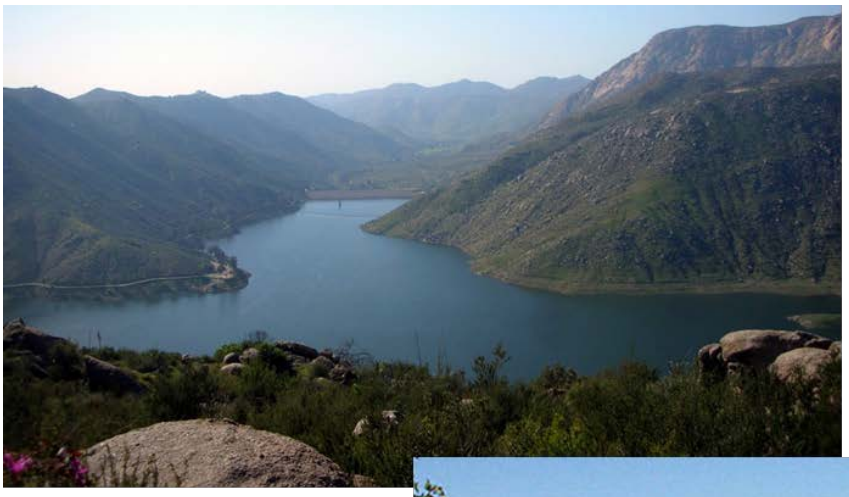
RECLAMATION

Managing Water in the West

San Diego Watershed Basin Study

Task 2.1 – Water Supply and Demand Projections Interim Report



U.S. Department of the Interior
Bureau of Reclamation

City of San Diego
Public Utilities Department

March 2016

Mission Statements

The mission of the City of San Diego Public Utilities Department is to ensure the quality, reliability, and sustainability of water, wastewater and recycled water services for the benefit of the ratepayers and citizens served.

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Cover Photo: Clockwise from top left: Hodges Reservoir facing west; Lake Miramar facing west; the City of San Diego's Advanced Water Purification Demonstration Facility at the North City Water Reclamation Plant; and Lake Murray facing north.

San Diego Watershed Basin Study

Task 2.1 – Water Supply and Demand Projections Report

March 2016

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Contents

Figures

Tables

Acronyms and Abbreviations

AF	acre-foot (1 AF = 43,560 cubic feet).
AF/y	acre-feet per year
Cal Am	California American Water
cfs	cubic feet per second
CVWD	Coachella Valley Water District
DWR	California Department of Water Resources
ESP	Emergency Storage Project
IRWM	Integrated Regional Water Management
MGD	Million Gallons per Day
MWD	Metropolitan Water District of Southern California
QSA	Quantification Settlement Agreement
Reclamation	United States Department of the Interior, Bureau of Reclamation
RWMG	Regional Water Management Group
SANDAG	San Diego Association of Governments
SBX7-7	Senate Bill X7-7, the Water Conservation Act of 2009
SDCWA	San Diego County Water Authority
SDPUD	City of San Diego Public Utilities Department
STAC	Stakeholder Technical Advisory Committee
UWMP	Urban Water Management Plan

Glossary

Fiscal Year (SDCWA): The 12-month period from July 1, for any given year, through June 30 of the following year. The fiscal year is designated by the calendar year in which it ends. Thus, the year ending June 30, 1999 is called the "1999" fiscal year.

IRWM Program: A California DWR program for supporting water resources planning under the Regional Water Management Planning Act (SB 1672). Integrated Regional Water Management (IRWM) is a collaborative effort to manage all aspects of water resources in a region. The fundamental principle of IRWM is that regional water managers, who are organized into regional water management groups (RWMGs), are best suited and best positioned to manage water resources to meet regional needs.

San Diego Basin Study Area: The area bounded on the north, west, and south by the San Diego County boundary and on the east by the boundaries of 11 Study Watersheds. The Study Area is the same as the San Diego IRWM Region

Study Watersheds: The entirety of the San Luis Rey, Carlsbad, San Dieguito, Peñasquitos, San Diego River, Pueblo, Sweetwater, and Otay watersheds and the portions of the San Juan, Santa Margarita, and Tijuana watersheds within San Diego County.

Urban Water Management Plans: Plans prepared by California's urban water suppliers every five years to meet the requirements identified in the California Water Code, Sections §10608– 10656 and submitted to the Department of Water Resources (DWR). Every urban water supplier that either provides over 3,000 acre-feet of water annually, or serves more than 3,000 urban connections is required to assess the reliability of its water sources over a 20-year planning horizon, and report its progress on 20% reduction in per-capita urban water consumption by the year 2020, as required in the Water Conservation Bill of 2009 SBX7-7.

Watershed: Surface drainage area upstream of a specified point on a watercourse. A geographical portion of the Earth’s surface from which water drains or runs off to a single point.

Water Year: The 12-month period from October 1, for any given year, through September 30 of the following year. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 1999 is called the "1999" water year.

Executive Summary

Study Objective

The purpose of the San Diego Basin Study (Basin Study) is to determine potential climate change impacts on water supplies and demands within the San Diego region. The intention of Task 2.1 is the characterization of existing and projected water supply and demand within the Study Area. This Interim Report (report) describes the methodologies and findings for this Task.

Water Demand

Demand for water in the San Diego County Water Authority (SDCWA)'s service area falls into two classes of service: municipal and industrial (M&I), and agricultural. In fiscal year 2015, total demand was 539,361 AF of which 92% was for M&I uses and 8% was for agricultural uses (San Diego County Water Authority, 2015).

Water demand projections for 2015-2035 were extracted from SDCWA's normal year water demand projections as documented in the 2010 Urban Water Management Plan (San Diego County Water Authority, 2011). These demands were then extended to 2050 based on regression analysis using population projections for each of the SDCWA member agencies as calculated by the San Diego Association of Governments (SANDAG). Total water demands are projected to increase by 26% between 2015 and 2050 as a result of the projected increases in population. Water demand projections for individual SDCWA member agencies vary from 8% to 55% increase (except for Camp Pendleton Marine Corps Base, with zero increase).

Water Supply

Water supply for the San Diego region comes from two types of sources: local supplies and imported supplies. Local supplies include surface water runoff, groundwater, recycled water, and ocean desalination, and have historically made up approximately 13% of the water supply (San Diego County Water Authority, 2011; San Diego County Water Authority, 2012; San Diego County Water Authority, 2013; San Diego County Water Authority, 2014; San Diego County Water Authority, 2015). Imported supplies include water from the Colorado River and the State Water Project, and have historically made up approximately 87% of the San Diego water supply.

Water supply projections were based on values in the SDCWA 2010 Urban Water Management Plan for the period 2015-2035, and extended to 2050 using regression analysis. The 2010 SDCWA UWMP indicates that under normal and single dry year weather conditions water supplies are projected to increase to meet demand, although the supply mix will change over time. The 2014-2015 supply

portfolio was 10.0% local water and 90.0% imported water. By 2050, the mix is projected to include 25% local water supplies and 75% from imported sources.

Supply-Demand Gap Analysis

Under normal year and single dry year supply and demand conditions, the 2010 SDCWA UWMP anticipated that sufficient supplies would be available to meet demands. Local supplies and transfer agreements for conserved water would be used to their full extent, and remaining demand would be supplied by purchases from MWD. For the multiple dry year analysis, supply shortages were calculated for some of the three-consecutive-dry-year cycles, even with utilization of carryover supplies designated for use in dry years. Shortages ranged from approximately 7,500 AF to 77,000 AF. Shortages occurred in four of the five-year time periods analyzed between 2015 and 2035.

1. Introduction

1.1. Study Overview and Purpose

The purpose of the San Diego Basin Study (Basin Study) is to determine potential climate change impacts on water supplies and demands within the California Department of Water Resources' (DWR) Proposition 50 Integrated Regional Water Management (IRWM) Program San Diego planning region, and to analyze structural and non-structural concepts that can assist the region in adapting to the uncertainties associated with climate change. The Basin Study will investigate potential changes to existing operating policies for regional water supply facilities (i.e. dams, reservoirs, conveyance facilities, and treatment and reclamation plants), modifications to existing facilities, and development of new facilities that could optimize the reservoir systems, and additional new water supply options including desalination and indirect potable reuse options.

The Study's two primary objectives are:

1. Determine how climate change will impact the current and future water supply portfolio of the San Diego region; and
2. Develop structural and non-structural concepts within the San Diego region that can serve as adaptation strategies to manage climate change impacts, focusing on optimizing the reservoir systems and furthering development of new water supply sources.

The Basin Study is divided into two interrelated tasks. Task 1 comprises the project management aspects of the work, while Task 2 addresses the detailed scientific, engineering, and economic analyses that will be completed to meet the study objectives. Task 2 is further divided into sub tasks numbered 2.1 through 2.6:

2.1 – Water Supply and Water Demand Projections
2.2 – Downscaled Climate Change and Hydrologic Modeling
2.3 – Existing Structural Response and Operations Guidelines Analysis
2.4 – Structural and Operations Concepts
2.5 – Trade-Off Analysis and Recommendations
2.6 – Final Report

1.2. Overview of Task 2.1

This Interim Report (report) describes the methodologies and findings for Task 2.1 – Water Supply and Water Demand Projections. The purpose of Task 2.1 is to characterize existing and projected water supply and demand within the Study Area.

This report contains an overview of current water supply and demand, an inventory of projected water supply and demand, and discussion of potential supply and demand imbalances.

The report primarily utilizes existing documents as references for projecting supplies and demands. The main source of supply and demand information was the 2010 SDCWA Urban Water Management Plan (San Diego County Water Authority, 2011). As necessary, this information was supplemented with information found in other documents such as the SDCWA Regional Facilities Optimization and Master Plan (San Diego County Water Authority, 2013) and the San Diego IRWM Plan (Regional Water Management Group, 2013). The supply and demand projection values from the 2010 SDCWA UWMP were compared to projections in Urban Water Management Plans from MWD and individual SDCWA member agencies. Due to differing assumptions, modeling techniques, and input data, projections tabulated in Urban Water Management Plans from SDCWA member agencies and MWD generally do not exactly match the SDCWA projections, although the general supply and demand trends are similar. For consistency, only the 2010 SDCWA UWMP supply values were used for this report. Analysis for the Task 2.1 report was limited to calculations that extend the projections of supply and demand to 2050. The projections contained in the 2010 SDCWA UWMP end in 2035, so the projections were extended to cover the 2015-2050 planning horizon of the Basin Study. Where references were not available to assist in projecting water supplies and demands to 2050, assumptions were made regarding how supplies and demands may reasonably be expected to change between 2035 and 2050. These assumptions were discussed and reviewed through a stakeholder process with the San Diego Basin Study Stakeholder Technical Advisory Committee (STAC).

1.3. Study Background

For more than 60 years, the San Diego area has relied on imported water as the primary source of supply for the region. Unlike other large metropolitan areas within southern California, such as those located within the Los Angeles or Santa Ana watersheds, San Diego does not have large productive groundwater basins within its borders. This is due to a number of factors including the limited geographic extent of the more productive sand and gravel (alluvial) aquifers, the relatively shallow nature of most existing alluvial aquifers, lack of rainfall and groundwater recharge, and degraded water quality resulting from human activities.

Prior to the introduction of imported water supplies to the region, surface water reservoirs served as the primary source of water supply for the region. Local surface water supplies remain an integral part of the region's supply portfolio and are currently the largest source of local supply.

With a strong military presence before, during, and after World War II, San Diego's growing population was in desperate need of water supply solutions. The

Bureau of Reclamation (Reclamation) was tasked with constructing the San Diego Project, two large diameter pipelines that connected the area to The Metropolitan Water District of Southern California's (MWD) infrastructure system, to bring in supplemental supplies from the Colorado River. The first pipeline was completed in 1947 and the second in 1954 (together known as the 'First Aqueduct'), which the San Diego County Water Authority (SDCWA) now owns and operates along with three additional large diameter pipelines (collectively, the 'Second Aqueduct') that deliver imported supplies into the region. Imported supplies from the Colorado River and State Water Project remain the region's predominant source of supply, comprising approximately 70% to 90% of the supplies utilized within the region. These imported supplies now consist of water purchased from MWD in addition to long-term transfers of up to 200,000 acre-feet per year (AF/y) of conserved water from the Imperial Irrigation District (IID) and an additional 80,200 AF/y of conserved water as a result of canal lining projects. Both the IID transfer water and the canal lining water are wheeled through MWD's conveyance facilities.

The reliability of imported water deliveries to the San Diego region is uncertain and supplies could be limited for a number of reasons, including periodic droughts in northern California and the Colorado River Basin, regulatory restrictions related to endangered species in the Bay-Delta that limit State Water Project deliveries, the potential for catastrophic events, such as earthquakes, and climate change. While SDCWA and its member agencies have taken steps through the development of local supplies to diversify the region's supply portfolio, the region remains highly reliant on imported water sources. To meet current and future water supply reliability goals, it is essential that the region evaluate its existing system and develop concepts to improve the ability to store imported and local water supplies when available and develop new water supplies, making the region more resistant to drought, climate change, and water delivery service interruptions.

1.4. Study Area

The Study Area (Figure 1) for the Basin Study is the same as the San Diego IRWM region boundary. The San Diego IRWM region is bounded on the north, west, and south by the San Diego County boundary and on the east by the boundaries of 11 regional watersheds. Numerous other political, management, and hydrologic boundaries exist in the San Diego region, and water in the region is managed by a variety of agencies. The region shares attributes such as overlapping municipal and water agency boundaries and a common planning purpose with major ongoing efforts such as the San Diego IRWM Plan. As a regional study, the Study Area for the Basin Study overlays a number of these agencies and boundaries.

The major political boundary of the San Diego region is the San Diego County boundary, which extends from the Pacific coastline in the west to Imperial County

in the east and from the international boundary with Mexico in the south to Orange and Riverside Counties in the north.

Management agency boundaries (Figure 2) include the SDCWA service area, which encompasses most of the western portion of San Diego County. Within the SDCWA boundary are 24 member agency boundaries. The City of San Diego is the largest SDCWA member agency, and its service area makes up approximately one-third of the SDCWA service area. Approximately 95% of the population of San Diego County is served by SDCWA (San Diego County Water Authority, 2015).

Hydrologically, the region is divided into 11 watersheds that drain the western portion of San Diego County. The two northernmost watersheds (San Juan and Santa Margarita) and the southernmost watershed (Tijuana) extend beyond the San Diego County and SDCWA boundaries. The region also includes 24 groundwater basins.

The demand scope of the Basin Study consists of the SDCWA service area, and is therefore a subset of the total demand for the San Diego IRWM region. This includes the demands served by all 24 SDCWA member agencies. The Basin Study demand scope does not include areas of the County and San Diego IRWM region that are outside of the SDCWA service area, such as people in unincorporated areas of the County whose water demands are met by individual wells.

The supply scope for the Basin Study consists of local supplies originating from the eight watersheds that are completely within San Diego County (San Luis Rey, Carlsbad, San Dieguito, Los Peñasquitos, San Diego, Pueblo, Sweetwater, and Otay) as well as the portions of the two northern watersheds (San Juan and Santa Margarita) and one southern watershed (Tijuana) that are within San Diego County. Together these watersheds are referred to as the Study Watersheds. The supply scope also includes sources of imported supply, including IID transfer water, conserved water from canal lining projects, and imported supplies from MWD from the State Water Project (California Aqueduct) and Colorado River (Colorado River Aqueduct)

Table 1. Study Watersheds

Watershed	Area (mi^2)	Major Drainages in Study Area	Groundwater Basins	Reservoirs
San Juan	496, 150 in Study Area	San Mateo Creek	San Mateo Valley, San Onofre Valley	none
Santa Margarita	750, 200 in Study Area	Santa Margarita River	Santa Margarita Valley	none

San Luis Rey	562	San Luis Rey River	San Luis Rey Valley, Warner Valley, Ranchita Town Area	Henshaw, Turner
Carlsbad	211	small stream systems draining to coast	Batiquitos Lagoon Valley, San Elijo Valley, San Marcos Area, Escondido Valley	Wohlford, Dixon, Olivenhain, San Dieguito
San Dieguito	346	San Dieguito River	San Pasqual Valley, Santa Maria Valley, San Dieguito Valley, Pamo Valley	Sutherland, Ramona, Poway, Hodges
Peñasquitos	162	small streams	Poway Valley	Miramar
San Diego River	440	San Diego River	Mission Valley, San Diego River Valley (including Santee-El Montee), El Cajon	El Capitan, San Vicente, Cuyamaca, Jennings, Murray
Pueblo	60	none	Sweetwater Valley	none
Sweetwater	230	Sweetwater River	Sweetwater Valley	Loveland, Sweetwater
Otay	160	Otay River	Otay Valley	Lower Otay (Savage Dam)
Tijuana	1750 (467 in Study Area)	Tijuana River	Tijuana, Cottonwood Valley, Campo Valley, Portrero Valley	Morena, Barrett

The facilities scope of the Basin Study includes local surface water, groundwater, and desalination facilities, treatment facilities, and facilities for storing and transporting imported water (Figure 3 and Figure 4). There are 21 surface water reservoirs located within the Study Watersheds. These reservoirs are owned and operated by a variety of agencies, including SDCWA and SDCWA member agencies. They may store local supplies and/or imported water. Groundwater facilities include wells for extracting groundwater, brackish groundwater recovery facilities, and groundwater recharge and recovery project facilities. Dry year supplemental storage purchased by SDCWA in the Semitropic-Rosamond Water Bank Authority and Semitropic Water Bank (40,000 and 30,000 AF, respectively) located in Kern County is also included in groundwater facilities. The Carlsbad Seawater Desalination Project is the only desalination facility currently in the Study Area. Facilities for imported water transportation are the First and Second San Diego Aqueducts, which deliver supplies from MWD as well as SDCWA's IID transfer and canal lining water. Both local and imported water supplies consist of raw water which must be treated prior to potable use. Water and wastewater treatment facilities within the Study area are operated by SDCWA

and/or its member agencies. There are 13 potable water treatment facilities and 38 wastewater treatment facilities (Regional Water Management Group, 2013). Within the Study Area, there are also a variety of conveyance facilities which transport water to its point of delivery. For example, the City of San Diego oversees approximately 3,300 miles of distribution pipeline delivering water to approximately 276,000 service connections (City of San Diego, 2015).

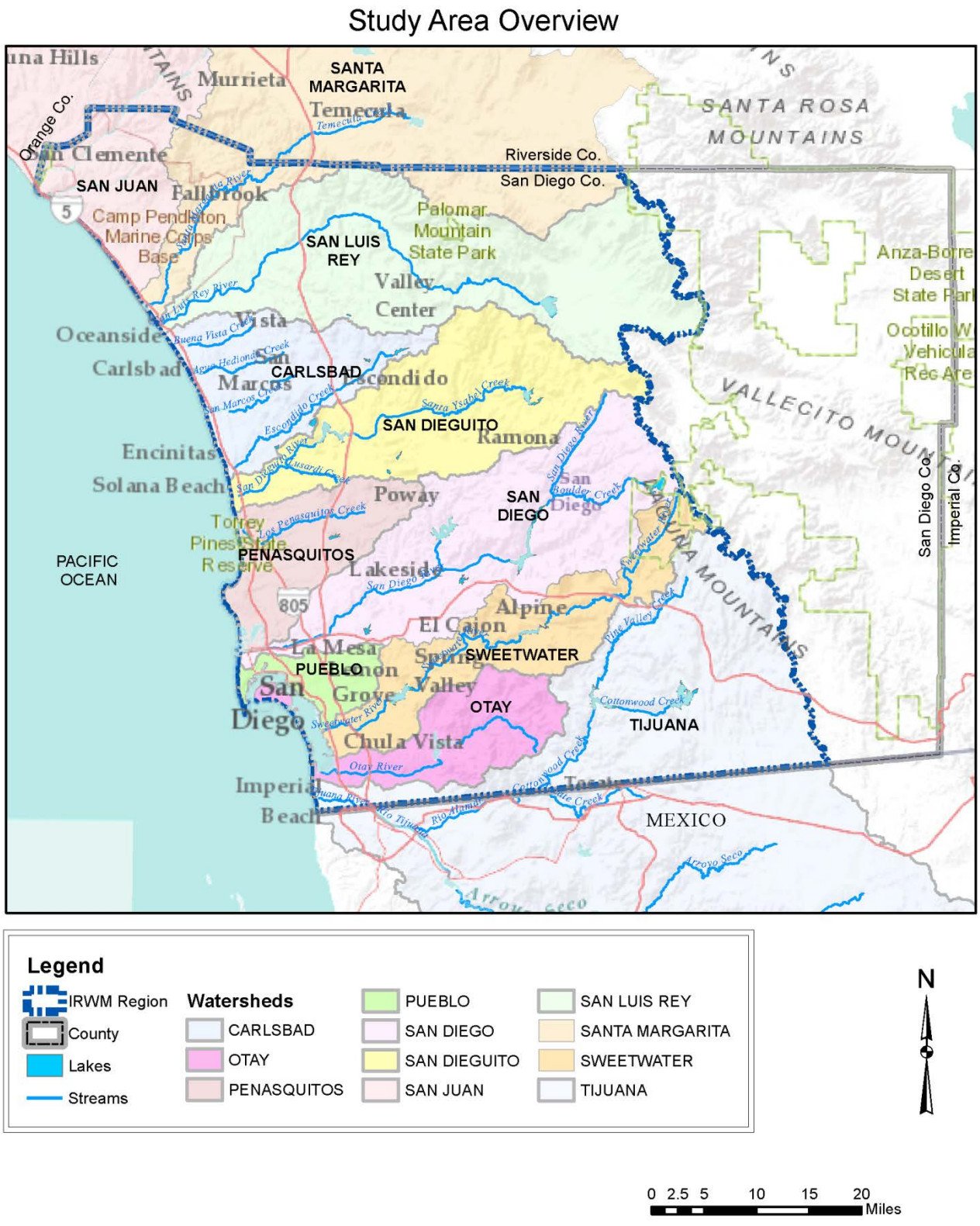

Figure 1. Overview of the San Diego Basin Study Study Area.

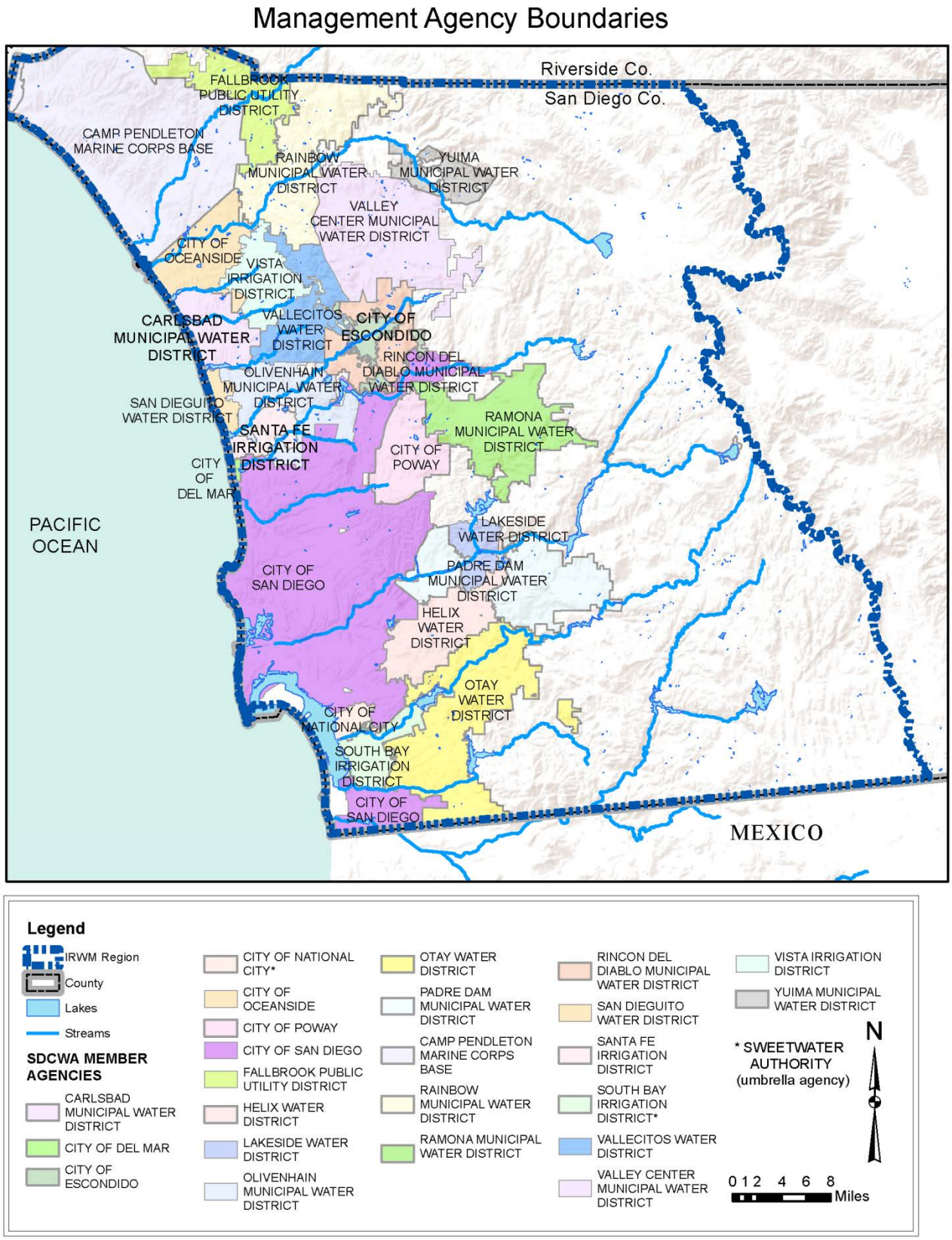

Figure 2. SDCWA member agency boundaries.

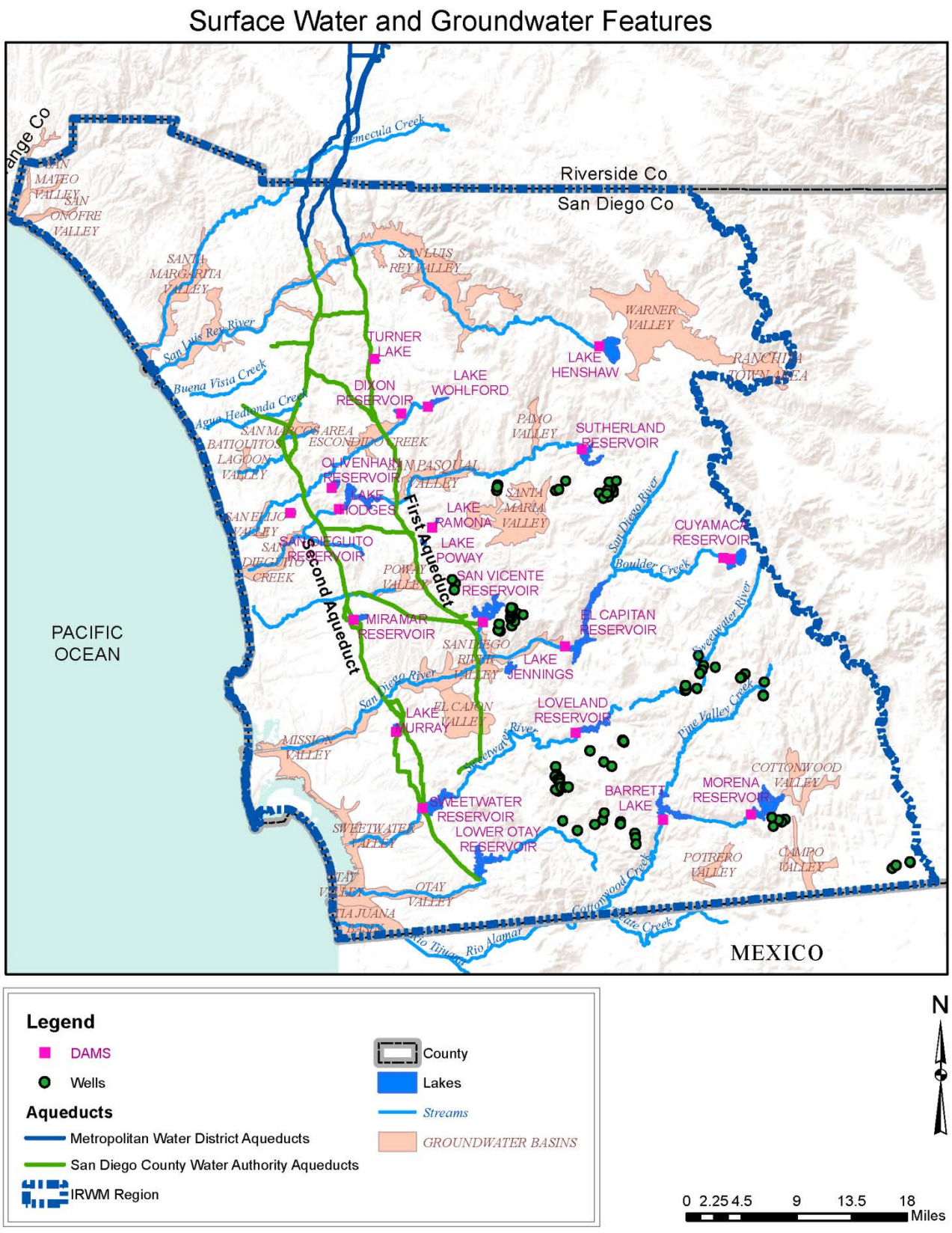

Figure 3. Surface and groundwater features in the San Diego Basin Study Area

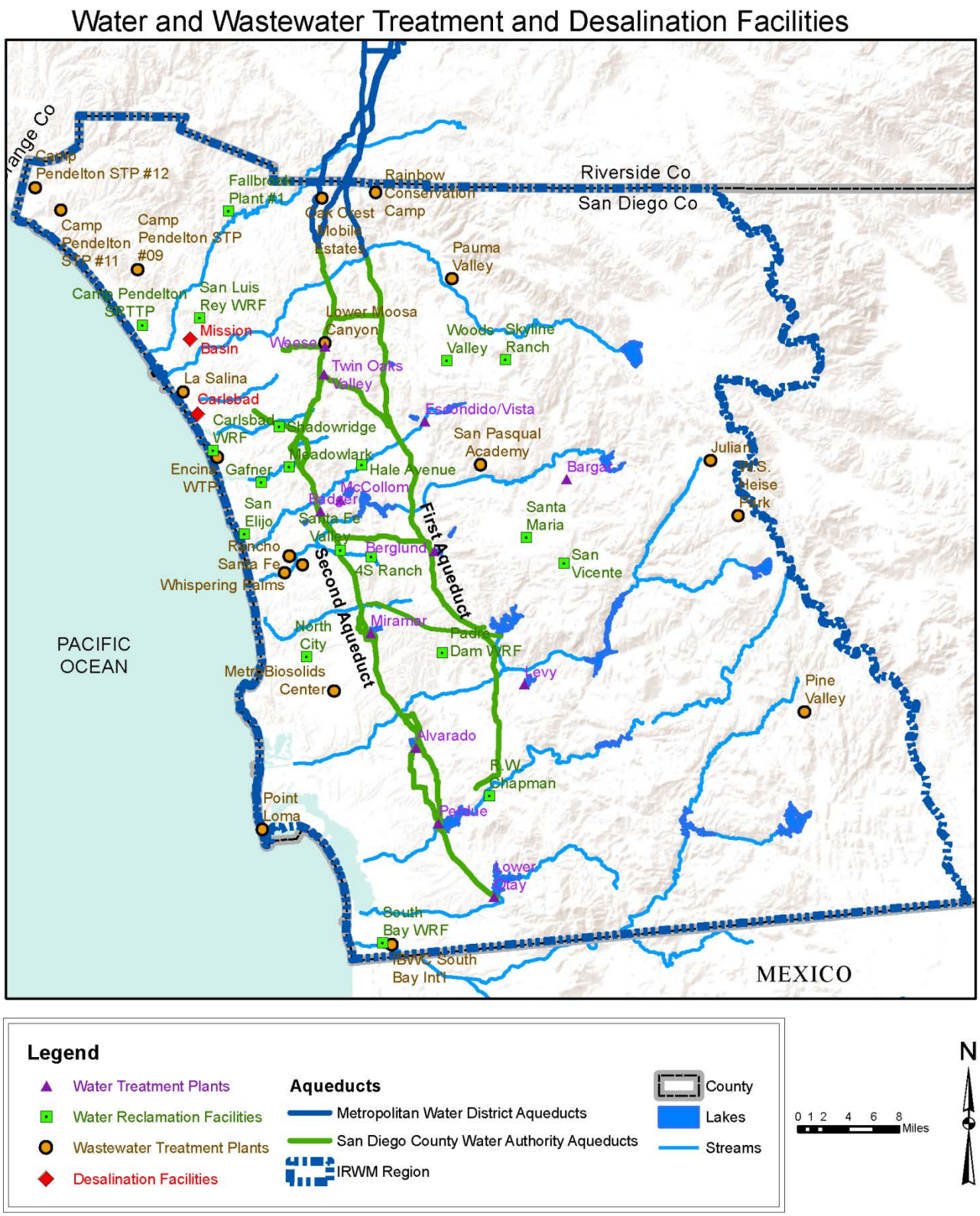

Figure 4. Water and wastewater treatment and desalination features in the San Diego Basin Study Area

2. Water Demand

2.1. Current and Future Water Demands

Demand for water in the Water Authority's service area falls into two classes of service: municipal and industrial (M&I), and agricultural. In fiscal year 2015, total demand was 539,361 AF of which 92% was for M&I uses and 8% was for agricultural uses (San Diego County Water Authority, 2015).

Agricultural demands have decreased significantly since 2007, when MWD implemented mandatory restrictions on water it sold under agricultural rates. Agricultural products produced in the San Diego region include avocados, citrus, cut flowers, and nursery products, along with crops and livestock for local markets. In fiscal year 2005, agricultural demands made up 13% of water use, while in 2015, only 8% of the total water demand was for agricultural use (San Diego County Water Authority, 2015).

Conservation measures are an important element of an agency's water resources mix. A variety of conservation programs are already underway (San Diego County Water Authority, 2011). However, as conservation measures are put into place, "demand hardening" may limit opportunities for additional conservation savings.

In the future, M&I demands are expected to grow while agricultural demands are expected to continue to decrease, leading to an even larger dominance of M&I demands in the region. Agricultural demands are projected to decrease to 6% of total demand by 2035 (San Diego County Water Authority, 2011).

Section 2.2 describes the demand projections developed for Task 2.1 of the Basin Study, which are based on 2010 SDCWA UWMP projections extended to 2050. These projections are intended to quantify one scenario of potential future demands based on input from SDCWA and its member agencies. It is important to recognize that any projection of demand has inherent uncertainty due to uncertainty in the pace of economic development, population growth, weather, and other factors affecting water demand. As part of the UWMP process, demand projections are updated every five years. The 2015 SDCWA UWMP demand projections are anticipated to be released in June 2016, and will be evaluated for potential use in later tasks of the Basin Study.

2.2. Water Demand Projections

2.2.1. 2010 SDCWA UWMP Demand Projections for 2015-2035

Water demand projections for 2015-2035 were extracted from SDCWA's normal year water demand projections as documented in the 2010 Urban Water Management Plan (San Diego County Water Authority, 2011) (Appendix A,

Table A-1). Total demand projections in the 2010 SDCWA UWMP included M&I demands, agricultural demands, and conservation required under the Water Conservation Act of 2009 (SBX7-7). Except for Camp Pendleton Marine Corps Base, SDCWA used a demand model (CWA-MAIN) to estimate municipal and industrial demands for each member agency. These estimates were based on historical water demand patterns, household income, consumer response to the price of water, and weather data. These data were compiled from the San Diego Association of Governments (SANDAG), SDCWA member agencies, and other sources. Daily weather data was compiled from National Aeronautics and Space Administration. Camp Pendleton Marine Corps Base demands were estimated based on projections provided by the Marine Corps. Agricultural demands were estimated using a separate demand model based on historical water use, crop type distribution, and irrigated acreage data. SBX7-7 conservation was incorporated based on the water use efficiency targets for each member agency.

Total projected demands for 2015-2035 for each member agency were also broken down into local and imported demand projections in the 2010 SDCWA UWMP. Projected local demands were calculated by the amount of water available from local supply types (surface water, groundwater, and recycled water). This methodology assumes that all available local supplies will be used to meet demands. The local supply sources were listed by the individual facilities supplying water to meet the demand. The supply available to meet demand from each facility and supply type was summed by member agency to obtain the total local demand by member agency. Only existing or verifiable local supplies, as defined in the 2010 SDCWA UWMP, were included. Verifiable supplies are "those supplies identified by [SDCWA] or member agencies as having achieved a level of certainty in their planning and implementation where California Environmental Quality Act has been satisfied, permits are in hand or contracts have been executed." The projected imported demands in the 2010 SDCWA UWMP were listed by member agency, and were equivalent to the difference between the total demand and the demands on local supplies.

2.2.2. Demand Projections for 2015-2050

The planning horizon of the Basin Study is 2015-2050; therefore, the demands from the 2010 SDCWA UWMP, which contained projections through 2035, were extended to 2050 as part of the analysis for the Task 2.1. Regressions of projected demand against population projections for each of the SDCWA member agencies were used to extend the demand projections. Two population datasets were available from SANDAG: Series 12 and Series 13 (SANDAG, 2013; SANDAG, 2010). The Series 12 data was released in 2010 and contained projections for 2015-2035, with a base year of 2008. The Series 13 data was released in 2015 and contained projections for 2020-2050 with a base year of 2012. The Series 13 data did not include population projections for 2015, so linear interpolation was used on Series 13 projections to estimate 2015 population for each member agency.

Because the 2010 SDCWA UWMP demands were developed using the Series 12 population projections, the total member agency demands, as calculated above, were regressed against the Series 12 population projections for each member agency (Figure 5; Appendix A, Figure A-1). Population projections were available for all member agencies except for City of National City and South Bay Irrigation District, which were grouped in the SANDAG data as Sweetwater Authority.

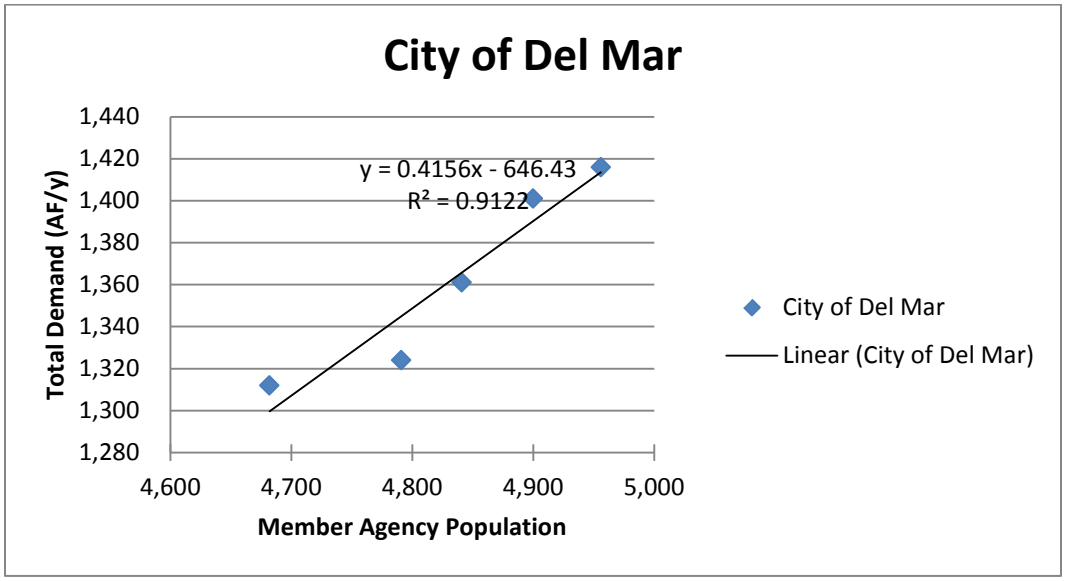

Figure 5. Example of regression between member agency population and total demand for the City of Del Mar.

Population was generally found to be a strong predictor of member agency demand, except for Camp Pendleton Marine Corps Base. Coefficient of determination (R^2) values ranged from a low of 0.05 for Camp Pendleton Marine Corps Base and 0.31 for Santa Fe Irrigation District to a high of 1.0 for City of Poway, Fallbrook Public Utility, and Sweetwater Authority. The coefficient of determination ranges between 0 and 1 and describes how well the data fit a regression model. Excluding Camp Pendleton Marine Corps Base, the average R^2 value for the member agencies was 0.90, indicating that the regressions on member agency population explained most of the variation in demand. Differences between the coefficients of determination for different member agencies may be due to differences in input data or methodology in the demand model. While some member agencies appear to correlate strongly with population projections, other agencies may be more strongly correlated with other parameters. For example, the Camp Pendleton Marine Corps Base demands in the 2010 SDCWA UWMP show a gradual increase for 2015-2035, even though population is relatively stable over the same period, which results in a poor fit for the regression.

To extend the projections of water demands from 2035 to 2050, the regressions developed using the Series 12 SANDAG data were applied to the Series 13 SANDAG data, except for Camp Pendleton Marine Corps Base (Table 2;

Appendix A, Figure A-2). For Camp Pendleton Marine Corps Base, demands were assumed to be constant at the average of the 2010 SDCWA UWMP projection values.

Based on this analysis, total water demands are projected to increase by 26% between 2015 and 2050 as a result of the projected increases in population. The largest growth is projected for the Otay Water District, with a 55% increase in demand. The City of Poway has the smallest projected increase, with a change of just 8%. Camp Pendleton Marine Corps Base showed zero increase in demand as calculated above.

Table 2. Projected Water Demands by SDCWA Member Agency 2015-2050 calculated from SANDAG Series 13 population data and regression equations developed using 2010 UWMP demands. Demands are rounded to the nearest hundred.

	Member Agency Demand (AF/y)							
	2015	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Carlsbad Municipal Water District	20,100	23,800	25,200	26,600	27,200	27,400	27,300	27,400
City of Del Mar	1,000	1,100	1,200	1,200	1,200	1,200	1,200	1,300
City of Escondido	31,600	34,900	35,600	36,700	37,400	37,600	37,700	37,500
City of National City[1]	NA	NA	NA	NA	NA	NA	NA	NA
City of Oceanside	28,700	29,600	30,400	31,100	31,300	31,500	31,400	31,500
City of Poway	12,200	12,500	12,800	13,100	13,100	13,100	13,100	13,200
City of San Diego	220,200	235,100	242,400	256,400	270,900	277,600	284,200	288,200
Fallbrook Public Utility District	15,000	15,700	17,500	17,800	17,100	17,500	17,800	18,500
Helix Water District	34,500	35,300	37,400	38,600	39,900	40,600	41,100	42,200
Lakeside Water District	5,100	5,400	5,800	5,800	5,900	5,900	6,100	6,300
Olivenhain Municipal Water District	25,600	26,100	27,200	27,600	27,900	27,800	27,800	28,000
Otay Water District	35,600	41,600	49,500	50,000	50,100	51,500	53,000	55,200
Padre Dam Municipal Water District	16,400	17,100	18,200	18,700	19,100	19,300	19,600	19,900
Camp Pendleton Marine Corps Base	12,700	12,700	12,700	12,700	12,700	12,700	12,700	12,700
Rainbow Municipal Water District	21,600	23,400	25,800	26,500	27,200	27,200	27,300	27,700
Ramona Municipal Water District	10,800	11,300	12,400	12,900	12,700	13,100	13,400	13,400
Rincon del Diablo Municipal Water District	9,700	10,700	12,100	12,300	12,400	12,300	12,300	12,200
San Dieguito Water District	7,300	7,500	7,700	7,800	7,800	8,000	8,100	8,100
Santa Fe Irrigation District	11,700	12,000	12,300	12,400	12,600	12,800	12,800	13,000
South Bay Irrigation District[1]	NA	NA	NA	NA	NA	NA	NA	NA
Sweetwater Authority[1]	22,200	22,500	22,500	23,600	25,200	26,200	27,100	28,200
Vallecitos Water District	16,600	18,200	19,900	20,300	20,400	21,200	21,200	21,100
Valley Center Municipal Water District	32,000	33,400	35,400	35,900	36,000	36,400	36,700	37,400
Vista Irrigation District	20,200	20,600	21,800	23,500	23,900	25,200	26,000	26,500
Yuima Municipal Water District	3,200	3,400	3,800	3,900	3,800	3,900	3,900	3,900
Total	**613,900**	**653,800**	**689,400**	**715,500**	**735,700**	**750,100**	**761,800**	**773,400**

[1]City of National City and South Bay Irrigation District make up the Sweetwater Authority

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3. Water Supply

Water supply for the San Diego region comes from two types of sources: local supplies and imported supplies. Local supplies include surface water runoff, groundwater, recycled water, and ocean desalination. These supplies have historically made up approximately 13% of the water supply (Table 3). . Local supplies are managed and distributed by SDCWA or its member agencies. Imported supplies have historically provided approximately 87% of the San Diego water supply (Table 3). These supplies include water from the Colorado River and the State Water Project. These supplies are purchased by SDCWA from MWD or transferred by MWD to SDCWA.

Table 3. SDCWA Historical Water Supply.

Fiscal Year[1]	Total Regional Supply (calculated) (AF/y)[2]	SDCWA Imported Supply (AF/y)	Member Agency Local Supply (AF/y)	Percent Imported	Percent Local
1999-2000	694,995	580,118	114,877	83.5%	16.5%
2000-2001	646,387	564,140	82,247	87.3%	12.7%
2001-2002	686,529	615,572	70,957	89.7%	10.3%
2002-2003	649,622	586,849	62,773	90.3%	9.7%
2003-2004	715,763	666,008	49,755	93.0%	7.0%
2004-2005	644,845	573,048	71,797	88.9%	11.1%
2005-2006	687,253	576,620	110,633	83.9%	16.1%
2006-2007	741,893	661,309	80,584	89.1%	10.9%
2007-2008	691,932	608,903	83,029	88.0%	12.0%
2008-2009	644,000	555,789	88,211	86.3%	13.7%
2009-2010	566,444	494,960	71,484	87.4%	12.6%
2010-2011	526,945	416,844	110,101	79.1%	20.9%
2011-2012	542,438	439,552	102,886	81.0%	19.0%
2012-2013	594,536	505,985	88,551	85.1%	14.9%
2013-2014	573,901	480,048	93,853	83.6%	16.4%
2014-2015	539,361	485,162	54,199	90.0%	10.0%
Average	**634,178**	**550,682**	**83,496**	**86.6%**	**13.4%**

[1] Values for Fiscal Year 1999-2000 through 2010-2011 are adapted from Table 3-12 of the San Diego IRWM Plan (Regional Water Management Group, 2013). Values for Fiscal Year 2011-2012 through 2014-2015 were extracted from SDCWA's annual reports (San Diego County Water Authority, 2011; San Diego County Water Authority, 2012; San Diego County Water Authority, 2013; San Diego County Water Authority, 2014; San Diego County Water Authority, 2015).

[2] The Total Regional Supply is the sum of the SDCWA Imported Supply and the Member Agency Local Supply.

3.1. Current and Future Water Supply Sources

3.1.1. Local Supplies

Local supplies include surface water runoff, groundwater, recycled water, and ocean desalination. Together, these supplies make up approximately 13% of the region's supply (Table 3).

3.1.1.1 Surface Water Runoff

Water supply from surface water runoff in the Study Watersheds is limited. There is a high degree of spatial variability in precipitation distribution, with more precipitation generally falling at high elevations. Mean annual precipitation ranges from less than 10 inches along the coast to approximately 35 inches inland along the eastern watershed boundaries (Regional Water Management Group, 2013). The majority of precipitation falls between November and April. Precipitation generally falls as rain, but some snow may fall in the upper elevations of the watersheds.

Major streams in the region include the Otay River, San Diego River, San Dieguito River, San Mateo Creek, San Luis Rey River, Santa Margarita River, Santa Maria Creek, Sweetwater River, and Tijuana River. Many streams in the region are regulated by storage reservoirs, which affects the magnitude and timing of flows within the year. For unregulated streams, more than 75% of the annual runoff volume generally occurs between December and April, and flows can drop to zero during the dry summer months (Figure 6). Interannual variability is also significant, with a standard deviation for annual flow that is approximately 1.5 to 2 times the mean. Since 1980, annual surface water yields have ranged from a low of 4,100 AF in fiscal year 2015 to a high of 140,300 AF in fiscal year 1984.

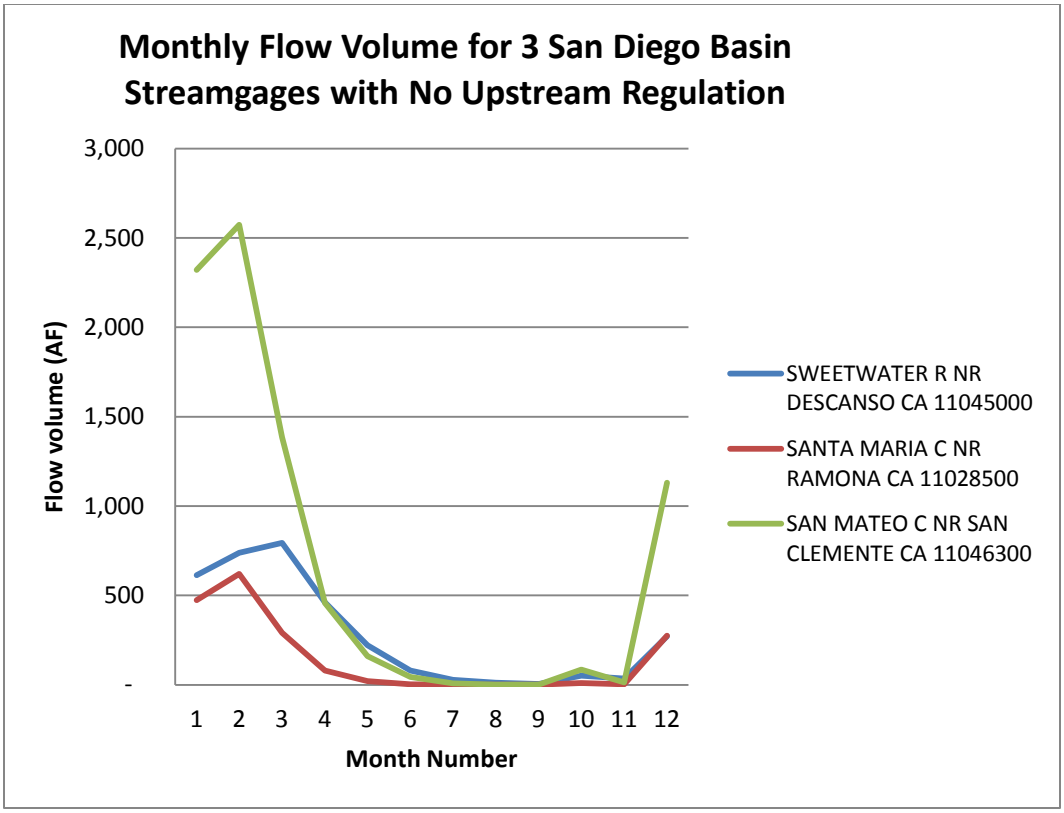

Figure 6. Mean monthly flow volume for Water Years 2000-2014 for three San Diego Basin streamgages with no upstream regulation.

Surface water runoff is captured in 12 reservoirs in the basin. In addition to local runoff, these reservoirs may also store imported water or water transferred from other reservoirs.

Table 4. Reservoirs capturing surface water runoff

Reservoir	Owner	Watershed	Storage Capacity (AF)	Average Annual Inflow from table 3-1 in SDCWA 2013 Master Plan (AF)
Wohlford	City of Escondido	Carlsbad	6,506	1,613
Cuyamaca	Helix Water District	San Diego River	8,195	N/A
El Capitan	City of San Diego	San Diego River	112,807	24,414
Hodges	City of San Diego	San Dieguito	30,251	25,119
Lower Otay	City of San Diego	Otay	49,510	5,771
Morena	City of San Diego	Tijuana	50,207	9,672

Sutherland	City of San Diego	San Dieguito	29,685	7,768
San Vicente	City of San Diego	San Diego River	90,230	8,935
	SDCWA		152,000	
Olivenhain	SDCWA	Carlsbad	24,364	0
San Dieguito	San Dieguito Water District/ Santa Fe Irrigation District	Carlsbad	883	N/A
Loveland	Sweetwater Authority	Sweetwater	25,387	10,707
Sweetwater	Sweetwater Authority	Sweetwater	28,079	4,534

3.1.1.2 Groundwater

There are 24 groundwater basins underlying the study watersheds. All groundwater supplies for the region are operated by SDCWA member agencies. SDCWA itself does not own groundwater rights or operate any groundwater facilities. SDCWA member agencies have produced an annual average of 18,944 AF of water supply from groundwater (San Diego County Water Authority, 2015). Groundwater is produced from either brackish groundwater desalination or municipal wells. Privately owned groundwater wells may be used by individual irrigators or households; those users are outside the scope of the Basin Study and therefore the volume from those wells is not included in the total. Groundwater that is extracted and then stored in Lake Henshaw is also not included in the total, because it is included in the surface water supply.

Potential production of groundwater in the study area is limited. The most productive types of aquifers are alluvial deposits that formed in narrow river valleys, but the extent of these sand and gravel aquifers is limited and most are at shallow depths. Groundwater may also be produced from fractured bedrock and sedimentary deposits, but yields are small. Further, the low rainfall in the region results in low groundwater recharge. There are also water quality concerns with available groundwater resources, such as contamination from septic tanks. High quality aquifers that produce water requiring minimal treatment have generally already been developed.

Future expansion of groundwater is expected to come from further development of brackish groundwater desalination. The city of Oceanside’s 6.37 MGD capacity Mission Basin Desalter and the Sweetwater Authority's existing 4.0 MGD Richard A. Reynolds Groundwater Desalination Facility (capacity to be increased by 5,200 AF by fiscal year 2017) are the only currently operating brackish groundwater recovery and treatment facilities within the SDCWA’s service area. Additional facilities are in the planning or conceptual phases.

3.1.1.3 Recycled Water

Recycled water refers to wastewater that has been treated and disinfected so that it may be used in place of other supplies. Depending on treatment level and permitting, recycled water may be used for non-potable, indirect potable, or direct potable uses. Potential non-potable uses include irrigation of parks and golf courses, dust control, cooling, and toilet flushing. Recycled water for non-potable use is distributed through the "purple pipe" system. At a higher level of treatment, advanced treated wastewater may be used indirectly for potable use by discharging it to an environmental buffer, such as a groundwater basin or surface water reservoir and then later extracting and treating it for distribution through the potable distribution system. Direct potable use eliminates the environmental buffer, transferring advanced treated wastewater directly from the advanced wastewater treatment facility to the water distribution system.

Non-potable use of recycled water is already widespread in the San Diego region. 16 SDCWA member agencies currently use recycled water for some portion of their water supply, totaling 27,931 AF/yr in 2010 (San Diego County Water Authority, 2011). It is anticipated that member agencies will expand their use of non-potable recycled water in the future. Indirect potable reuse is currently being pursued in the region. The City of San Diego's Pure Water program completed a demonstration project in 2013 and aims to produce up to 30 MGD of water for indirect potable reuse by 2021. Since this was not a verifiable supply in the 2010 SDCWA UWMP it was not included in the supply projections. However, it may be included in future Basin Study analyses. No direct potable reuse projects are currently planned, but direct reuse may be pursued in the future.

3.1.1.4 Ocean Desalination

As of the 2010 SDCWA UWMP, ocean desalination was not used in the San Diego region. However, it is being pursued as a future supply option, and one project, the Carlsbad Seawater Desalination Project, was completed in late 2015.

Development of seawater desalination in the San Diego region will assist the region in diversifying its water resources, reduce dependence on imported supplies, and provide a new drought-proof, locally treated water supply. The Claude "Bud" Lewis Carlsbad Desalination Plant is a fully-operational seawater desalination plant and conveyance pipeline developed by Poseidon, a private investor–owned company that develops water and wastewater infrastructure. The plant, located at the Encina Power Station in Carlsbad, was completed in 2015 and provides a highly reliable local supply of up to 56,000 AF/yr for the region. In 2012, SDCWA entered into a 30-year agreement with Poseidon for purchase of the water. The agreement with Poseidon includes the option for SDCWA to purchase the plant after 10 years, or at the end of the 30-year agreement. Water from the desalination plant will be conveyed via a pipeline to the SDWCA Second Aqueduct and transferred to the Twin Oaks Valley Water Treatment Plant. There it will be blended with treated imported water and distributed via SDCWA's distribution system.

Other ocean desalination projects that may provide water for the San Diego region in the future include the Camp Pendleton Marine Corps Base Seawater Desalination Project and the Rosarito Beach Binational Desalination Project. Both projects are still in the planning phase (San Diego County Water Authority, 2015).

3.1.2. Imported Supplies

3.1.2.1 Imported Supply Purchased from MWD

Prior to 2003, SDCWA relied on MWD to meet the majority of the region's water demands. MWD water supplies are mainly comprised of imported water from the Colorado River delivered through MWD's Colorado River Aqueduct and State Water Project supplies under a water purchase agreement with the California Department of Water Resources (Metropolitan Water District of Southern California, 2015). The MWD Act provides each of its member agencies with "preferential rights" according to a formula that establishes what percentage of MWD's available water each of its member agencies are legally entitled to receive. Preferential rights are calculated based on each member agency's proportional share of total payments to MWD, "excepting" payments for the purchase of water (The Metropolitan Water District Act, 2008). In 2015, MWD calculated that SDCWA had preferential rights to purchase 18.27% of MWD's water. SDCWA's actual purchases in 2015 were approximately 21% of MWD's supply. SDCWA successfully challenged MWD's methodology for calculating preferential rights and in 2015, San Francisco Superior Court ruled in favor of SDCWA, finding that MWD has been under-calculating its preferential rights. The ruling is being appealed by MWD. If affirmed on appeal, SDCWA's preferential right to MWD water will be significantly higher than MWD has calculated (San Diego County Water Authority, 2015; San Diego County Water Authority vs. Metropolitan Water Dist, of Southern California, et al., 2015).

MWD's Colorado River water is diverted from the MWD intake at Lake Havasu and transported via the Colorado River Aqueduct to Lake Mathews, near Riverside CA. MWD's State Water Project water is pumped from the Bay Delta and conveyed to three facilities (Castaic Lake, Devil Canyon Afterbay, and Lake Perris) in Southern California via the California Aqueduct.

MWD has a firm Colorado River Supply of 550,000 AF from California's 4.4 million AF. MWD has also used its non-firm 5th priority rights for up to 662,000 AF/yr.

3.1.2.2 Colorado River Conserved Water

In 2003 the Colorado River Quantification Settlement Agreement (QSA) was completed to settle longstanding disputes between Imperial Irrigation District (IID), MWD and Coachella Valley Water District (CVWD) related to priority, use, and transfer of Colorado River water. The agreement established terms for distribution of Colorado River water among the parties for up to 75 years and facilitated actions to enhance the reliability of Colorado River water supplies.

Two of the actions identified in the QSA were the transfer of water made available by canal lining projects on the All-American and Coachella Canals and the transfer of water conserved by IID through delivery improvements and Imperial Valley farmer conservation. Both of these conservation efforts made water available for SDCWA.

Conserved Water from Canal Lining

As part of the execution of the QSA, SDCWA contracted for 80,200 AF/y of conserved water from projects to line the All-American Canal and Coachella Canal. By agreement with MWD, the water is diverted by MWD from the Colorado River at Lake Havasu and an equivalent volume is conveyed to San Diego via MWD's delivery facilities.

Conserved Water from the Imperial Irrigation District (IID) Transfer Agreement

In 1998, SDCWA and IID approved terms of an agreement for transfer of conserved Colorado River water from IID to SDCWA. However, due to concerns about the impacts of the agreement on other stakeholders, the agreement was not implemented until after the completion of the QSA in 2003. Conservation is achieved by IID through system efficiency improvements or by actions of Imperial Valley farmers. The initial term of the transfer agreement is 45 years, with a provision that either IID or SDCWA may extend the agreement for an additional 30-year period. The quantity of water increases according to a stepped schedule from 20,000 AF/y in Year 1 (2003) to 200,000 AF/y by Year 19 (2021), then remains constant at 200,000 AF/y for the duration of the agreement. By agreement with MWD, the water is diverted by MWD from the Colorado River at Lake Havasu and an equivalent volume is conveyed to San Diego via MWD's delivery facilities.

3.1.3. Dry-Year Supplies

In addition to supplies used to meet demands in normal years, SDCWA has also developed a carryover storage program to store water when it is available in wet years and draw on it when supply is not sufficient to meet demand. The carryover storage consists of approximately 100,000 AF of storage created as part of a project to raise San Vicente Dam and 70,000 AF of groundwater bank storage in the Semitropic-Rosamond Water Bank Authority and Semitropic Water Bank. Groundwater banking allows water to be stored in times of surplus, and extracted when it is needed to meet demands. SDCWA acquired 40,000 AF of storage capacity in the Semitropic-Rosamond Water Bank Authority and 30,000 AF in the Semitropic Water Bank in 2008. Both water banks are located in Kern County, California and allow exchange of water through the State Water Project. The groundwater bank authorities manage the banking process, and State Water Project and MWD facilities are used to convey water to SDCWA when it is requested. The supply is considered reliable, and is expected to be available in the year that it is requested.

Use of the dry year carryover storage is managed on a case-by-case basis, taking into account factors such as water demands and normal supply availability, current and projected hydrology, available carryover supply, and avoidance of depletion of the carryover supply.

3.1.4. Emergency Supplies

In addition to the normal and dry-year supplies, emergency supplies provide water in the case of a severe drought, earthquake, or other disruption in imported water supplies (San Diego County Water Authority, 2015; City of San Diego, 1973). The SDCWA Emergency Storage Project's (ESP) storage and distribution facilities allow water to be stored and moved around the SDCWA service area to supply water in the event of a partial or complete loss of supply from MWD. Construction of Olivenhain Dam added 24,000 AF of storage and the San Vicente Dam Raise added 52,100 AF of emergency storage (in addition to approximately 100,000 AF of carryover storage), for a total of 90,100 AF of emergency storage. This is about 15% of the projected annual demand for 2015, or approximately two months of emergency supply (San Diego County Water Authority, 2011). Olivenhain Reservoir began to fill in 2003, and the San Vicente Dam Raise was completed in 2014. Distribution facilities include pipelines and pump stations between Olivenhain reservoir and SDCWA's Second Aqueduct and Hodges Reservoir, and a pipeline connecting San Vicente Reservoir to the Second Aqueduct.

3.2. Water Supply Projections

Water supply projections were based on normal year values in the 2010 SDCWA Urban Water Management Plan and on the estimated demand projections extended to 2050. The UWMP contains projections of supplies for the SDCWA service area for 2015-2035. Since the 2010 SDCWA UWMP only includes projections to 2035, to extend the projections of supply to 2050, each supply source was evaluated and extended using regression analysis as described below.

For surface water, the 2010 SDCWA UWMP lists the volume of surface water that member agencies expect to use for 2015-2035. Only six member agencies (City of Escondido, Helix Water District, City of San Diego, Sweetwater Authority, San Dieguito Water District/Santa Fe Irrigation District, and Vista Irrigation District) planned to use surface water to meet demands. Assuming normal hydrology, the demands were held steady for 2015-2035, except for slight decreases in City of San Diego planned surface water use due to slight increases in the volume of local water wholesaled by the City of San Diego to California American Water (Cal Am), a water and wastewater company serving Coronado, Imperial Beach, and parts of San Diego. A regression between projected surface water supply and year for 2015-2035 was used to project water supply for 2040, 2045, and 2050.

For groundwater, seven member agencies provided volumes of normal year groundwater yield from existing and verifiable proposed expansions that they plan to use to meet demands for 2015-2035. For 2040, 2045, and 2050, the groundwater yield was assumed to be constant at the 2035 volume, under the assumption that the remaining undeveloped groundwater sources are limited and member agencies will have fewer opportunities to expand groundwater production in the future.

For recycled water, sixteen member agencies provided expected yields for existing and verifiable proposed expansions. A regression between projected recycled water supply and year for 2015-2035 was used to project water supply for 2040, 2045, and 2050. Because the recycled water supply relies on the wastewater stream that already exists in the San Diego system, rather than sources with naturally limited availability like surface water and groundwater, it may continue to be expanded in the future. The amount of expansion and type of recycling (non-potable, indirect potable, or direct potable) will likely depend on factors such as economics and the success of current projects.

As the only ocean desalination project currently in development, only the Carlsbad Desalination Project was included in the supply projections for the 2010 SDCWA UWMP. The volume of water was set by the water purchase agreement between SDCWA and Poseidon Resources. The 30 year agreement commits SDCWA to purchasing at least 48,000 AF and up to 56,000 AF per year (Carlsbad Desalination Project, 2015). In the 2010 SDCWA UWMP, a value of 56,000 AF per year was assumed for 2015-2035, and this value was also used to extend the projection to 2050.

The supply projections for imported conserved water were set based on the applicable agreements. The IID transfer volumes increase according to the schedule in the IID Transfer Agreement, and the canal lining volume is SDCWA's allocated volume under the allocation agreement described in the QSA.

MWD supply was used to make up the difference between other sources of supply and the projected demand. MWD does not set contracted volumes; it provides water to supplement the local supplies of its member agencies (Metropolitan Water District of Southern California, 2015). Therefore, sufficient water was anticipated to be available from MWD to meet all demands in normal years. MWD purchases were set as the difference between the projected demands and the other available local and imported supplies. The sum of all other supplies was subtracted from the demand values for 2015-2050, calculated as described in Section 2.2. Due to this methodology, supply and demand are equivalent in the normal year projections. However, as described in Section 4.2, when MWD is assumed to be allocating supplies based on preferential rights (The Metropolitan Water District Act, 2008), supply-demand imbalances are possible.

Water supplies are projected to increase to meet demand, although the supply mix will change over time. The Carlsbad desalination facility is expected to come online in 2016 and the IID transfers will ramp up the full capacity of 200,000 AF per year by 2021. Planned verifiable groundwater and recycled water projects will also increase the water available from local sources, but supplies from local surface water runoff are projected to remain essentially constant. The 2014-2015 supply portfolio was 10.0% local water and 90.0% imported water (Table 3). By 2050, the mix is projected to include 25% local water supplies and 75% from imported sources.

Table 5. Normal Year Supply Projections. Projections are rounded to the nearest hundered.

Category	Type	Normal Year Supply Projections (AF/y)							
		2015	2020	2025	2030	2035	2040	2045	2050
Local	Runoff	48,200	47,900	47,900	47,500	47,300	47,100	46,900	46,700
Local	Groundwater	22,000	26,600	27,600	28,400	28,400	28,400	28,400	28,400
Local	Recycled Water	38,700	43,700	46,600	48,300	50,000	53,600	56,300	59,100
Local	Ocean Desalination	0	56,000	56,000	56,000	56,000	56,000	56,000	56,000
Imported	MWD	324,800	209,300	231,100	255,200	273,900	284,900	294,000	303,200
Imported	IID Transfers	100,000	190,000	200,000	200,000	200,000	200,000	200,000	200,000
Imported	Canal Lining	80,200	80,200	80,200	80,200	80,200	80,200	80,200	80,200
Total		**613,900**	**653,800**	**689,400**	**715,500**	**735,700**	**750,100**	**761,800**	**773,400**

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4. Supply-Demand Gap Analysis

As required by the Urban Water Management Act, the 2010 SDCWA UWMP included assessments of supply and demand reliability for each five- year period from 2015-2035. The assessment was done for periods consisting of all normal years, periods consisting of normal years with a single dry year, and periods with multiple (two to three) dry years. The normal year analysis used the supply and demand values described in Sections 2 and 3 above. The analysis for a single dry year within each five-year period and multiple dry years within each five-year period used adjusted supply and demand data as described in Section 4.2.

4.1. Normal Years

Using the normal year supply and demand projections described in Sections 2 and 3 above, the 2010 SDCWA UWMP anticipated that sufficient supplies would be available to meet demands. Local supplies and transfer agreements for conserved water would be used to their full extent, and remaining demand would be supplied by purchases from MWD.

It is important to note that due to the methodology by which SDCWA and its member agencies compiled supply and demand information for the Urban Water Management Plan, supply values are linked with demand values, and do not represent independent estimates of available supply separate from demand. Instead, the values represent the volumes of each supply type that are expected to be used to meet demands. For conserved water transfers and ocean desalination, the volumes are set by agreements or contracts. For surface water, groundwater, and recycled water, the volumes are the amount that each member agency expects to use to meet demand. For water purchased from MWD, the supply volume was directly calculated from the remaining demand after all other sources were used. This methodology assumes that supply imbalances are not possible, and that sufficient water will be available to meet the projected demands. This assumption is supported by MWD's 2010 Urban Water Management Plan, which projects that sufficient water will be available to meet demands under average hydrological conditions (Metropolitan Water District of Southern California, 2010).

4.2. Dry Years

4.2.1. Supply and Demand Data

In the 2010 SDCWA UWMP, demands were also calculated for a single dry year within each five-year period and for multiple dry years within each five-year period. The single and multiple dry year demand projections were based on SDCWA CWA-MAIN and agricultural demand model runs using historical dry year weather data with all other parameters held constant. The single dry year demand projection used weather data from 1989, and the multiple dry year

demand projection used a combination of consecutive dry year weather data and statistical analysis.

In the 2010 SDCWA UWMP, supplies were adjusted for dry year hydrology by a variety of methods depending on the type of supply. For surface water supply in the single dry year analysis, the UWMP used historical volumes from 1990. For multiple dry year hydrology, the volumes were based on historical surface water supplies for 1990, 1991, and 1992. Similar to surface water, groundwater volumes for single and multiple dry years were based on historical data from 1990 and 1990-1992. Based on past trends in recycled water volumes, recycled water projections were the same for normal, single dry, and multiple dry years. The values for desalination and imported conserved water were also the same for normal, single dry, and multiple dry years, as they were set by the applicable contracts and agreements. For water purchased from MWD, similar to normal years, in the single dry year analysis sufficient water was anticipated to be available from MWD to meet all demands. This assumption aligns with MWD's findings in its UWMP that there would be no shortages under single dry year hydrology (Metropolitan Water District of Southern California, 2010). For the multiple dry year analysis, it was anticipated that MWD would allocate water to member agencies based on the system of preferential rights. MWD's 2010 UWMP does not specify whether it implemented preferential rights allocation, but it projects that sufficient water would be available to meet demands in its multiple dry year analysis (Metropolitan Water District of Southern California, 2010).

Dry year carryover supplies were assumed to be full at the start of each period. However, in the case of a shortage, only a portion of the available carryover supply was used in a given year for shortage mitigation, so that some would be left for reducing shortages in future years (San Diego County Water Authority, 2011).

4.2.2. Supply-Demand Gaps

Due to the method of setting demands for MWD, in the case of a single dry year within each five-year period, no supply gaps were projected by the 2010 SDCWA UWMP for any period from 2015-2035. However, for the multiple dry year analysis, supply shortages were calculated for some of the three-consecutive-dry-year cycles, even with utilization of carryover supplies designated for use in dry years. Shortages ranged from approximately 7,500 AF to 77,000 AF. Shortages occurred in four of the five-year time periods analyzed between 2015 and 2035.

Since MWD projects that it will have sufficient water to meet demands, (Metropolitan Water District of Southern California, 2010), future shortages are likely due to the inability of existing and verifiable local water supplies to keep up with increasing demands, or loss of imported supplies due to unanticipated hydrologic conditions, or environmental restrictions. In the early years, the 2010 SCDWA UWMP attributed the shortages to the Carlsbad Desalination facility not yet being online and the IID Transfer Agreement not yet reaching its full volume.

In the later years, the shortages were attributed to increasing water demands (San Diego County Water Authority, 2011), which were not offset by additional local water supply. Although the 2010 SDCWA UWMP only projects supplies and demands to 2035, shortages in multiple dry years could be expected to continue to 2050, due to the continued increase in demands as estimated in Section 2.2. However, implementation of some of the additional planned projects listed in the 2010 SDCWA UWMP, as well as other adaptation strategies, may be able to address shortages. This will be investigated in later tasks of the Basin Study.

A limitation of the supply-demand gap analysis in Urban Water Management Plans is the consideration of only historical climate, hydrology, and operating conditions. Although the normal, single dry, and multiple dry year analysis examines the impacts of climatic variability, the analysis is based on historical climate and does not account for the potential effects of climate change. For example, climate change in the Colorado River Basin or in the basins that provide water to the State Water Project may impact the availability of imported water from MWD. Local surface water supplies and groundwater recharge in the San Diego region may also be impacted by changes in precipitation volume and timing as a result of climate change. The Urban Water Management Plan framework also does not consider the risks associated with the water needs of endangered species and environmental uses, or other changes in water use that may impact the available supply. In particular, the Sacramento-San Joaquin Bay Delta, which supplies water to San Diego via MWD, is the subject of ongoing efforts to sustain endangered species. Factors such as these may lead to shortages that were not anticipated in the 2010 SDCWA UWMP.

4.3. Suggestions for Analysis in the San Diego Basin Study

As evidenced by the potential for shortages in multiple dry years, the San Diego region is vulnerable to imbalances in supply and demand. Water sources such as the Carlsbad Desalination Project and the IID transfers will provide additional water for the region as they come online. These are highly reliable sources that will be minimally affected by drought. However, demand is projected to continue to increase, leading to future potential shortages even with those additional supplies available. Further, climate change may alter the availability of local and regional water supply sources, such as surface water runoff and groundwater. The impacts of climate change on basin hydrology will be explored in San Diego Basin Study Task 2.2, and impacts on water supply will be modeled in Task 2.3.

In Task 2.4, the San Diego Basin Study will examine structural and non-structural concepts for addressing gaps in water supply and demand. Many agencies are already exploring additional groundwater and water recycling projects. The 2010 SDCWA UWMP listed an additional 14 groundwater and 21 water recycling projects or project concepts that could provide an additional 62,000 AF per year of groundwater and 39,000 AF per year of recycled water to the available supply

by 2035. Project concepts include non-potable reuse, indirect potable reuse, new groundwater wells, and development of brackish groundwater recovery. Additional seawater desalination projects, including the Camp Pendleton Marine Corps Base Seawater Desalination Project and the Rosarito Beach Binational Desalination Project are also in the planning phases. The San Diego Basin Study will evaluate concepts such as these in Task 2.4, under both current and future climate scenarios.

5. Conclusion

The key objectives of Task 2.1 of the San Diego Basin Study were to describe and inventory current and future water supplies and demands in the Study Area, and explore potential imbalances in supply and demand. Through a comprehensive literature review of planning documents and previous studies, this report summarizes the region's demands and the types and quantities of supply sources available to meet those demands for 2015 through 2050.

Demands were found to be dominated by municipal and industrial demands, while agricultural demands make up the remaining demand volume. Demands are expected to increase in the future as the population of the San Diego region grows. Supplies have historically been dominated by imported water. This is expected to continue in the future, but local supplies are expected to become more important as SDCWA continues to diversify its water supply portfolio.

Under normal and single dry year conditions, no supply gaps were projected through 2035. However, under multiple dry year conditions, supply gaps were the result of both limited supplies and increasing demands. Modeling to evaluate these supply gaps further and evaluation of structural and non-structural concepts for addressing potential imbalances will be the focus of Tasks 2.3 and 2.4 of the San Diego Basin Study.

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6. References

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Appendix A: Demand Projections

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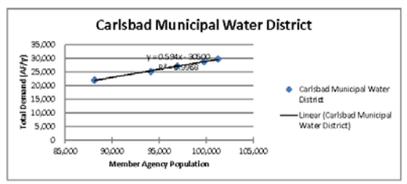
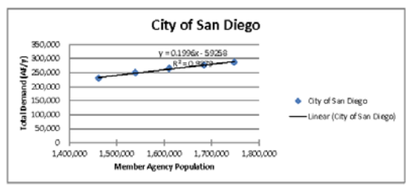
Table A-1. Total, Imported, and Local demands compiled from 2010 SDCWA UWMP.

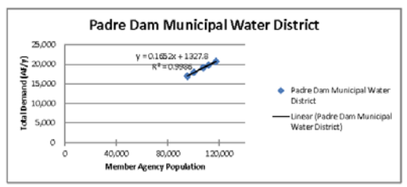
	Total Demand =Imported+Surface Water+Groundwater+Recycled Water (AF/y)							Imported Demand - Extracted from Table 2-9 of UWMP (AF/y)							Local Supply Projection = Surface Water+Groundwater+Recycled Water (AF/y)						
Member Agency	2005	2010	2015	2020	2025	2030	2035	2005	2010	2015	2020	2025	2030	2035	2005	2010	2015	2020	2025	2030	2035
Carlsbad Municipal Water District			22,004	25,100	27,112	28,773	29,753	21,132	16,170	16,862	18,600	20,612	22,273	23,253			5,142	6,500	6,500	6,500	6,500
City of Del Mar			1,312	1,324	1,361	1,401	1,416	1,297	1,075	1,222	1,224	1,236	1,251	1,266			90	100	125	150	150
City of Escondido			32,494	31,597	34,173	35,191	35,861	21,446	14,388	23,734	21,337	22,913	23,931	24,601			8,760	10,260	11,260	11,260	11,260
Fallbrook Public Utilities District			14,683	15,590	16,881	18,071	18,861	17,333	11,593	14,140	15,047	16,338	17,528	18,318			543	543	543	543	543
Helix Water District			37,708	36,393	38,021	40,090	42,165	28,754	25,780	33,441	32,126	33,754	35,823	37,898			4,267	4,267	4,267	4,267	4,267
Lakeside Water District			5,014	5,324	5,500	5,634	5,945		3,129	4,114	4,424	4,600	4,734	5,045			900	900	900	900	900
City of Oceanside			30,836	32,314	33,317	34,514	34,922	31,307	21,765	23,566	24,094	25,097	26,294	26,702			7,270	8,220	8,220	8,220	8,220
Olivenhain Municipal Water District			24,318	24,752	25,074	25,739	26,054	22,429	18,461	21,118	21,552	21,874	22,539	22,854			3,200	3,200	3,200	3,200	3,200
Otay Water District			44,883	46,244	49,734	52,689	56,524	40,100	29,387	40,483	41,244	43,934	45,889	48,524			4,400	5,000	5,800	6,800	8,000
Padre Dam Municipal Water District			16,951	17,929	19,121	19,756	20,672	19,945	11,578	14,935	15,913	17,105	17,740	18,656			2,016	2,016	2,016	2,016	2,016
Camp Pendleton Marine Corps Base			11,910	11,400	12,900	13,740	13,740	846	844	850	850	850	850	850			11,060	10,550	12,050	12,890	12,890
City of Poway			13,018	13,445	13,847	14,379	14,501	14,209	10,266	12,593	13,020	13,422	13,954	14,076			425	425	425	425	425
Rainbow Municipal Water District			21,537	21,070	22,446	24,078	26,137	28,911	18,322	21,537	21,070	22,446	24,078	26,137			0	0	0	0	0
Ramona Municial Water District			12,028	11,450	12,270	12,974	13,354	10,257	6,047	11,213	10,635	11,455	12,159	12,539			815	815	815	815	815
Rincon del Diablo Municipal Water District			8,975	11,208	12,303	13,544	14,303	7,952	5,750	3,696	5,429	6,024	6,765	7,024			5,279	5,779	6,279	6,779	7,279
City of San Diego			229,792	249,263	265,365	277,135	287,261	184,335	181,691	201,721	221,458	237,622	249,728	260,107			28,071	27,805	27,743	27,407	27,154
San Dieguito Water District			7,868	8,207	8,685	8,959	9,138	6,113	1,635	4,736	5,025	5,453	5,677	5,836			3,132	3,182	3,232	3,282	3,302
Santa Fe Irrigation District			12,606	11,961	12,294	12,572	12,787	11,158	4,374	8,738	8,093	8,426	8,704	8,919			3,868	3,868	3,868	3,868	3,868
Sweetwater Authority			21,325	21,692	22,071	22,861	23,692	12,109	6,985	8,125	3,292	3,671	4,461	5,292			13,200	18,400	18,400	18,400	18,400
Vallecitos Water District			18,666	17,454	18,777	19,547	19,949	19,428	15,419	18,666	17,454	18,777	19,547	19,949			0	0	0	0	0
Valley Center Municipal Water District			32,544	32,573	34,506	36,450	38,584	42,265	25,619	32,497	32,526	34,459	36,403	38,537			47	47	47	47	47
Vista Irrigation District			21,491	21,372	22,365	23,236	25,411	18,367	11,225	16,080	15,961	16,954	17,825	20,000			5,411	5,411	5,411	5,411	5,411
Yuima Municipal Water District			3,098	3,006	3,267	3,510	3,707	3,103	1,847	2,098	2,006	2,267	2,510	2,707			1,000	1,000	1,000	1,000	1,000
Sub-Total			**645,061**	**670,668**	**711,390**	**744,843**	**774,737**	**562,796**	**443,350**	**536,165**	**552,380**	**589,289**	**620,663**	**649,090**			**108,896**	**118,288**	**122,101**	**124,180**	**125,647**
Accelerated Forecast Growth 6			2,224	4,421	6,605	8,776	10,948			2,224	4,421	6,605	8,776	10,948							
Total			**647,285**	**675,089**	**717,995**	**753,619**	**785,685**	**562,796**	**443,350**	**538,389**	**556,801**	**595,894**	**629,439**	**660,038**							

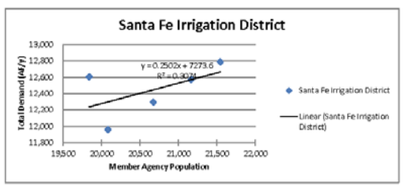
	Surface Water Demand - Extracted from Table F-1 of UWMP (AF/y)							Groundwater Demand - Extracted from Table F-2 of UWMP (AF/y)							Recycled Water Demand - Extracted from Table F-4 of UWMP (AF/y)						
Member Agency	2005	2010	2015	2020	2025	2030	2035	2005	2010	2015	2020	2025	2030	2035	2005	2010	2015	2020	2025	2030	2035
Carlsbad Municipal Water District																**3,935**	**5,142**	**6,500**	**6,500**	**6,500**	**6,500**
City of Del Mar																73	90	100	125	150	150
City of Escondido			7,260	7,260	7,260	7,260	7,260									413	1,500	3,000	4,000	4,000	4,000
Fallbrook Public Utilities District																543	543	543	543	543	543
Helix Water District			4,117	4,117	4,117	4,117	4,117		150	150	150	150	150	150							
Lakeside Water District									900	900	900	900	900	900							
City of Oceanside									5,227	6,720	6,720	6,720	6,720	6,720		119	550	1,500	1,500	1,500	1,500
Olivenhain Municipal Water District																**2,366**	**3,200**	**3,200**	**3,200**	**3,200**	**3,200**
Otay Water District																**3,785**	**4,400**	**5,000**	**5,800**	**6,800**	**8,000**
Padre Dam Municipal Water District																**2,016**	**2,016**	**2,016**	**2,016**	**2,016**	**2,016**
Camp Pendleton Marine Corps Base									7,256	6,960	6,350	7,350	8,090	8,090		**1,184**	**4,100**	**4,200**	**4,700**	**4,800**	**4,800**
City of Poway																425	425	425	425	425	425
Rainbow Municipal Water District																					
Ramona Municial Water District																**729**	**815**	**815**	**815**	**815**	**815**
Rincon del Diablo Municipal Water District																3,279	5,279	5,779	6,279	6,779	7,279
City of San Diego			18,318	18,052	17,990	17,654	17,401		500	500	500	500	500	500		**7,933**	**9,253**	**9,253**	**9,253**	**9,253**	**9,253**
San Dieguito Water District			2432.19	2432.19	2432.19	2432.19	2432.19									590	700	750	800	850	870
Santa Fe Irrigation District			3267.81	3267.81	3267.81	3267.81	3267.81									497	600	600	600	600	600
Sweetwater Authority			7,400	7,400	7,400	7,400	7,400		5,800	5,800	11,000	11,000	11,000	11,000							
Vallecitos Water District																					
Valley Center Municipal Water District																44	47	47	47	47	47
Vista Irrigation District			5,411	5,411	5,411	5,411	5,411														
Yuima Municipal Water District									1,000	1,000	1,000	1,000	1,000	1,000							
Sub-Total	**0**	**0**	**48,206**	**47,940**	**47,878**	**47,542**	**47,289**	**0**	**20,833**	**22,030**	**26,620**	**27,620**	**28,360**	**28,360**	**0**	**27,931**	**38,660**	**43,728**	**46,603**	**48,278**	**49,998**
Accelerated Forecast Growth 6																					
Total																					

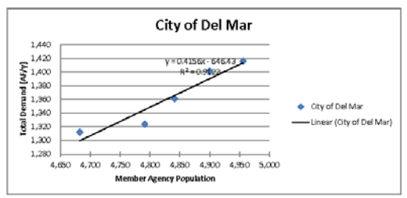
City of National City and South Bay Irrigation are shown as part of Sweetwater Authority

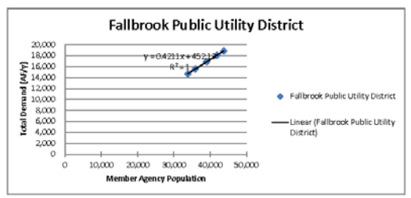


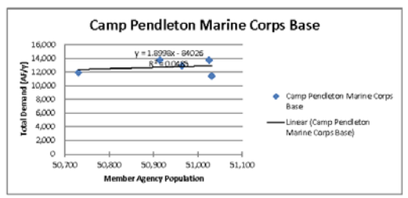


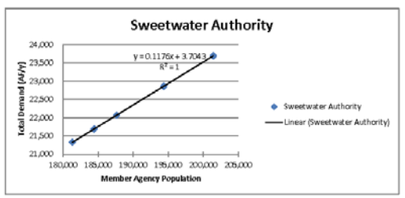


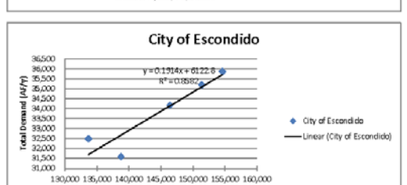


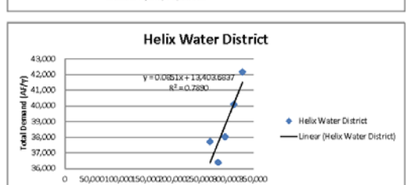


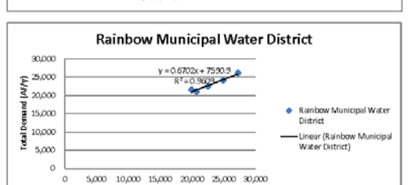


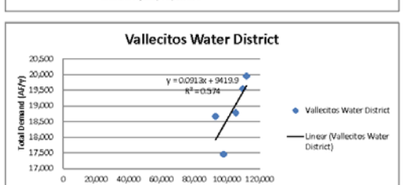


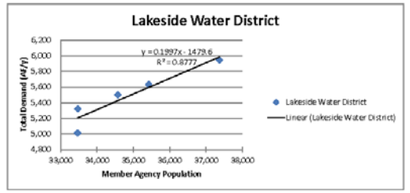


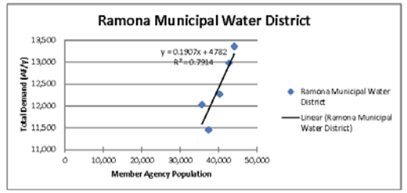


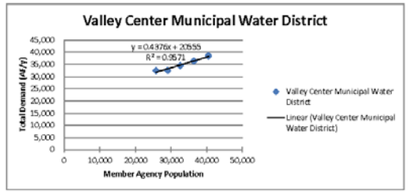


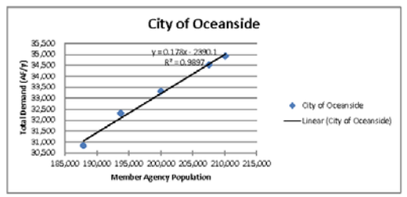


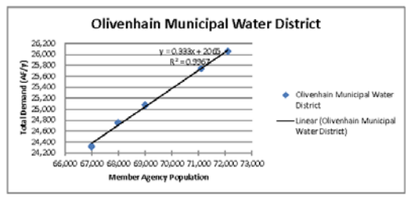


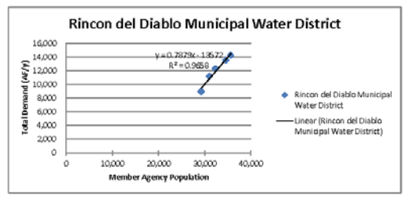


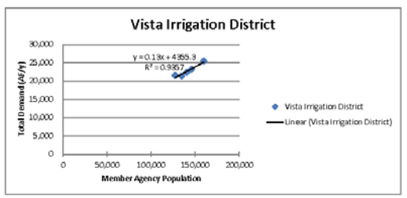


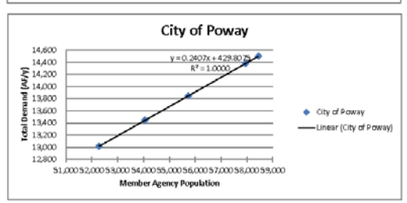


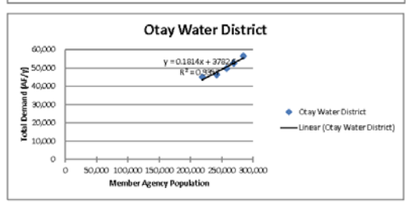


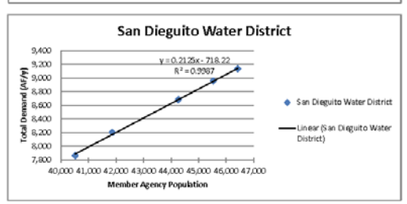












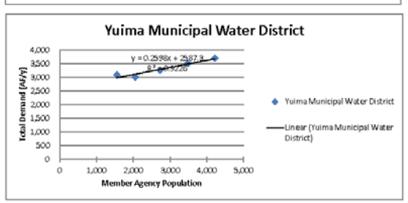


Figure A-1. Regressions of Total Demand from 2010 SDCWA UWMP against SANDAG Series 12 population projections.

City of National City and South Bay Irrigation are shown as part of Sweetwater Authority

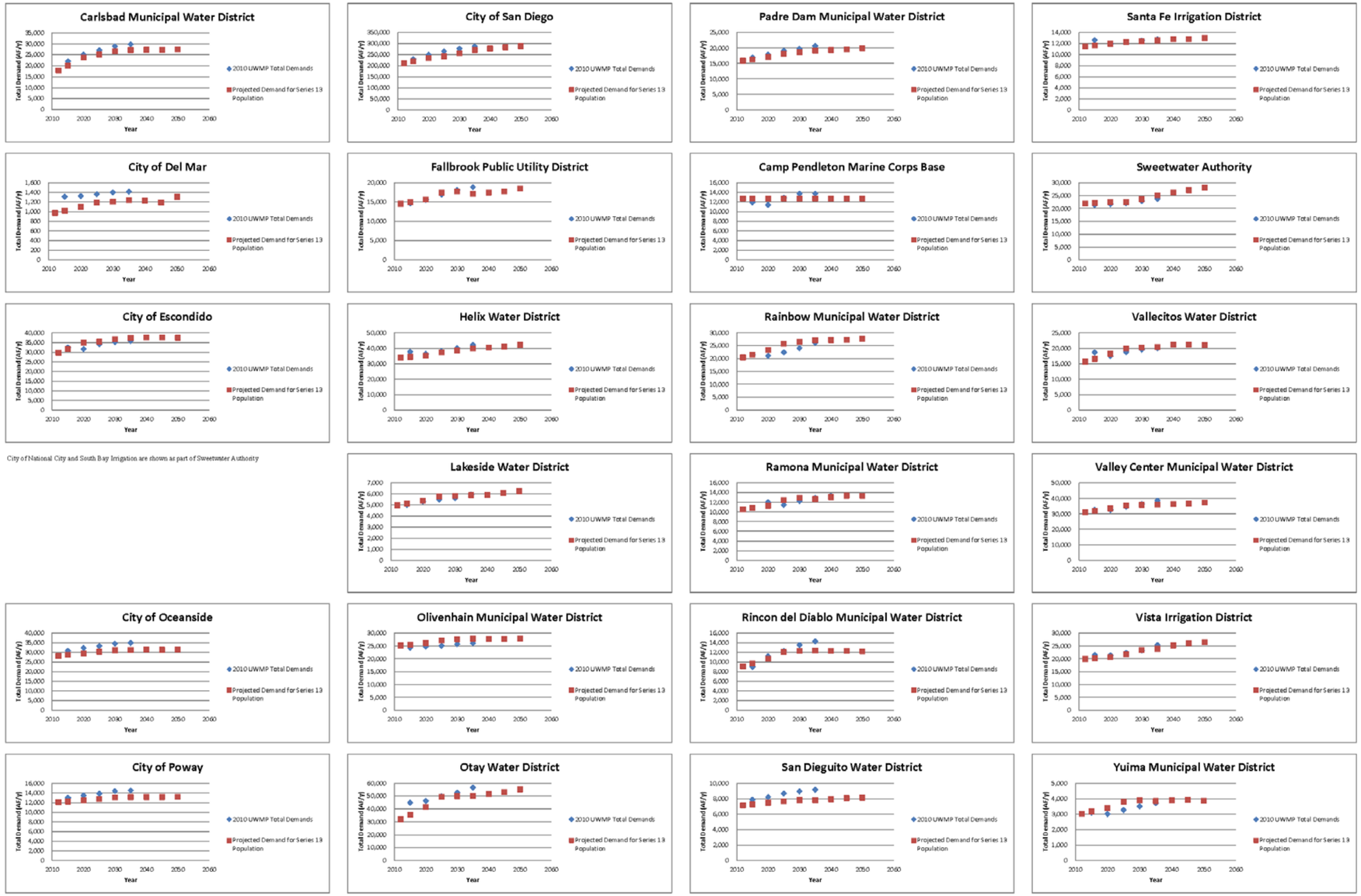


Figure A-2. Plots of projected demands from the 2010 SDCWA UWMP (blue) and projections calculated from Series 13 population projections using regression equations (red).

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