully implement this strategy, and would need to increase this capability over time.

Figure 5.1-23 Current Groundwater Delivery Capability versus Total Demand



In summary, this strategy of "base loading" off of imported water appears feasible and could enhance the watershed's utilization of imported water and provide enhanced reliability during drought periods. However, to fully implement this strategy will require the construction of additional facilities to fully utilize wet year deliveries of imported water and additional groundwater delivery facilities to almost completely rely on stored groundwater during drought periods. **Table 5.1-9** summarizes the additional facilities necessary to fully implement this management strategy.

Table 5.1-9 Additional Capability Required to Fully Implement the "Base Load Off of Imported Water" Concept (AF)

	Additional Groundwater Delivery Capability	Additional Imported Water Capability
Upper Watershed	--	75,800
T	225,079	175,311
Lower Watershed	36,000	45,500

Although more facilities are required to fully implement this strategy, this strategy could be implemented on a smaller scale and then gradually increased over time.

Delta Conveyance Facility

Estimated benefit: Increased reliability

Nearly all of the reduction of imported water deliveries through the SWP is due to environmental and other problems in the Delta. The *Delta Vision Blue Ribbon Task Force* has been assigned the task to develop solutions for the Delta. One solution to help protect aquatic species while also protecting SWP deliveries (SWP deliveries are only a portion of the total flow through the Delta) is to transport them "around" the Delta in some sort of "Delta conveyance facility." Not only would this "Delta conveyance facility" protect deliveries, but it also would improve SWP water quality.

Prevent Invasive Species from Clogging Infrastructure

Estimated benefit: Improved reliability and reduced costs

Quagga Mussels and the closely related Zebra Mussels are small shellfish, usually less than half inch in size. Once only found in the Great Lakes, the Quagga Mussel has now been discovered in Lake Mead, the CRA, and a local reservoir in San Diego County. They will live and reproduce in pipes causing them to clog. Once they are established, they are very difficult to eradicate. Quagga Mussels can be controlled by super chlorination and drying out, sometimes requiring the temporary drawing down of water supplies. The additional maintenance costs associated with controlling these mussels could cost tens of millions of dollars a year. There is concern that Quagga Mussels could become more widespread and migrate into the Watershed through untreated water pipelines or larvae carried on boats and other watercraft. The Watershed should participate in any programs, such as the one initiated by MWDSC, which target the prevention of these species from entering water infrastructure.

Develop New Sources of Supply Strategies

One way to directly improve the water supply reliability for the Watershed is to identify and develop "new" sources of water supply. The following are opportunities to develop new supplies for the watershed.

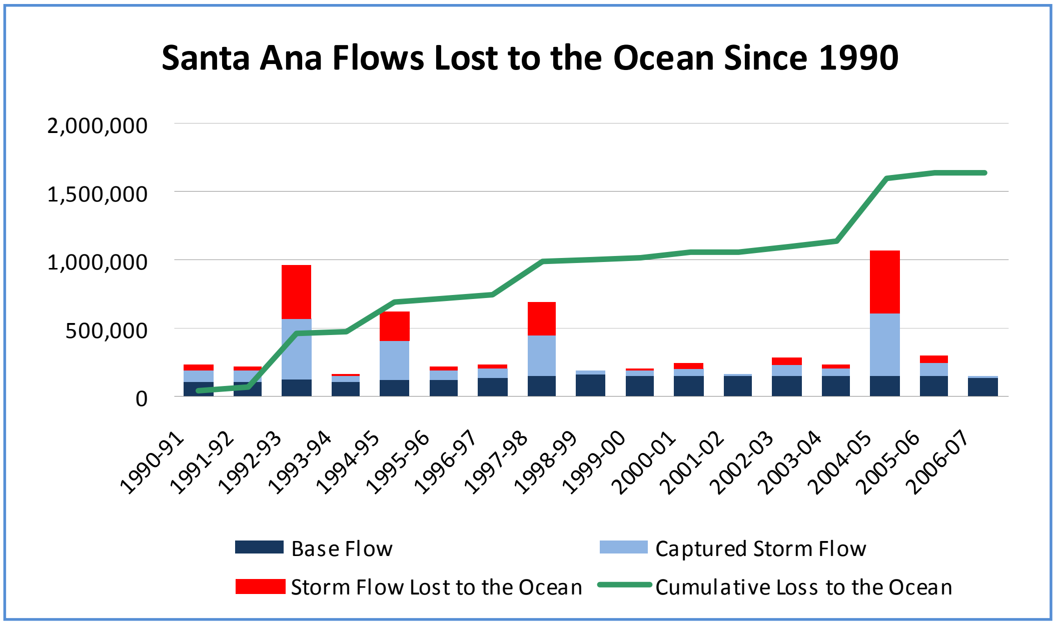
Capture and use more stormwater.

Estimated benefit: 25,000 AFY

As seen in **Figure 5.1-4**, in addition to the SAR, there also are a large number of tributaries to the SAR, each of which convey stormwater. Because this water originates in the mountains, it can be diverted relatively high in elevation allowing it to be delivered by gravity which saves energy costs. In addition to the low energy cost, this water also is very high quality, which helps the Watershed achieve both surface water and groundwater quality objectives established by State and Federal agencies. Therefore, the Watershed should work toward implementing strategies which increase the diversion and use of more stormwater.

Capturing stormwater runoff within the Watershed presents an interesting challenge due to the "flashy" hydrology. **Figure 5.1-24** shows how much stormwater has gone to the Pacific Ocean over the past 16 years. As the figure shows, most of the uncaptured flow came during "flood" years when it was nearly impossible to capture. However, if these flood years are removed, there is still an opportunity to capture approximately 25,000 AF annually. Water agencies have identified a number of strategies to increase the capture of stormwater.

Figure 5.1-24 Stormwater Flow Lost to the Ocean since 1990



One strategy for capturing more stormwater involves working with flood control agencies to re-operate flood control facilities with the goal of increasing stormwater capture. For example, when weather forecasts do not show any impending storms, the flood control agencies may be able to release stormwater at a slower rate. This relatively minor operational change would make stormwater flows easier to capture and put to use. It also would result in impounding the water longer, which would increase artificial recharge during the "holding period".

Another way to increase stormwater capture would be to work with flood control agencies to increase the size of existing, or new, detention basins. Larger detention basins would slow the flow and increase the recharge area, which would increase the amount of stormwater that is artificially recharged. In addition to this increased recharge, the larger basins also would provide greater flood protection. A related strategy would be to construct additional surface water reservoirs within the Watershed. Unlike detention basins, which need to be drained every year before the flood season, surface water reservoirs provide the added flexibility of allowing the water to be stored until it is needed. In addition, surface water reservoirs also provide a storage location(s) for other sources of water such as imported water. Although effective, both of these strategies would be viable only in areas of the Watershed that have vacant land.

Another strategy to increase stormwater capture would be to implement new development standards that promote the construction of infrastructure that increases the infiltration of stormwater such as porous concrete, infiltration galleries, and perforated pipelines. These facilities could be implemented in public areas such as parking lots, schoolyards, parks and greenbelts, as well as private areas, by establishing a requirement in local development codes.

Recycled Water Strategies

Treating and reusing wastewater, referred to as "recycled water", provides one of the most reliable sources of water in the Watershed. Wherever recycled water can be put to use, it effectively replaces a like amount of potable water. Over the years, the Watershed has seen significant accomplishments in the development of recycled water. In fact, at present, nearly all of the recycled water from the upper and middle Watershed is being discharged into the SAR and is being reused at various locations downstream. In the future, the upper and middle Watershed plan to develop enhanced recycling programs that could change the place of use for much of this resource. Should enhanced recycling occur in the upper and middle Watershed, it would reduce the amount of recycled water flowing to the lower Watershed. This likely would result in the lower Watershed increasing local recycling programs (see *Recycle sewage effluent from Orange County Sanitation District Plant No. 1/Plant No. 2 that is currently flowing to the ocean* below), increasing conservation measures, desalting the ocean and/or purchasing more imported water. Another alternative might be for the upper, middle and lower Watersheds to enter into some form of agreement to keep some recycled water flows in the SAR. Under this alternative, the upper and middle Watershed would continue to discharge recycled water to the SAR for delivery downstream, by gravity. The lower Watershed would then provide a "replacement" source, of like quantity and reliability, to the upper and middle Watershed. Although many details would need to be worked out, such a concept could potentially save the Watershed a significant amount of money in capital costs and energy costs.

Recycle sewage effluent from Orange County Sanitation District Plant No. 1 that is currently flowing to the ocean.

Estimated benefit: Approximately 85,400 AFY

As presented in the Recycled Water Chapter of this report, by 2030 the Orange County Sanitation District expects to "dispose" of 84,500 AF of effluent into the ocean each year from its Plant No. 1. This effluent could be treated and used for a variety of purposes including the offset of any reduction in recycled water flows to the Lower Watershed due to recycling in the Upper and Middle Watersheds.

Recycle sewage effluent from Orange County Sanitation District Plant No. 2 that currently is flowing to the ocean.

Estimated benefit: 151,200 AFY

As presented in the Recycled Water Chapter of this report, by 2030 the Orange County Sanitation District expects to "dispose" of 151,200 AF of effluent into the ocean each year from its Plant No. 2. However, based on current Department of Public Health (DPH) requirements, this water cannot be recycled because it includes the effluent from the Santa Ana Regional Interceptor (SARI) pipeline which contains discharges from the Stringfellow Hazardous Waste Site, and other sources that would require further characterization by DPH. The Watershed should consider working with DPH on a strategy that would allow this effluent to be recycled.

Importation of recycled water from outside the Watershed

Estimated benefit: Requires more investigation

There may be opportunities to import recycled water from outside the Watershed. Any recycled water imported into the watershed would be viewed as a new supply.

Desalt the Pacific Ocean

Estimated benefit: 70,000 AFY

The lower Watershed has an abundant water source that includes a high concentration of salt which is better known as the Pacific Ocean! While ocean desalination generally is considered technically and institutionally feasible, it also is subject to significant regulatory scrutiny depending upon the environmental impact of the specific project. It also requires significant energy that is costly. Over the last five years, a number of water agencies have been investing significant effort and funds in ocean desalination program development work. There are currently two sites along coastal Orange County that have completed extensive exploratory work and permit approvals to construct desalination facilities:

Dana Point Ocean Desalination Project

- Estimated Cost: $136 million
- Estimated Supply: 16,000 AFY
- Estimated Unit Cost: $1,287 per AF
- End Use: Drinking water
- Anticipated Construction: 2013-2015 timeframe.

Poseidon Resources Huntington Beach Desalination Project

- Estimated Cost: $300 million
- Estimated Supply: 55,000 AFY
- Estimated Unit Cost: $950 per AF
- End Use: Drinking water
- Anticipated Construction: Currently in permitting phase

The cost of this water is significantly more expensive than any other current source of supply. As treatment methods improve, treating this abundant source of water may become more cost effective which could significantly enhance overall water supply reliability in the Watershed.

Increase Storage

In general, the hydrology for the watershed can be characterized by a short series of wet years followed by a longer series of dry years. When the wet years come, they tend to be really wet, or "flood" type years. Thus, a fundamental water management challenge for the State and the watershed is to capture the water during wet years, when it is plentiful, and store it for later use during dry years. The water may be stored in surface water reservoirs or the groundwater basins within the Watershed.

Surface Water Storage

Estimated benefit: water supply following an emergency, increased reliability during drought (related to "base load" concept)

As shown in **Table 5.1-1**, the Watershed is fortunate to have a number of surface water reservoirs. However, additional surface storage space would allow the capture of additional stormwater and "unused" imported water. Not only do surface water reservoirs provide a location to store water when it is available, but they also enhance reliability during a disaster. Therefore, the Watershed should work toward increasing surface water storage both inside and outside the region. Due to the fast development within the Watershed, the number of potential reservoir sites inside the Watershed continues to diminish every year. Potential surface storage opportunities outside of the Watershed would include any additional reservoirs constructed as part of the SWP and/or the CRA.

Groundwater Storage

In addition to additional surface water storage, the Watershed also should pursue the utilization of any unused groundwater storage both inside and outside the Watershed. Like a surface water reservoir, these underground reservoirs provide a place to store wet year supplies for later use during extended drought periods. The following management strategies would enhance groundwater storage:

"Base Load" off of imported water (see Optimize Imported Water Strategies)

This concept was presented under *Optimize Imported Water Strategies* and involves importing all available imported water. The net effect of this strategy is to increase groundwater storage which later would be available during drought periods.

Utilize unused groundwater capacity within the watershed

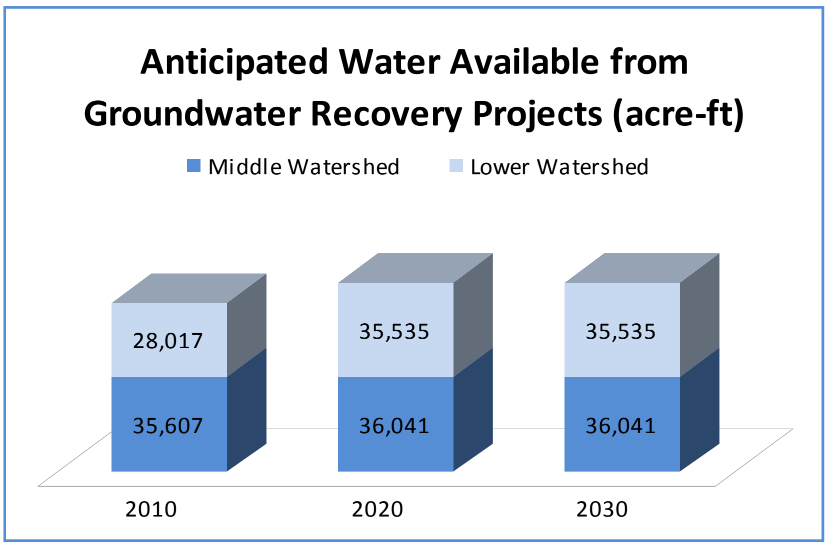
Estimated benefit: increased reliability during drought (related to "base load" concept)
Figure 5.1-4 provides an estimate of the amount of unused groundwater storage capacity in the Watershed. Regardless of the source, the Watershed should work collectively toward filling this unused capacity with wet year water that could then be used during drought years.

Recover "tainted" groundwater (salt, contaminants, color, odor, etc.) basins within the Watershed

Estimated benefit: 70,000 AFY

Some groundwater basins in the Middle and Lower Watershed have been abandoned or have not been fully utilized due to high salt content, contamination, color, odor or some other concern. Projects to pump and treat water in these basins, or portions thereof, provide restoration of groundwater storage that may not have been historically available for municipal use. In addition to recovering this groundwater storage space, it also could result in additional groundwater yield. **Figure 5.1-25** shows the anticipated amount of water that the Watershed is anticipating from groundwater recovery projects.

Figure 5.1-25 Anticipated Water Available from Groundwater Recovery Projects



Pursue groundwater storage opportunities outside the watershed.

Estimated benefit: increased reliability during drought (related to "base load" concept)

Although the Watershed has a significant amount of unused groundwater storage, it may not be easily accessible to the entire Watershed. In some cases, it may be more efficient to participate in a groundwater storage opportunity outside the Watershed. These storage opportunities are often referred to as "water banks" and are located throughout the State. Both the upper and lower Watersheds have plans to utilize water banks as storage locations for water available during wet years.

Emergency Measures Strategies

Estimated benefit: Improved recovery time following a disaster

Despite careful planning, there will still be catastrophic events and unforeseen circumstances. Although the timing and extent of such events or circumstances are unknown, the following strategies will help the watershed prepare for the unknown.

Local Emergency Plans

Each of the water agencies within the Watershed must have an emergency plan that complies with both the Standardized Emergency Management System (SEMS) and the National Incident Management System (NIMS).

Mutual Aid and Coordination

All of the water agencies should have mutual aid agreements in place. One mutual aid option used by many of the water agencies is to join the California Water/Wastewater Agency Response Network (CalWARN), www.calwarn.org. CalWARN provides a "standard" mutual aid agreement, and also maintains a database of personnel and equipment that could be made available during an emergency. It is recommended that each of the water agencies in the Watershed join CalWARN and "upload" their personnel and equipment data. In addition to participating in mutual aid agreements, the water agencies also may want to consider additional coordination with one another through a regional group. Two such groups already have been formed in the Watershed: Water Emergency Response Organization of Orange County (WEROC), and the Emergency Response Network of the Inland Empire (ERNIE). Water agencies should consider partnering with one of these groups or, perhaps, forming an additional group, if necessary.

System Interconnections

Wherever possible, water agencies should pursue interconnections to increase redundancy and provide aid during an emergency situation.

Extraordinary Conservation

"Extraordinary" conservation would be required following an extreme catastrophic event such as an earthquake. In these situations, the only way demands can be met is by asking the public to implement extraordinary conservation measures such as halting all outside irrigation, limiting the frequency of bathing, etc. In the upper Watershed, outside uses account for nearly 70% of water use. Thus, this type of extreme conservation could reduce demands in the upper watershed by the same amount.

Water Management Strategies

Table 5.1-10 summarizes the estimated benefits of the various management strategies developed in the OWOW process. In those cases where there is not enough information to adequately quantify the benefit; it has been labeled "more investigation".

Table 5.1-10 Summary of Water Management Strategies and Estimated Benefits

No.	Strategy (in no particular order)	Estimated Benefit (AFY)
1	Comply with 20% reduction by 2020	50,000
2	Increase Water Use Efficiency	More investigation
3	Reduce Evapotranspiration	More investigation
4	Base Load off imported water	70,000
5	Construct Delta Conveyance Facility	More investigation
6	Capture more stormwater	25,000
7	Recycle wastewater flowing to the ocean	215,000
8	Recycle the Santa Ana Regional Interceptor Effluent	38,000
9	Import recycled water from outside the watershed	More investigation
10	Ocean Desalination	70,000
11	Recover Tainted Groundwater Basins	70,000
12	Increase Storage (surface and groundwater)	More investigation
13	Water Banking (outside the watershed)	
14	Emergency Measures	Preparation for catastrophic event
	TOTAL	**538,000**

Even without quantities for the strategies labeled “more investigation”, the estimated annual benefit of the management strategies greatly exceeds the reliability goal of 369,000 AF. However, given the uncertainty of future hydrologic conditions and other unknowns, it is strongly recommended that most, if not all, of the above strategies be implemented to further improve reliability in the Watershed and, perhaps, even the State. The data suggests that the deficit will not occur until 2020, which means there is time to fully develop those strategies that require more development.

Figure 5.1-26 shows that each of these strategies helps to overcome the anticipated vulnerabilities of each scenario. Therefore, implementation of one, or more, of the listed strategies is not dependent upon overcoming a particular scenario. All of the strategies will help in all of the scenarios.

Figure 5.1-26 Which Management Strategies Apply to the Various Reliability Scenarios

Management Strategies	Scenarios Average	Drought	Climate Change	Other Shortages	Disaster
Reduce Demand	•	•	•	•	•
Optimize Imported Water	•	•	•	•	•
Develop New Sources of Supply	•	•	•	•	•
Increase storage	•	•	•	•	•
Emergency Measures	•	•	•	•	•

A summary of agreements, judgments, and compacts regulating water use can be found in Chapter 4.

References

EMWD 2005 Urban Water Management Plan
IEUA 2005 Urban Water Management Plan
MWDOC 2005 Urban Water Management Plan
SBVMWD 2005 Urban Water Management Plan
WMWD 2005 Urban Water Management Plan
SAWPA – Maps from Various Documents
SAWPA 2002 IRP

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