Final

Groundwater Assessment Study

A Status Report on the Use of Groundwater
in the Service Area of the
Metropolitan Water District of Southern California

Report Number 1308

September 2007

MWD
Metropolitan Water District of Southern California

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GROUNDWATER ASSESSMENT STUDY
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
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GLOSSARY

Definitions of key terms as used in this report follows. During the preparation of this report it became clear that the specific usage of some terms varies among basins and that some terms are subject to a wide range of interpretation. In addition to the terms described below, Chapter III, Regional Overview, includes a more detailed discussion with specific examples of important differences among basins regarding concepts such as ‘safe yield’ and ‘available storage’.

"A"

Accumulated overdraft. The cumulative difference between the inflows and outflows in a groundwater basin. In the Orange County Basin, this definition is expanded to include the amount of water necessary to be replaced into the groundwater basin to prevent the landward movement of ocean water into the fresh groundwater body.

Adjudicated basin. A groundwater basin that is managed pursuant to an adjudication.

Adjudication. A court judgment or decree, pursuant to settlement or otherwise, specifying rights to surface water or groundwater and management procedures and/or pumping limits providing for long-term sustainable management of a river system or groundwater basin.

AF. Acre-foot. The amount of water needed to cover an acre (approximate a football field) one foot deep, or 325,900 gallons. One acre-foot can support the annual indoor and outdoor needs of between one and two households per year, and, on average, three acre-feet are needed to irrigate one acre of farmland.

AFY. Acre-foot per year.

Alluvium. A stratified bed of sand, gravel, silt, and clay deposited by flowing water (may also be referred to as alluvial).

Annual overdraft. The quantity by which the production of water from the groundwater supplies during the year exceeds the natural replenishment of such groundwater supplies during the same year.

Aqueduct. A structure for transporting water form one place to another by means of a pipeline, canal, conduit, tunnel or a combination of these things.

Aquifer. A geologic formation of sand, rock and gravel through which water can pass and which can store, transmit and yield significant quantities of water to wells and springs.

Aquitard. A geologic formation of clay, silt or other material that retards but does not completely stop the flow of water to or from an adjacent aquifer. It does not readily yield significant water to wells and springs.

Artesian. An aquifer in which the water is under sufficient pressure to cause it to rise above the bottom of the overlying confining bed, if opportunity to do so should be provided.

Artificial recharge. The addition of water to a groundwater reservoir by human activity, such as putting surface water into recharge basins or injecting water through wells.

Available storage capacity. The volume of a groundwater basin that is unsaturated and capable of storing groundwater. A more detailed discussion of this term is provided in Chapter III, Regional Overview.

"B"

Base flow. Surface flow of a river, not counting storm flow and/or purchased imported water.

Basin equity assessment (BEA). The additional fee charged by Orange County Water District on water pumped that exceeds the BPP, which makes the cost of that water equal to the cost of imported water.

Basin production percentage (BPP). The percentage of an Orange County Water District member agency's total potable water demand that can be produced from the basin without subjecting that member agency to the BEA.

Beneficial use. One of many ways that water can be used either directly by people or for their overall benefit. The State Water Resources Control Board recognizes 23 type of beneficial use criteria for those uses established by the Regional Water Quality Control Boards.

Brackish water. Water containing dissolved minerals in amounts that exceed normally acceptable standards for municipal, domestic, and irrigation uses. Considerably less saline than seawater.

"C"

Calendar year. The period between January 1 and December 31.

CEQA. California Environmental Quality Act.

cfs. Cubic feet per second.

Chloramines. A mixture of ammonia and chlorine used to disinfect water.

Closed basin. A groundwater basin whose topography and geology prevent subsurface outflow of water.

Colored water. Groundwater that is unsuitable for domestic use without treatment due to high color and odor exceeding drinking water standards.

Confined aquifer. A water-bearing subsurface stratum that is bounded above and below by formations of impermeable, or relatively impermeable soil or rock.

Conjunctive use. The planned use of groundwater in conjunction with surface water in overall management to optimize total water resources.

Contaminant. Any substance or property preventing the use or reducing the usability of the water for beneficial uses.

"D"

Deep percolation. The percolation of surface water through the ground beyond the lower limit of the root zone of plants into a groundwater aquifer.

Degraded water. Water within the groundwater basin that, in one characteristic or another, does not meet primary drinking water standards.

Desalting (or desalination). Specific treatment processes, such as reverse osmosis or multi-stage flash distillation, to demineralize seawater or brackish (saline) waters for reuse. Also sometimes used in wastewater treatment to remove salts other pollutants.

Disinfection. Water treatment that destroys potentially harmful bacteria.

Drought condition. Hydrologic conditions during a defined period when rainfall and runoff are much less than average.

"E"

Effective porosity. The volume of voids or open spaces in alluvium and rocks that is interconnected and can transmit fluids.

Effluent. Wastewater or other liquid, partially or completely treated or in its natural state, flowing from a treatment plant.

Evapotransporation (ET). The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surface. Quantitatively, it is expressed in terms of depth of water per unit area during a specified period of time.

"F"

Fiscal year. The period from July 1 to June 30 of the following calendar year.

Forebay. A portion of a groundwater basin where large quantities of surface water can recharge the basin through infiltration; also a reservoir or pond situated at the intake of a pumping plant or power plant to stabilize water level.

"G"

Groundwater. Water that occurs beneath the land surface and fills partially or wholly pore spaces of the alluvium, soil or rock formation in which it is situated. Does not include water that is being produced with oil in the production of oil and gas or in a bona fide mining operation.

Groundwater basin. Alluvial reservoir defined by the overlying land surface and all underlying alluvial aquifers that contain water or have the potential to contain water. Boundaries of successively deeper aquifers may differ and make it difficult to define the limits of the basin.

Groundwater budget. A numerical accounting of the recharge, discharge and change in storage of an aquifer, series of aquifers or groundwater basin.

Groundwater in storage. The quantity of water in the zone of saturation.

Groundwater management. The planned and coordinated management of a groundwater basin or portion of a groundwater basin with a goal of long-term sustainability of the resource.

Groundwater management plan. A comprehensive written document developed for the purposes of groundwater management and adopted by an agency having appropriative legal or statutory authority that meets the formal requirements for groundwater management plans as defined under Senate Bill (SB) 1938.

Groundwater mining. The withdrawal of water from an aquifer in excess of recharge over a period of time. If continued, the underground supply would eventually be exhausted or the water table could drop below economically feasible pumping lifts.

Groundwater overdraft. The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average.

Groundwater recharge. The action of increasing groundwater storage by natural conditions or by human activity. See also: Artificial recharge.

Groundwater storage capacity. Volume of void space that can be occupied by water in a given volume of a formation, aquifer or groundwater basin. See also: Total storage. A more detailed discussion of this concept in provided in Chapter III, Regional Overview.

Groundwater subbasin. A subdivision of a groundwater basin created by dividing the basin using geologic or hydrologic conditions or institutional boundaries.

Groundwater table. The upper surface of the zone of saturation (all pores of subsoil filled with water), except where the surface if formed by an impermeable body.

gpm. Gallons per minute.

"H"

Hydrogeology. The branch of geology that deals with the occurrence, distribution, and effect of ground water

Hydrograph. A graph that shows some property of groundwater or surface water (e.g. water level) as a function of time.

Hydrologic balance. An accounting of all water inflow to, water outflow from, and changes in water storage within a hydrologic unit over a specified period.

Hydrologic cycle. The process by which water constantly circulates from the ocean, to the atmosphere, falling to the earth in some form of precipitation, and finally returning to the ocean.

Hydrostratigraphy. The identification of mappable units based upon aquifer properties that have lateral extent and composing a reasonably distinct hydrologic system.

"I"

Imported water. Water that has originated from one hydrologic region and is transferred to another hydrologic region. For example, the Metropolitan Water District (Metropolitan) of Southern California imports water from the Colorado River and Northern California.

Infiltration. The flow of water downward from the land surface into and through the upper soil layers.

Infiltration capacity. The maximum rate at which infiltration can occur under specific conditions of soil moisture.

In-lieu recharge. The practice of using alternate source of supply (e.g. imported water) in place of groundwater thereby leaving groundwater in storage for later use. When supplies are available, Metropolitan financially encourages groundwater producers, through its various in-lieu programs, to turn off their pumping facilities and use imported water from Metropolitan to meet their demands.

“J”

Joint Powers Authority (JPA). An agreement entered into by two or more public agencies that allows them to jointly exercise any power common to the contracting parties. The JPA is defined in Chapter 5 (commencing with §6500) of Division 7 of Title 1 of the California Government Code.

"L"

Land subsidence. The lowering of the natural land surface due to groundwater (or oil or gas) extraction.

Lithology. The description of rock or sediments on the basis of such characteristics as color, mineral composition and grain size.

"M"

Managed basin. A groundwater basin that is managed pursuant to a groundwater management plan developed in accordance with the California Water Code section 10753 (SB 1938, Machado, 2002) or managed pursuant to a State statute establishing a groundwater management agency and setting out the agency's responsibilities, authorities, and powers (e.g. Orange County Water District, Fox Canyon Groundwater Management Agency).

Maximum contaminant level (MCL). The highest drinking water contaminant concentration allowed under Federal and State Drinking Water Regulations.

MGD. Million gallons per day.

Microfiltration. A physical separation process where tiny, hollow straw-like membranes separate particles from water. It is used very effectively as a pre-treatment for reverse osmosis.

mg/L. Milligrams per liter.

"N"

National Pollutant Discharge Elimination System (NPDES). A federal permit authorized by the Clean Water Act, Title IV, which is required for discharge of pollutants to navigable waters of the United States, which includes any discharge to surface waters-lakes, streams, rivers, bays, the ocean, wetlands, storm sewer, or tributary to any surface water body.

Natural recharge. Natural replenishment of an aquifer or groundwater basin from snowmelt, runoff or infiltration of precipitation through seepage from the ground surface.

Natural safe yield. The maximum quantity of water can be drawn over a long period of time without adverse effects exclusive of artificial recharge or other human influences. Also referred to as native yield. A more detailed discussion of this concept is provided in Chapter III, Regi4onal Overview.

Notification level. Notification levels are health-based advisory levels established by CDHS for chemicals in drinking water that lack maximum contaminant levels (MCLs). When chemicals are found at concentrations greater than their notification levels, certain requirements and recommendations apply.

"O"

Operational yield. An optimal amount of groundwater should be withdrawn from an aquifer or groundwater basin each year. It is be a dynamic quantity that is determined based upon basin specific groundwater management goals. Also referred to as operational safe yield. A more detailed discussion of this concept is provided in Chapter III, Regional Overview.

Ordinance. A law set forth by a governmental authority.

Overdraft. See: groundwater overdraft.

"P"

Perched groundwater. Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater.

Percolation. The downward movement of water through the soil or alluvium to the groundwater table. See also: infiltration.

Perforated interval. The depth interval where slotted casing or screen is lace in a well to allow entry of water from the aquifer.

Permeability. The capability of soil or other geologic formations to transmit water.

Potable water. Suitable and safe for drinking.

ppb. **Parts per billion**. Used interchangeably with µg/L (micrograms per liter.)

ppm. Parts per million. Used interchangeably with mg/L (milligrams per liter.)

ppt. Parts per trillion. Used interchangeably with ng/L (nanograms per liter.)

Primary treated water. First major treatment in a wastewater treatment facility, usually sedimentation but not biological oxidation.

Production, producing. The act of extracting groundwater by pumping or otherwise.

psi. Pounds per square inch.

Purveyor. Another name for groundwater producer or pumper.

"R"

Replenishment assessment (RA), commonly known as a pump tax. A charge on each AF of groundwater extracted from the Orange County Basin. Income from the RA finances the replenishment of the Orange County Basin and projects for water recycling and water quality improvements.

Replenishment obligation. Replacement water. Terms used in management of groundwater basins that allow production to be greater than natural safe yield but balance the basin's water budget by utilizing imported or other sources of water to make up the difference.

Recharge. The physical process where water naturally percolates or sinks into a groundwater basin.

Recharge basin. A surface facility, often a large pond, used to increase the infiltration of surface water into a groundwater basin.

Reclamation project. A project where water obtained from a sanitary district or system undergoes additional treatment for a variety of uses, including landscape irrigation, industrial uses, and groundwater recharge.

Recycling. A type of reuse, usually involving running a supply of water through a closed system again and again. Legislation in 1991 legally equates the term "recycled water" to reclaimed water.

Riparian. Of or on the banks of a stream, river, or other body of water.

RO. Reverse osmosis. A method of removing salts or other ions from water by forcing water through a semi-permeable membrane.

Runoff. The volume of surface water flow from and area.

"S"

Safe yield. The maximum quantity of water that can be withdrawn from a groundwater basin over a long period of time without resulting in adverse conditions. Sometimes referred to as sustained yield. A more detailed discussion of this concept is provided in Chapter III, Regional Overview.

Salinity. Generally, the concentration of mineral salts dissolved in water. Salinity may be measured by weight (total dissolved solids - TDS), electrical conductivity, or osmotic pressure. Where seawater is known to be the major source of salt, salinity is often used to refer to the concentration of chlorides in the water.

SARI. Santa Ana Regional Interceptor. A used water discharge line that runs from the Inland Empire to the Orange County Sanitation District.

Saturated zone. The zone in an aquifer in which all interconnected openings, or pore spaces, are filled with water.

Seawater intrusion. The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater basins.

Seawater intrusion barrier. A physical facility or method of operation designed to prevent the intrusion of salt water into a body of freshwater, such as the Talbert Barrier or Alamitos Barrier in Orange County and Central basins, respectively.

Secondary MCL. Maximum contaminant level to address taste and odor concerns.

Secondary treatment. Generally, a level of treatment that produces 85 percent removal efficiencies for biological oxygen demand and suspended solids. Usually carried out through the use of trickling filters or by the activated sludge process.

Seepage. The loss of water by infiltration into the soil from a surface water body or source.

Semi-confined aquifer. An aquifer that has aquitards either above or below that allow water to leak into or out of the aquifer.

Spreading basin; spreading grounds. See: recharge basin.

Spring. A location where groundwater flows naturally to the land surface or a surface water body.

Storm flow. Surface flow originating from precipitation and runoff that has not percolated into an aquifer or groundwater basin.

SWP. State Water Project. An aqueduct system that delivers water from northern California to central and southern California.

Subsidence. See: land subsidence.

Sustained yield. See safe yield.

"T"

TDS. Total dissolved solids. A quantitative measure of the residual minerals dissolved in water that remain after evaporation of a solution. Usually expressed in milligrams per liter.

Tertiary treatment. The treatment of wastewater beyond the secondary or biological stage. Normally implies the removal of nutrients, such as phosphorous and nitrogen, and a high percentage of suspended solids.

THM. Trihalomethanes. Any of several synthetic organic compounds formed when chlorine or bromine combine with organic materials in water.

Transpiration. The process in which plant tissues give off water vapor to the atmosphere as an essential physiological process.

Turbidity. Thick or opaque with matter in suspension; muddy water.

"U"

Ultraviolet light disinfection. A disinfection method for water that has received either secondary or tertiary treatment, used as an alternative to chlorination.

Unconfined aquifer. An aquifer that is not bounded on the top by an aquitard. The upper surface of an unconfined aquifer is the water table.

Unsaturated zone. The zone below the land surface in which the pore space is not completely filled with water.

Urban water management plan (UWMP). An UWMP is required for all urban water suppliers having more than 3,000 connections or supplying more than 3,000 AFY of water. The plans include discussions on water supply reliability, water use, water conservation, and water shortage contingency and serve to assist urban water suppliers with their long-term water resources planning.

Usable storage capacity. The quantity of groundwater of acceptable quality that can be economically withdrawn from storage. In some cases the amount of groundwater that can be extracted from a groundwater basin or amount of storage that is used is limited by an adjudication.

"V"

Vadose zone. See: unsaturated zone.

VOC. Volatile organic compound. A chemical compound that evaporates readily at room temperature and contains carbon. These compounds are often highly mobile in groundwater and are generally associated with industrial activities.

"W"

Wastewater. Water that has been previously used by a municipality, industry or agriculture and has suffered a loss of quality as a result of use.

Wastewater reclamation. Treatment and management of municipal, industrial or agricultural wastewater to produce water of suitable quality for additional beneficial uses.

Water rights. A legally protected right to take possession of water occurring in a natural waterway and to divert that water for beneficial use.

Water table. See: groundwater table.

Water year. The period between October 1 and September 30 of the following calendar year.

Watermaster. A court appointed person(s) that has specific responsibilities to carry out court decisions pertaining to a river system or watershed.

Watershed. The total land area that from which water drains or flows to a river, stream, lake or other body of water.

Wellhead treatment. Water quality treatment of water being produced at the well site.

CHAPTER I

INTRODUCTION

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INTRODUCTION

Groundwater is a key component of the water supply picture for Southern California. On a regional level, local groundwater production is used to meet nearly 40 percent of the total annual water demands within Metropolitan's service area. Groundwater production is used to offset peak seasonal water demands on the imported water treatment and distribution systems. Further, surplus water supplies available during wet years are stored in groundwater basins for later use during dry, drought, or emergency periods. As such, the groundwater resource is a key component of water supply reliability planning within Metropolitan's service area. The Groundwater Assessment Study provides a description of the current status of groundwater within The Metropolitan Water District of Southern California (Metropolitan) service area.

PURPOSE

In October 2005, the Metropolitan Board of Directors (Board) directed staff to conduct this Groundwater Assessment Study. The purpose of the study is to document the current status and use of the groundwater basins within the Metropolitan service area.

Groundwater is an important part of Metropolitan's Integrated Water Resource Plan (IRP). The IRP sets out reliability strategies for dry years, and has targeted dry-year yield from service-area groundwater basins of 275,000 AFY by 2010, and 300,000 AFY by 2020/25. Because Metropolitan plans for the potential of three consecutive dry years, the yield targets are multiplied by three for dry-year storage target of 825,000 AF by 2010 and 900,000 AF by 2020/25. These dry-year targets rely on healthy groundwater basins that can maintain baseline annual production during dry years and, in addition, produce the stored dry-year supplies.

As of late 2006 Metropolitan has developed strategies and executed ten contractual agreements for development of dry-year groundwater storage within its service area. Contractual storage capacity totals to nearly 422,000 AF with progress being made each year to fill the storage accounts. Additionally, Metropolitan delivers approximately 200,000 AF of replenishment service in normal years, and for planning purposes anticipates ability to interrupt this service during dry years with groundwater basins able to maintain production levels for three years. To further encourage development of groundwater, Metropolitan also provides incentives for recovery of poor quality groundwater through its Local Resources Program.

Additional progress needs to be made toward the IRP dry-year yield targets for in-service area groundwater storage. This Groundwater Assessment Study provides the basic framework for policy discussions and development of strategies that will allow new thinking about how the groundwater basin resources can be best integrated into the IRP for water supply reliability.

REPORT ORGANIZATION

This report provides a status update on groundwater basins throughout Metropolitan's service area from Ventura County in the north to the southern limits of San Diego County in the south and east into Riverside and San Bernardino Counties.

Chapter I – Introduction

Provides statement of purpose and outline for report.

Chapter II - Methodology

Documents the methodology used to compile the information and mapping.

Chapter III – Regional Overview

Provides a regional overview for orientation and perspectives of the overall service area. It also provides some key discussion of basic differences among the groundwater basins that are important to understanding and interpreting the detailed groundwater basin reports.

Chapter IV – Groundwater Basin Reports

Provides detailed overviews of basins or groups of basins that are organized by sub-regions.

CHAPTER II

METHODOLOGY

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INTRODUCTION

This Groundwater Assessment Study has been prepared with existing data from each of the groundwater basins within the Metropolitan service area. No new studies or technical analyses were conducted. This chapter outlines the process for compiling and displaying the available data that are used herein.

DATA COLLECTION AND REVIEW PROCESS

The following section describes the data collection and review process for the preparation of this document.

Scope of Study and Analysis Period

In its direction to staff in October 2005, the Board defined the scope of the study to include a description of the following items:

- Status and trends in groundwater management and use
- Investments in capital infrastructure
- Current conditions within the basins

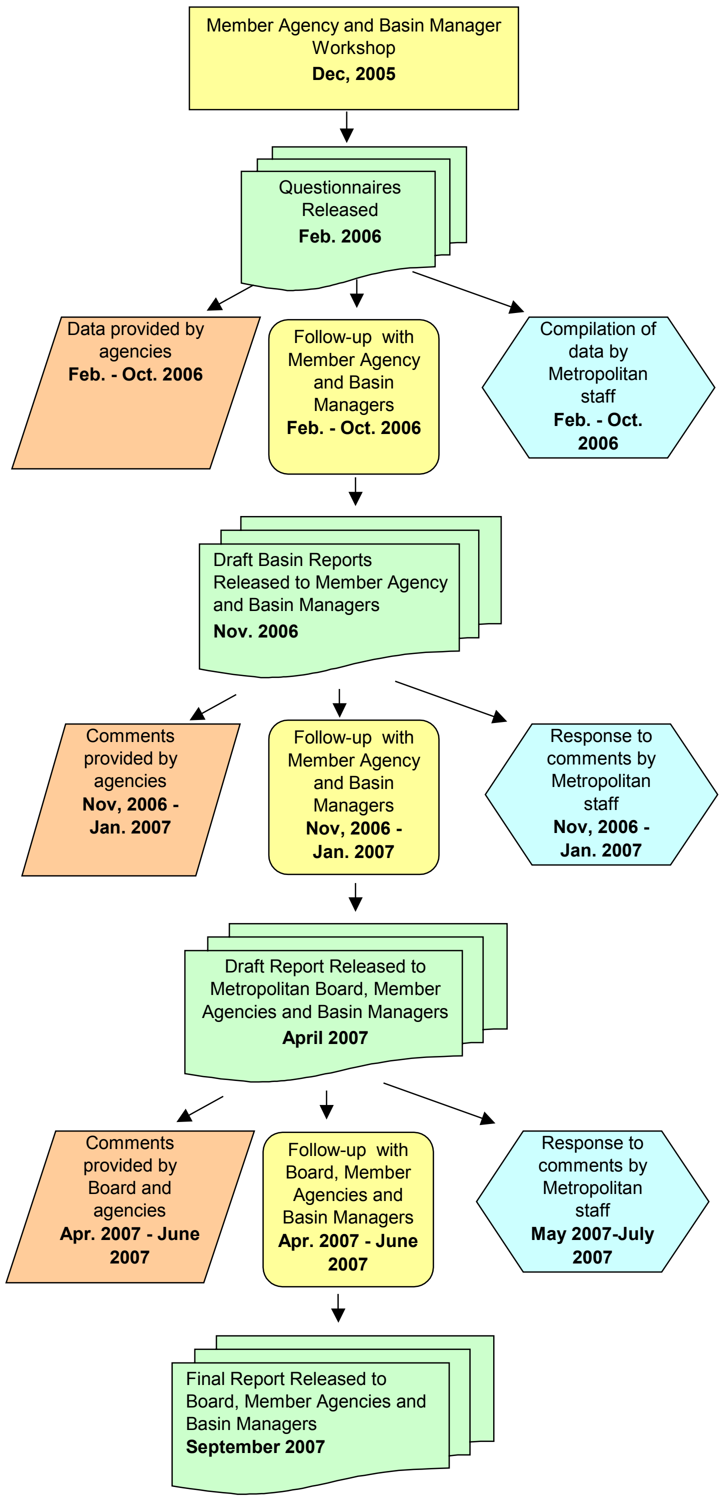
The analysis period for this study is the 20-year period from fiscal years 1985/86 to 2004/05. In some cases (e.g. San Fernando Basin), the basin is managed on a calendar year or water year basis. In these cases, the analysis period is modified to match the data available. This time period was selected to characterize the long-term trends and be as consistent with the most recent urban water management plans, which were adopted in 2005.

Member Agency and Basin Manager Input

The layout and data presented herein was developed based upon extensive input from the overlying Metropolitan member agencies and the groundwater basin managers. The process to prepare this document is shown as a flowchart in **Figure II-1.** Following the Board directive to prepare the Groundwater Assessment Study, Metropolitan invited its member agencies and groundwater basin managers throughout its service area to a workshop to discuss the Groundwater Assessment Study and the desire to establish a collaborative process for gathering and presenting information. At this December 2005 workshop, it was determined that a questionnaire should be developed and distributed to the member agencies and basin managers as the basis for providing input.

In February 2006, the questionnaire was sent out to each member agency and basin manager. The questionnaire requested input regarding the physical description of each basin, groundwater production and recharge, groundwater levels, facilities descriptions, water quality and basin management. Basin data, maps, reports, and questionnaire responses were subsequently.

Figure II-1
Review Process and Report Preparation Timeline



provided by the member agencies or basin managers for many basins within the Metropolitan service area.

In November 2006, the each draft chapter was provided to the overlying member agencies and respective basin managers for review and comment. Draft reports of each basin or group of basins were prepared using a standardized outline. Member agencies and basin managers received copies of their respective groundwater basin reports for review. A regional overview (Chapter III, presented herein) was subsequently prepared using the compiled information from the basin chapters. Metropolitan staff incorporated comments from the member agencies and basin managers.

In April 2007, a draft of the Groundwater Assessment Study report was completed and submitted to the Metropolitan Board of Directors, member agencies and basin managers for review and comment. Comments revised on the draft report were incorporated into this final report. In addition, an executive summary was prepared to accompany the final report.

Literature Review

Metropolitan staff and consultants reviewed the provided information and supplemented it with extensive literature review and discussions with basin parties. Documents reviewed, many of which could be accessed online, included items such as:

- Urban water management plans for water purveyors
- Water management plans
- Engineering reports
- Hydrogeologic reports
- Modeling reports

In addition, water quality data were augmented by data compiled from the Regional Water Quality Control Boards (Regional Boards) through their online Geotracker database. These data can be accessed at: http://www.geotracker.swrcb.ca.gov/.

MAPPING AND DATA PRESENTATION

Data for this study are organized in a Geographic Information System (GIS) format. A GIS is a combination of a database program and a graphical interface that displays data on maps. By compiling the information in a GIS, information can be accessed more easily and can be presented spatially to obtain a better understanding of the groundwater basins. Maps were developed using Environmental System Research Institute (ESRI) ArcGIS 9.1. The groundwater GIS is created in NAD83, California State Plane, Zone VI coordinate system.

Base Map Information

Base map information including freeways, water bodies, aerial photography, and Metropolitan facilities were compiled from Metropolitan files.

Groundwater Basin Boundaries

The groundwater basin boundaries of the California Department of Water Resources Bulletin 118 2004 Update were used initially for this study. This DWR base map was revised for this report based on information and GIS data supplied by the member agencies, the groundwater basin managers, and the Santa Ana Watershed Project Authority (SAWPA). These changes to the DWR mapping provided additional detail or revisions based on current technical studies and/or to reflect basin management and data reporting.

Specific changes to the DWR mapping are described in **Appendix A** and key changes are summarized below.

Ventura County Basins: These basins are within the management jurisdiction of the Fox Canyon Groundwater Management Agency (GMA), and are limited to those within the Metropolitan service area. Based on recent work performed by the U.S. Geological Survey for the GMA, the basin boundaries have been revised by the GMA and used in its groundwater management plan. Specifically, the U.S. Geological Survey divided DWR's Las Posas Valley basin into the West, East and South Las Posas basins. In addition, the Oxnard Forebay has been distinguished from the Oxnard Plain basin. The revised basin boundaries used by the GMA are used in this report.

San Gabriel Valley: This large DWR basin was divided to reflect groundwater basin adjudications and associated management and use: Main San Gabriel Basin, Puente Basin, Six Basins and Spadra Basin.

Upper Santa Ana Valley: DWR's Upper Santa Ana Valley is broken into the following six subbasins: Temescal, San Timoteo, Riverside-Arlington, Chino Cucamonga, and Rialto-Colton. The Rialto-Colton area is outside the Metropolitan service area and has not been covered in this report. With respect to the remaining basins, the mapping utilized by the Santa Ana Watershed Project Authority (SAWPA) has been used. There are slight variations in the basin boundaries, and divisions of basins to reflect management. The mapping of the common boundary between the Chino and Cucamonga basins has been adjusted to reflect hydrogeology as reflected in mapping rather than the adjudicated boundary presented in DWR Bulletin 118. Riverside Basin has been separated from Arlington Basin. The mapping of Temescal Basin is also somewhat modified from Bulletin 118 as relates to the boundary with Elsinore Basin.

Coastal Plain of Orange County: This basin was modified using the boundaries identified by SAWPA. In addition, the La Habra basin, which was included in the DWR basin, was separated from the Orange County Basin in this report.

Elsinore and Temescal Basins: DWR's mapping of Elsinore and Temescal basins has been broken down into subcomponents for purposes of this report, again using SAWPA's mapping. For purposes of this report, the Bedford, Coldwater and Lee Lake basins have been distinguished from the Elsinore Basin and addressed in one groundwater basin report titled Temescal Valley Basins along with the Temescal Basin. The remainder of Lake Elsinore Basin is addressed in its own groundwater basin report.

San Jacinto Basin: The San Jacinto Basin of Bulletin 118 has been divided into the Hemet-San Jacinto Basins (Hemet North, Hemet South, San Jacinto Upper Pressure, and San Jacinto Canyon) and the West San Jacinto Basins (Perris North, Perris South, Lakeview, Menifee, and San Jacinto Lower Pressure). These more detailed mapping units are reflected in groundwater management plans for this area. Overall boundaries are quite similar to those of Bulletin 118, but have been somewhat refined to better reflect geology.

Temecula Valley: This report addresses only a portion of the area mapped by DWR as the Temecula Valley Basin. Herein the covered portion is called Temecula-Murrieta Basin and is comprised of the Pauba and Temecula aquifers as mapped in the Santa Margarita River Watershed Management Plan and consistent with input received from the Santa Margarita River Watermaster and the Rancho California Water District. We have not used local surface water hydrology designations to further delineate these aquifers as sometimes done in the local documents.

San Diego County Basins: This report's mapping and inclusion of groundwater basins in coastal San Diego County reflects input from Metropolitan's member agency, the San Diego County Water Authority. Basins not used to meet municipal water supply are not included. The Las Flores Basin and San Diego Formation aquifer have been added. Sub-basins have been distinguished for the San Luis Rey Valley Basin.

Basin Management Facilities

The geographic distribution of groundwater management facilities is important to understanding the groundwater basin. Data included in the GIS coverage for each basin are:

- Key wells
- Spreading basins
- Seawater intrusion barriers
- ASR wells
- Desalters
- Other regionally significant facilities

These data were provided by the member agencies or basin managers, or from the literature review as applicable. Each facility is highlighted in a map for each basin that is included in Chapter IV – Groundwater Basin Reports of this document.

Other Data

Production and water level data for each basin are compiled for the period between fiscal years 1985/86 to 2004/05 where available. Primary data sources included electronic data directly from member agencies, basin managers, and water purveyors. When these data were not available, additional sources as part of the literature review were cited to obtain additional production and water level data. Often times, data for all producers in a basin, particularly those who are non-member agencies are not available. For example, production from private wells are often unquantified and could be significant in some groundwater basins. A complete list of references is provided in each basin report in Chapter IV, Groundwater Basin Reports.

Precipitation data were obtained from representative stations in each basin. Sources included: the California Irrigation Management Information System (CIMIS), University of California Integrated Pest Management (UC IPM) and applicable watermaster reports. CIMIS data can be accessed via the Internet at: http://wwwcimis.water.ca.gov/cimis/data.jsp. UC IPM data can be accessed via the Internet at: http://www.ipm.ucdavis.edu/WEATHER/wxretrieve.html. A complete list of references is provided in each basin report in Chapter IV, Groundwater Basin Reports.

Groundwater recharge data including direct groundwater recharge via spreading basins and injection wells were generally obtained via electronic data directly from the member agencies, basin managers and water purveyors. For some basins in Los Angeles County, runoff recharge data are compiled from Los Angeles County Department of Public Works data. These data are available via the Internet at: http://ladpw.org/wrd/report/

Groundwater data compiled as part of this study have been used to assess the state of the groundwater within the Metropolitan service area. The remaining chapters of this report summarize the data for the entire region (Chapter III, Regional Overview) and for individual groundwater basins (Chapter IV, Groundwater Basin Reports).

DISCLAIMER

This report has been prepared using a wide variety of data and sources. Metropolitan makes no warranties, either expressed or implied, with respect to the data within this report, its accuracy, its quality, or fitness for a particular purpose or use. In no event will Metropolitan be liable for direct, indirect, consequential or incidental damages resulting from any inaccuracies in the data. The readers should review and evaluate the data to determine its suitability of use for their activities.

CHAPTER III

REGIONAL OVERVIEW

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INTRODUCTION

The focus of this chapter is to provide a regional overview on key topics that may assist big-picture thinking and understanding about groundwater use and management in Metropolitan's service area. Information reviewed and considered in this overview is drawn from the groundwater basin reports presented in Chapter IV, Groundwater Basin Reports and is compiled to allow comparison of subregions as well as an assessment of the Metropolitan service area as a whole. Topics addressed in this chapter are: management inclusive of differences related to safe yield, facilities, trends in groundwater production and recharge, groundwater levels and changes in groundwater storage, and availability of basin space for storage. This chapter is not intended to provide a comprehensive summary of the groundwater basin reports presented in Chapter IV.

GROUNDWATER BASIN MANAGEMENT

The following section describes groundwater basin management in the Metropolitan service area. The discussion begins with a description of the various types of management or governing structure within the service area. There are many definitions for safe yield. This section describes how safe yield is interpreted and incorporated in the sustainable operations of the basins. Groundwater storage also plays an important role in groundwater management. A brief description of how groundwater storage opportunities are addressed in the basins is also provided.

Types of Groundwater Management Structure

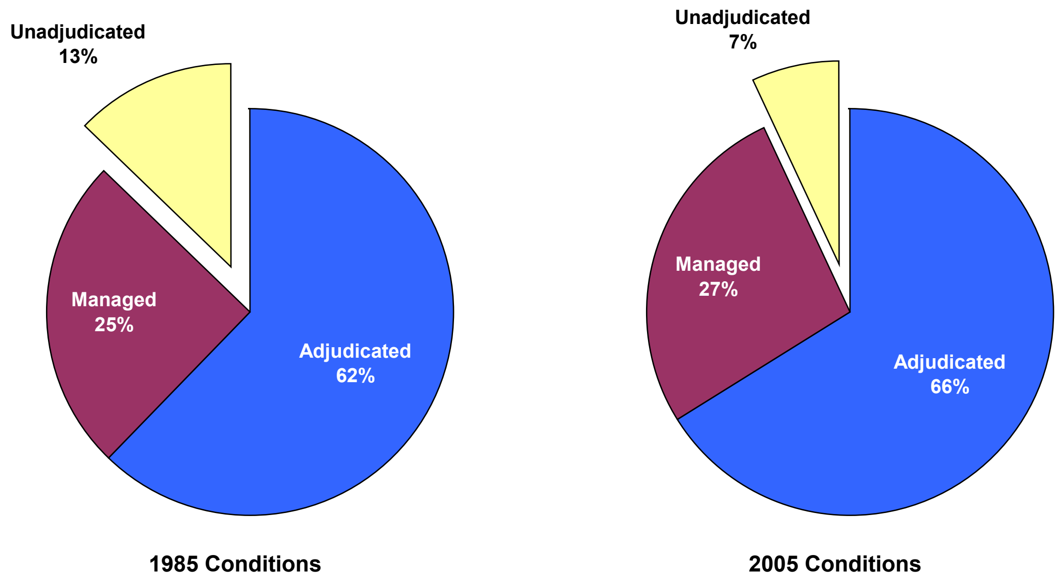
There are various ways that groundwater is managed in Southern California. To assist in understanding these differences, the groundwater basins in the Metropolitan service area are divided into five specific types. These include:

- Formally adjudicated with respect to production, water levels, or downstream flows within the basin,
- managed by an agency created and given authority by State statute,
- managed pursuant to an adopted groundwater management plan developed in accordance with the State water code provisions,
- managed informally by city ordinance or by consensus among some or all of the producers, and
- not governed, managed or adjudicated.

More than 90 percent of the groundwater resources within the Metropolitan service area are adjudicated or formally managed pursuant to statute or adopted groundwater management plan. **Plate III-1** shows the basins as adjudicated, formally managed, or unadjudicated. Basins with a court judgment are included in the 'adjudicated' category. Basins with either a statutory management agency or adopted groundwater management plan are shown as formally managed. Two substantial basin areas are managed pursuant to state statutes creating groundwater management agencies: the Ventura County basins within the jurisdiction of the Fox Canyon Groundwater Management Agency and the Orange County Basin managed by the Orange County Water District. Basins with groundwater management plans in progress, informal management, or no management framework are designated as 'unadjudicated' on **Plate III-1**.

As shown in **Figure III-1**, nearly two-thirds of the total groundwater production in the Metropolitan service area during 2004/05 was pumped from an adjudicated basin and about 27 percent from a managed basin (combined from both adjudicated and managed is about 93 percent). Only 7 percent of the total groundwater production is pumped from unadjudicated basins. Seven groundwater basins have become managed or adjudicated since 1985, which accounts for the decrease of about 6 percent in production from unadjudicated basins.

Figure III-1
Groundwater Production Classified by Basin Management Type



Of those shown as unadjudicated in 2005, many are in process of moving toward status as formally managed. For example, a groundwater management plan for the Hemet-San Jacinto Basins is likely to be adopted in 2007, superseding the existing judgment covering two of the subbasins in that group. The city of Corona is also preparing a groundwater management plan for the Temescal Basin. The city of Beverly Hills has adopted ordinances that place requirements on groundwater dewatering activities within the Hollywood Basin. The San Luis Rey Watershed Council adopted Watershed Management Guidelines in 2000. The Sweetwater Authority adopted an Interim Groundwater Management Plan in 2001 for the Sweetwater Basins and the San Diego Formation. Additionally, consideration is being given to formal management of the San Dieguito River Basins and Mission Valley Basin in San Diego County. Management of each groundwater basin has features and characteristics that are unique. These unique features are due to need, specific physical characteristics of basins, history, and preferences of the parties within each of the basins. **Appendix B** summarizes the status of groundwater basin management and summarizes the key provisions of the statutes, judgments, and management plans addressing basins covered by this report.

Safe Yield in Basin Management

Safe yield is generally defined as the maximum quantity of water that can be withdrawn from a groundwater basin over a long period of time without resulting in adverse conditions. Safe yield is typically determined by technical professionals based upon a defined hydrology, water levels or groundwater models and is often used to define the legal rights to extract groundwater in a basin. An operational safe yield may be defined to address short-term basin changes. The natural safe yield (or native safe yield) is often used to define the yield of a basin without active recharge and, in basins where active recharge is common, stresses the importance of groundwater recharge operations in basin management. Safe yield estimates among basins generally differ in how active recharge is handled. Because of these differences, the definition of safe yield is often basin-specific.

For example in the San Fernando Basin, the judgment distinguishes between native safe yield (portion of safe yield derived from native waters) and safe yield (includes return flows from imported water), and divides pumping rights based on native and imported water origins. In contrast, the Raymond Basin judgment sets out fixed pumping rights based upon a safe yield calculation that factors in natural recharge alone and does not include active recharge of runoff. In Raymond Basin, rights to divert surface water for spreading are separately specified for the basin water rights holders so that pumping rights are adjusted upward by recharge activities utilizing native water. In further contrast is the Six Basins judgment which sets out safe yield that is inclusive of active spreading and imported water return flows.

The determination of safe yield may also include quantitative measures to evaluate when adverse conditions occur. Adverse conditions include such things as permanently lowered groundwater levels, subsidence, or degradation of water quality in the aquifer. This is particularly important in basins in which seawater intrusion is a factor. For example, the Ventura County Basins operate under a safe yield that is based upon maintaining water levels to prevent seawater intrusion or migration of contaminants among aquifers. This safe yield is significantly lower than the safe yield determined based on a hydrologic water balance alone.

A basin is in overdraft if the amount of water pumped from the basin exceeds the safe yield of the basin over a period of time. Pumping in individual years may vary above or below the long-term yield of the basin during drought or wet years, or as dictated by basin management strategies and does not necessarily mean that a basin is in overdraft. Basins such as the Orange County Basin may allow short-term "overdraft" of the basin (based upon change in storage) to meet management goals yet have established a maximum accumulated overdraft allowable that prevents adverse conditions within the basin. The Basin Pumping Percentage (BPP) is used to maintain the storage in the Orange County Basin within this desired range.

It is also important to recognize that if water management or other factors in the basin change, the safe yield of the basin may also change. Cultural or land use factors that were in place at the time that the technical calculations were performed are also important. Where land use has changed considerably, the safe yield may no longer reflect actual conditions. This is particularly important in basins where impervious cover has increased runoff and reduced recharge. Where rights to produce groundwater are fixed and are not adjusted based on key well elevations or other on-going type of measurement, the basin may become over drafted even though adjudicated. On-going monitoring of water levels by watermasters is helpful to identify these types of situations so that appropriate management actions can be implemented.

This variability is important to understanding the role of imported water in the sustained operations of the groundwater basins. It is important to note that imported replenishment water is factored into the safe yield and fixed rights for production of groundwater in some groundwater basins while in other basins, imported replenishment water allows increased pumping. While all the managed and adjudicated basins are focused at sustainability, as described below, the means of getting there can vary.

Methods of Sustainable Basin Operations

One of the key objectives of groundwater basin management is to provide for sustainable operations of the groundwater basin over the long term. This means that long-term recharge and production or discharge of groundwater is balanced and that the basin is operated within its safe yield. Each basin has developed unique management characteristics for accomplishing this objective. Examples of various management operation styles are described below.

Some basins are managed or adjudicated to maintain a fixed maximum amount of groundwater pumping from year to year. For example, the Central Basin has been adjudicated with a fixed pumping allocation above the native safe yield of the basin, which requires supplemental recharge with imported and recycled water to support the fixed pumping rights of the groundwater producers. The amount of supplemental recharge is dependent upon annual hydrologic conditions. The Water Replenishment District of Southern California was created by statute with duties for accomplishing the supplement recharge. The watermaster function is focused on strict accounting pursuant to the established rules.

Other basins are managed or adjudicated to allow for variations in groundwater pumping but still maintain sustainable operations. For example, the judgment for the Main San Gabriel Basin provides for setting an annual operational safe yield with associated adjustments in pumping rights that are not subject to payment for replacement water. Producers may pump in excess of the annual pumping right set through this process, but this excess production is subject to payment for imported supplemental water to recharge the basin. The watermaster is a board comprised of representatives of the basin producers, and makes decisions regarding setting of the annual operational yield.

The Orange County Basin management model is similar to the Main San Gabriel Basin model. In the Orange County Basin pumping limits are not fixed. The Orange County Water District (OCWD) establishes the annual Basin Pumping Percentage (very similar to annual operating safe yield), and production over the BPP incurs costs (basin equity assessment). The key difference is that the Orange County Basin's BEA will parallel Metropolitan's full service water costs (this is a price signal associated with basin management objectives), whereas the cost of replacement water in Main San Gabriel Basin will parallel the cost of replenishment water from Metropolitan's member agency and from the San Gabriel Valley Municipal Water District. Water supply strategies adopted in Main San Gabriel and Orange County basins differ in that water purveyors in Main San Gabriel Basin are mostly dependent on groundwater. In Orange County Basin, water purveyors use both imported water and groundwater and the BPP dictates the percentage of each that is used.

Chino Basin is also similar to the Main San Gabriel Basin with respect to safe yield and pumping. In Chino, the safe yield is specified in the judgment and divided among three groups or pools of producers. This production is sustained by natural recharge and no replenishment costs are assessed to support it. The judgment allows production in excess of the safe yield, but requires the replacement of these pumped amounts that then incur the replenishment obligation costs.

Provisions for Groundwater Storage and Recapture

In many basins, groundwater storage is an important aspect of groundwater management. A review of basin adjudications and management plans has pointed out differences in the allowances made for storage and recapture of surplus water. Most of the judgments, statutes, and plans for groundwater basin management clearly provide for storage and recovery of surplus water. In most cases, the basin manager or watermaster must approve of the storage and extraction, and provide accounting for the stored and extracted water. Of note, however, are the judgments in Central, West Coast, and Puente basins that do not provide for more than carryover of limited unpumped rights. Further, the Central Basin judgment appears to restrict recovery of water not expressly provided for in the specification of fixed pumping rights. Also of note is the provision of the Orange County Water District Act which gives OCWD the power to regulate and control the storage of water and use of groundwater basin storage space but also gives the directive that use of the groundwater basin for replenishing and managing the groundwater supplies shall have priority over use of the groundwater basin for storage of water.

BASIN OPERATIONS

The following section describes current operations in the groundwater basins within the Metropolitan service area. This section includes a description of groundwater facilities, production, active recharge and treatment.

Groundwater Facilities

Groundwater facilities identified within the service area include:

- More than 4,300 active groundwater production wells
- 36 ASR wells
- 5,000 acres of spreading
- 400 acres of water quality wetlands
- 7 seawater intrusion barriers and
- 16 desalters

The locations of these facilities are shown on **Plate III-2**. These facilities are summarized by region in **Table III-1**.

Groundwater Production

One of the factors that affect groundwater production is precipitation. The locations of representative precipitation stations and key wells are shown in **Plate III-3**. Average precipitation is approximately 15.2 inches (based upon average of 17 stations throughout service area). Periods 1985/86 to1994/95 and 1995/96 to 2004/05 have approximately equal precipitation. Each period had two significantly wet years. Cumulative departure from mean curves (which both begin and end at approximately zero) suggest similar hydrologic conditions between the two periods. As shown in **Figures III-2 and III-3**, groundwater production generally increases during periods of low precipitation and decreases during periods of high precipitation. Groundwater production varies as much 30 percent between the wettest and driest years.

Changes in production patterns are important to understanding the water supply needs of the region. Groundwater production currently meets about 40 percent of the total water demand within the Metropolitan service area. Groundwater production increased about 8 percent from the period between 1985/86 and 1994/95 to the period between 1995/96 and 2004/05. These changes are summarized in **Plate III-4**. Likewise, full- service plus agricultural Metropolitan deliveries increased 14 percent over this same period. Groundwater production increased in all areas except in the Northwest Metropolitan service area, which decreased 20 percent due to mandatory pumping restrictions implemented to address declining water levels and seawater intrusion. The largest increases in production occurred in the San Fernando Valley and the Eastside portion of the Metropolitan service area. The smallest increases were noted in Los Angeles Coastal Plain and San Diego County. Small increases in the Los Angeles Coastal Plain are a result of strict pumping limits in these basins under their respective adjudications. Data summarized by region are provided in **Table III-2**.

Active Groundwater Recharge

Active groundwater recharge is an important component of groundwater management within the Metropolitan service area. The term ‘active recharge’ is used herein to mean all artificial recharge using local (i.e. runoff diverted to spreading basins), imported and recycled waters exclusive of natural recharge.

Table III-1
Groundwater Facilities in Metropolitan Service Area

Sub-Region	Active Wells	ASR/ Injection Wells	Spreading Basins (acres)	Water Quality Wetlands (acres)	Seawater Barriers	Desalters
Northwest Service Area	611	19	220	0	0	1
San Fernando Valley	146	0	314	0	0	0
San Gabriel Valley	414	7	1,930	0	0	0
Los Angeles Coastal Plain	1,382	4	1,006	0	3[1]	3
Orange County	500	0	1,034	400	1[1]	3
Inland Empire	773	2	350	0	0	2
Eastside Service Area	453	4	53	0	0	5
San Diego County.	85 [3]	0	65	0	3[2]	2
Total	**4,364**	**36**	**4,972**	**400**	**7**	**16**

1. Alamitos Barrier Project is attributed to the Los Angeles Coastal Plain region.
2. Wastewater effluent from Camp Pendleton is spread to create seawater intrusion barriers in San Mateo, and San Onofre Basins and injected in the Las Flores Basin.
3. Data for several basins in San Diego are incomplete.

Table III-3 summarizes the active recharge in the Metropolitan service area by region. **Figure III-4** shows the total active recharge within the Metropolitan service area for the period 1985 through 2004. For this 20-year study period, an average of approximately 681,000 AFY or about 90 percent of the total active recharge was recharged to the groundwater basins by direct recharge methods (i.e. injection or spreading). For this period, about 77,000 AFY was recharged to the groundwater basins via in-lieu methods.

Figure III-2
Precipitation in Metropolitan Service Area

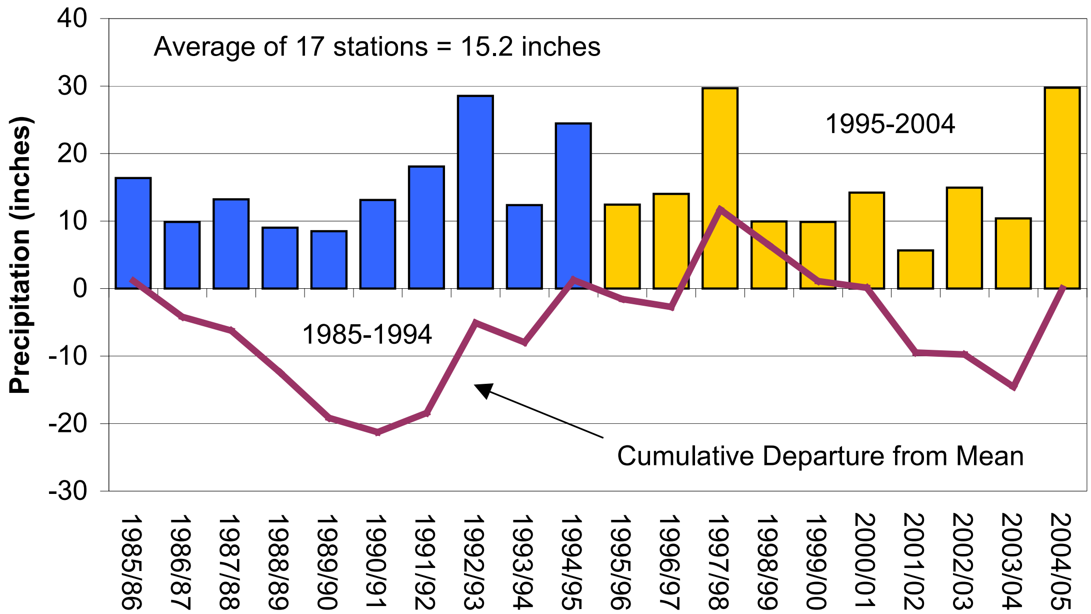


Figure III-3
Groundwater Production in Metropolitan Service Area

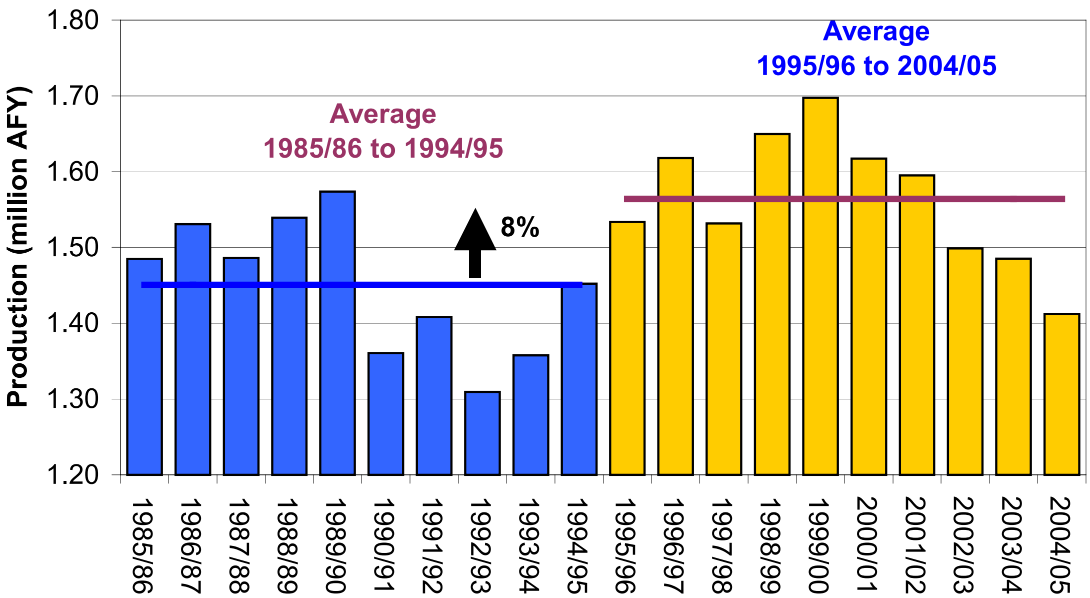


Table III-2
Groundwater Production in the Metropolitan Service Area by Sub-Region

Sub-Region	Average 1985-2004 (AFY)	Average 1985-1994 (AFY)	Average 1995-2004 (AFY)	Percent Change 1985-94 to 1995-04
Northwest Service Area	137,000	152,000	122,000	-20%
San Fernando Valley	99,000	90,000	109,000	21%
San Gabriel Valley	308,000	297,000	320,000	8%
Los Angeles Coastal Plain	244,000	241,000	248,000	3%
Orange County	297,000	275,000	318,000	16%
Inland Empire	172,000	164,000	181,000	10%
Eastside Service Area	197,000	181,000	213,000	18%
San Diego County	52,000	51,000	52,000	3%
Total	**1,506,000**	**1,451,000**	**1,563,000**	**8%**

Note: Data are rounded to nearest 1,000 AF.

Methods of groundwater recharge have generally remained unchanged over the past 20 years as the relative proportion of each method are essentially the same between the 1985/86 to 1994/95 and 1995/96 to 2004/05 time periods as shown in **Figure III-5**. Likewise, the total recharge remained nearly constant with a decrease of about 2 percent between the two timeframes.

Recharge of captured runoff is by far the largest component of active recharge. When comparing the recharge portfolios for the two timeframes, the percentage of the recharge accomplished with use of runoff increased by 7 percent. Moreover, use of imported water for recharge as a component of the total groundwater recharge portfolio decreased 5 percent when comparing the two, ten-year timeframes (as shown in **Figure III-5**). In addition, the amount of active recharge supporting production decreased from 53 to 48 percent as shown in **Table III-4**. In other words, groundwater production grew about 5 percent more than artificial recharge between the two timeframes.

Trends in groundwater recharge have been examined in two different ways. **Table III-3** compares average annual recharge by sub-region for the two, ten-year time frames. These data include direct and in-lieu recharge as well as recharge that was accomplished under the cyclic pre-delivery program.

Table III-3
Groundwater Recharge in Metropolitan Service Area by Sub-Region

Sub-Region	Average 1985-2004 (AFY)	Average 1985-1994 (AFY)	Average 1995-2004 (AFY)	Change 1985-94 to 1995-04 (%)
Northwest Service Area	60,000	57,000	64,000	13%
San Fernando Valley	31,000	28,000	34,000	20%
San Gabriel Valley	169,000	168,000	170,000	2%
Los Angeles Coastal Plain	195,000	221,000	170,000	-23%
Orange County	257,000	243,000	271,000	11%
Inland Empire	23,000	28,000	18,000	-36%
Eastside Service Area	23,000	22,000	23,000	4%
San Diego County	0	0	0	0%
Total	**758,000**	**767,000**	**750,000**	**-2%**

Note: Data are rounded to nearest 1,000 AF.

Table III-4
Comparison of Production to Active Recharge for the Metropolitan Service Area
1985-1994 to 1995-2004

Component	Average 1985-1994 (AFY)	Average 1995-2004 (AFY)	Change %
Production	1,451,000	1,563,000	8%
Active recharge	767,000	750,000	-3%
Percent of Production Supported by Active Recharge	53%	48%	-5%

Note: Data are rounded to nearest 1,000 AF.

Figure III-4
Active Recharge in the Metropolitan Service Area 1985 to 2004

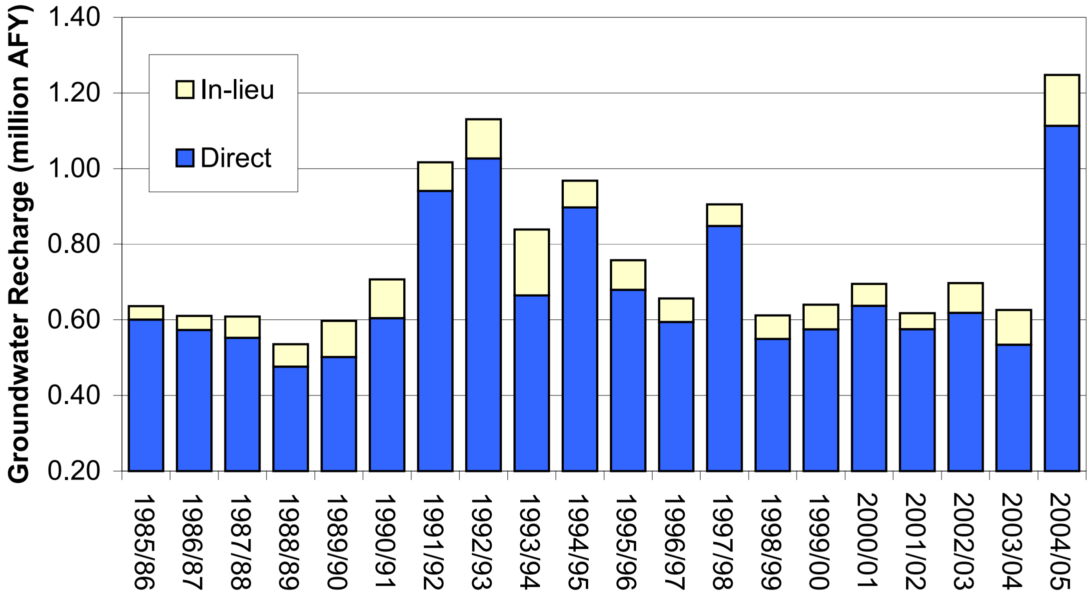
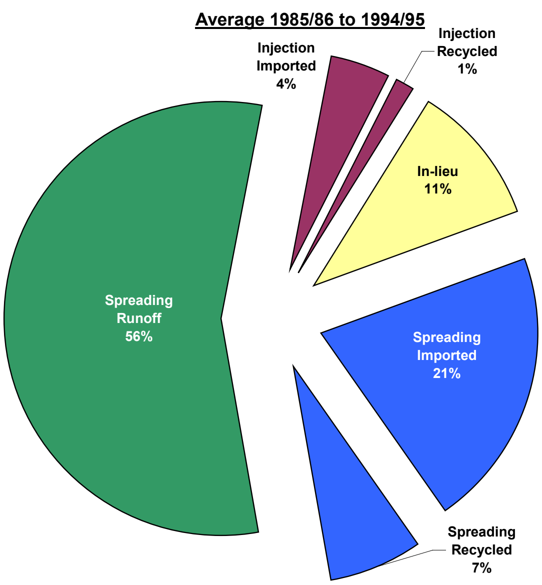


Figure III-5
Comparison of Recharge in the Metropolitan Service Area
1985-1994 to 1995-2004



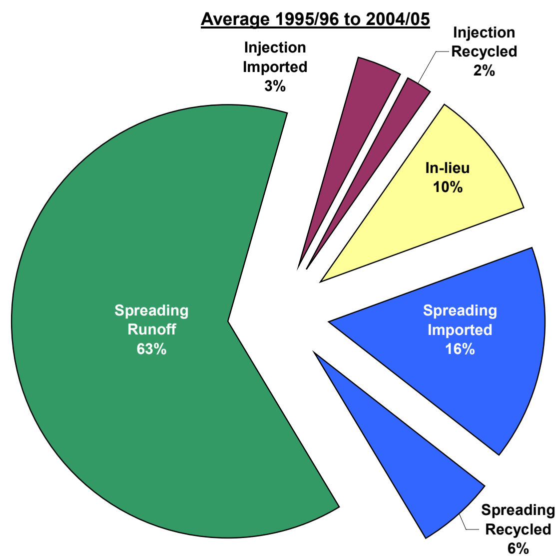


Plate III-5 compares direct recharge within the sub-regions for two wet years, 1992/93 and 2004/05. Each of these wet years was preceded by a series of drier years as shown on **Figure III-2**. This comparison presents a different picture for recharge. In most sub-regions, total direct recharge for these two years was either relatively constant or showed substantial increases in recharge. This may be due in part to rainfall patterns during the course of each of the two years and to investments and increased efforts to capture runoff. Of note, active recharge in the Northwest subregion declined between these two years. This is a result of less water recharged from the Santa Clara River. A comparison of the two years is not made for the San Diego County basins due to limited available data.

In 2004/05, direct recharge used about 60 percent of the reported available capacity for spreading and injection. Total direct recharge (all sources of water) for the year totaled about 1.11 million AF as compared to the reported capacity of 1.85 million AFY for spreading and injection. This usage rate reflects rainfall patterns, and availability of regional and local conveyance and recharge capacity.

Groundwater Treatment

Many new groundwater treatment facilities have been constructed since 1985, which have greatly increased the amount of groundwater that can be used for beneficial uses. Groundwater treatment and blending needs within the Metropolitan service area are summarized in **Table III-5**.

Approximately 21 percent (300,000 AF) of groundwater production in 2004/05 was either treated or is blended for water quality considerations. These estimates are based upon data received from basin managers or groundwater producers. Because the amount of water blended is often not measured, the estimate of amount blended could be significantly underestimated. About 40,000 AF, or nearly 20 percent of the water treated, was produced in 2004/05 as part of Metropolitan's LRP Groundwater Recovery Projects. Nearly all of the treated groundwater is treated for TDS, nitrate, volatile organic compounds (VOCs), or perchlorate.

The largest percentage of treated or blended groundwater occurs in the San Fernando Valley and San Gabriel Valley, where significant VOC plumes have been identified, and in the Eastside and the San Diego County basins where high TDS groundwater is common. For example, many of the San Diego basins are not used for municipal demand because of high TDS. The Arlington, Temescal, Perris and Menifee Desalters in the Eastside area basins have come online since 1985, which has greatly increased the treatment capacity in these basins.

Lower percentages of treated groundwater are found in Northwest, Orange County, and Los Angeles Coastal Plain basins. The Northwest area basins are largely used to serve agricultural demand, for which significant treatment is not needed. On the other hand, about 15 percent of the municipal groundwater in the Fox Canyon GMA is treated or blended. Because large portions of the Los Angeles and Orange County basins are protected from surface contaminants by clay aquitards, these basins tend to have less of a need to treat produced groundwater.

Table III-5
Groundwater Treatment and Blending in Metropolitan Service Area by Sub-Region in 2004

Sub-Region	Treated (AF)	Blended (AF)	Treated or Blended (AF)	Percent Treated	Percent Treated or Blended
Northwest Service Area	3,000	10,000	13,000	2%	11%
San Fernando Valley	18,000	51,000	69,000	22%	88%
San Gabriel Valley	83,000	4,000	87,000	28%	29%
Los Angeles Coastal Plain	15,000	0	15,000	6%	6%
Orange County	20,000	2,000	22,000	8%	8%
Inland Empire	12,000	7,000	19,000	7%	11%
Eastside Service Area	50,000	11,000	61,000	24%	29%
San Diego County	14,000	0	14,000	27%	27%
Total	**215,000**	**85,000**	**300,000**	**15%**	**21%**

Note: Data are rounded to nearest 1,000 AF.

GROUNDWATER LEVELS AND CHANGE IN STORAGE

Groundwater level changes between 1985 and 2004 are highly variable throughout the Metropolitan service area. In some basins, water levels are increasing while in others, they are decreasing. In addition, it is not uncommon for some portions of the basin to be increasing while other areas within the basin are decreasing or stable.

Five general patterns of water level trends have been identified for the groundwater basins in the Metropolitan service area. These are:

- basins in slow decline
- basins in arrested decline and recovery
- basins with stable, flat water levels
- basins with stable average water levels but with wide swings
- basins with rising water levels often due to poor water quality and decreases in use

A few basins also calculate annual changes in storage. In general, these estimates correlate well with changes in water level and help to quantify the relative importance of water level changes. A summary of groundwater level and storage trends is provided in **Table III-6**.

A number of groundwater basins have had slowly declining water levels over the study timeframe. These include the San Fernando, Raymond, Hemet-San Jacinto, Elsinore and Temescal basins. In all cases, the decline is recognized but turnaround is not yet seen in the data. Both the San Fernando and Raymond basins are adjudicated with pumping restrictions tied to fixed estimate of safe yield recognized in the judgment. For example, total groundwater in storage has decreased about 12 percent in the Raymond Basin since 1985. These situations point out the need to monitor and re-assess safe yield as cultural conditions change and a longer period of record becomes available. In addition, several of the groundwater basins in Riverside County have declining water levels.

The Ventura County basins within the jurisdiction of the Fox Canyon Groundwater Management Agency also showed declining water levels between 1985 and 1990. The GMA has instituted mandatory production cutbacks of 20 percent in these managed groundwater basins to allow recovery of groundwater levels and halting of seawater intrusion. Since 1990, most of these basins have shown a healthy recovery in groundwater level.

The Central and Chino basins are examples of basins operated such that water levels are generally very stable from year-to-year. Each of these basins has a drawdown area, but overall water levels are consistent. In Central Basin, the judgment restricts pumping to a safe yield that depends upon active recharge from runoff, recycling and imported water sources. The Water Replenishment District of Southern California has statutory responsibility to recharge the Central Basin. This combination of management has resulted in the stable water levels.

The Orange County and Main San Gabriel basins, managed and adjudicated, respectively, provide examples of basins with stable water levels over the long-term but with operational swings in the short-term. Each of these basins is very responsive to stormwater recharge, and the management structures in each case provide sufficient flexibility to take full advantage of the hydrologic conditions.

Table III-6
Groundwater Storage and Water Level Changes in Metropolitan Service Area

Sub-Region	Change in Storage 1985-2004 (AF)	Change in Storage 1985-2004 (%)	Water Level Changes (1985-2004)	Status
Northwest Metropolitan Service Area				
Ventura County Basins	Insufficient data to determine		Water levels in key wells increased 25 to 50 feet in the inland basins since 1990. Water levels in key wells in coastal areas increased as much as 120 feet between 1990 and 1995 and have remained relatively stable since that time.	Arrested decline and recovery
San Fernando Valley				
San Fernando	-108,245	-4%	Water levels in key wells dropped 25 to 50 feet	Long-term decline
Sylmar	Insufficient data to determine		Water levels in key wells increased about 15 feet	Rising
Verdugo	Insufficient data to determine		Water levels in key well decreased 40 feet	Long-term decline
Eagle Rock	Insufficient data to determine			Insufficient Data
San Gabriel Valley				
Raymond	-114,410 (through 2002)	-12%	Water levels in key wells in eastern portion of Pasadena unit and Santa Anita unit decrease about 75 feet. Despite increases of between 50 and 100 feet in key wells in Monk Hill and western portion of Pasadena unit, net decrease in water level and storage is noted.	Long-term decline
Main San Gabriel	Insufficient data to determine		Water levels in key well suggest that water levels in basin are essentially unchanged.	Stable with wide swings
Puente	Insufficient data to determine		Water levels in key well suggest that water levels in basin are essentially unchanged.	Stable with flat water levels
Six Basins	Insufficient data to determine		Water levels in key wells in upper basins decrease as much as 70 feet. Water levels in key well in Pomona basin increases about 150 feet	Rising
Los Angeles Coastal Plain				
Central	27,101	+ Less than 0.5%	Water levels in keys well increase less than 10 feet in the forebay areas and decrease about 15 feet in the forebay areas.	Stable with flat water levels
West Coast			Water levels in key well increased about 10 feet.	Stable with flat water levels
Hollywood	Insufficient data to determine		Water levels in key wells in the eastern portion of the basin are essentially unchanged.	Stable with flat water levels

Table III-6 (continued)
Storage and Water Level Changes in Metropolitan Service Area by Region

Region	Change in Storage 1985-2004 (AF)	Change in Storage 1985-2004 (%)	Water Level Changes (1985-2004)	Status
Los Angeles Coastal Plain (continued)				
Santa Monica	Insufficient data to determine		Water levels in key wells increased from 20 to 50 feet in Arcadia and Charnock subbasins. Other basins remained unchanged.	Rising
Orange County				
Orange County	-110,000 (through 2004/05)	- Less than 0.5%	Water levels in key well in south-central pressure area decreased up to 70 feet that may be due to seasonal variations. Water levels in key wells are essentially unchanged in northern central pressure and forebay locations.	Stable with wide swings
San Juan	Insufficient data to determine		Insufficient data to determine	Insufficient Data
Inland Empire				
Chino	Insufficient data to determine		Water levels in key wells are essentially unchanged throughout most of the basin.	Stable with flat water levels
Cucamonga	Insufficient data to determine		Water levels in key well decreased about 120 feet.	Long-term decline
Eastside Metropolitan Service Area				
Riverside	Insufficient data to determine		Water levels in key well in Riverside North are stable. Water levels in key well in Riverside South dropped about 30 feet.	Stable/Decreasing
Arlington	Insufficient data to determine		Water Levels in key well near desalter wells dropped 50 feet. Other wells in basin seem to be stable.	Stable with flat water levels
Temescal Valley	Insufficient data to determine		Water levels in key well in Temescal Basin dropped about 50 feet. Water levels in key well in Coldwater Basin dropped about 200 feet. Water levels in Lee Lake and Bedford were stable.	Long-term decline
Elsinore	-43,343	-4%	Water levels in key wells dropped as much as 240 feet.	Long-term decline
West San Jacinto	Insufficient data to determine		Except for the San Jacinto Lower Pressure area, water levels are increasing in key wells as much as 90 feet	Rising
Hemet-San Jacinto	-219,235	-8%	Water levels are declining in all basins with drops ranging from 20 to more than 100 feet.	Long-term decline
Temecula-Murrieta	Insufficient data to determine		Water level in key well dropped about 75 feet.	Long-term decline
San Diego Co	Insufficient data to determine			Insufficient Data

AVAILABILITY OF GROUNDWATER BASIN STORAGE

As of June 2006, there is at least 7.5 million AF of unused storage space in the groundwater aquifers within the Metropolitan service area, assuming that all the unsaturated space below the ground surface or the full basin level could be used for groundwater storage programs. Clearly, not all the unsaturated space identified can be used. For example, groundwater levels within 50 to 100 feet of the ground surface increases the risk for liquefaction so the upper 50 to 100 feet is generally not considered usable for storage. In addition, because of some overlying land uses that may require lower groundwater levels (e.g. gravel mining, landfills), the entire unused portion may not be able to be used for storage. Given these considerations, the estimated amount of the unused space that could potentially be used for storage is referred to herein as *available storage space*. As of June 2006, there is approximately 3.2 million AF of available storage space within the Metropolitan service area, a portion of which has already been allocated for groundwater storage programs but has not been stored yet, as described below. The estimated available storage space does not consider the feasibility of actually delivering water or the facilities needed to store and extract the water. **Table III-7** summarizes the amount of groundwater storage space available by sub-region. **Plate III-6** shows the distribution of the available storage space.

Feasibility may be affected by institutional uncertainties, expense of necessary capital investment for storage, extraction, and/or conveyance of water supplies, water quality issues including contaminant remediation operations, lack of overlying demand for imported water supplies, watermaster allocations of storage space for long or short-term use, or other factors.

For example, nearly 1 million AF of available storage space has been identified for the Ventura County basins. Evaluations of feasibility of a storage program in these basins would need to consider factors such as the current distribution of demand for imported water supplies, sources of water available for storage, and concern for migration of contaminants, particularly in the coastal areas. Similarly, more than 500,000 AF of storage space is available in the San Fernando Valley, but use of a portion of this storage capacity would need to consider the on-going contaminant remediation operations in the basin and ensure that neither clean-up nor stored water would be compromised.

Further, management objectives within each basin must be considered. For instance, the Orange County Water District Act directs that basin operations take priority over storage. Basins such as Orange and Main San Gabriel allocate basin space to capturing runoff available during periodic wet years, while also allocating a portion of the available space to address dry-year needs. The Main San Gabriel Basin has cyclic agreements to store up to 180,000 AF of pre-delivered replenishment water. Orange County Basin has, to date, allocated 66,000 AF to long-term dry-year storage and an additional 16,000 AF to mid-term storage. Chino Basin has allocated up to 500,000 AF of storage space to long-term storage and has entered an agreement with Metropolitan for 100,000 AF of that. Chino Basin is also considering a re-operation of the basin to generate additional operational benefits. Lastly, the parties in Central and West Coast basins are discussing the allocation and institutional structure to manage 450,000 AF of available space within those basins.

Table III-7
Available Groundwater Storage Space in Metropolitan Service Area by Sub-Region

Sub-Region	Portion of Unused Storage Space Available for Storage (AF)	Amount Allocated to MWD [1] (AF)	Amount in account as of June 2006 (AF)	Net Portion of Unused Storage Space Available [2] (AF)
Northwest Service Area	1,000,000	210,000	55,000	945,000
San Fernando Valley	504,000	0	0	504,000
San Gabriel Valley	270,000	177,000	83,000	245,000
Los Angeles Coastal Plain	450,000	19,000	15,000	450,000
Orange County	135,000	82,000	51,000	135,000
Inland Empire	500,000	100,000	61,000	439,000
Eastside Service Area	512,000	12,000	0	500,000
San Diego County	19,000	0	0	19,000
Total	**3,390,000**	**600,000**	**265,000**	**3,237,000**

1. Includes Conjunctive Use, Supplemental Storage, Cyclic and Cooperative Storage Accounts
2. The estimate of available storage space does not account for institutional uncertainties, necessary capital investments, water quality considerations, and presence of overlying demand or other considerations.

Existing Groundwater Storage Programs

Metropolitan has historically supported groundwater storage programs within its service area. At this time, about 600,000 AF of groundwater storage is currently allocated for storage programs within the service area, including dry-year conjunctive use, supplemental storage and cyclic storage programs. As of June 2006, about 265,000 AF was in storage in these programs.

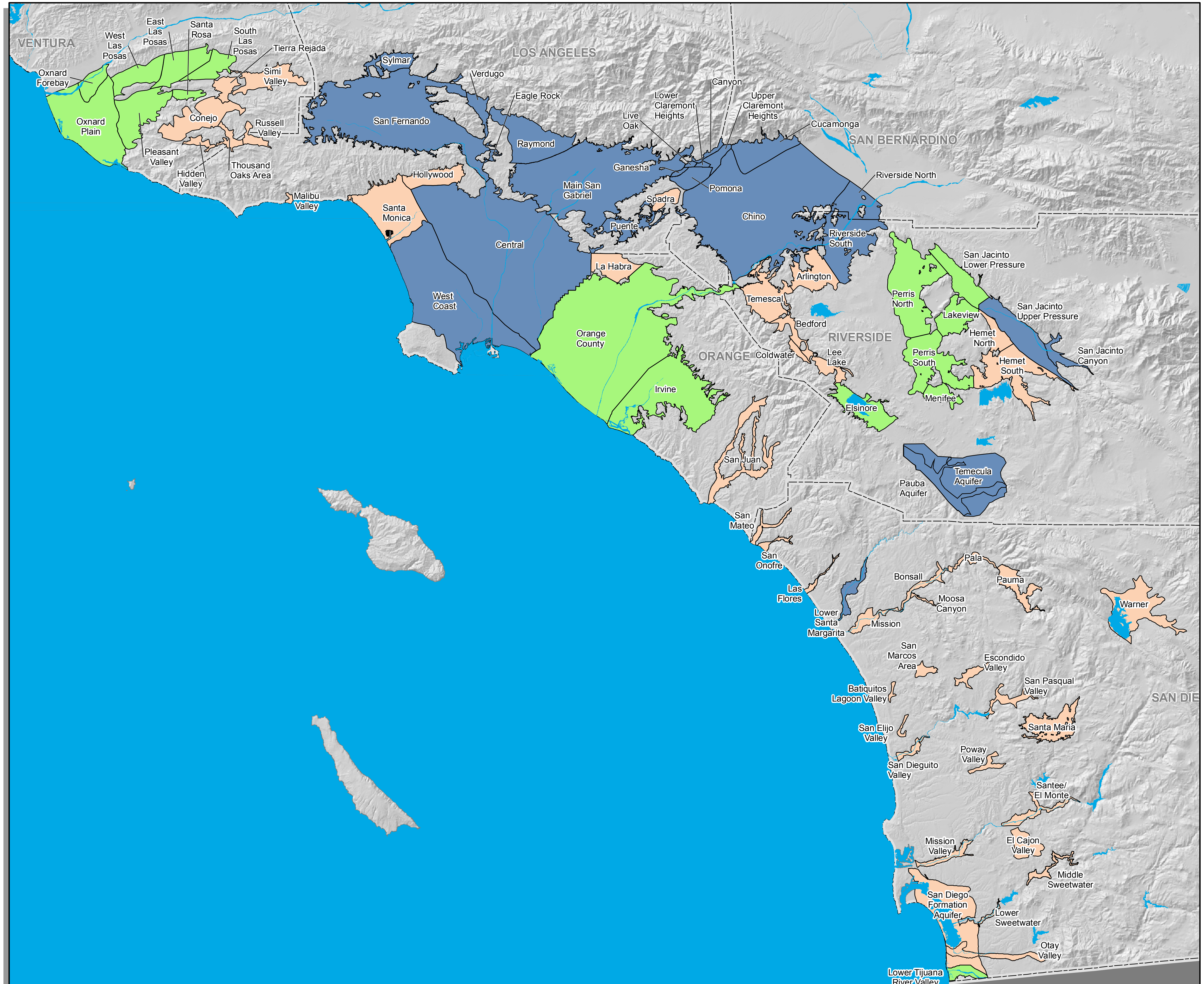
Plate III-7 shows the location of existing dry-year conjunctive use storage programs. The agreement for Metropolitan's initial contractual storage program was executed with the Calleguas Municipal Water District in 1995. Since then, an additional nine programs have been developed utilizing State Proposition 13 funds and Metropolitan capital funds. Facilities to implement these programs are currently under design and construction, and are anticipated to be fully operational prior to 2010. A tenth program, the Raymond Basin conjunctive use program, is currently in preliminary design and environmental review. **Table III-8** summarizes these programs.

Table III-8
Contractual Groundwater Dry-Year Conjunctive Use Programs in the Metropolitan Service Area in 2006

Basin	Partners	Total Storage (AF)	Dry Year Yield (AF)
Proposition 13 Programs			
Central Basin	Long Beach	13,000	4,300
Raymond Basin (Monk Hill)	Foothill MWD	9,000	3,000
Chino Basin	IEUA Three Valleys MWD Chino Basin Watermaster	100,000	33,000
Orange County Basin	MWDOC OCWD	66,000	20,000
Six Basins (Live Oak)	Three Valleys MWD City of La Verne	3,000	1,000
Central Basin	Compton	2,289	763
Central Basin	Long Beach with Lakewood	3,600	1,200
Six Basins (Upper Claremont Heights)	Three Valley MWD	3,000	1,000
Elsinore Basin	Western MWD Elsinore Valley MWD	12,000	4,000
Other Programs			
East Las Posas Basin	Calleguas MWD	210,000	47,000
Total Contracted Capacity	--	**421,889**	**115,263**
Programs in Process			
Raymond Basin (Monk Hill/Pasadena)	Pasadena Foothill MWD	66,000	22,000

SUMMARY

The status of groundwater in the Metropolitan service area is generally good. More than 90 percent of annual groundwater production is from basins that are either adjudicated or formally managed. Extensive groundwater facility improvements have been made over the past 20 years, which have supported an 8 percent increase in groundwater production. Improvements include construction of groundwater treatment facilities, a portion of which are funded under Metropolitan's LRP program. In 2004/05, more than 20 percent of the groundwater produced within the service area was treated or blended to address water quality issues. With respect to the water supply portfolio for recharge of the groundwater basins, the proportion of runoff used increased 7 percent while the use of imported water supplies decreased 5 percent. With respect to storage, nearly 600,000 AF has been allocated for Metropolitan storage in the service area to improve reliability. Up to 3.2 million AF of storage capacity could be developed in the future.



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Management Category

- Adjudicated
- Unadjudicated
- State Management Statute or Adopted Groundwater Management Plan

Other Features

- Groundwater Basin Boundary
- County Boundary
- Water

N W E S

7 3.5 0 7 Miles

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Plate III-1

Groundwater Basin Management in 2006

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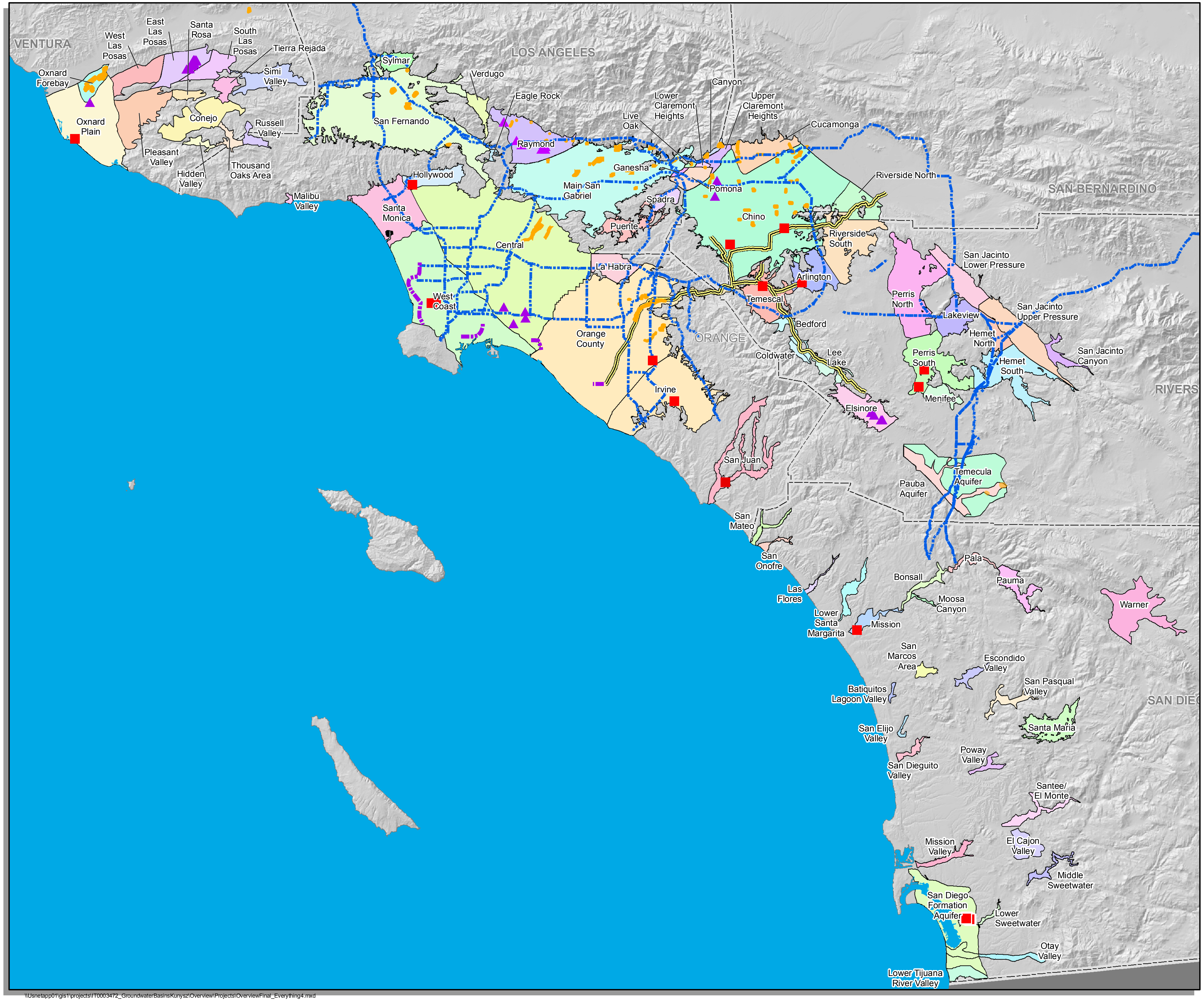

Legend

- ASR Well
- Desalter
- Seawater Barrier
- Santa Ana Regional Interceptor Line
- MWD Pipeline
- Spreading Facility/Recharge Basin

N E S W

7 3.5 0 7 Miles

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Plate III-2

Groundwater Basin Facilities as of 2006

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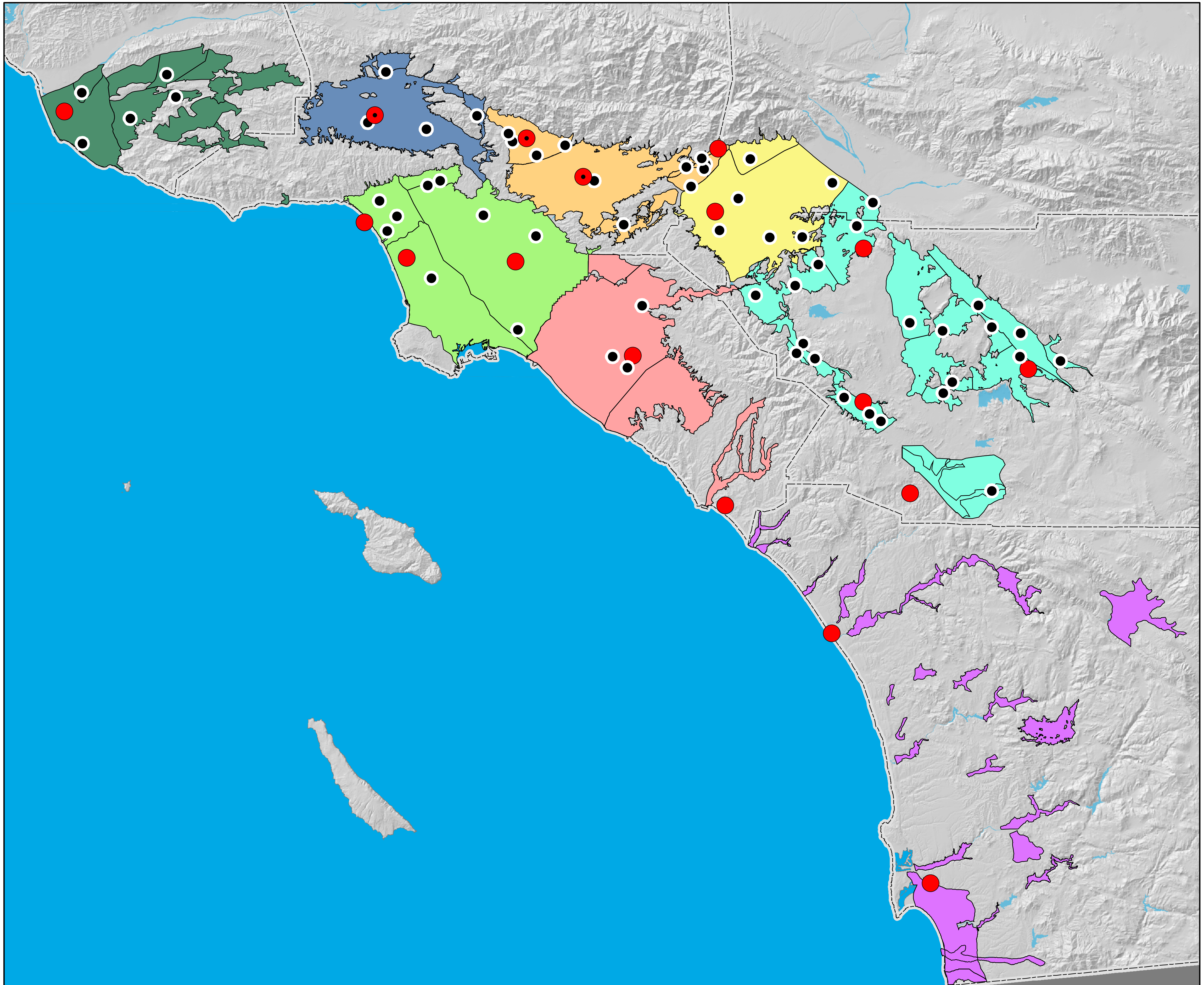

Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Other Features

- Average of Multiple Stations
- Precipitation Stations
- Key wells
- **Water Body**
- **County**

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W E
S

7.5 3.75 0 7.5 Miles

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Plate III-3

Locations of Precipitation Stations and Key Wells

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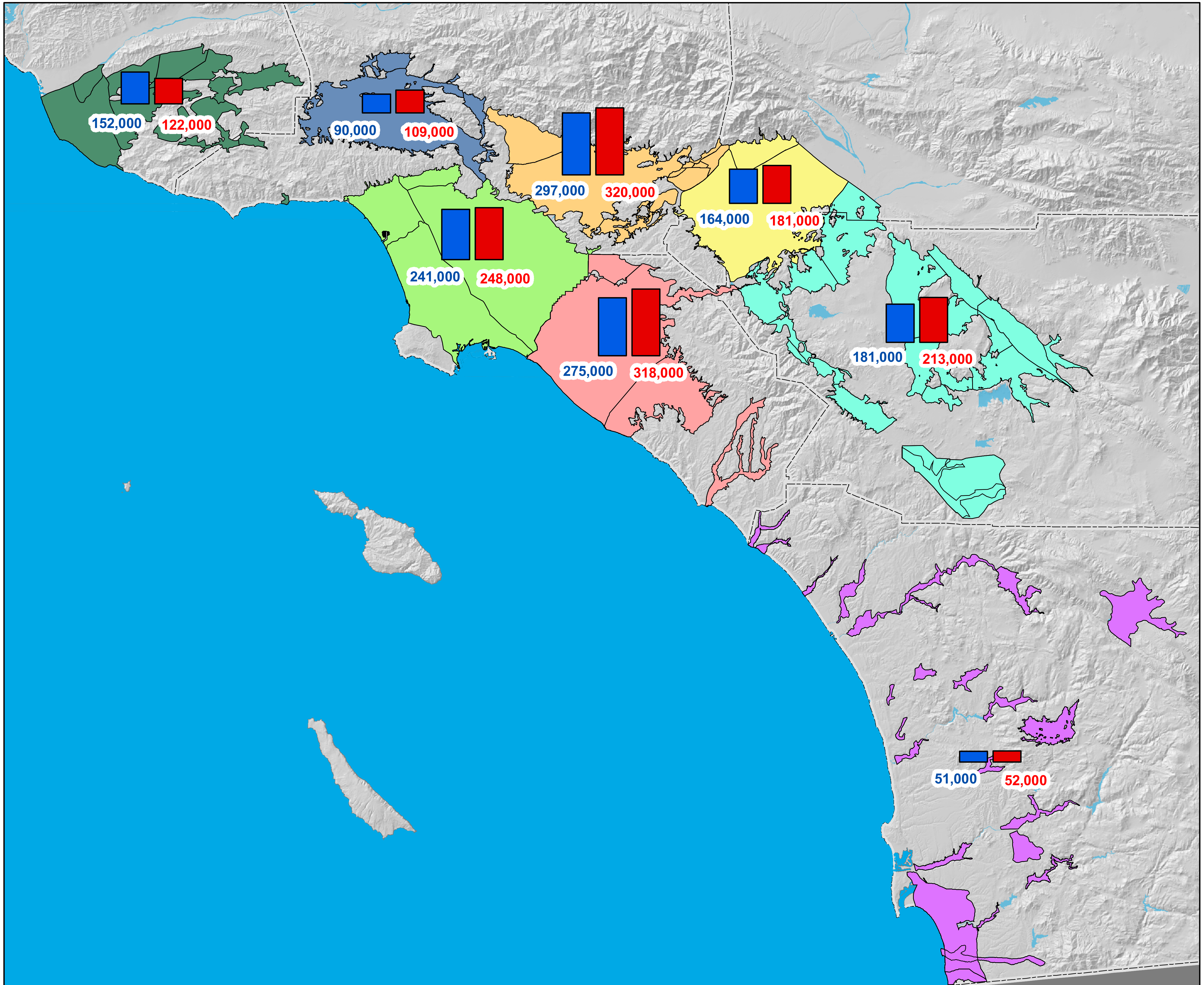

Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Average Annual Production (AFY)

160,000

1985/86 to 1994/95

1995/96 to 2004/05

Other Features

Water Body

County

N W E S

6 3 0 6 Miles

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Plate III-4

Trends in Average Annual Groundwater Production by Sub-Region

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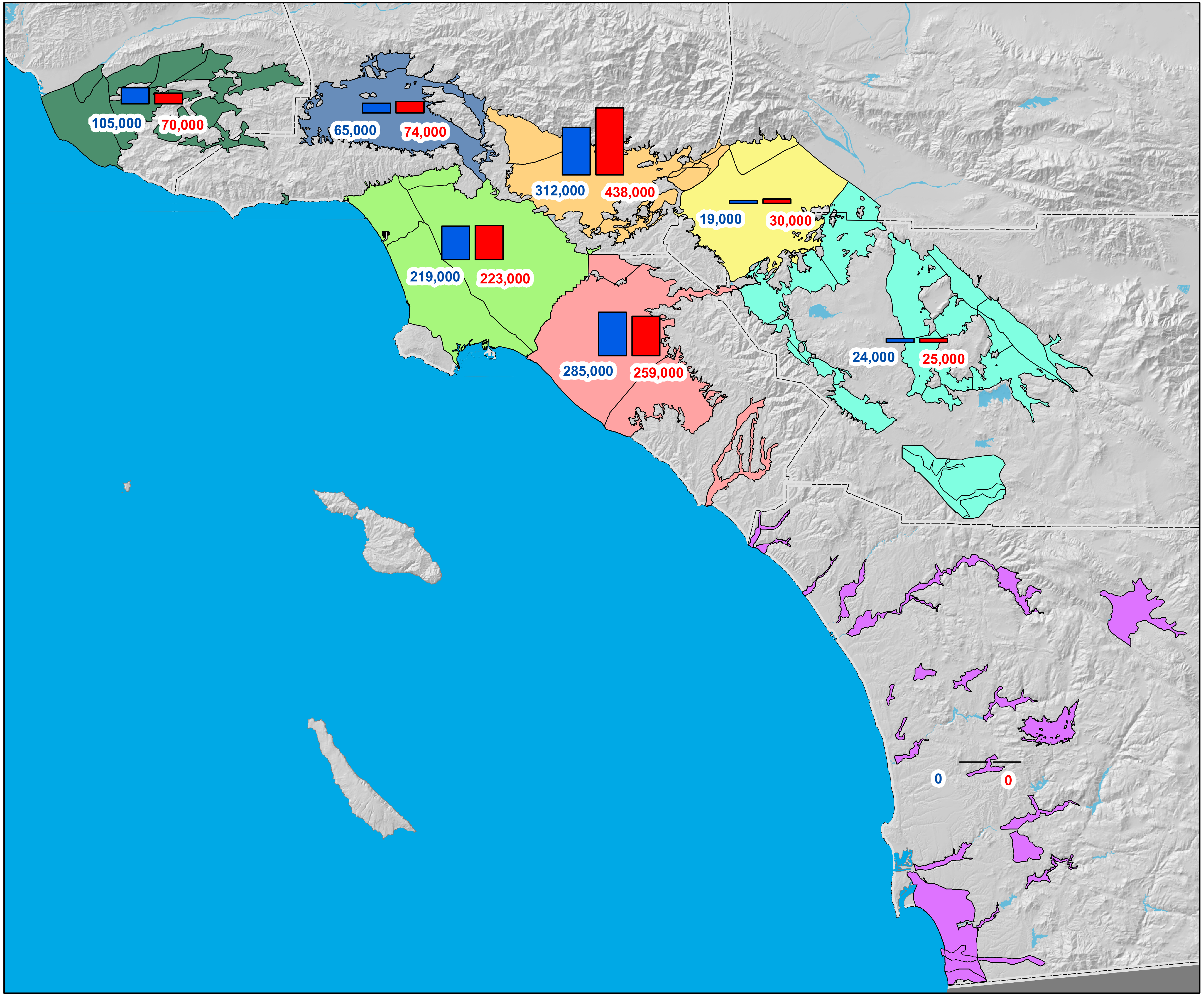

Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Wet Year Direct Recharge (AFY)

220,000

1992/93

2004/05

Other Features

County

Water Body

N
W E
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6 3 0 6 Miles

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Plate III-5

Trends in Wet Year Direct Groundwater Recharge by Sub-Region

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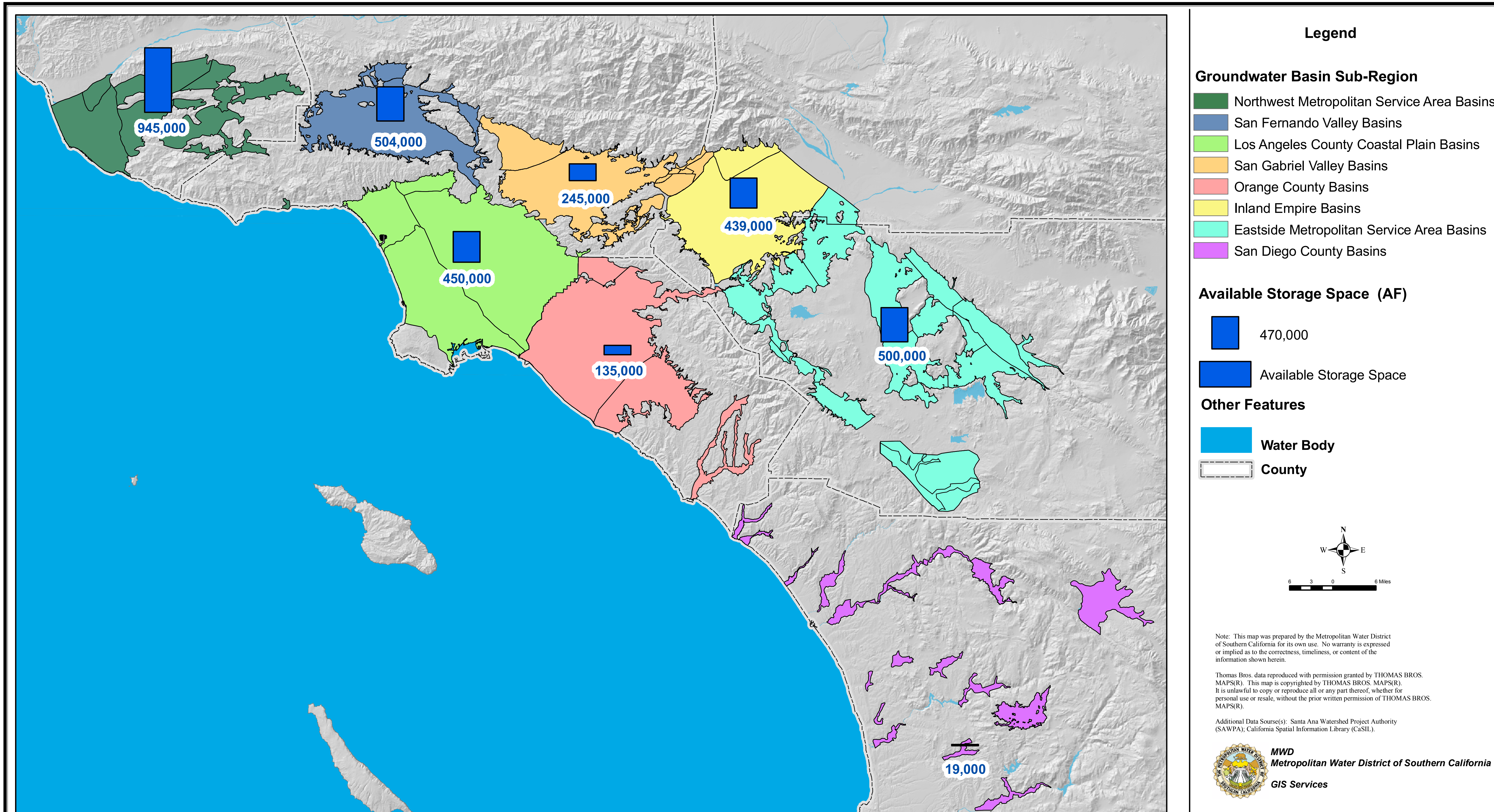

Plate III-6

Available Groundwater Storage Space in 2006

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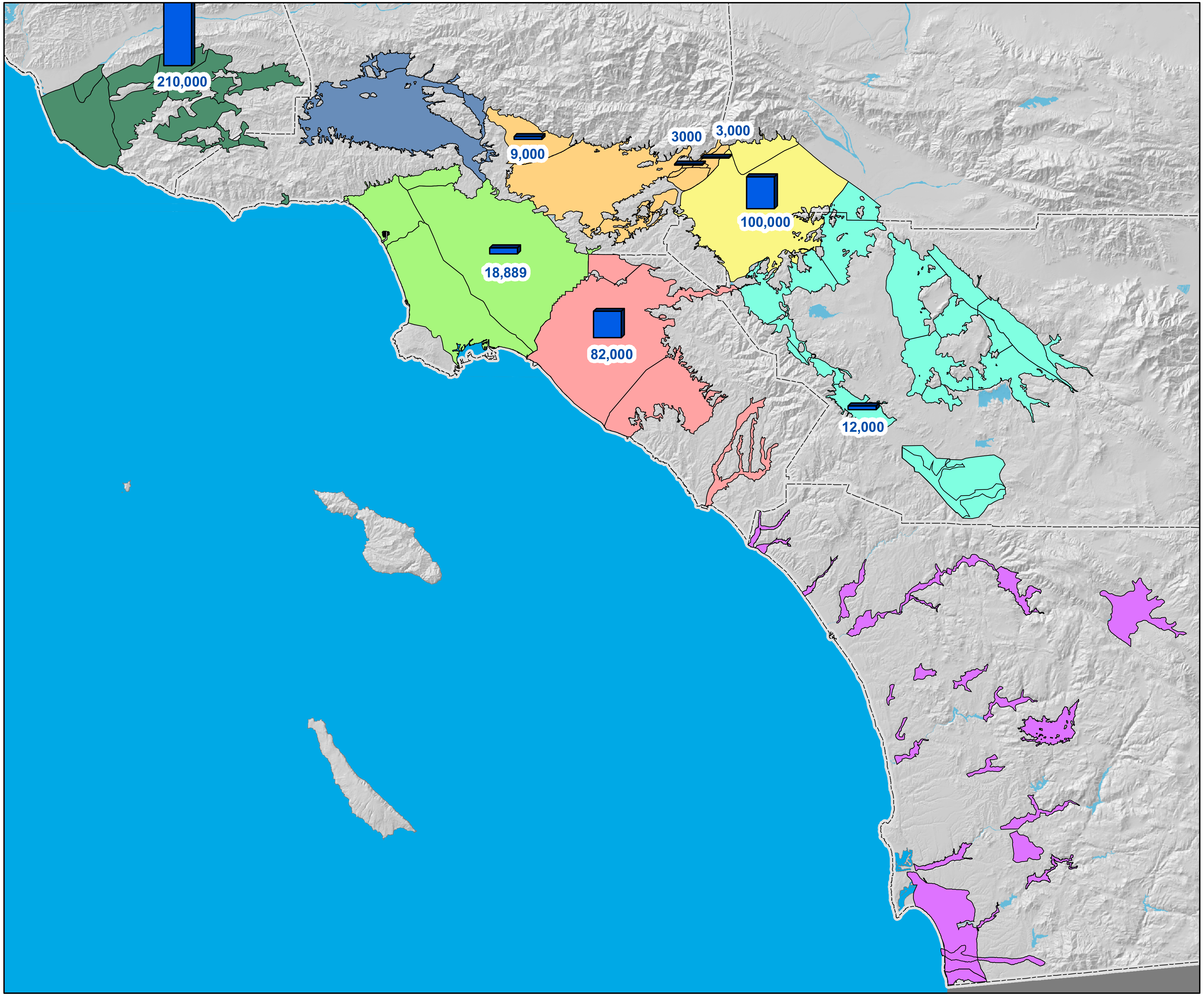

Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Contracted Groundwater Storage (AF)

110,000

Contracted Groundwater Storage

Other Features

Water Body

County

N W E S

6 3 0 6 Miles

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Plate III-7

Contractural Conjunctive Use Programs in 2006

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CHAPTER IV

GROUNDWATER BASIN REPORTS

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Legend

Chapter IV Basin Reports
Northwest Metropolitan Service Area Basins
1. Ventura County

San Fernando Valley Basins
2. Upper Los Angeles River Area

Los Angeles County Coastal Plain Basins
3. Central
4. West Coast
5. Santa Monica
6. Hollywood

Los Angeles County Coastal Plain Basins
7. Main San Gabriel and Puente
8. Raymond
9. Six

Orange County Basins
10. Orange County
11. San Juan

Inland Empire Basins
12. Chino and Cucamonga

Eastside Metropolitan Service Area Basins
13. Riverside
14. Arlington
15. Temescal Valley
16. Elsinore
17. West San Jacinto
18. Hemet-San Jacinto
19. Temecula-Murrieta

San Diego County Basins
20. Overview
21. North San Diego County
22. Central San Diego County
23. South San Diego County

Other Basins Not Covered
24. Other

Other Features
County
Groundwater Basin Boundary
Water Body

Plate IV-1

Groundwater Assessment Study
Basin Reports Index Map

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CHAPTER IV

GROUNDWATER BASIN REPORTS

NORTHWEST METROPOLITAN SERVICE AREA BASINS

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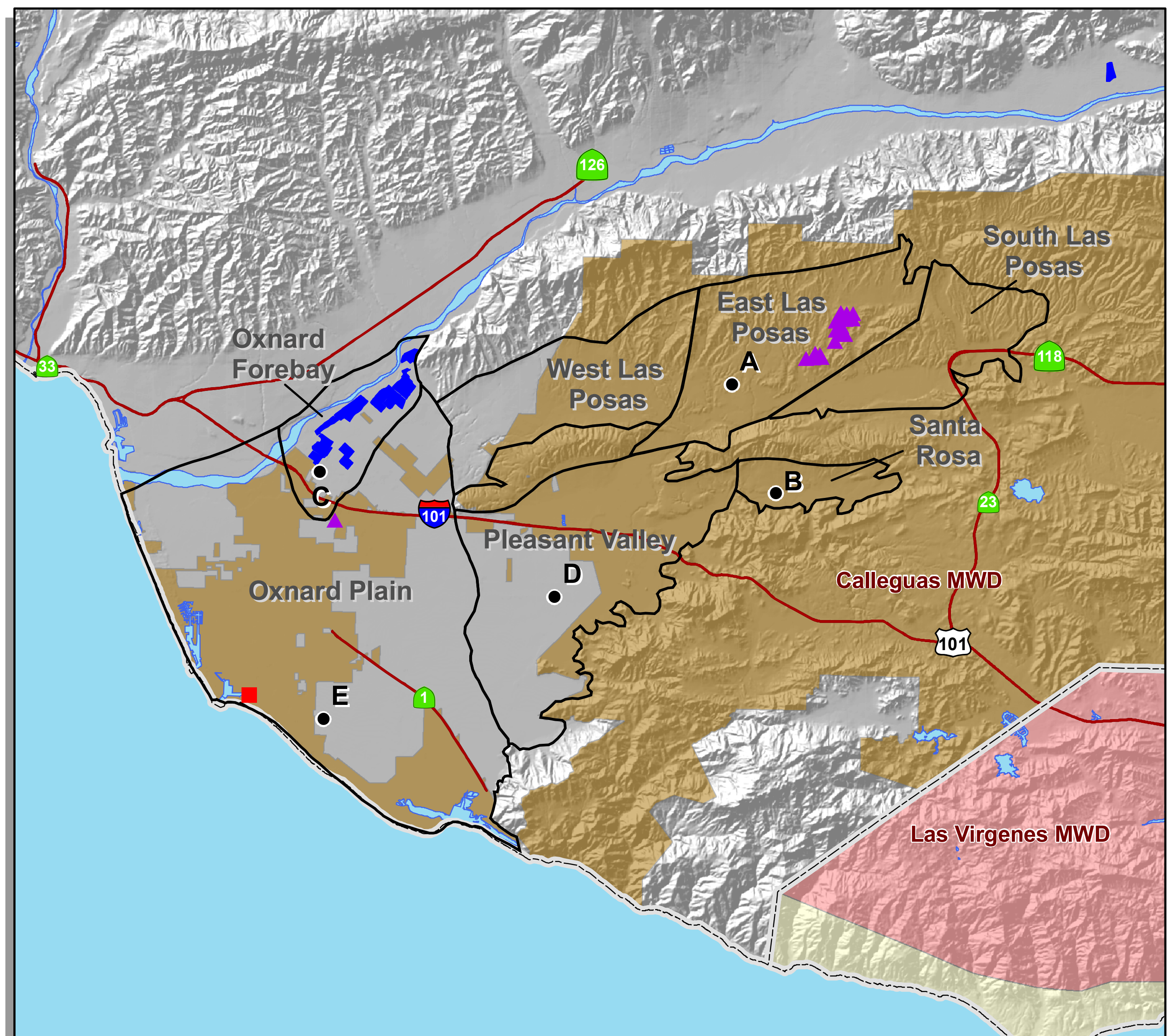

Ventura County Basins

A ●	Key wells		County
▲	ASR Wells		Freeways
■	Desalter		Water Body
	Recharge Basins		Groundwater Basins
			MWD Member Agency Boundary (color varies)

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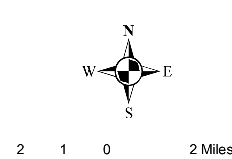
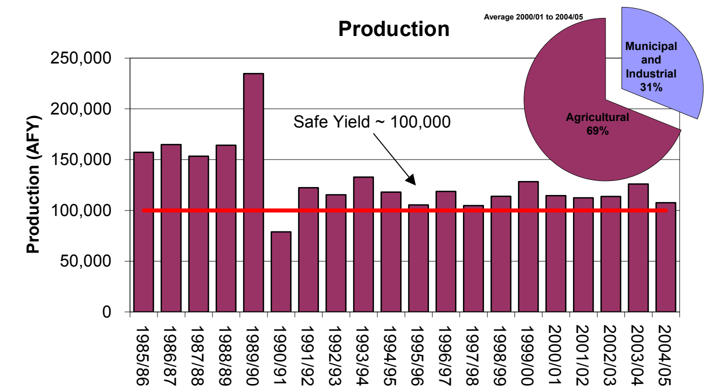
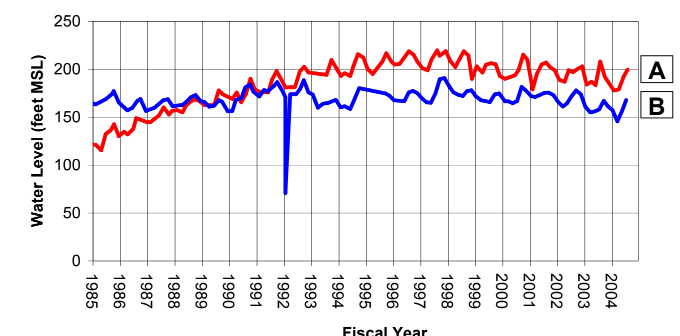
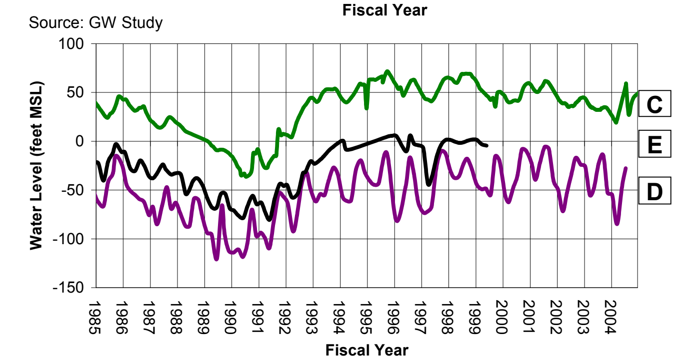


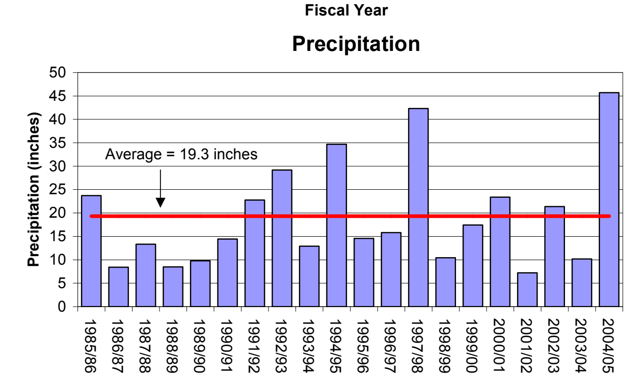


Source: Bachman, 2006a

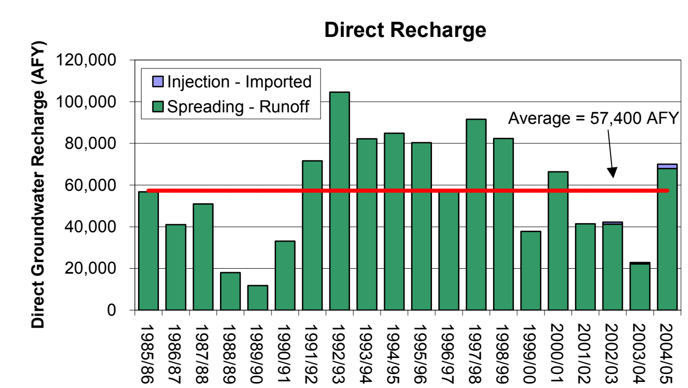


Source: GW Study





Source: UC IPM, 2006



Source: Bachman, 2006a

BASIN FACTS

Ventura County Basins

Description
Location: Ventura County
Watershed Surface Area: ~ 177 square miles
Subbasins:
Oxnard Plain,
Oxnard Forebay
Pleasant Valley
Las Posas
Santa Rosa
Management: Managed.
Managed by Fox Canyon Groundwater Management Agency since 1983.
MWD Member Agencies:
Calleguas MWD

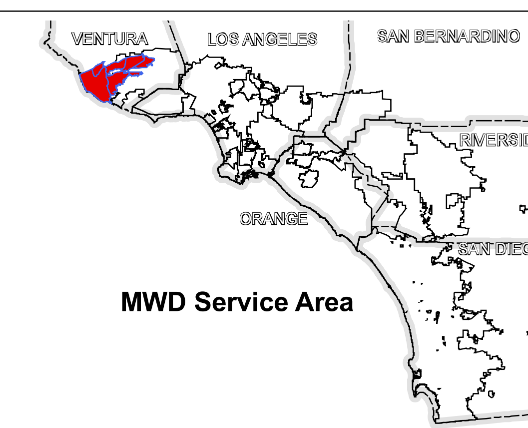
	Ventura
Safe Yield	100,000 AFY
Total Storage	3 to >6 million AF
Unused Storage Space	Unknown
Portion of Unused Storage Available for Storage (2005)	~1 million AF

Storage and Extraction Facilities

	Ventura
Production Wells	
Production Capacity	~470,000 AFY
Average 1985/86-2004/05	~129,000 AFY
Injection Wells	
Injection Capacity	~45,600 AFY
Average 2002/03-2004/05	~1,200 AFY
Spreading Basins	
Spreading Capacity	~160,000 AFY
Average 1985/86-2004/05	~57,200 AFY

Basin Management Considerations

- Groundwater production in Oxnard Plain limited by seawater intrusion
- TDS and nitrate concentrations may limit groundwater production.
- Subsidence potential limits groundwater production
- Production is limited by GMA
- SWRCB requirements for surface water recharge when groundwater levels drop below specified levels during droughts affect amount of recharge.



MWD Service Area

Plate 1-1
Overview of Ventura County Basins

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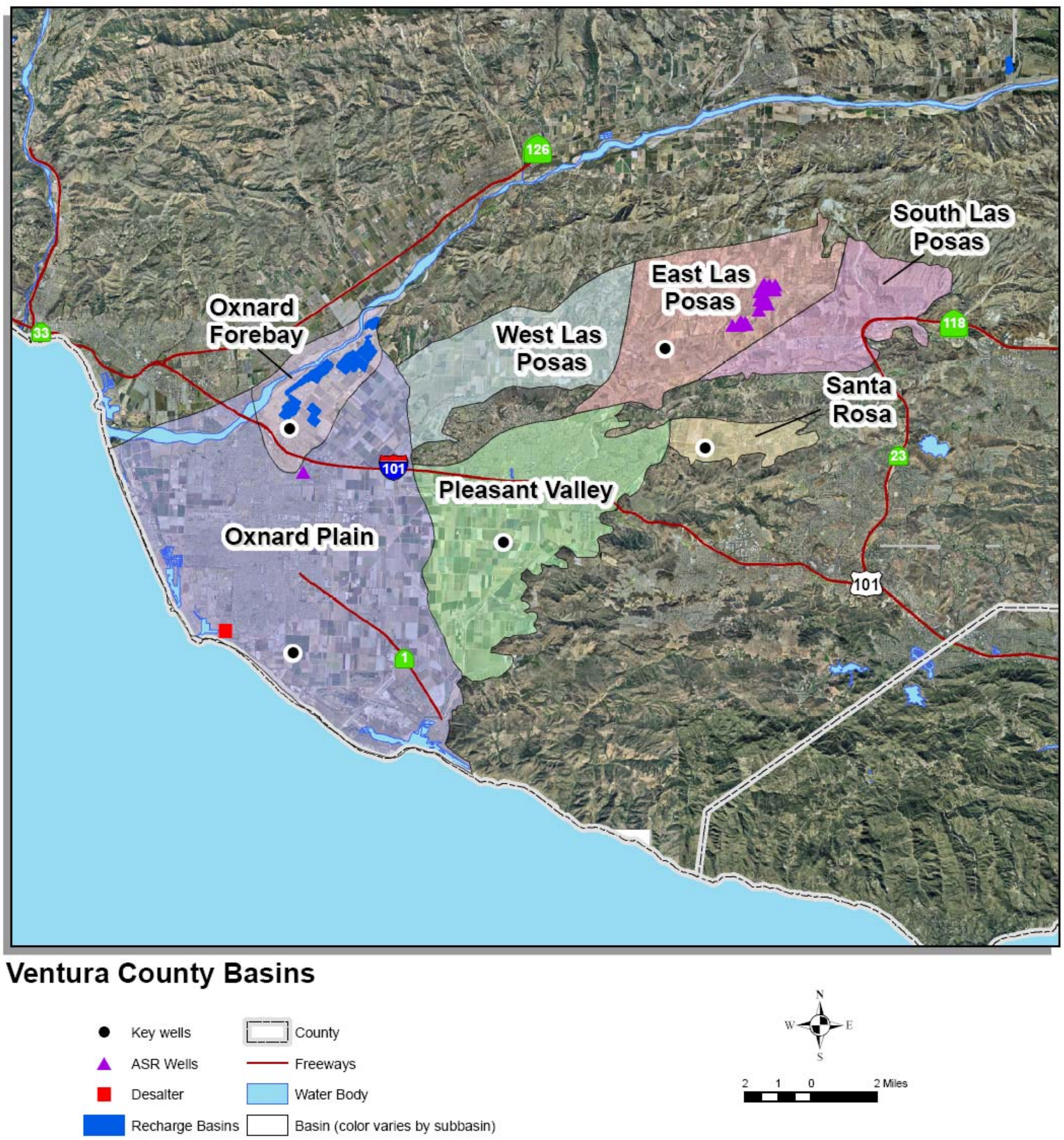
The Ventura County Basins include seven groundwater basins located within the Metropolitan service area in southern Ventura County, portions of which underlie the Santa Clara River Valley. The groundwater basins include: Oxnard Plain, Oxnard Forebay, Pleasant Valley, Santa Rosa and West, East and South Las Posas Basins. The location of the Ventura County Basins is shown in **Figure 1-1**.

Figure 1-1
Map of the Ventura County Basins



BASIN CHARACTERIZATION

The following section provides a physical description of the Ventura County Basins and their hydrogeologic character. The basins comprise a series of east-west trending valleys that drain westerly to the Pacific Ocean by the Santa Clara River, Calleguas Creek and Conejo Creek. The river and creeks drain the Santa Monica Mountains on the south, the Santa Susana Mountains on the east and the intervening Camarillo Hills, Las Posas Hills, South Mountain, and Oak Ridge.

Basin Producing Zones and Storage Capacity

A summary of the general hydrogeologic characteristics of the basins is provided in **Table 1-1** (Fox Canyon GMA, 2006; Bachman, 2006a).

Basin Producing Zones

The Ventura County Basins generally contain two major aquifer systems: the Upper Aquifer System (UAS) and the Lower Aquifer System (LAS). The UAS consists of late Pleistocene to Holocene-age sands and gravels that locally comprise the Oxnard and Mugu aquifers. The LAS includes the Hueneme, Fox Canyon and Grimes Canyon aquifers. The aquifers are unconfined in the Oxnard Forebay and confined beneath the Oxnard Plain and Pleasant Valley basins. Aquifers in the Las Posas and Santa Rosa basins generally are unconfined where the aquifers reach the surface and adjacent to surface water streams and confined elsewhere. The nature and extent of the aquifers within each subbasin is discussed below.

Oxnard Forebay and Oxnard Plain Basins

Both UAS and LAS are present in these basins. The Oxnard Plain Forebay Basin is the main source of recharge to aquifers beneath the Oxnard Plain. Recharge to the Forebay basin comes from a combination of percolation of Santa Clara River flows, artificial recharge at spreading grounds, irrigation return flows, percolation of rainfall, and underflow from adjacent basins. The Oxnard aquifer is the primary aquifer used for groundwater supply in the Oxnard Plain (Fox Canyon GMA, 2006). Seawater intrusion into the Oxnard Plain Basin has long been a primary concern of the Fox Canyon Groundwater Management Agency (Fox Canyon GMA, 2006). **Figure 1-2** shows a cross section through the Oxnard Forebay and Oxnard Plain basins showing areas of seawater intrusion.

Pleasant Valley Basin

The Fox Canyon aquifer is the major water-bearing unit in this basin. The groundwater hydrology of portions of this basin are little understood, and additional monitoring and studies are needed (Fox Canyon GMA, 2006).

Santa Rosa Basin

Santa Rosa Basin is the smallest of the Ventura County basins. Aquifers in the basin include a shallow alluvial aquifer and portions of the LAS. Groundwater levels are heavily influenced by flows in the overlying Conejo Creek. Discharges from a wastewater treatment plant and dewatering wells in Thousand Oaks have considerably increased year-round flows in the creek. Elevated nitrate and sulfate have been a problem in the basin (Fox Canyon GMA, 2006).

Table 1-1
Summary of Hydrogeologic Parameters of Ventura County Basins

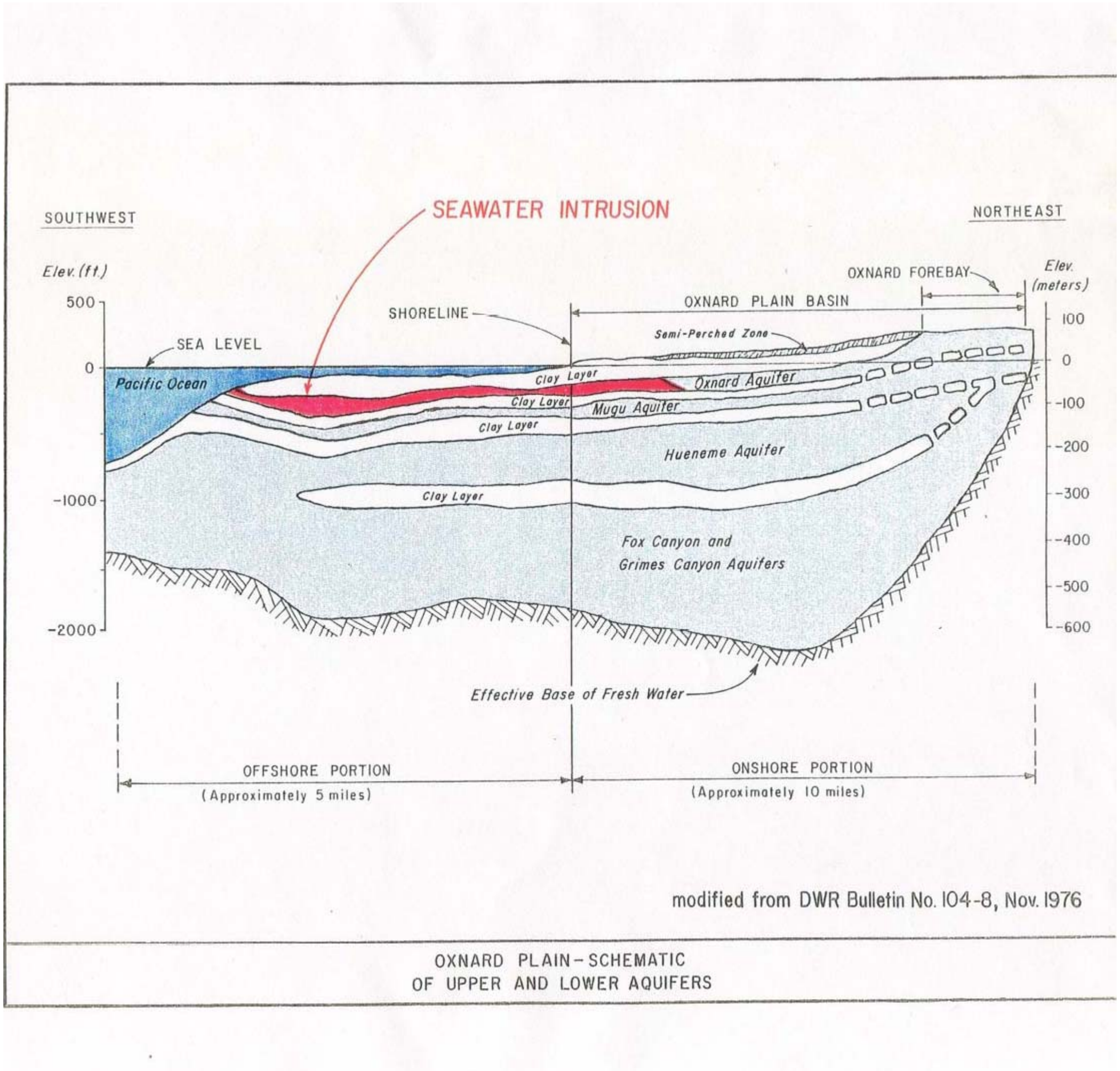
Parameter	**Description**
Structure	
Basins	Oxnard Plain, Oxnard Plain Forebay, Pleasant Valley, Santa Rosa, and East, West and South Las Posas basins
Aquifer(s)	Upper Aquifer System • Oxnard aquifer • Mugu aquifer Lower Aquifer System • Hueneme aquifer • Fox Canyon aquifer • Grimes Canyon aquifer
Depth of groundwater basin	~ 300 to 3,000 feet
Depth of producing zones or screen intervals	100 to 700 feet (to top of producing zone)
Thickness of water-bearing units	Several 10s to several 100s of feet
Yield and Storage	
Natural Safe Yield	~ 45,000 AFY
Operational Safe Yield	~100,000 AFY
Total Storage	~ 3 to > 6 million AF
Unused Storage Space	Unknown
Portion of Unused Storage Space Available for Storage	~ 1 million AF

Source: Bachman, 2006a and 2006b

Las Posas Basin

The Las Posas Basin has been previously subdivided into north and south, and more recently into west, east, and south basins. The GMA is now utilizing the more recent delineation developed by the USGS in the late 1990s, and basin maps and discussion in this overview have been adjusted to reflect the USGS terminology.

Figure 1-2
Geologic Cross Section in Oxnard Forebay and Oxnard Plain



Source: Fox Canyon GMA, 2006

The South Las Posas Basin is separated from East Las Posas Basin by an east-west trending rise in the subsurface. Over the past 40 years groundwater levels in South Las Posas Basin have risen more than 100 feet due to recharge from wastewater treatment plant discharges. Salts in the South Las Posas Basin groundwater have also increased, apparently leached from shallow aquifer sediments as groundwater levels reached historic highs (Fox Canyon GMA, 2006).

The East Las Posas Basin is separated from West Las Posas by a north-trending unnamed fault, across which groundwater levels differ by as much as 400 feet. Recharge of East Las Posas Basin is also now dominated by wastewater treatment plant discharges and groundwater levels have risen 125 to 200 feet over the past 30 years (Fox Canyon GMA, 2006).

West Las Posas Basin is isolated from the South and East Las Posas basins by a north-south fault, and is hydrologically connected to the Oxnard Plain Basin (Fox Canyon GMA, 2006).

Storage Capacity

The estimated total storage capacity of the Ventura County Basins is not clearly known because a large portion of this volume is located beneath the Pacific Ocean. Estimates range between 3 and 6 million AF. The amount of usable storage has been affected by seawater intrusion along the coastal plain, impact of saline plumes from marine sediments and contamination in the UAS by nitrates from overlying fertilizer use and septic system discharges.

The available storage capacity has not been calculated for all basins (except in the Las Posas basin, where it has been calculated at about 300,000 AF). However, the USGS and United Water Conservation District (UWCD) have calculated that about 1 million AF of water has been overdrafted from the coastal Ventura County Basins, with subsidence reducing the replaceable storage volume to about 800,000 AF. This storage volume is not all available, however, because seawater has filled a portion of this storage space. Much of this replaced storage occurs in offshore portions of the aquifers where it cannot be monitored and, therefore, the remaining available storage space is unknown. However, the available storage capacity is likely to be substantial with a rough estimate of 1 million AF (Bachman, 2006a).

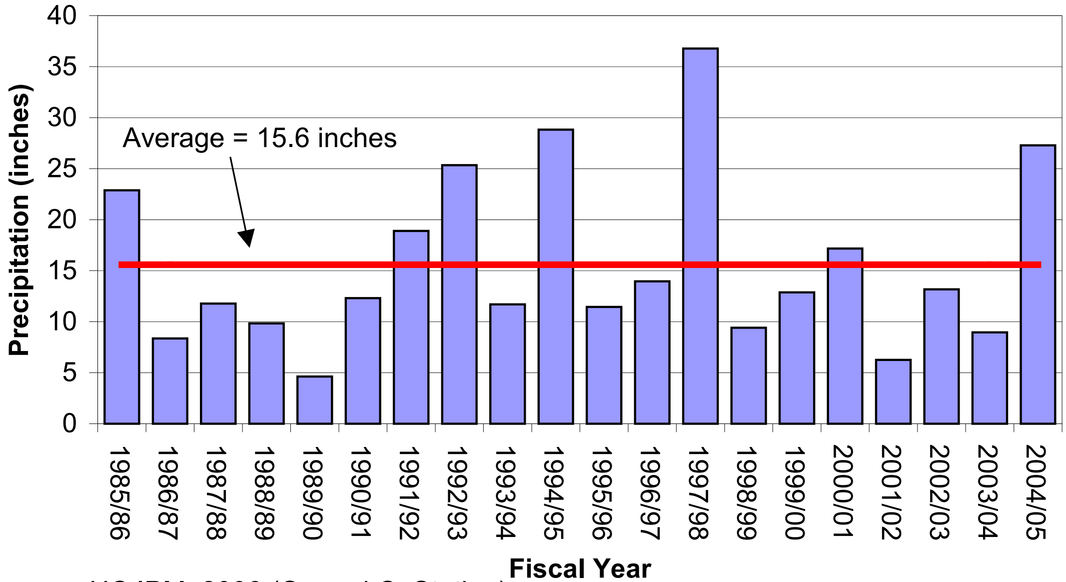
Safe Yield/Long-Term Balance of Recharge and Discharge

Natural groundwater recharge to the Ventura County Basins occurs through infiltration of rainfall and percolation of surface runoff along the main drainages (primarily the Santa Clara River) in areas where the underlying aquifer is unconfined.

Natural recharge from precipitation and runoff is the largest inflow to the basin. Precipitation over the watershed of the Ventura County Basins varies significantly from year to year and by elevation. Historical precipitation at the Oxnard rain gauge between fiscal years 1985/86 and 2004/05 is shown in **Figure 1-3**. Over this time period the precipitation at the Oxnard gauge ranged between about 5 and 37 inches per year and averaged about 15.6 inches per year (UC IPM, 2006). These data suggest below average precipitation between 1986 and 1990 and between 1999 and 2003, above average precipitation between 1991 and 1998. Groundwater discharge occurs predominantly through pumping.

In 1985, the operational safe yield (the amount of production that the basin can sustain without incurring negative impacts) for the Ventura County Basins was estimated to be 120,000 AFY (Bachman, 2006b). In 2006, the operational safe yield estimate was updated using a groundwater model to be approximately 100,000 AFY (Fox Canyon GMA, 2006). This operational safe yield is based upon historical recharge with additional pumping reductions in the Oxnard Plain and Pleasant Valley subbasins. As discussed below, historically, production from the Ventura County Basins has exceeded the basins' yield and the basins have been in overdraft for decades (Fox Canyon GMA, 2006).

Figure 1-3
Historical Precipitation in the Ventura County Basins



Source: UC IPM, 2006 (Oxnard C. Station)

GROUNDWATER MANAGEMENT

The following section provides a brief description of the groundwater management activities and governing structure for the Ventura County Basins.

Basin Governance

The Ventura County Basins are managed. In 1982, the California State Legislature established the Fox Canyon Groundwater Management Agency (GMA) under the State Water Code for the overall management of the southern Ventura County Basins. The statute specifies the GMA's activities as "planning, managing, controlling, preserving, and regulating the extraction and use of groundwater within the territory of the agency" and distinguished those duties of the GMA from those of the other agencies providing flood control, operating spreading grounds, water distribution and the sale of water. Under this legislative act, the GMA has worked closely with other districts and county agencies to study and control the groundwater resources in these basins. The agencies and their roles and responsibilities for the Ventura County Basins are summarized in **Table 1-2**.

The GMA adopted its first management plan in 1987. The Groundwater Management Plan has been recently updated with a current draft published in October 2006. The plan reviews the status of the basins, identifies problems, documents knowledge of their causes, and sets out specific basin management objectives for resolution.

Table 1-2
Summary of Management Agencies in the Ventura County Basins

Agency	Role
Fox Canyon Groundwater Management Agency (GMA)	Establishes policy Sets pumping allocations, phased reductions, water level and water quality criteria through its Groundwater Management Plan
United Water Conservation District (UWCD)	Operates river diversions, spreading basins, in-lieu pipelines, and reservoir to capture winter runoff. Conducts seawater intrusion monitoring, area-wide monitoring database management, area-wide studies and reporting, maintenance of area-wide groundwater model, and technical analyses for GMA
Calleguas Municipal Water District (Calleguas MWD)	Operates the Las Posas ASR project. Performs duties specified in the East Las Posas Basin Management Plan (included within the GMA Groundwater Management Plan) with local pumpers in the Las Posas Basin Users Group. Performs regional water supply planning with United Water Conservation District.
Ventura County Water Resources Dept.	Issues well permits and ordinances (including which aquifers to pump). Shares monitoring responsibilities with UWCD.
State Water Resources Control Board	Controls conditions for the Oxnard Forebay Basin: when groundwater levels fall below a specified level, all diverted surface waters must go to spreading
Las Posas Basin Users Group	Forum for discussion of issues related to Las Posas ASR Project

In 1990, to address continuing seawater intrusion in the Oxnard Plain due to overpumping, the GMA adopted an ordinance that requires a 25 percent phased reduction in groundwater pumping throughout the GMA (the phasing will be complete in 2010). In 2006, the pumping allocation reduction was adjusted to 20 percent. In addition, storage projects require GMA approval (time and place of extraction); new wells are restricted to certain aquifers depending on seawater intrusion limits and coastal pumping patterns (Bachman, 2006a). Further, the State Water

Resources Control Board directed that all surface water be channeled to the spreading basins when groundwater levels drop below a certain level during drought periods (Bachman, 2006a). The 2006 Groundwater Management Plan builds on these prior efforts and seeks additional success in managing seawater intrusion in the Oxnard Plain, nitrate levels in the Oxnard Plain Forebay and Santa Rosa basins, and chloride concentrations in the Pleasant Valley and Las Posas basins.

In 1987, the GMA adopted an ordinance that limited new production in the Los Posas Basin. The Las Posas Basin Users Group, consisting of representatives of the well owners and Calleguas MWD discuss issues related to the Las Posas Aquifer Storage and Recovery (ASR) Project and wells within the Las Posas Basin (Bachman, 2006b). The 2006 Groundwater Management Plan includes a draft East Las Posas Basin Management Plan specifying a management process and reporting and meeting requirements for coordinating the operation of the ASR wells and other production within the basin. (Fox Canyon GMA, 2006).

Interactions with Adjoining Basins

The Santa Clara River is a major source of natural recharge to the Oxnard Plain Forebay, Oxnard Plain, and Pleasant Valley groundwater basins. As such, there is a Memorandum of Understanding among the United Water Conservation District and the water purveyors of the Santa Clarita area in Los Angeles County that calls for flows of the Santa Clara River across the Los Angeles-Ventura county line not to be diminished by water management policies in Santa Clarita.

WATER SUPPLY FACILITIES AND OPERATIONS

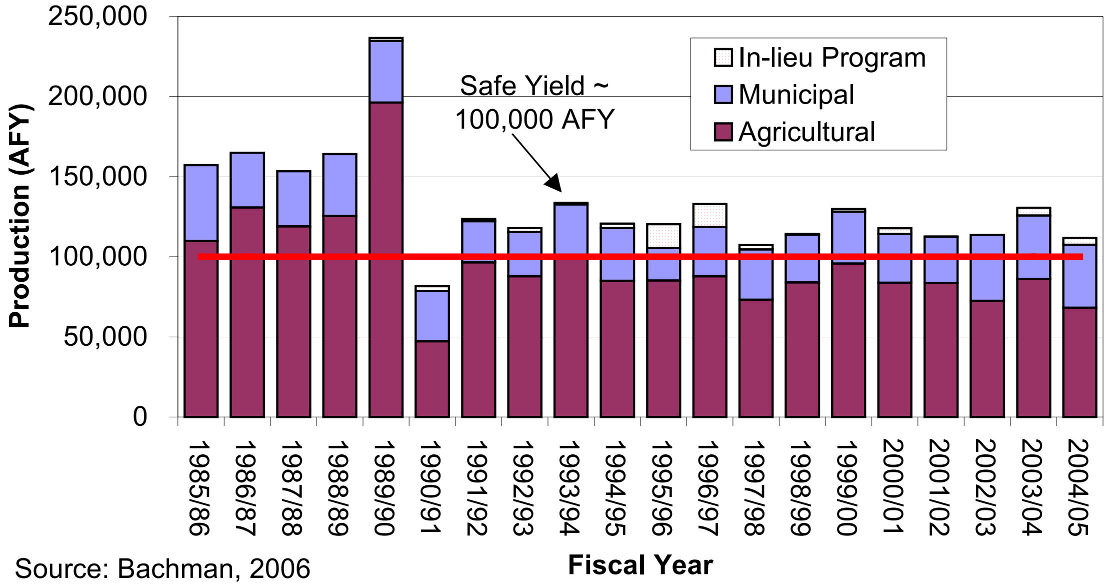
Facilities within the Ventura County Basins include: Approximately 600 groundwater production wells, 18 ASR wells in the East Las Posas Basin and one injection well in the Oxnard Plain Basin, and 220 acres of spreading basins in the Oxnard Forebay Basin.

Active Production Wells

Table 1-3 summarizes the details of the production wells in the Ventura County Basins. There are approximately 94 active municipal supply wells in the Ventura County Basins that produce only about 1/3 of the total production. Out of the 94 municipal wells, 10 are scheduled for rehabilitation or replacement in the next 5 years (Bachman, 2006a). The operational costs of the municipal wells are summarized in **Table 1-3**.

Figure 1-4 summarizes the historical production data between 1985 and 2004. Basin production decreased from an average of about 150,000 AFY between 1985 and 1989 and a peak of about 240,000 in the 1989/90 water year to an approximate average near 114,000 AFY between the 1990/91 and 2004/05 water years (Bachman, 2006a). Note that agricultural production decreased from an average of more than 136,000 AFY between 1985 and 1990 to about 82,500 AFY after 1990. This decrease in production is largely due to pumping reductions implemented by the GMA in 1990 and some agricultural to municipal land use changes (Bachman, 2006b).

Figure 1-4
Historical Groundwater Production in the Ventura County Basins



Source: Bachman, 2006

Table 1-3
Summary of Production Wells in the Ventura County Basins

Category	Number of Active Wells	Estimated Production Capacity [2] (AFY)	Average Production 1985-1989 (AFY)	Average Production 1990-2004 (AFY)	Well Operation Cost ($/AF)
Municipal/Industrial/ Domestic Wells	120	94, 000	38,500	31,700	$85
Other Wells (Agricultural)	491	393,000	136,300	82,500	
Total	611	487,000	174,800	114,200	

Source: CMWD (2006)
1. Active wells have production within past 5 years
2. Estimated production capacity is based upon maximum semi-annual production for the past 5 years.

Ventura County Basin producers participate in a variety of in-lieu groundwater storage programs whereby they receive imported water from Metropolitan in lieu of pumping groundwater. Historically, these programs have included Metropolitan's replenishment water and conjunctive use programs. The long-term in-lieu storage is included in **Figure 1-4.** Between fiscal years 1985/86 and 2004/05, about 3,500 AFY was stored for long-term storage via in-lieu. These and other storage programs are discussed in more detail below.

Other Production

As discussed above, agricultural production within the Ventura County Basins is more than 2/3 of the total production. To help manage this production, the GMA is working to limit export of groundwater to lands that do not directly overlie the groundwater basins (Fox Canyon GMA, 2006).

ASR Wells

Of the 94 municipal wells, 18 are active ASR wells, all located in the Las Posas Basin. The well locations are shown in **Figure 1-1**. The Las Posas ASR wells have a total injection capacity of 63 cfs and a total extraction capacity of 90 cfs for the ASR Project (Bachman, 2006a). The annual recharge amounts from these wells are shown in **Figure 1-5**. An average of about 1,500 AFY was injected as part of the ASR Project in the Las Posas Basin between 2002 and 2005.

The City of Oxnard currently owns and operates an injection well in the Oxnard Plain. Details regarding operation of this well are not available at this time.

Spreading Basins

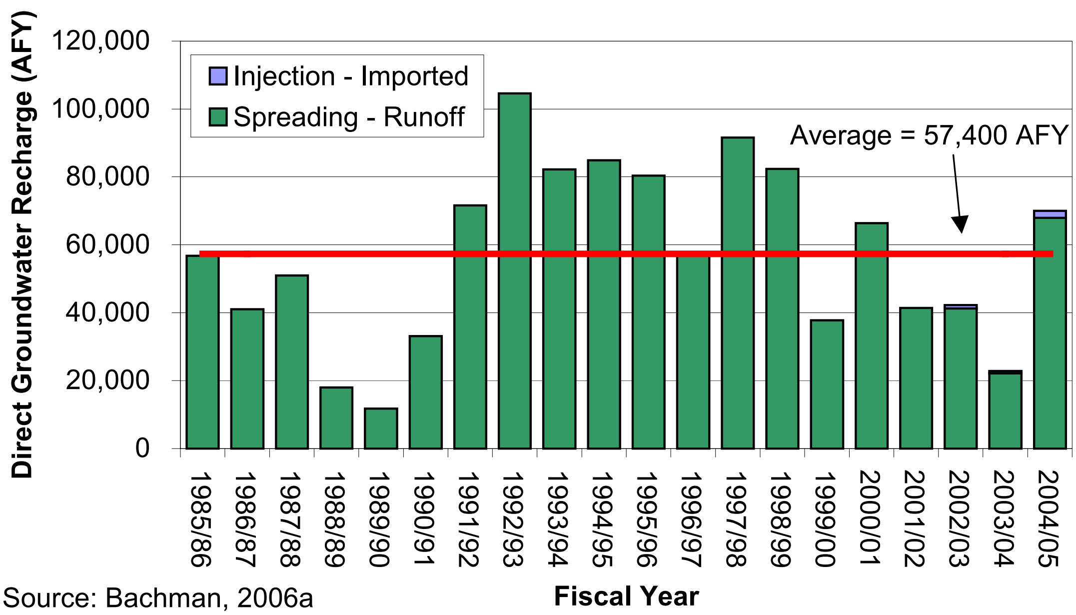
There are approximately 220 acres of spreading basins in the Ventura County. Data related to these basins are summarized in **Table 1-4.** Groundwater recharge from 1985 to 2005 is shown on **Figure 1-5**. An average of about 57,200 AFY of runoff was recharged in the Oxnard Forebay between fiscal years 1985/86 and 2004/05.

Table 1-4
Summary of Spreading Basins in the Ventura County Basins

Spreading Basin	Area (acres)	Recharge Capacity (cfs)	Recharge capacity[1] (AF/month)	Source water	Owner
Saticoy	120	Data not available	7,500	Runoff Recycled [2]	United Water CD
El Rio	100	Data not available	6,000	Runoff Recycled [2]	United Water CD

Source: Bachman, 2006a
1. Based on existing recharge; 2. Incidental recycled water recharge only

Figure 1-5
Historical Groundwater Recharge in the Ventura County Basins



Source: Bachman, 2006a

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Ventura County Basins.

Desalters

The City of Port Hueneme operates a desalter using reverse osmosis to reduce TDS concentrations in the Oxnard Plain Basin. This desalter came online in 1997. This desalter is discussed in more detail in the water quality section below.

GROUNDWATER LEVELS

Figures 1-6 and 1-7 summarize historical groundwater levels in the Ventura County Basins. Water levels have risen in the Las Posas Basin in both the UAS and the LAS. Note that water levels in the LAS are generally as much as 100 feet lower than the UAS. This is consistent throughout the Ventura County Basins.

As shown in **Figure 1-7**, groundwater levels in the coastal basins (Oxnard Forebay, Oxnard Plain and Pleasant Valley) have begun to recover since the implementation of pumping restrictions in 1990. However, at the present low groundwater levels, seawater intrusion and other contaminants are continuing to invade the potable water aquifers in the Oxnard and Pleasant Valley basins (Bachman, 2006a). Water levels in many areas remain below sea level. It is also important to note that water levels in the LAS are generally lower than the UAS resulting in a downward gradient, which has led to increasing saline intrusion in the LAS.

Figure 1-6
Historical Water Levels in the Las Posas and Santa Rosa Basins

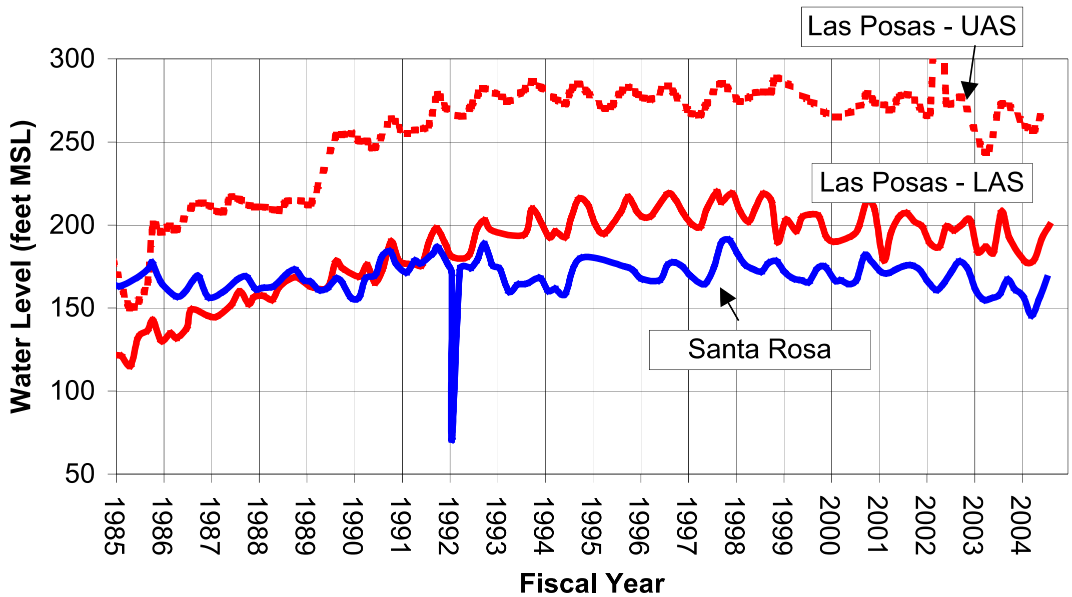
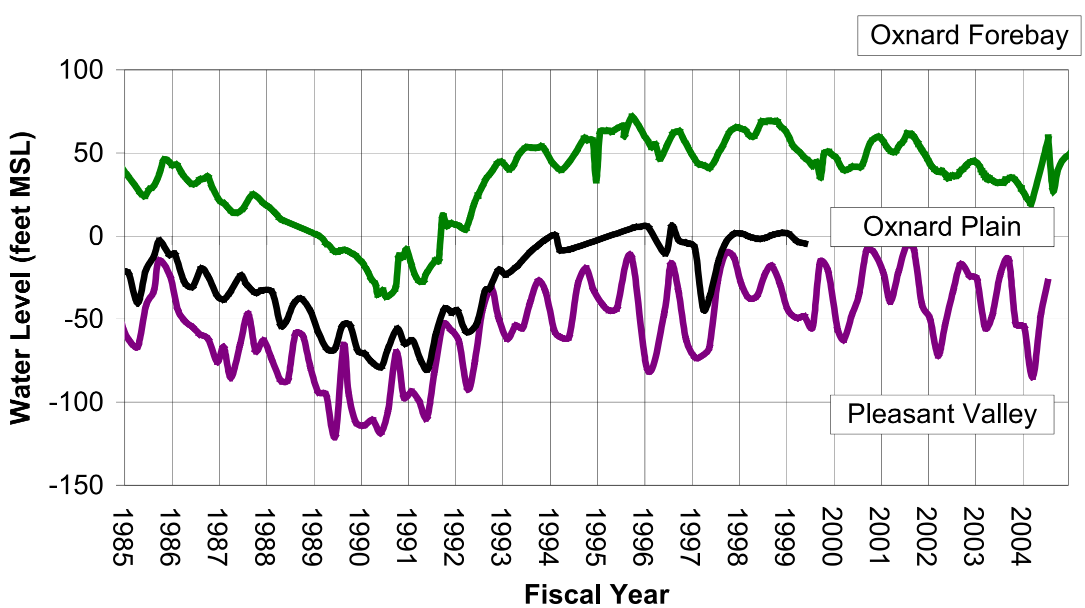


Figure 1-7
Historical Water Levels in the Oxnard Forebay,
Oxnard Plain and Pleasant Valley Basins



In addition, areas of subsidence have been observed in the coastal basins. As much as 2.7 feet of land subsidence has been observed in the Oxnard and Pleasant Valley basins.

Groundwater levels have also increased in the Las Posas and Santa Rosa subbasins. As discussed in more detail below, these increases have resulted in leaching of salts from the previously unsaturated sediments into the groundwater.

GROUNDWATER QUALITY

The following section describes the water quality issues in the Ventura County Basins. General water quality issues include seawater intrusion in the coastal aquifers and nitrate and sulfate concerns in the agricultural areas. TDS concentrations throughout much of the Ventura County Basins exceed 1,000 mg/L.

Groundwater Quality Monitoring

Water quality is measured on a regular basis at key wells throughout the Ventura County Basins. In addition over 100 non-drinking water production wells are monitored for water quality (Bachman, 2006a). In 1989, the U.S. Geological Survey initiated their Regional Aquifer-System Analysis (RASA) study in a cooperative effort with local agencies. As part of this and companion cooperative studies, a series of 14 nested well sites with three or more wells installed at each site, were drilled and completed at specific depths in the Oxnard Plain, Oxnard Plain Forebay, Pleasant Valley, and Las Posas basins (Fox Canyon GMA, 2006).

Groundwater Contaminants

Constituents of concern for the Ventura County Basins include: total dissolved solids (TDS), nitrate, chloride, iron, manganese and sulfate. Concentrations of these constituents since 2000 are summarized in **Table 1-5**. In addition, constituents of regional concern (volatile organic compounds, or VOCs, and perchlorate) are also included for reference.

Seawater intrusion has long been the primary water concern within the GMA and was the problem for which the GMA was originally formulated to help fix. The intrusion occurs exclusively along the coastline in the Oxnard Plain basin. The U.S. Geological Survey also identified another type of saline intrusion on the Oxnard Plain – salts moving from the surrounding marine clays and older geologic units as pressure in the aquifers is reduced from overpumping. This type of intrusion may also be occurring on a minor scale in the Pleasant Valley basin. Chloride has also become a problem along Arroyo Las Posas, where groundwater from an area in the East and South Las Posas basins must be blended with lower-chloride water to meet irrigation suitability. This problem appears to have migrated downstream, with some of the City of Camarillo's wells now affected.

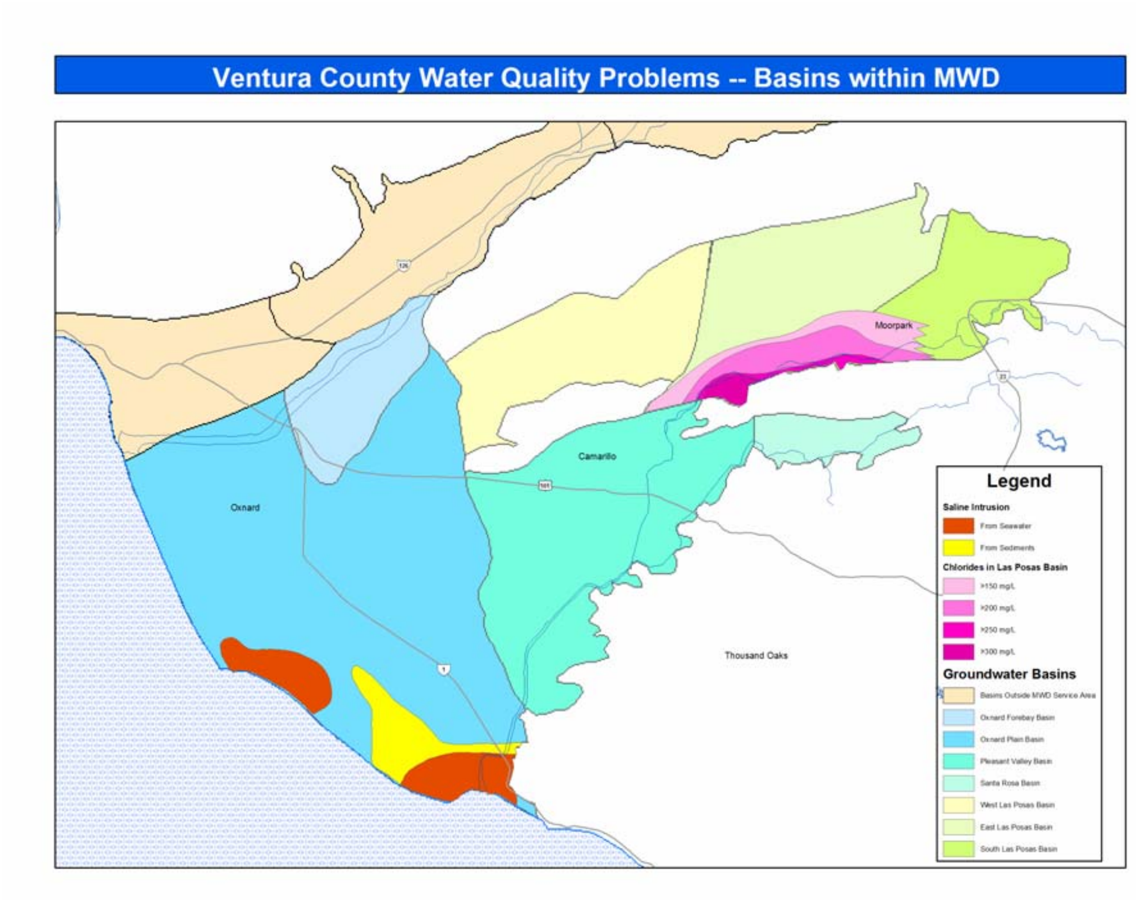
Figure 1-8 shows the areas impacted by TDS and chloride due to seawater intrusion or leaching of minerals salts from marine sediments. TDS concentrations in many locations are greater than 1,000 mg/L throughout the basins with maximum concentrations 32,600 mg/L reported for several wells in the Oxnard Plain. Seawater intrusion has occurred along the coastline due to

Table 1-5
Summary of Constituents of Concern in the Ventura County Basins

Constituent	Units	Range[1]	Description
TDS Secondary MCL = 500	mg/L	Oxnard Plain: 340 to 32,600 Oxnard Forebay: 490 to 1,750 Pleasant Valley: 525 to 2,515 West Las Posas: 330 to 1,410 East Las Posas: 270 to 1,800	TDS concentrations in many locations are greater than 1,000 mg/L throughout the basins with maximum concentrations of 32,600 mg/L reported for wells in the Oxnard Plain.
Nitrate (as N) Primary MCL = 10	mg/L	Oxnard Plain: <0.1 to 44.4 Oxnard Forebay: <0.1 to 34.4 Pleasant Valley: <0.1 to 18.9 West Las Posas: <0.1 to 15.6 East Las Posas: <0.1 to 27.8	Reported as an issue resulting from use of agricultural fertilizers and septic systems in the Oxnard Forebay and Oxnard Plain Basins
VOCs	µg/L	Data not available	No significant or widespread contamination reported
Perchlorate Notification level = 6	µg/L	Pleasant Valley: 2 to 5[2] South Las Posas: up to 2[3]	No significant or widespread contamination reported
Iron Secondary MCL = 300	µg/L	Oxnard Plain: <50 to 16,700 Oxnard Forebay: <50 to 9,300 Pleasant Valley: <50 to 3,250 West Las Posas: <50 to 9,760 East Las Posas: <0.1 to 15,000	Concentrations in many wells are above the MCL.
Manganese Secondary MCL = 50	µg/L	Oxnard Plain: <10 to 4,010 Oxnard Forebay: <10 to 780 Pleasant Valley: <10 to 355 West Las Posas: <30 to 1,400 East Las Posas: <30 to 730	Concentrations in many active wells are above the 50 µg/L MCL
Chloride Secondary MCL = 500	mg/L	Oxnard Plain: 11 to 19,000 Oxnard Forebay: 20 to 110 Pleasant Valley: 42 to 340 West Las Posas: 10 to 275 East Las Posas: 10 to 220	Significant concern in the Oxnard Plain and Pleasant Valley basins due to seawater intrusion. Also an issue in the Las Posas Basin due to rising groundwater levels and leaching from marine sediments.
Sulfate Secondary MCL = 500	mg/L	Oxnard Plain: 32 to 2,910 Oxnard Forebay: 20 to 820 Pleasant Valley: 55 to 1,005 West Las Posas: 55 to 675 East Las Posas: 14 to 840	Could limit ability to use for agricultural purposes. Issue for municipal supply in Camarillo area.

[1] Bachman, 2006b
[2,3] Geotracker, Camarillo and Moorpark wells, 2006

Figure 1-8
Water Quality Issues in the Ventura County Basins



decades of over drafting in the Oxnard Plain Basin, which has reversed groundwater gradients within both the UAS and LAS (Bachman, 2006a). Also along the southern flank of the East and South Los Posas groundwater basins and in the Pleasant Valley Basin high levels of chlorides and sulfates have been detected due to higher groundwater levels leaching salts from shallow aquifers and transporting them into deeper aquifers (Bachman, 2006a).

Nitrate concentrations (as N) exceeding the 10 mg/L MCL occur within the basins and are of greatest concern in the Oxnard Plain Forebay. High nitrate levels (as high as 44.4 mg/L) in this area have resulted from agricultural applications of fertilizers and septic waste discharges. Nitrate concentrations tend to spike during dry periods when recharge to the basin is reduced. Nitrate concentrations as high as 44 mg/L have also been detected in the Santa Rosa Basin.

Iron and manganese, as shown on **Table 1-5** have also been detected at concentrations above applicable MCLs in the Ventura County Basins. Concentrations of iron and manganese are highest in the Oxnard Plain Basin. In addition, as described below, the ASR wells in the Las Posas Basin could require treatment for iron and manganese.

Perchlorate has been detected at levels of 5 µg/L or less in several wells in the Pleasant Valley and South Las Posas basins, although no widespread or significant contamination has been reported. Significant contamination associated with VOCs in the basins has not been reported.

Blending Needs

The cities of Oxnard and Port Hueneme use on average about 10,000 AFY of imported water from Metropolitan to blend with native groundwater that has about 1,000 mg/L TDS. The City of Camarillo is also increasing its usage of Metropolitan water to blend with its groundwater (Bachman, 2006a).

Groundwater Treatment

The City of Port Hueneme treats groundwater before it is blended with imported water from Metropolitan at its desalter as summarized in **Table 1-6**. Groundwater from the ASR wells in the Las Posas basin may require treatment to remove iron and manganese (Bachman, 2006a).

Table 1-6
Summary of Groundwater Treatment in the Ventura County Basins

Treatment Type	Number of Wells	Constituents(s) of Concern	Treatment Target*	Treatment Cost ($/AF)	Amount Treated (AFY)
Reverse Osmosis	Data not available	TDS	500-1000 mg/L	$600-800	2,800

Bachman, 2006a
*When blended

CURRENT GROUNDWATER STORAGE PROGRAMS

In 1995, Calleguas MWD and Metropolitan entered into an agreement for the North Las Posas ASR Project. The ASR Project allows Metropolitan to store up to 210,000 AF in the Las Posas Basin via injection or in-lieu methods to be taken later by Metropolitan in-lieu of imported supplies during water shortage events. As of June 30, 2006, the account balance in the storage account was approximately 55,000 AF (about 49,000 AF via in-lieu and 6,000 AF via injection).

In-lieu replenishment deliveries of imported water from Metropolitan are another means for maintaining groundwater storage in the basin when producers are able to reduce their pumping by the amount of the delivery. Ventura County Basin producers participate in a variety of in-lieu groundwater storage programs with Metropolitan since 1985. These include Metropolitan's replenishment water programs for purchase of imported water for direct recharge and in-lieu. Direct recharge volumes are discussed above. An average of approximately 850 AFY was stored in-lieu as part of the long-term replenishment program between fiscal year 1985/86 and 2004/05.

BASIN MANAGEMENT CONSIDERATIONS

The primary management issues within the Ventura County Basins include:

- Production limitations by the GMA
  - With no physical or hydraulic barriers to seawater intrusion, groundwater levels must be managed to minimize contaminating the potable water resources (Bachman, 2006a). The resulting GMA policies to control over drafting has required 20 percent phased reductions in groundwater pumping throughout the GMA (the phasing will be complete in 2010). In addition, new storage projects require GMA approval and new well restrictions have been imposed on specific aquifers to limit coastal pumping and seawater intrusion (Bachman, 2006a).
- Land subsidence in the coastal areas may limit ability to extract water
- Water quality
  - As discussed above, many areas throughout the Ventura County Basins have concentrations of TDS above 1,000 mg/L. These concentrations limit the ability to store and extract water from these basins.
  - In addition, seawater intrusion or migration of saline water through adjacent sediments also play a significant role in the management of the Ventura County Basins.

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CHAPTER IV

GROUNDWATER BASIN REPORTS

SAN FERNANDO VALLEY BASINS

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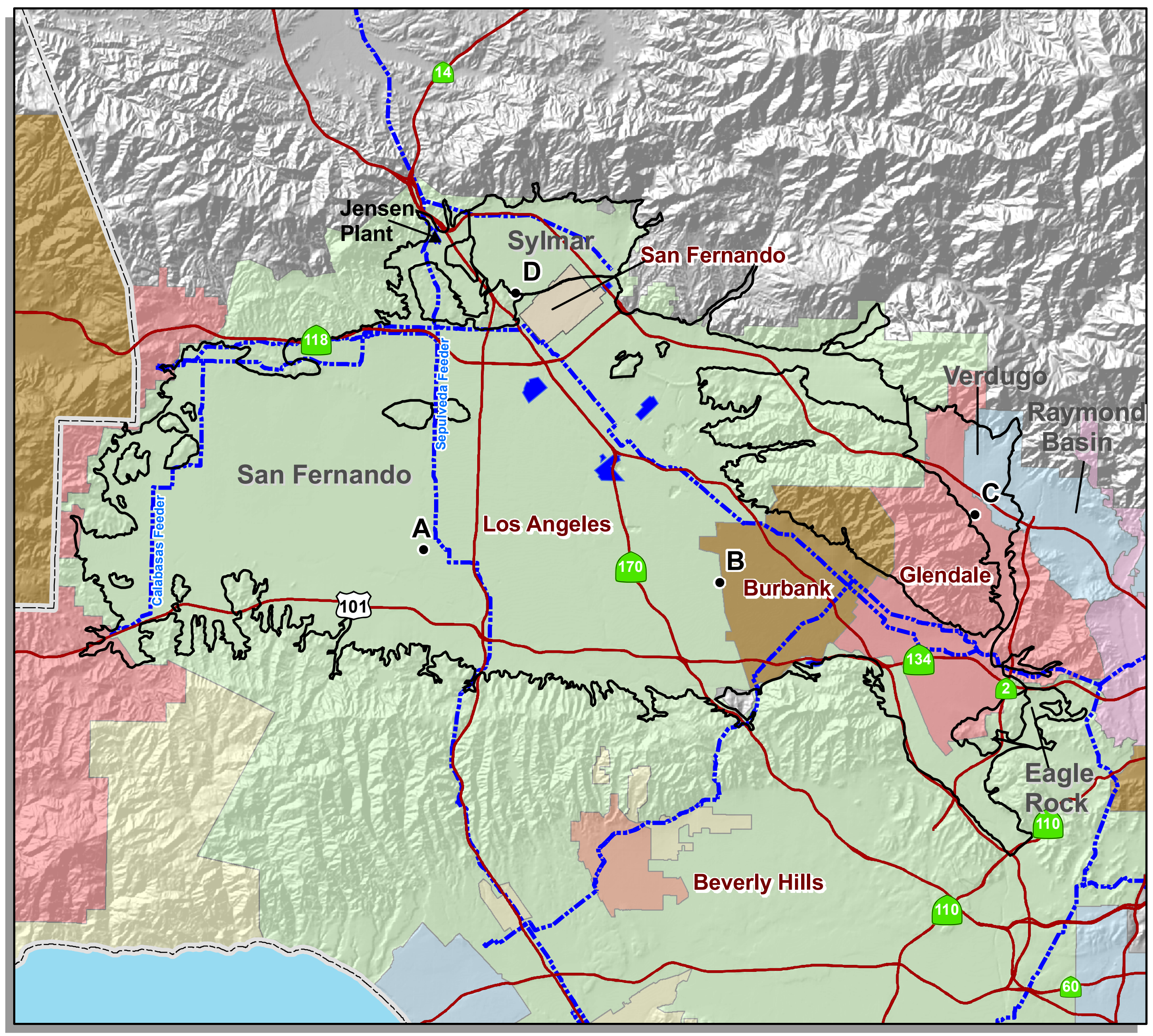

Upper Los Angeles River Area Basins

A ● Key Well
Recharge Basins
Freeways
County
MWD Pipeline
▲ MWD Facility
Groundwater Basin
MWD Member Agency Boundary (color varies)

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).

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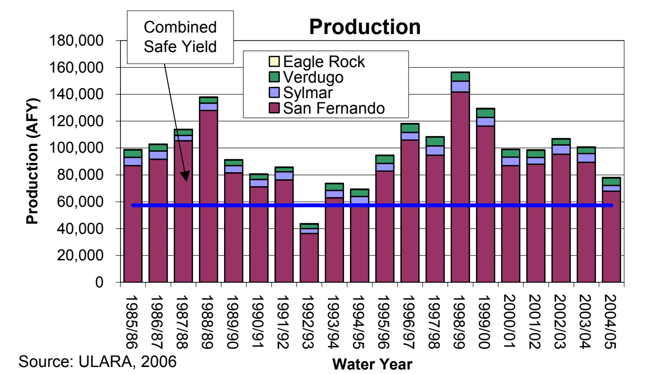
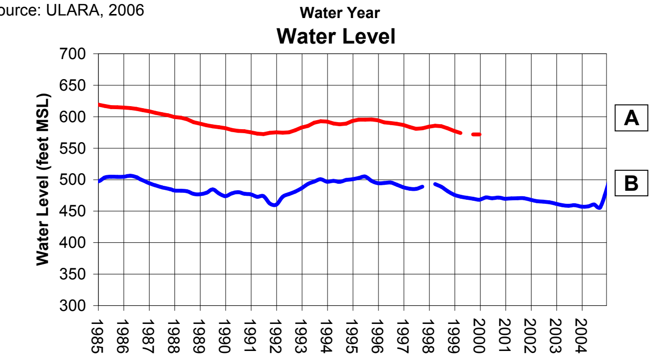
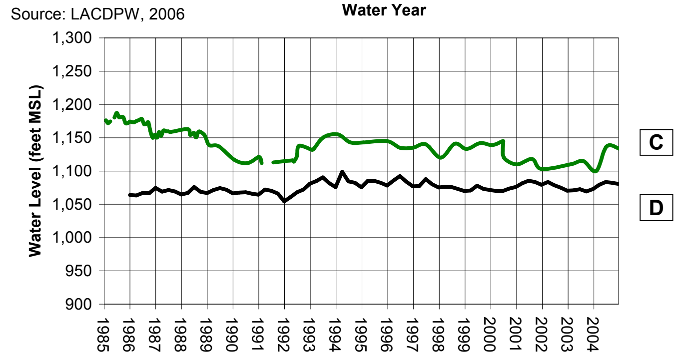


Source: ULARA, 2006



Source: LACDPW, 2006



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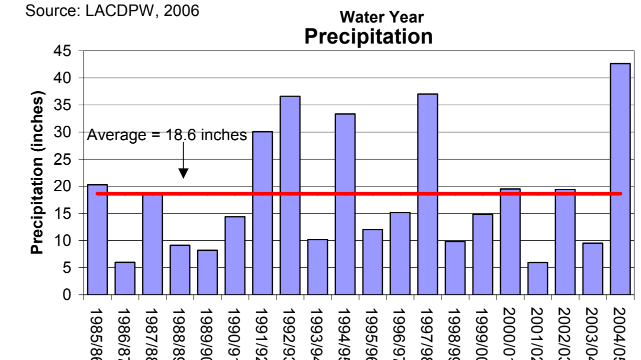
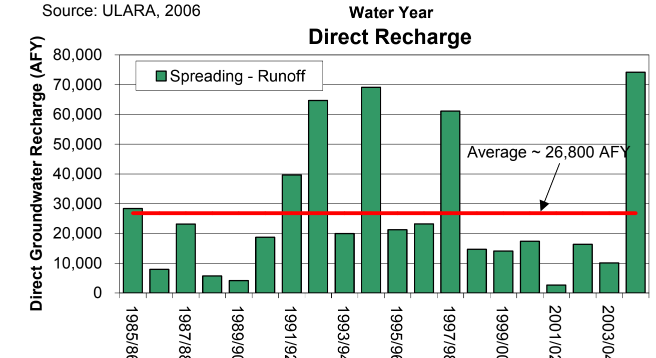


Source: ULARA, 2006



Source: ULARA, 2006

BASIN FACTS

Upper Los Angeles River Area Basin

Description
Location: Los Angeles County
Surface Area: 226 square miles
Subbasins:
San Fernando
Sylmar
Eagle Rock
Verdugo
Management: Adjudicated
Basin is adjudicated by 1979 Final San Fernando Judgment and 1984 Stipulated Sylmar Judgment
MWD Member Agencies:
City of Los Angeles
City of Burbank
City of Glendale
City of San Fernando
Foothill MWD

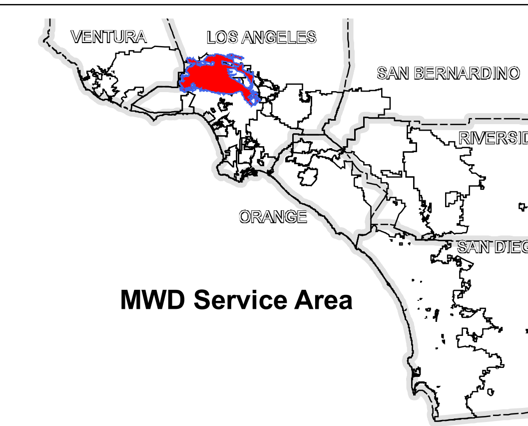
	San Fernando	Sylmar	Verdugo	Eagle Rock
Native Safe Yield	43,660 AFY	--	--	Negligible
Safe Yield	90,680 AFY	6,810 AFY	7,150 AFY	Negligible
Extraction Rights (2005//06)	96,838 AFY	6,510 AFY	7,150 AFY	Negligible
Total Storage	3.2 million AF	310,000 AF	160,000 AF	Unknown
Unused Storage	Unknown	Unknown	Unknown	Unknown
Portion of Unused Storage Space Available (end of 2004/05)	504,475 AF	Unknown	Unknown	Unknown

Storage and Extraction Facilities

	San Fernando	Sylmar	Verdugo	Eagle Rock
Production Wells				
Production Capacity	220,000 AFY	8,700 AFY	7,400 AFY	230 AFY
Average 1985-2004	88,370 AFY	5,770 AFY	5,090 AFY	224 AFY
Injection Wells				
Injection Capacity	None	None	None	None
Average 1985-2004	None	None	None	None
Spreading Basins				
Spreading Capacity	104,000 AFY	None	None	None
Average 1985-2004	26,800 AFY	None	None	None

Basin Management Considerations

- 1979 Final San Fernando Judgment and 1984 Sylmar Judgment limit amount of water that can be pumped
- Water quality concerns related to the Superfund sites in the east-central portion of the basin could limit ability to store and extract water in the basin
- Shallow groundwater and liquefaction potential are concerns in western portion of San Fernando Basin
- Rising groundwater could increase losses to Central Basin



MWD Service Area

Plate 2-1
Overview of Upper Los Angeles River Basins

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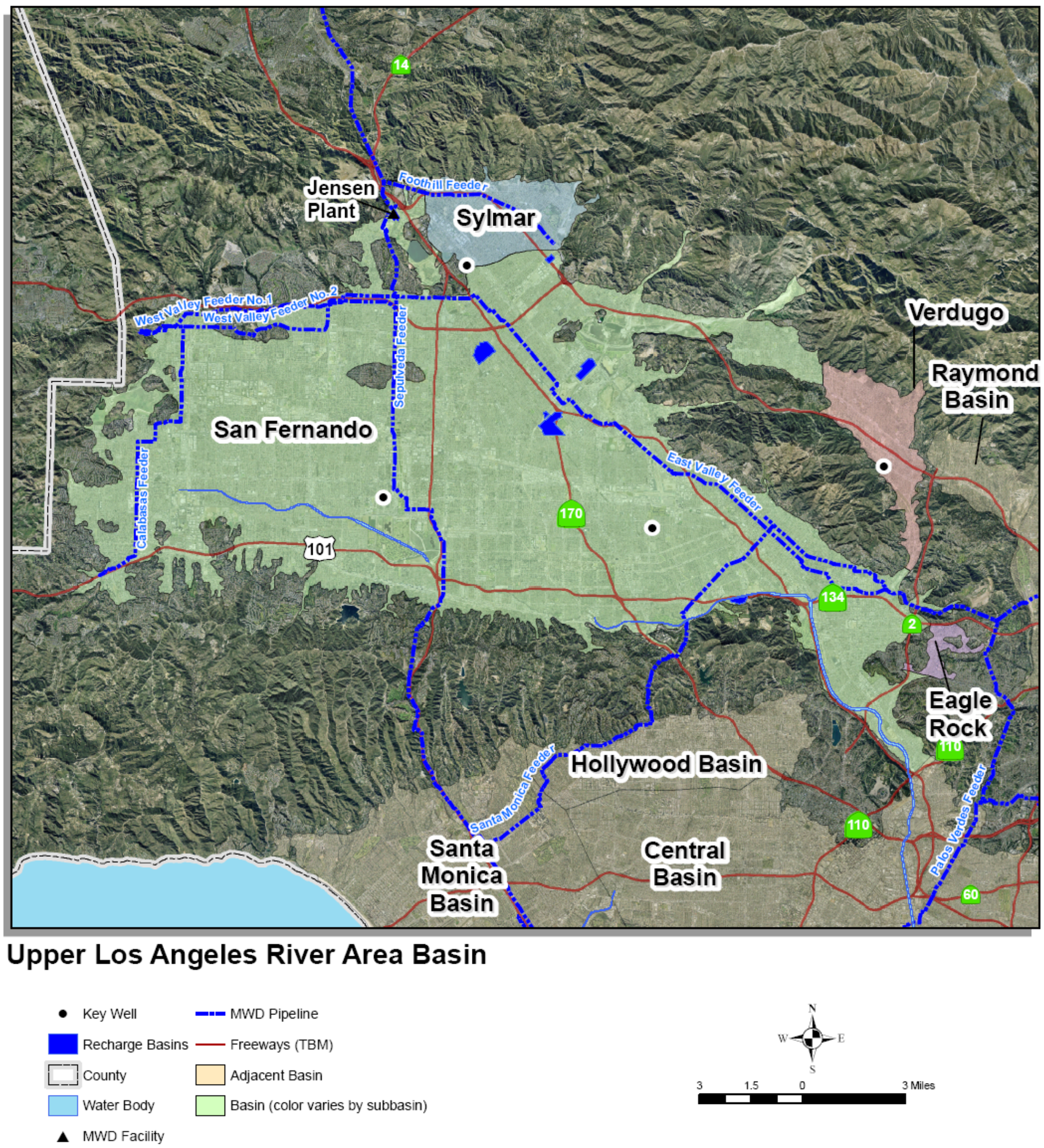
The Upper Los Angeles River Area (ULARA) Basins are located within Los Angeles River Watershed in Los Angeles County. The ULARA Basins include the San Fernando, Sylmar, Verdugo and Eagle Rock Basins and underlie the Metropolitan member agencies of the cities of Los Angeles, San Fernando, Burbank, and Glendale and Foothill Municipal Water District (Foothill MWD). A map of the basins with the ULARA is provided in **Figure 2-1**.

Figure 2-1
Map of the ULARA Basins



BASIN CHARACTERIZATION

The following section provides a physical description of the groundwater basins within the ULARA including their location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The groundwater basins within ULARA are nearly surrounded by impermeable sedimentary, granitic and metamorphic bedrock underlying the surrounding San Gabriel and Santa Monica mountains. **Table 2-1** provides a summary of the characteristics of the ULARA Basins.

The San Fernando Basin, the largest of the four basins within the ULARA, is an unconfined aquifer contained by the Santa Monica Mountains on the south, the Simi Hills to the West, the Santa Susana Mountains to the northwest, and the San Gabriel Mountains and Verdugo Hills on the northeast with a relatively thin finger extending eastward into the Tujunga Canyon between the San Gabriel Mountains and the Verdugo Hills. The Sylmar Basin, is a confined aquifer system separated from the San Fernando Basin by the Sylmar Fault Zone in the underlying geology. The Verdugo Basin is located in Crescenta Valley, a down-dropped block between the San Gabriel Mountains to the northeast, and the Verdugo Mountains to the southwest and east of the groundwater divide that separates it from the finger of the San Fernando Basin in Tujunga Canyon. In contrast to the other nearby groundwater basins, the Verdugo Basin (1) is relatively small in area and relatively steeply sloping, (2) the aquifer units are relatively thin, and (3) the aquifer units have relatively low hydraulic conductivity (Geomatrix, 2005). The smallest basin within the ULARA and least significant in terms of groundwater storage is the Eagle Rock basin, located in the extreme southeastern edge of the San Fernando Basin.

The State Water Rights Board in the Report of the Referee for the Judgment over the ULARA estimated approximately 3.2 million AF of total groundwater storage capacity in the San Fernando Basin. The estimated storage capacities of the Sylmar and Verdugo Basins are 310,000 AF and 160,000 AF, respectively. Considering the relatively insignificant total storage capacity of the Eagle Rock groundwater basin, these combined volumes lead to an estimated total of about 3.67 million AF for the storage capacity of the groundwater basins within the ULARA.

Safe Yield/Long Term Balance of Recharge and Discharge

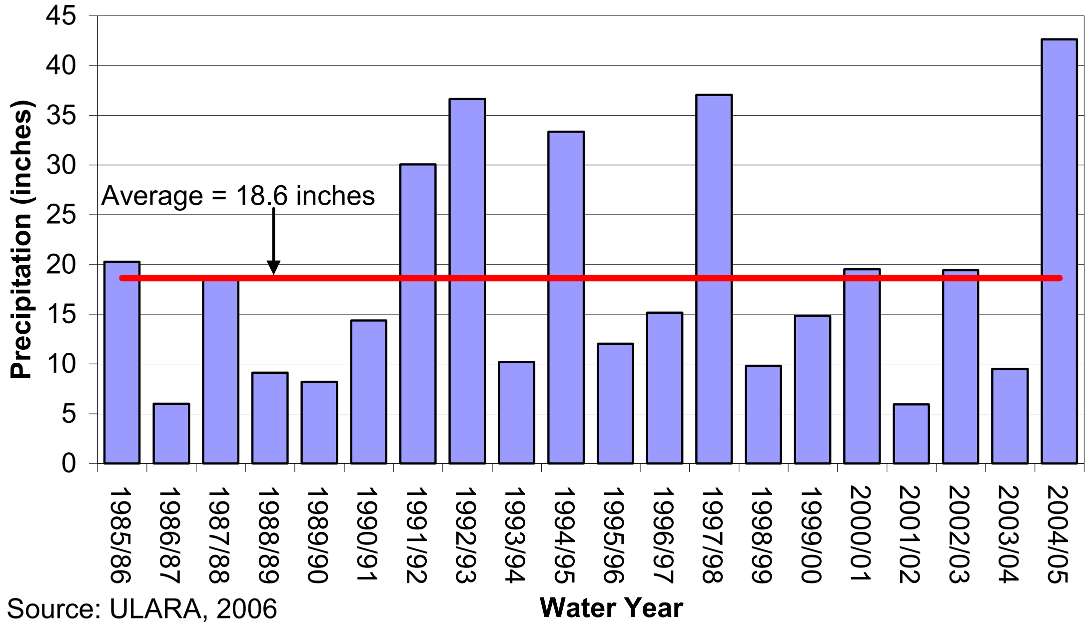
The primary inflows to the ULARA groundwater basins are imported water and natural precipitation and runoff during the rain season. Because the runoff is seasonal in nature, natural recharge is limited. **Figure 2-2** provides the historical precipitation data from the San Fernando Basin between the 1985/86 to 2004/05 water years. Over this time period, rainfall varied between 6 to about 43 inches per year, with an average of about 18.6 inches per year. The data on **Figure 2-2** shows above average precipitation between 1991 and 1993, in 1994/95, in 1997/98, with the highest of about 43 inches occurring in the 2004/05 water year. In contrast, the historical annual precipitation for water years 1949 through 2003 in the Verdugo Basin has ranged from 8.95 to 55.16 inches with a long-term average of 23.37 inches (Geomatrix, 2005).

Table 2-1
Summary of the Hydrogeologic Parameters of the ULARA Basins

Parameter	Description
Structure	
Aquifer(s)	Unconfined to confined
Depth of groundwater basin	San Fernando: 0 to 1,200 feet Sylmar: 50 to 6,000 feet Verdugo: 40 to 400 feet Eagle Rock: Data not available
Depth of producing zones or screen intervals	San Fernando: 58 to 800 feet Sylmar: 64 to 435 feet Verdugo: 150 to 400 feet Eagle Rock: Data not available
Yield and Storage	
Native Safe Yield	San Fernando: 43,660 AFY
Safe Yield	San Fernando: 90,680 AFY Sylmar: 6.810 AFY [2] Verdugo: 7,150 AFY Eagle Rock: Negligible
Extraction Rights [1] (2005-06 water year)	San Fernando: 96,838 AFY Sylmar: 6,510 AFY Verdugo: 7,150 AFY Eagle Rock: Negligible
Total Storage	San Fernando: 3.2 million AF Sylmar: 310,000 AF Verdugo: 160,000 AF Eagle Rock: Negligible
Unused Storage Space	Data not available
Portion of Unused Storage Available for Storage.(Following the 2004/05 water year)	San Fernando: 504,475 AF Sylmar: Limited Verdugo: Limited Eagle Rock: Negligible

Source: Watermaster 2006a and Watermaster, 2006b
[1]Does not include stored water credits or physical solution water
[2]Safe yield of Sylmar Basin was increased from 6,510 to 6,810 AFY in December 2006.

Figure 2-2
Historical Precipitation in the ULARA Basins

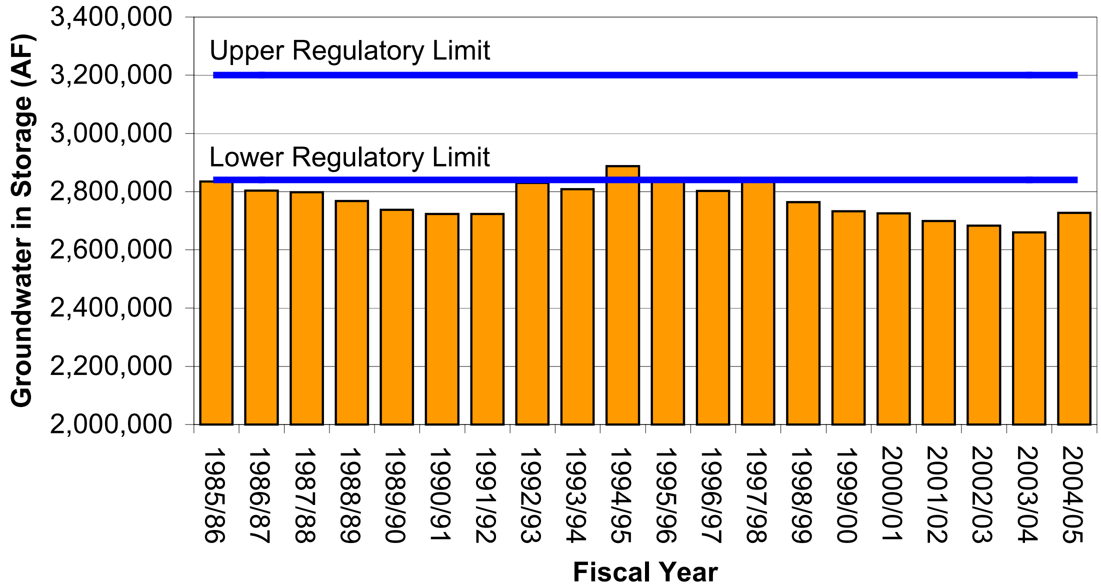


Source: ULARA, 2006

The native safe yield for the ULARA Basins is summarized in **Table 2-1**. These amounts have been fixed by the adjudication of the basins, as discussed below. In the San Fernando Basin, the Judgment (described below) distinguishes between native safe yield (portion of safe yield derived from native waters) and safe yield (includes return flows from imported water), and divides annual extraction rights based on native and imported water origins. The annual extraction right, which is also summarized in **Table 2-1**, includes the native safe yield plus imported water return credits in the San Fernando Basin. The total extraction rights within the ULARA Basins for water year 2005/06 were 110,498 AF (Watermaster, 2006a). At the end of the 2004/05 water year, there were nearly 419,000 AF in stored water credits in the ULARA Basins, increasing the allowable pumping to more than 529,000 AF. As discussed below, stored groundwater can be extracted by the parties in excess of annual pumping rights with approval of the Watermaster.

Figure 2-3 provides a summary of the groundwater in storage in the San Fernando Basin, the largest of the ULARA Basins, from water year 1985/86 to 2004/05. The State Water Rights Board derived a regulatory storage requirement of 360,000 AF for the San Fernando Basin, spanning the interval of 210,000 AF above and 150,000 AF below amount of water in storage in 1954 (2.99 million AF). Despite the heavy rains of the 2004/05 water year, the storage volume at the end of water year 2004/05 was about 113,000 AF below the lowest level of the regulatory storage requirement. Due to the currently depleted groundwater in the San Fernando Basin it is estimated that approximately 504,475 AF (decline in storage since 1928) is available as additional storage capacity (Watermaster, 2006a).

Figure 2-3
Historical Groundwater in Storage Estimates for the San Fernando Basin



GROUNDWATER MANAGEMENT

The following section describes how the ULARA Basins are managed. This discussion includes a brief description of the governing structure and the relationship with other groundwater basins.

Basin Governance

The ULARA Basins are adjudicated. Groundwater production in the ULARA Basins is constrained by the 1979 Final San Fernando Judgment (1979 Judgment) and the 1984 Sylmar Basin Stipulation (1984 Stipulation). This adjudication limits groundwater extraction from all four groundwater basins and established a court appointed Watermaster and Administrative Committee to administer the Court's rulings. The Administrative Committee, as summarized in **Table 2-2,** is made up of a representative from each of the five public agencies overlying the ULARA.

The 1979 Judgment upheld the Pueblo Water Rights of the city of Los Angeles to all groundwater in the San Fernando Basin derived from precipitation within the ULARA and all surface and groundwater underflows from the Sylmar and Verdugo basins (Watermaster, 2005). Furthermore the cities of Burbank, Glendale and Los Angeles were given rights to all San Fernando groundwater derived from water imported by these cities from outside the ULARA and either spread or delivered within the San Fernando Basin. Return credits are granted in the San Fernando Basin. The city of San Fernando was not granted return flow rights in the San Fernando Basin because they where not able to import water until becoming a member of Metropolitan in 1971. The Judgment also contains provisions and stipulations regarding storage of water, stored water credit and arrangements for physical solution water for certain parties (Watermaster, 2006a). There are no storage rights in either the Verdugo or the Eagle Rock Basins.

Under the 1984 Stipulation, the cities of Los Angeles and San Fernando were assigned equal rights to the safe yield of the Sylmar Basin. In 1996, the safe yield was increased from 6,210 AFY to 6,510 AFY. In addition, the safe yield was increased again in December 2006 to 6,810 AFY. These cities also have the right to store groundwater via in-lieu methods and the right to extract equivalent amounts.

Table 2-2
Summary of Management Agencies in the ULARA Basins

Agency	Role
ULARA Watermaster	Overall management authority under the California Superior Court
The City of Burbank	MWD member agency, water retailer and ULARA administrative committee member
The City of Glendale	MWD member agency, water retailer and ULARA administrative committee member
The City of Los Angeles	MWD member agency, water retailer and ULARA administrative committee member. Owns Tujunga Spreading Grounds
The City of San Fernando	MWD member agency, water retailer and ULARA administrative committee member
The Crescenta Valley Water District (CVWD)	Water retailer and ULARA administrative committee member
Los Angeles County Public Works (LACDPW)	Owns and operates spreading facilities

Interactions with Adjoining Basins

Groundwater outflow from the Verdugo Basin into the San Fernando Basin occurs beneath Verdugo Wash at the extreme eastern edge of the ULARA. Groundwater outflow from the ULARA occurs through the Los Angeles River Narrows in the southeast corner of the San Fernando Basin where approximately 400 AF of underflow passes downstream into the Central Basin. In addition, approximately 2,000 to 4,000 AFY of rising groundwater leaves the San Fernando Basin as surface flow into the Central Basin (Watermaster, 2007). An average of about 300 to 400 AF of underflow passes into the Raymond Basin from the Verdugo Basin (DWR, 2004 and Geomatrix, 2005). These flows are accounted for in each basin's adjudication so there are no separate agreements regarding these flows.

WATER SUPPLY FACILITIES AND OPERATIONS

The following section describes the existing water supply facilities in the ULARA Basins. These include 146 groundwater production wells and 314 acres of recharge ponds for groundwater recharge.

Active Production Wells

There are 146 active production wells within the ULARA Basins. A total of 77,995 AF were pumped from the ULARA groundwater basins during the 2004/05 water year. Approximately 94 percent or 73,500 AF of the total volume was pumped from municipal production with the remaining production from private wells. A summary of production from these wells is provided in **Table 2-3**. Historical production is also summarized on **Figure 2-4**.

Table 2-3
Summary of Production Wells in the ULARA Basins

Basin	Number of Wells	Estimated Production Capacity (AFY) [1]	Average Production 1985-2004 (AFY)	Well Operation Cost [2] ($/AF)
San Fernando	122	220,000	88,370	$24 to $165 Average $63 (2004)
Sylmar	6	8,700	5,770	
Verdugo	17	7,400	5,090	Data not available
Eagle Rock	3	230	224	Data not available
Total	**146**	**236,330**	**99,454**	--

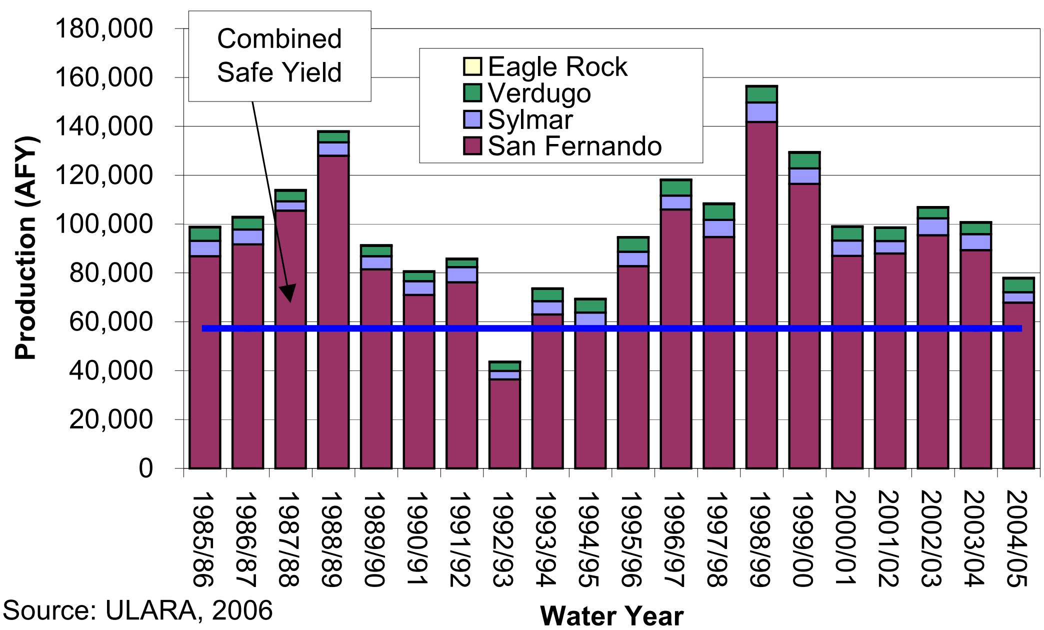
Source: Watermaster, 2006a and 2006b; LA, 2006c
1. Based on maximum annual basin production over the past 5 years for Eagle Rock Basin; Other Basins Watermaster, 2006c, LA, 2006c based upon 10 month per year operation.
2. LA, 2006a

Within the Verdugo Basin, CVWD groundwater production has generally declined since the late-1990s, from about 4,000 AFY in 1999 to about 3,000 AFY in 2002 (Geomatrix, 2005). CVWD pumps groundwater from 11 supply wells in Verdugo Basin. Five wells (6, 8, 10, 12, and 14) pump water to the Glenwood Ion Exchange Nitrate Removal Facility where nitrate is removed from the water. Discharge from five other wells (1, 5, 7, 9, and 11) is pumped without nitrate treatment into the CVWD system. Well 2 is used for standby or emergency supply and is not pumped on an ongoing basis (Geomatrix, 2005).

In the ULARA groundwater basins there were a total of 75 inactive wells. The City of Los Angeles reports that 8 of the inactive wells in the San Fernando groundwater basin are planned to be online within the next 5 years (LA, 2006a).

Table 2-3 also summarizes the general pumping and disinfection costs of municipal production wells in the San Fernando Basin. These costs do not include annual maintenance.

Figure 2-4
Historical Groundwater Production in the ULARA Basins



Source: ULARA, 2006

Other Production

The relatively small percentage of the total production is from private or non-municipal wells as summarized in **Table 2-3**.

ASR Wells

There are no ASR wells reported in the ULARA Basins.

Spreading Basins

Approximately 314 acres of recharge spreading basins are located over the San Fernando Basin with an estimated total capacity of approximately 104,000 AFY, as summarized in **Table 2-4**. The locations of the spreading areas are shown on **Figure 2-1**.

Table 2-4
Summary of Spreading Basins in the ULARA Basins

Spreading Basins	Area (acres)	Recharge Capacity (cfs) 1	Recharge Capacity (AFY) 1	Source Water	Owner
Hansen	105	49	35,000	Runoff	LACDPW
Pacoima	107	40	23,000	Runoff	LACDPW
Lopez	12	7	2,000	Runoff	LACDPW
Branford	7	1	1,000	Runoff	LACDPW
Tujunga	83	99	43,000	Runoff	LADWP
Total	**314**	**196**	**104,000**	--	--

Source: LA, 2006a.

These basins are used for spreading both imported water and surface water diversions, through mostly surface water runoff from the Pacoima, Big Tujunga and Hansen Dams which are operated by LACDPW both as flood control dams as well as to regulate storm flows to allow recapture of the flows in the downstream spreading basins (LA, 2006a; ULARA, 2005).

Figure 2-5 provides a summary of the spreading of surface water runoff to recharge groundwater in the ULARA Basins, principally the San Fernando Basin, over the 1985/86 to 2004/05 water years.

Recharge spreading basins do not currently exist in the Sylmar, Verdugo or Eagle Rock groundwater basins. However, within the Verdugo Basin, modifications and improvements to existing debris basins are being considered in order to retain water and increase the rate of recharge (Geomatrix, 2005).

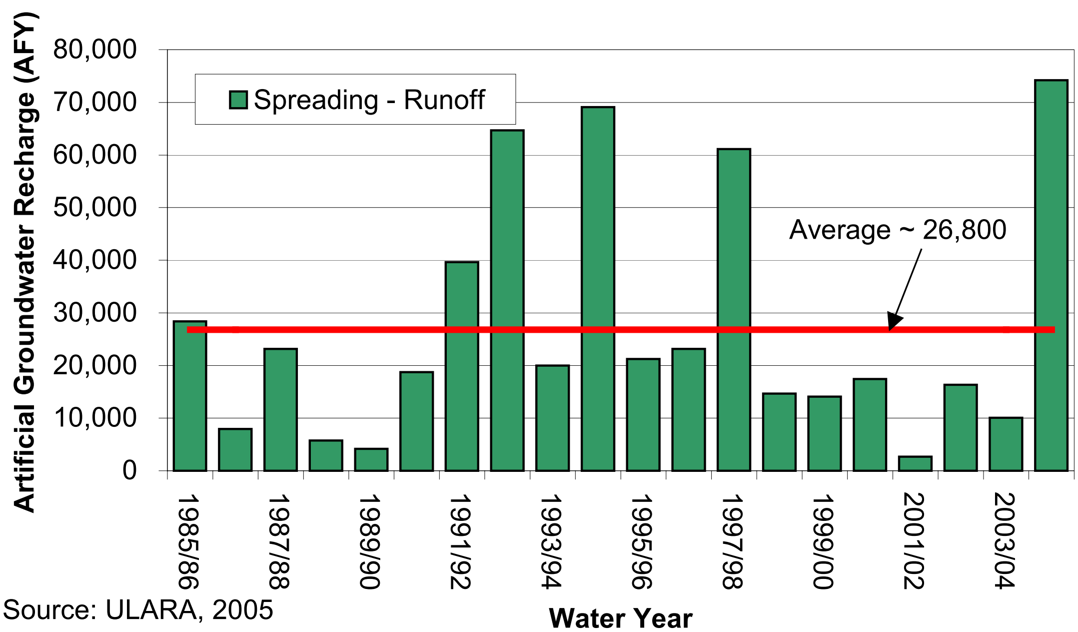
Seawater Intrusion Barriers

There are no seawater intrusion barriers in the ULARA Basins.

Desalters

There are no desalters in the ULARA Basins.

Figure 2-5
Summary of Groundwater Recharge in the ULARA Basins



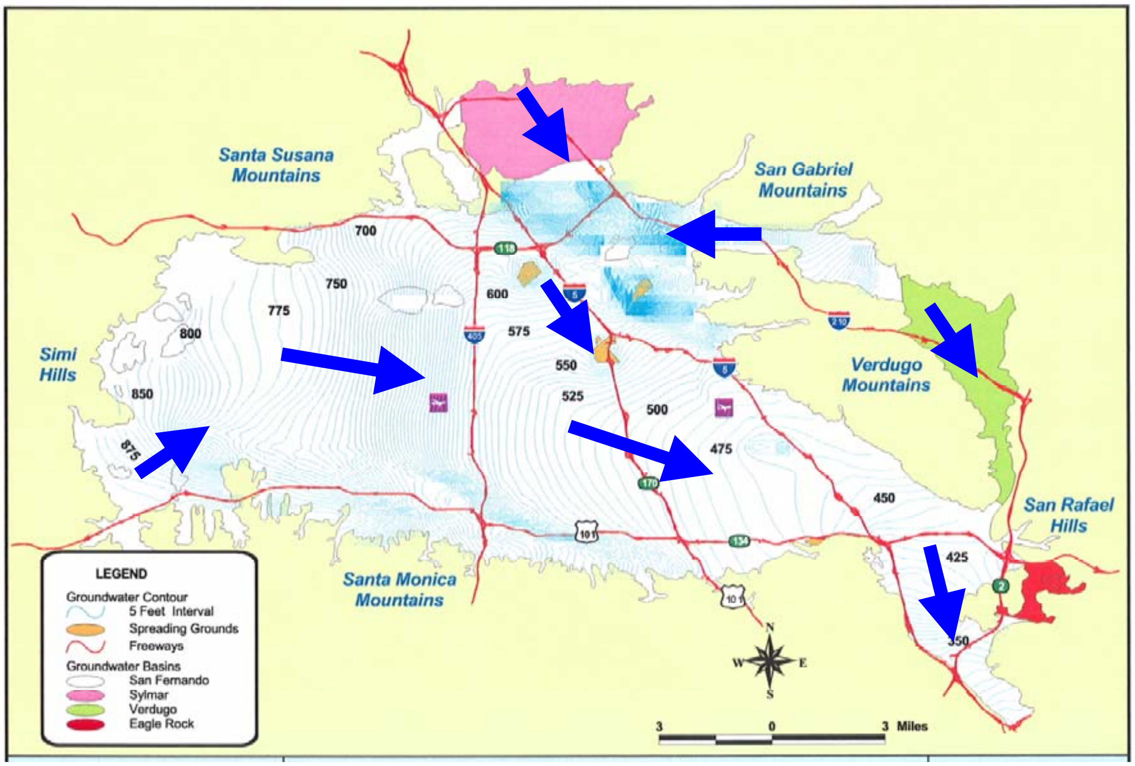
Source: ULARA, 2005

GROUNDWATER LEVELS

The depth to groundwater in the San Fernando, Sylmar, and Verdugo basins range between 24 to 400 feet, 50 to 115 feet, and 17 to 190 feet bgs, respectively. Shallow groundwater conditions are encountered in the western end of the San Fernando Basin. These areas are subject to rising groundwater and high liquefaction potential. However, because of finer sediments and naturally occurring high TDS in this portion of the basin, these areas are not produced. A groundwater contour map during the spring of 2005 is shown in **Figure 2-6**. Groundwater flow is generally from west to east across the majority of the San Fernando Basin. Groundwater flows turns southward in the eastern and southeastern portion of the basin where groundwater flows into the Central Basin. Groundwater flow is generally toward the south-southeast into the San Fernando Basin from the Verdugo and Sylmar Basins as water levels are substantially higher in these basins.

Figures 2-7 and 2-8 show the changes in groundwater level in representative areas within the ULARA from 1985 to 2004. Locally, groundwater levels have risen or remained reasonably constant due to reduction in specific well field production. In other areas, groundwater levels have fallen due to increased production from specific well fields and/or diminished recharge from specific spreading grounds. However, in general, groundwater storage has been steadily declining since the early 1980s in the San Fernando Basin due to heavy pumping, limited artificial recharge and low precipitation. Due to the heavy rains and decreased pumping during water year 2004/05, water levels in the basin have begun to recover, but this effect may be temporary. Despite a positive balance in stored water credits in the San Fernando Basin, groundwater levels and storage continued to decline. This imbalance is being addressed by the pumping parties and the Watermaster.

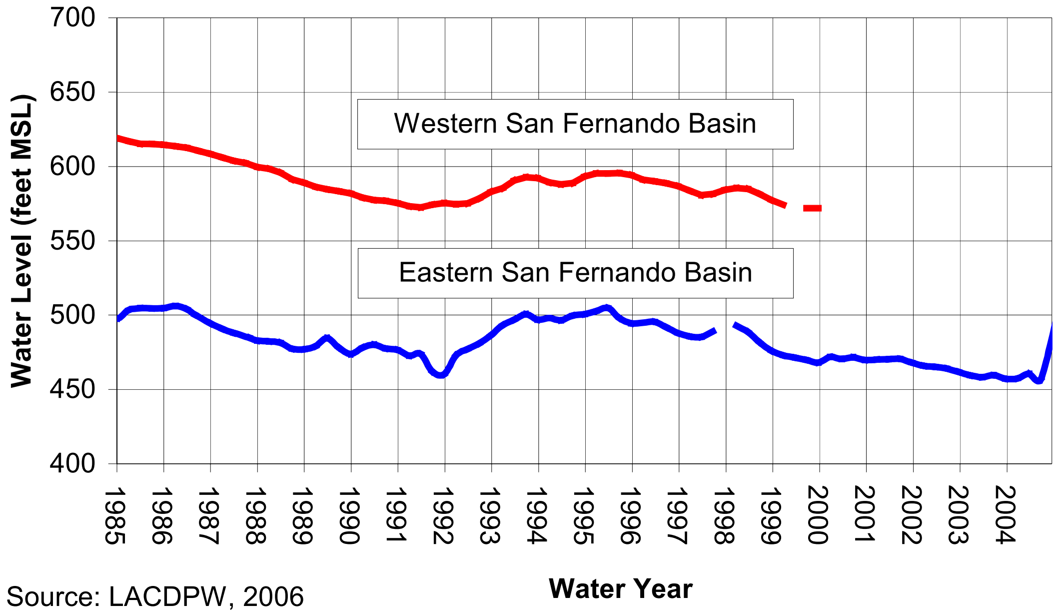
Figure 2-6
Groundwater Contour Map in the ULARA Basins – Spring 2005



Source: ULARA, 2006a

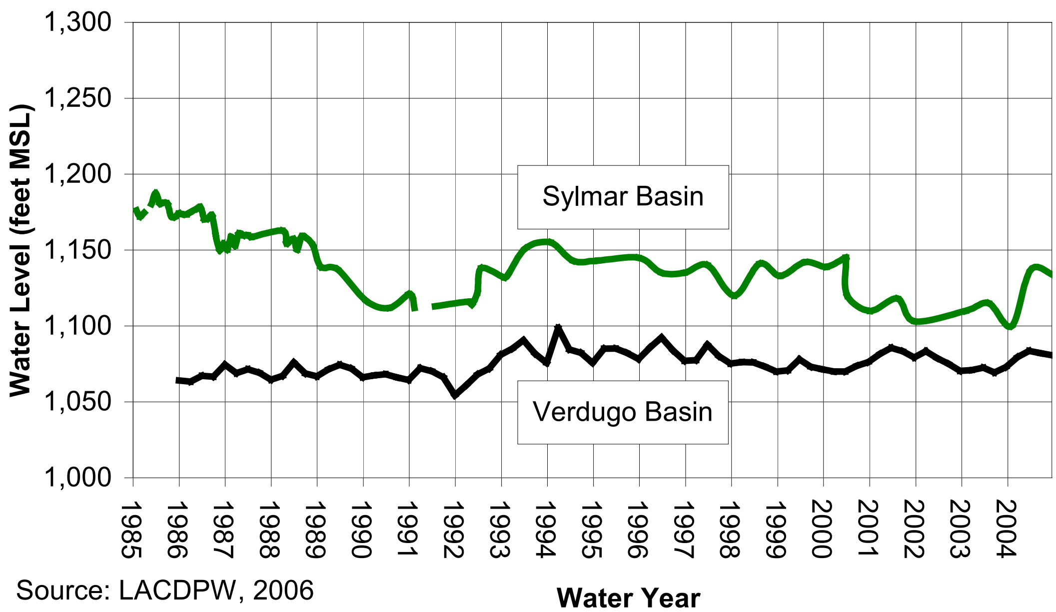
Groundwater levels show seasonal variation in response to precipitation, runoff and pumping. In the Verdugo Basin, depth to groundwater ranged from about 17 to approximately 190 feet below ground surface between 1981 and 2002. Between 1983 and 1992, groundwater level elevations declined following a prolonged dry period and cessation of septic system recharge. A significant rise occurred between 1992 and 1995, along with wetter climatic conditions. Since 1995 groundwater elevations have gradually declined throughout the basin. Water levels in the basin declined in recent years due to lower precipitation and increases in groundwater pumping (Geomatrix, 2005).

Figure 2-7
Historical Water Levels in the San Fernando Basin



Source: LACDPW, 2006

Figure 2-8
Historical Water Levels in the Verdugo and Sylmar Basins



Source: LACDPW, 2006

GROUNDWATER QUALITY

The following provides a brief description of the groundwater quality issues in the ULARA Basins.

Groundwater Quality Monitoring

The various cities and agencies operating municipal wells and responsible parties remediating contaminated groundwater are sampling their wells for water quality on a regular basis and the results are submitted to the California Department of Health Services (DHS) (LA, 2006a). The USEPA also samples approximately 100 monitoring wells in the eastern portion of the San Fernando Basin on a quarterly and annual basis (LA, 2006a). The results are also cataloged and monitored by the ULARA Watermaster and the Regional Board.

Groundwater Contaminants

Groundwater in the ULARA Basins has significant contamination issues. A number of the groundwater production wells are located with the bounds of a Superfund area. Elevated concentrations of volatile organic compounds (VOCs), such as trichloroethylene (TCE) and tetrachloroethylene (PCE), as well as other contaminants, such as hexavalent chromium have prompted the city of Los Angeles to discontinue pumping at numerous production wells. Maps depicting the locations of these plumes and nitrate are shown in **Figure 2-9** through **Figure 2-11** (LA, 2006a and Watermaster, 2006). Emerging contaminants, such as 1,4 dioxane, have also been found in concentrations high enough to necessitate the alteration of groundwater pumping operations. **Table 2-5** summarizes the constituents of concern within the ULARA Basins.

In addition, perchlorate, a constituent of regional concern has been detected in 2 wells above the notification level of 6 μg/L, one in the Sylmar Basin and one in eastern end of the San Fernando Basin. In these areas of contamination, wells have been removed from service or the groundwater is being blended or treated to meet State Drinking Water Standards as discussed below (LA, 2006a). In the San Fernando Basin, the estimated capacity of all the wells that have been removed from service due to elevated contamination levels is approximately 200 cfs or 396 AF/day. In addition to the contaminants in the San Fernando groundwater basin, one well was removed from service in the Sylmar basin due to elevated TCE levels (LA, 2006a).

As discussed in more detail below, continuing efforts to expand groundwater extraction capability, improve groundwater source quality, and treat extracted groundwater are underway in the basin. The USEPA, the Department of Toxic Substances Control, and the Los Angeles Regional Water Quality Control Board are working with the cities of Los Angeles, Glendale, and Burbank to identify and resolve San Fernando Basin contamination concerns. The City of Los Angeles' Department of Water and Power is currently undertaking a comprehensive study of the San Fernando Basin to fully characterize the extent and composition of known and emerging contaminants.

Figure 2-9
Location of VOC Contaminant Plumes in the ULARA Basins

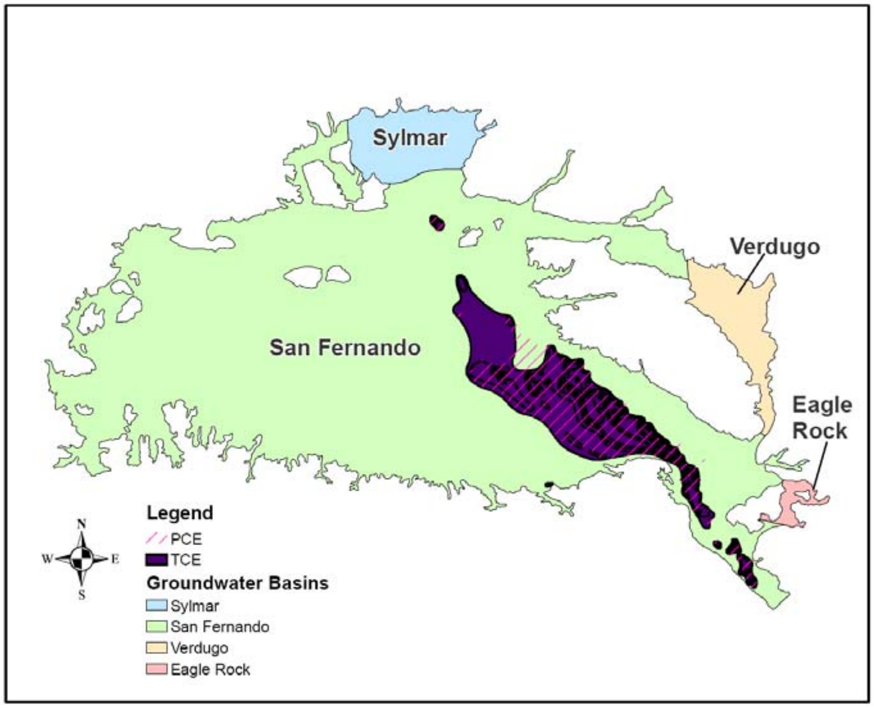


Figure 2-10
Location of Hexavalent Chromium Plumes in the ULARA Basins

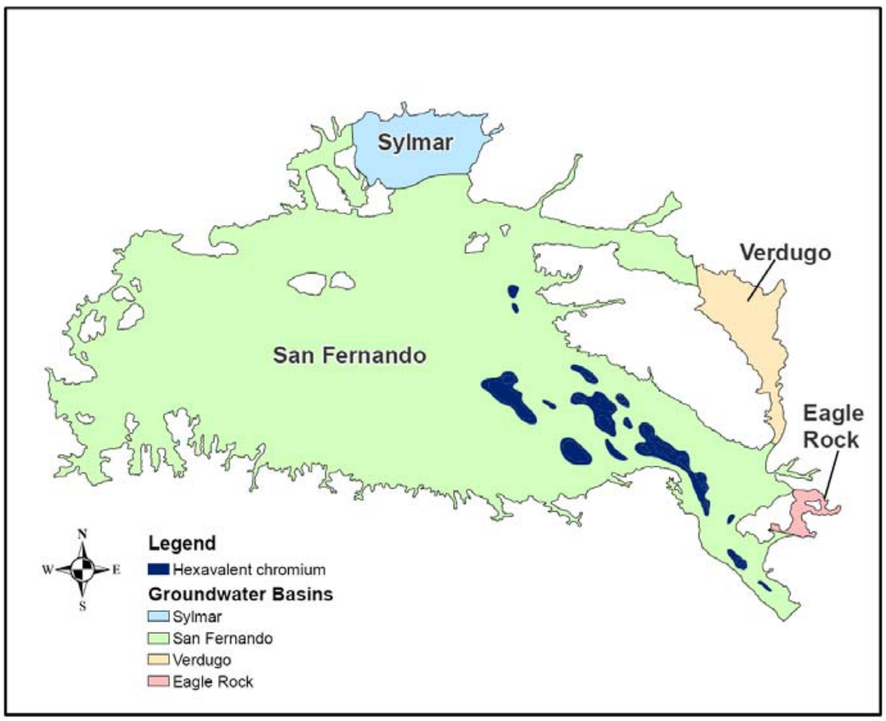
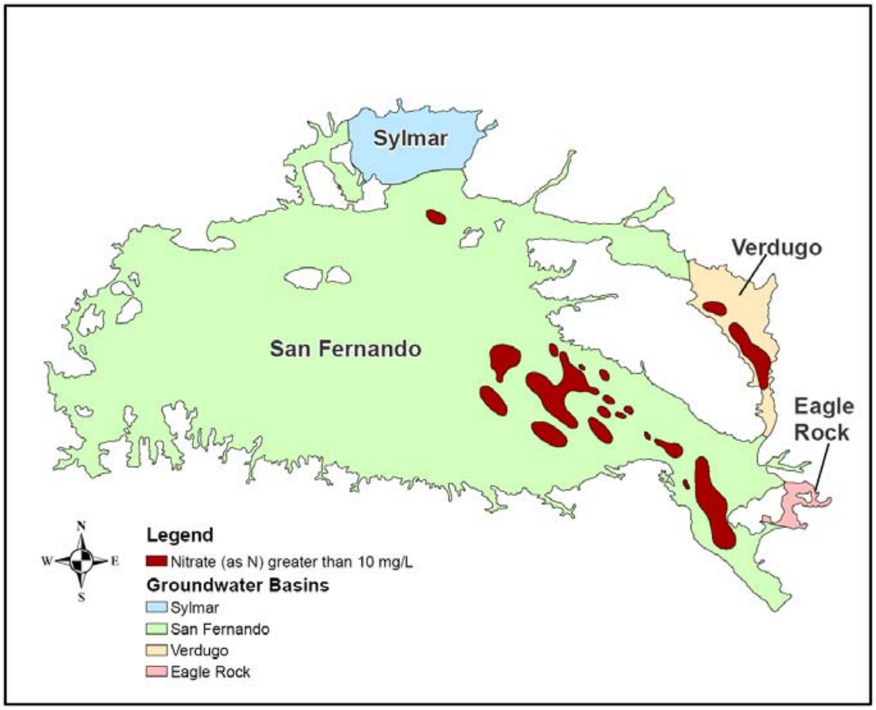


Figure 2-11
Location of Nitrate Plumes in the ULARA Basins



Blending Needs

All the cities and agencies are blending Metropolitan imported water with the groundwater extracted from selected wells to meet water quality standards. For example, the city of Los Angeles has blended imported water with groundwater contaminated with nitrate and VOC extracted from wells within the San Fernando groundwater basin, as summarized below in **Table 2-6**. These data suggest that nearly all the groundwater produced from the San Fernando Basin is blended with other sources of water.

For CVWD, in the Verdugo Basin, imported water purchased from Foothill MWD is received through a connection at the Paschall Blending Station and is blended with groundwater to reduce the nitrate concentration of the delivered water. Imported water is also received via the Briggs Meter Station, and the Ocean View Meter Station. Blending with imported water is used to help manage the nitrate concentration in water delivered to consumers (Geomatrix, 2005).

Groundwater Treatment

The cities of Burbank, Glendale and Los Angeles, and the CVWD are treating groundwater extracted from selected wells to meet water quality standards. For example, the city of Los Angeles operates treatment facilities for VOC-contaminated groundwater from wells in the San Fernando groundwater basin, as summarized below in **Table 2-7** (LA, 2006a). Costs of treatment range from $250 to $288 per AF.

Table 2-5
Summary of Constituents of Concern in the ULARA Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	280 to 729	Highest levels reported in the North Hollywood area of the San Fernando Basin.
Nitrate (as N) Primary MCL = 10	mg/L	2.6 to 79.2	Highest levels reported in the Verdugo Basin and eastern portion of the San Fernando Basin
VOCs **(TCE and PCE)** TCE Primary MCL = 5 PCE Primary MCL = 5	μg/L	<5 to over 100	The highest concentrations in Glendale and Burbank areas of the eastern San Fernando Basin are being treated. Other areas in the San Fernando Basin, which have levels significantly above the MCL, are currently being addressed through treatment or other means, while long-term solutions are being developed.
Total and Hexavalent Chromium Total Cr MCL = 50 Hexavalent Cr MCL = TBD	μg/L	ND to 423	Highest concentrations are in the Burbank and Glendale areas. These areas are currently being investigated. The city of Los Angeles discontinued pumping from one San Fernando Basin production well after total hexavalent chromium levels as high as 423 μg/L were detected.
Perchlorate Notification Level = 6	μg/L	ND to 8.9	Detected in 2 wells above notification level since 2000.

Source: Watermaster, 2006a; Regional Board 2006

In 1987, the USEPA initiated a remedial investigation of VOC (TCE and PCE) contamination in San Fernando and Verdugo basins. Operable Units for long-term groundwater remediation of VOCs have been established in North Hollywood, Burbank, Glendale North, and Glendale South. The operation of these treatment facilities has become more complex with the identification of nearby hexavalent chromium plumes. Remediation treatment facility operations are summarized in **Table 2-7**.

Within the Verdugo Basin, CVWD pumps groundwater from 11 supply wells in Verdugo Basin. Five of the wells pump water to the Glenwood Ion Exchange Nitrate Removal Facility where nitrate is removed from the water (Geomatrix, 2005).

Table 2-6
Summary of Blending Needs in the San Fernando Basin

Agency	Wellfield(s)	Constituent Blended	Average Annual Groundwater Blended (AFY)
City of Los Angeles	Tujunga	Nitrate and VOC(s)	21,778
City of Los Angeles	Rinaldi-Toluca North Hollywood Erwin Verdugo Whitnall	Nitrate and VOC(s)	66,932
City of Los Angeles	Pollock	Nitrate	1,697
Total		**--**	**90,407**

Source: LA, 2006a

Table 2-7
Summary of Groundwater Treatment in the ULARA Basins

Treatment Facility	Constituent Treated	Treatment Type	Amount Treated (AFY)	Comments
North Hollywood Operable Unit	VOC	Air stripping with air phase GAC	1,800 AF in 2002/03 1,228 AF in 2003/04 1,042 AF in 2004/05	Consent decree expired in 2004, but remediation incomplete. Declining water levels resulting in reduced treatment capacity. Concern with intercepting nearby chromium plume.
Burbank Operable Unit	VOC	Aeration and liquid phase GAC	Design capacity of 9,000 gpm 9,660 AF in 2003/04 6,398 AF in 2004/05	Effluent blended with Metropolitan water to reduce nitrate and chromium concentrations Additional well capacity needed to maintain design capacity.
Glendale North and South Operable Units	VOC	Aeration and liquid phase GAC	North: Design capacity of 3,300 gpm South: Design capacity of 1,700 gpm 7,283 AF in 2003/04 7,541 AF in 2004/05	Effluent blended with Metropolitan water

Table 2-7 (continued)
Summary of Groundwater Treatment in the ULARA Basins

Treatment Facility	Constituent Treated	Treatment Type	Amount Treated (AFY)	Comments
Glenwood Nitrate Water Treatment Plant	Nitrate	Ion Exchange	164 AF in 2003/04 782 AF in 2004/05	Operates in Verdugo Basin
Pollock Wells Treatment Plant	VOC	Liquid phase GAC	1,137 AF in 2003/04 1,752 AF in 2004/05	Treats rising groundwater in the Los Angeles River

ULARA Watermaster, 2005, 2006a

CURRENT GROUNDWATER STORAGE PROGRAMS

There are no formal groundwater storage programs in the ULARA Basins. The City of Los Angeles has regularly participated in Metropolitan's in-lieu replenishment program whereby the City takes imported water from Metropolitan at a discounted rate in lieu of pumping groundwater. An average of 10,400 AFY has been recharged via these programs since 1997.

BASIN MANAGEMENT CONSIDERATIONS

Not all of the 3.67 million AF for the storage capacity is usable and limitations are imposed on the volume of extraction. The primary considerations in the management of the ULARA groundwater basins are:

- The 1979 San Fernando Judgment and 1984 Sylmar Basin Stipulation, which limit production from the basin to the native safe yield plus any imported recharge.
- Rising groundwater levels may also increase surface flow losses out of the ULARA through the Los Angeles River Narrows to Central Basin, liquefaction potential and other factors resulting from near surface groundwater levels.
- In the Verdugo Basin, the vadose zone thickness affects the amount of available storage capacity (being reduced during wet periods). The basin's relatively small size and the basin area suitable for recharge also limit the potential storage capacity (Geomatrix, 2005).
- Widespread contamination with VOCs, hexavalent chromium and nitrate may limit the ability to store and extract water in this basin.
- The imbalance between stored water credits and the actual water in storage in the San Fernando Basin is being addressed by the management parties and the Watermaster.

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CHAPTER IV

GROUNDWATER BASIN REPORTS

LOS ANGELES COUNTY COASTAL PLAIN BASINS

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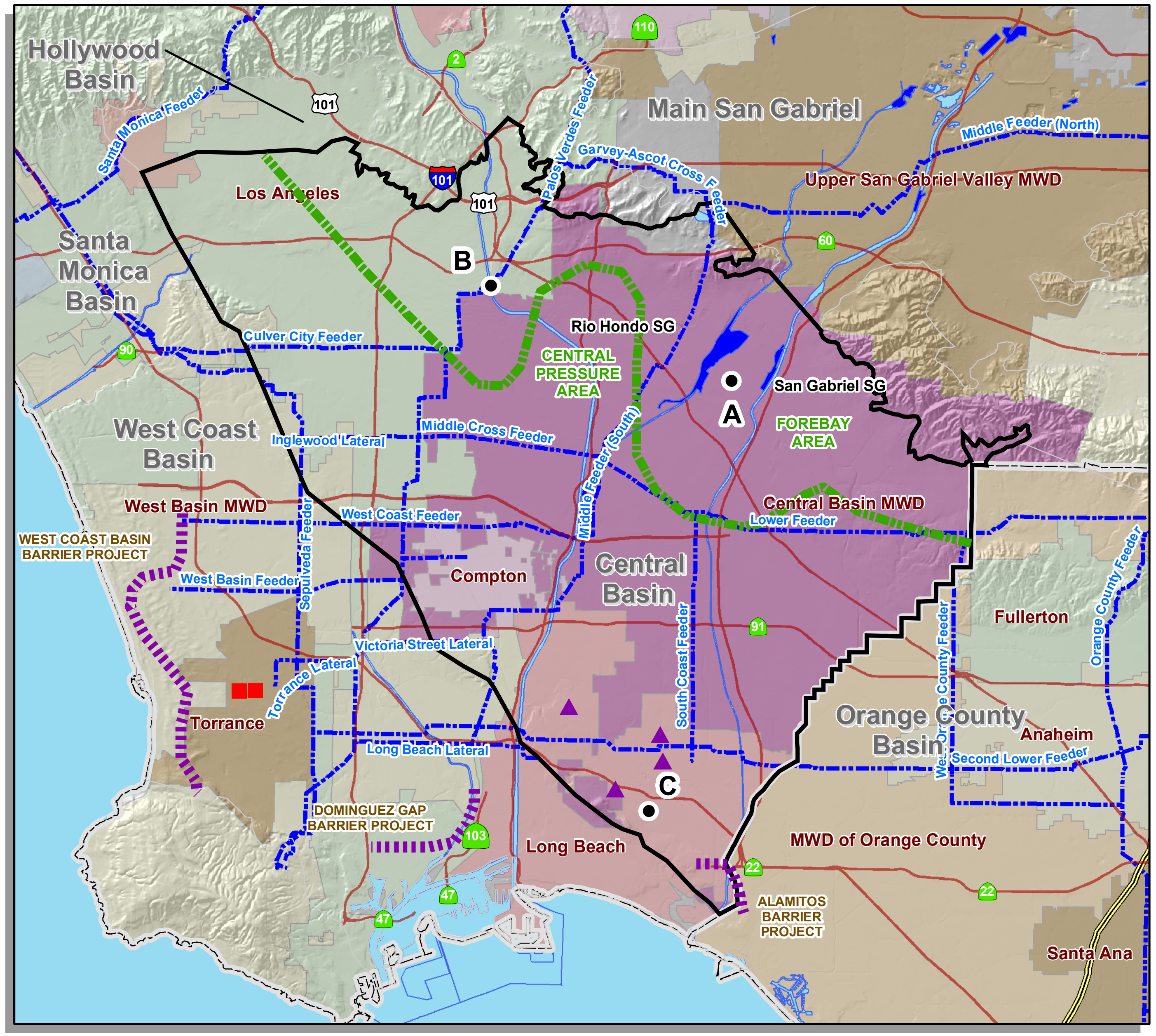

Central Basin

A ● Key Well
▲ ASR Wells
Desalter
Recharge Basin
Seawater Intrusion Barrier
County
Freeways
Water Body
Central Pressure Area
MWD Pipeline
Santa Ana Regional Interceptor Line
Adjacent Basin
Basin
MWD Member Agency Boundary (color varies)

N W E S

5 2.5 0 5 Miles

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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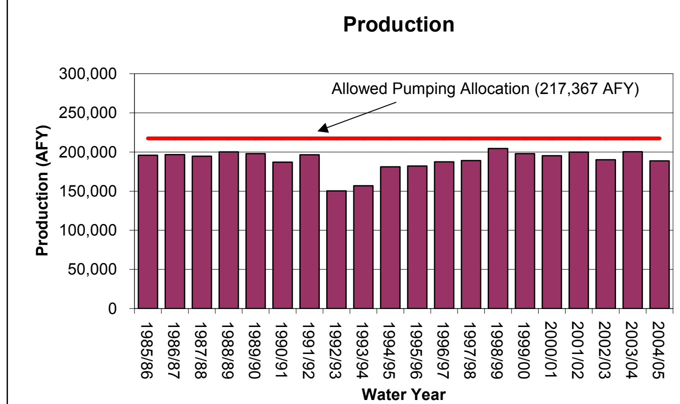
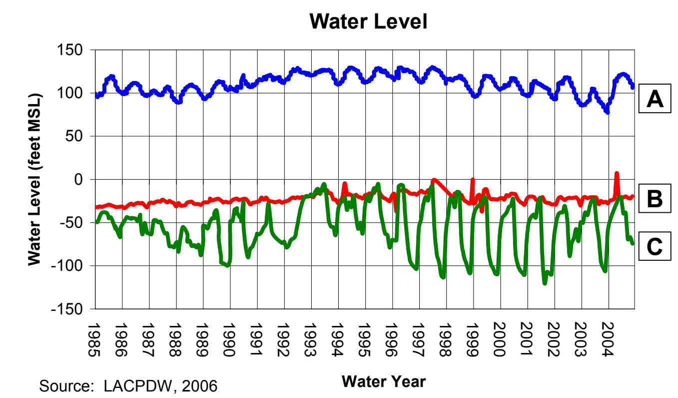
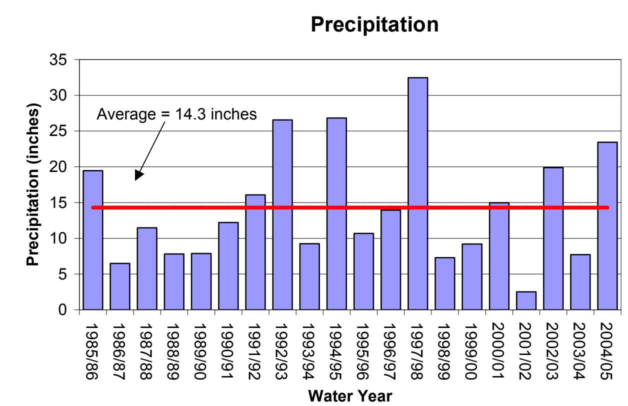
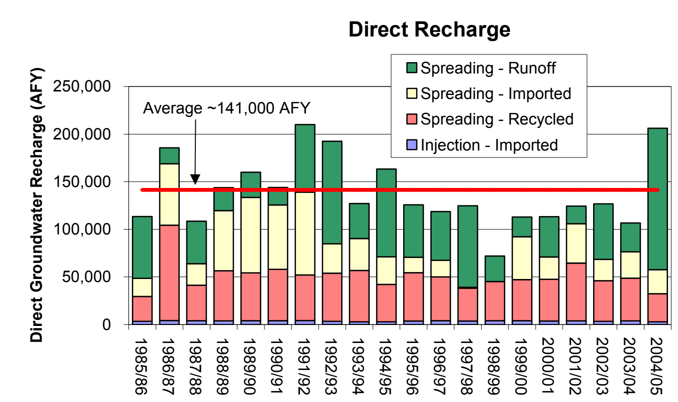
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).









BASIN FACTS

Central Basin

Description
Location: Los Angeles County
Watershed Surface Area: 227 square miles
Management: Adjudicated
Basin was adjudicated in 1965. Department of Water Resources is the Watermaster. The Water Replenishment District of Southern California purchases artificial replenishment water to make up the annual overdraft and has statutory authority to address water quality issues.
MWD Member Agencies:
City of Los Angeles
City of Compton
City of Long Beach
Central Basin MWD

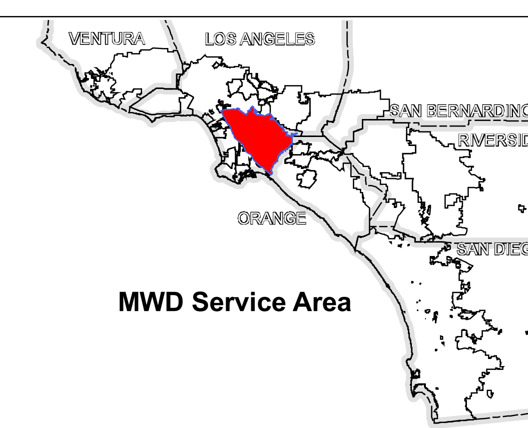
	Central Basin
Natural Safe Yield	125,805 AFY
Allowable Pumping Allocation	213,367 AFY
Total Storage	13.8 million AF
Usable Storage Space	1.1 million AF
Portion of Unused Storage Space Available for Storage (2005)	330,000 AF

Storage and Extraction Facilities

	Central Basin
Production Wells	
Production Capacity	Data not available
Average 1985-2004	~190,000 AFY
Injection Wells	
Injection Capacity	~4,300 AFY
Average 1985-2004	None
Spreading Basins	
Spreading Capacity	~398,000 AFY
Average 1985-2004	~135,000 AFY
Seawater Intrusion Barriers	
Injection Capacity	6,000 AFY
Average 1985-2004	~3,700 AFY

Basin Management Considerations

- Extraction is limited by the Judgment and the Allowable Pumping Allocation.
- Regional Board limits the amount of recycled water that can be spread.
- Disagreements related to groundwater storage space allocations in the Central and West Coast Basins may limit the ability to store water in the Central Basin.
- Potential for liquefaction and water quality concerns may limit ability to store water



MWD Service Area

Plate 3-1
Overview of Central Basin

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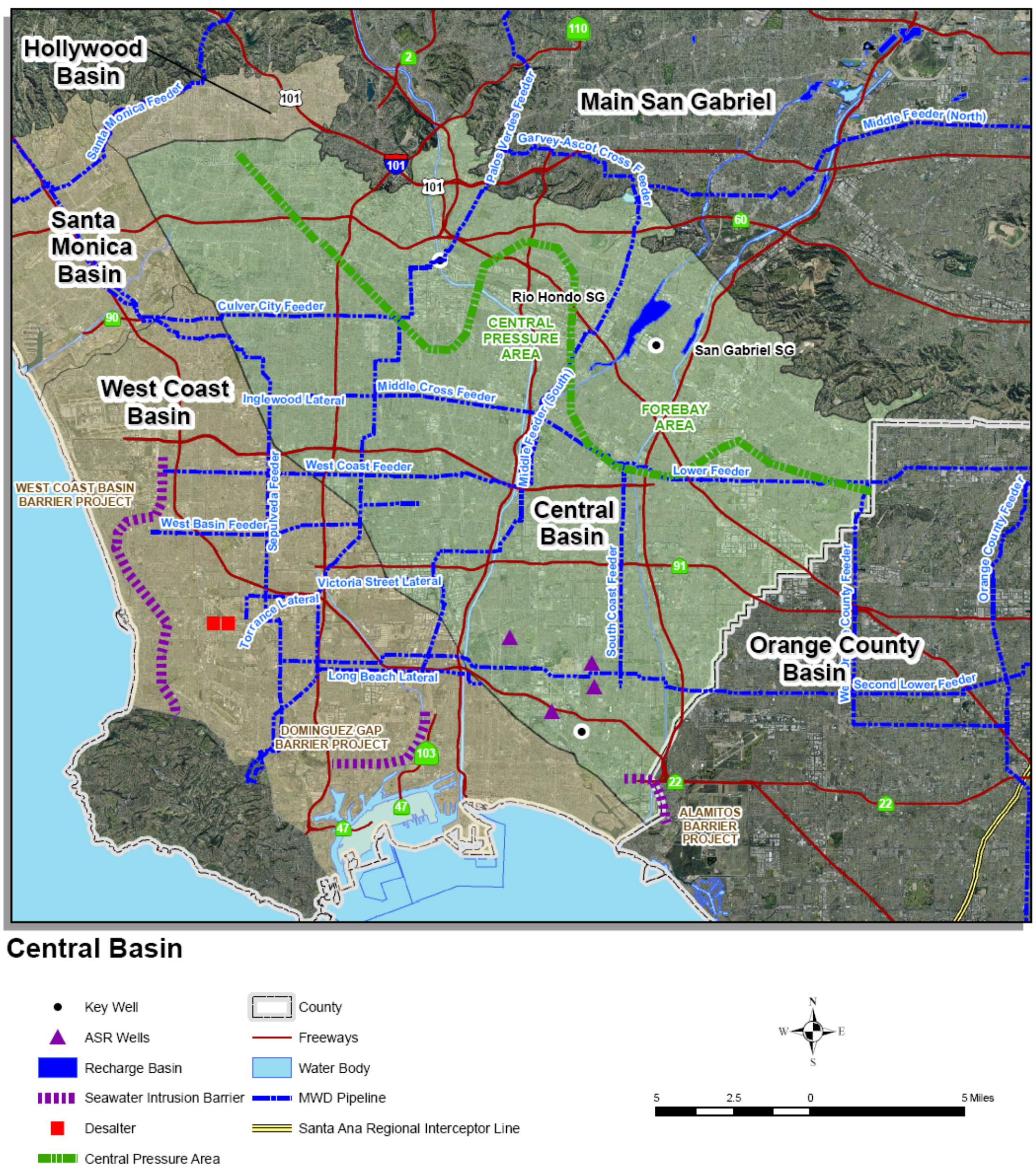
The Central Basin lies within central Los Angeles County, California. It underlies the service areas of Metropolitan member agencies Central Basin Municipal Water District (Central Basin MWD), West Basin Municipal Water District (West Basin MWD), the City of Compton, the City of Los Angeles, and the City of Long Beach. The cities of Artesia, Bellflower, Cerritos, Compton, Downey, Huntington Park, Lakewood, Los Angeles, Long Beach, Montebello, Paramount, Pico Rivera, Norwalk, Santa Fe Springs, Signal Hill, South Gate, Vernon and Whittier overlie the basin. A map of the Central Basin is provided in **Figure 3-1**.

Figure 3-1
Map of Central Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Central Basin, including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The Central Basin is bounded on the northeast and east by the Elysian, Repetto, Merced and Puente Hills. The southeast boundary of the Central Basin is along Coyote Creek, which is used to separate the Central Basin from the Orange County Basin, although there is no physical barrier between the two basins. The southwest boundary is the Newport, Inglewood fault system. The hydrogeologic parameters of the Central Basin are summarized in **Table 3-1 and Figure 3-2**.

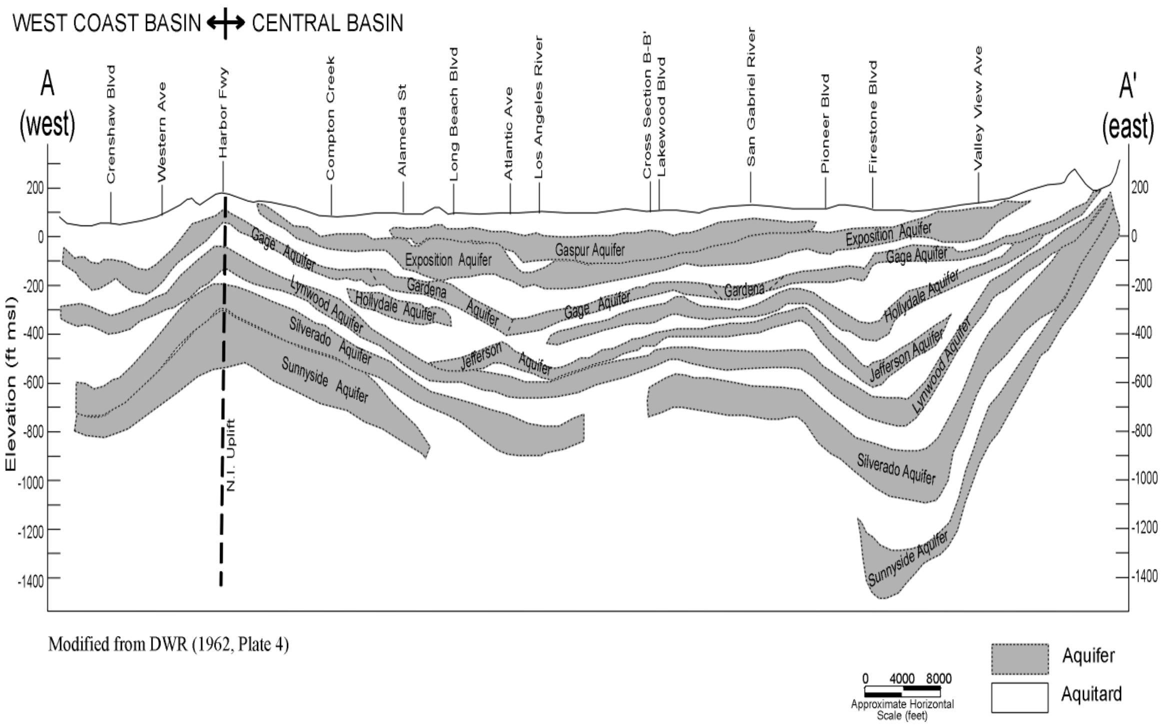
Table 3-1
Summary of Hydrogeologic Parameters of Central Basin

Parameter Structure	**Description**
Aquifer(s)	Forebay areas (unconfined) Pressure area (confined) • Alluvium (Gaspur and Semi-perched aquifers) • Lakewood Formation (Gardena and Gage aquifers) • San Pedro Formation (Lynwood, Silverado, and Sunnyside aquifers)
Depth of groundwater basin	Forebay areas – up to 1,600 feet Pressure area – up to 2,200 feet
Thickness of water-bearing units	Alluvium (up to 180 feet) Lakewood Formation (up to 280 feet) San Pedro Formation (up to 800 feet)
Yield and storage	
Natural safe yield	125,805 AFY
Allowable Pumping Allocation and Managed Safe Yield	217,367 AFY
Total Storage	13.8 million AF
Unused Storage Space	1.1 million AF
Portion of Unused Storage Available for Storage	330,000 AF

WRD, 2006a and WRD, 2006e

The depth of the Central Basin ranges from 1,600 to more than 2,200 feet. The main source of potable groundwater in the Central Basin is from the deeper aquifers of the San Pedro Formation (including from top to bottom, the Lynwood, Silverado and Sunnyside aquifers), which generally correlate with the Main and Lower San Pedro aquifers of Orange County. The shallower aquifers of the Alluvium and the Lakewood Formation (including the Gaspur, Exposition, Gardena-Gage, Hollydale and Jefferson aquifers) locally produce smaller volumes of potable water. In the northern portions of the Central Basin, referred to as the Forebay Area, many of the aquifers are merged and allow for direct recharge into the deeper aquifers. In the area referred to as the Pressure Area, the aquifers are separated by thick aquitards, which create confined aquifer conditions and protection from surface contamination.

Figure 3-2
Generalized Cross Section of Central Basin



Source: WRD, 2006

Total storage in the Central Basin is estimated to be approximately 13.8 million AF. Unused storage space is estimated to be approximately 1.1 million AF. Of the unused storage space, the amount available is approximately 330,000 AF assuming that up to 75 feet below the ground surface is actually available (WRD, 2006e).

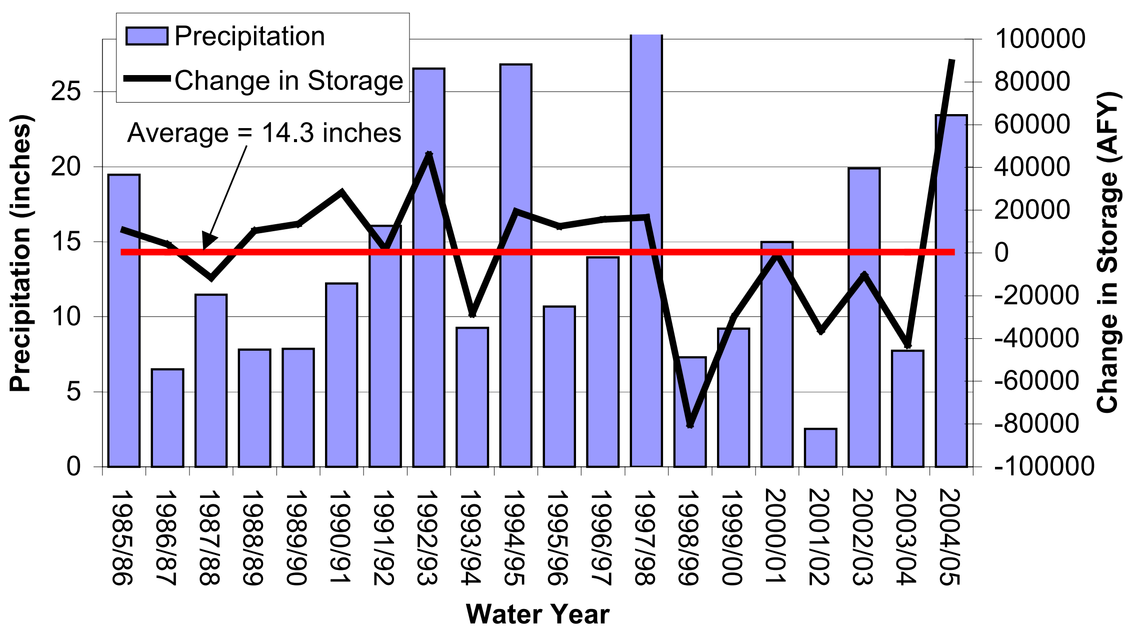
Safe Yield/Long-Term Balance of Recharge and Discharge

According to the California Department of Water Resources (DWR), groundwater enters the Central Basin through surface and subsurface flow and by direct percolation of precipitation, stream flow, and applied water in the forebay areas. Natural replenishment of the groundwater is largely from surface and subsurface inflow through Whittier Narrows. Percolation in the

Los Angeles Forebay from the north is restricted as a result of urbanization at the surface, which prevents downward percolation (DWR, 2004). The natural safe yield of the Central Basin is approximately 125,805 AFY (WRD, 2006e), which represents the amount of water from native waters alone. The managed safe yield of Central Basin is equal to the allowable pumping allocation amount of 217,367 AFY, which is substantially higher than the natural safe yield. This higher yield is possible because of artificial recharge maintained by the Water Replenishment District of Southern California (WRD).

Figure 3-3 shows the historical precipitation as it relates to the change in storage calculated by WRD (2006c). These data show that the average precipitation over the Central Basin is approximately 14.3 inches per year. In general, storage in the Central Basin increases during wet years and decreases during dry years. As discussed below, the amount of recharge in the forebay areas is also a controlling factor in the change in storage that may or may not be related to wet year and dry year cycles. The average change in storage between water year 1985/86 and water year 2004/05 was approximately 1,300 AFY, suggesting that the basin was nearly balanced.

Figure 3-3
Historical Precipitation and Change in Storage for Central Basin



GROUNDWATER MANAGEMENT

The following section describes how the Central Basin is currently managed.

Basin Governance

The Central Basin is an adjudicated basin. It was adjudicated in October 1965 with adjudicated rights set at 267,900 AFY (WRD, 2006f). The amount of the adjudicated water rights that can be pumped each year (Allowable Pumping Allocation, or APA) is limited to approximately 80 percent of the total adjudicated amount (217,367 AFY).

The Judgment allows annual overpumping of 20 percent of the APA as well as carryover of up to 20 percent of the APA. The DWR serves as Watermaster. The Water Replenishment District of Southern California (WRD), established in 1959, has the statutory authority to replenish the groundwater basin and address water quality issues. The Los Angeles County Department of Public Works (LACDPW) owns and operates the Montebello Forebay Spreading Grounds and the portion of the Alamitos Barrier Project located within Los Angeles County; Orange County Water District operates the Orange County section. WRD procures imported and recycled water to be recharged by LACDPW at these facilities. Table 3-2 provides a list of the management agencies in the Central Basin.

As discussed above, the Judgment APA is 217,367 AFY. However, natural recharge does not support this annual amount of pumping, and the APA exceeds the natural safe yield of the basin and is dependent upon artificial recharge of imported and reclaimed water. Each year WRD makes a determination of the amount of supplemental recharge that is needed based on an estimation of the ensuing year's groundwater production and an estimation of the annual change in storage based on groundwater levels collected throughout the basin.

Table 3-2
Summary of Management Agencies for Central Basin

Agency	Role
California Department of Water Resources	Court appointed Watermaster to administer the Judgment
Water Replenishment District of Southern California	Replenish groundwater, address water quality, administer storage in Central and West Coast Basins
Los Angeles County Department of Public Works	Operation of spreading facilities and Alamitos Barrier facilities
Sanitation Districts of Los Angeles County	Producer of recycled water for Montebello Forebay Spreading Grounds
California Regional Water Quality Control Board – Los Angeles Region (Regional Board)	Issuance of permits for spreading of recycled water in Montebello Forebay and injection of recycled water in seawater intrusion barriers

Note: WRD's authority to administer storage is the subject of disagreement among basin parties.

The WRD adopted Interim Rules for Conjunctive Use Storage and In-Lieu Exchange and Recovery in the Central and West Coast Basins in May 2005. The rules govern storage in the basins outside and above the adjudicated water rights that would utilize up to 450,000 AF of unused space in the two basins. As of June 2006, the interim rules were the subject of on-going controversy among some groundwater producers in the basins and WRD.

Available storage capacity addressed by WRD Interim Rules is 450,000 AF (330,000 AF in Central Basin and 120,000 AF in West Coast Basin). This estimated capacity is based upon modeling and takes into account requirements that the water level be 75 feet or more below ground surface. However, this analysis did not include potential water quality impacts from contaminated sites in the basin. These could reduce the amount of storage space available if rising water can interact with the contamination. Detailed studies to look at these issues and others are part of the review process prior to approval of a storage project.

Interactions with Adjoining Basins

Central Basin receives subsurface inflow from the San Fernando Basin via downward percolation from the Los Angeles River (Los Angeles Forebay). The Los Angeles Forebay was historically a recharge area from the Los Angeles River. This forebay's recharge capacity has been substantially reduced since the river channel was lined. Recharge is now limited to deep percolation of precipitation, in-lieu when available, and subsurface inflow from the Montebello Forebay to the east, the Hollywood Basin and relatively small amounts from the San Fernando Valley through the Los Angeles Narrows.

The Montebello Forebay, located in the northeastern portion of the Central Basin, connects the Main San Gabriel Basin to the north with the Central Basin via the Whittier Narrows. The Rio Hondo and San Gabriel River spreading grounds in the forebay provide the vast majority of surface recharge to the Central Basin aquifers. Judgment in Case No. 722647 entered in September 1965, provides an adjudication of Upper and Lower Areas on the San Gabriel River. The San Gabriel River Watermaster prepares an annual Watermaster Report providing an accounting of water received, credits, and make-up water.

The Newport Inglewood Uplift separates the Central Basin from the West Coast Basin. Groundwater moves across the uplift, but its movement is slow and restricted because of low permeability sediments and offset of aquifers along the fault.

The boundary with Orange County Basin is not a barrier to flow. Therefore, water can flow between the two basins.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Central Basin. Key storage and extraction facilities include nearly 500 production wells and associated facilities, the Rio Hondo and San Gabriel River spreading grounds and the Alamitos Barrier Project.

Municipal Production Wells

Table 3-3 provides a summary of the production wells in the Central Basin.

There are approximately 497 production wells in the Central Basin (WRD, 2006d). Of the 384 municipal wells identified by WRD (2006d), 367 of these are active and 17 are inactive. Poor water quality is the primary reason for inactive wells. Capacity of wells is not available at this time. WRD estimates that typical groundwater pumping costs for energy are about $65/AF.

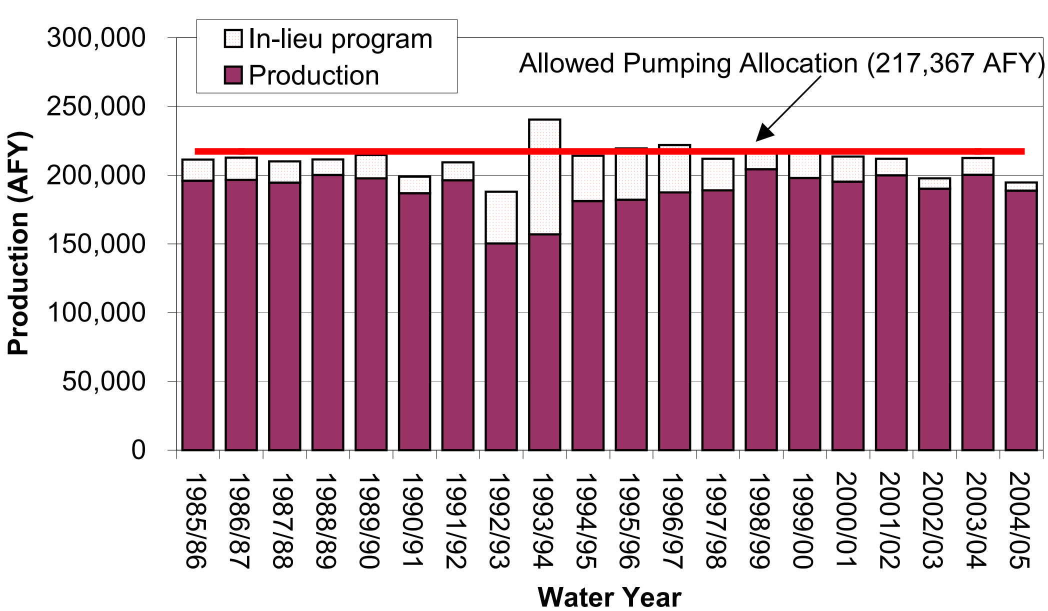
Table 3-3
Summary of Production Wells in the Central Basin

Category	Number of Wells	Estimated Production Capacity (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Municipal	384	Data not available	189,597	$65 Pumping cost
Active	367			
Inactive	17			
Other	113			
Total	**497**			

Source: WRD, 2006d

Production between 1985 and 2004 has ranged from 150,386 AFY to 204,418 AFY with an average of 189,597 AFY. These data are summarized in **Figure 3-4**.

Figure 3-4
Summary of Historical Production in Central Basin



The majority of groundwater production is from the deeper San Pedro Formation including the Lynwood, Silverado, and Sunnyside aquifers (WRD, 2006b). Note that production has been below the APA for the past 20 years.

Central Basin producers participate in an in-lieu groundwater replenishment program whereby they receive imported water purchased from Metropolitan in lieu of pumping groundwater and administered by WRD. In-lieu storage is included in **Figure 3-4**. Between water year 1985/86 and 2004/05, about 22,000 AFY was stored in-lieu. These and other storage programs are discussed in more detail below.

Other Production

According to WRD (2006d), there are approximately 113 other non-municipal wells in the Central Basin. Status information for these wells is not available.

ASR Wells

Two new ASR wells have recently been constructed in the City of Long Beach. In addition, two existing wells have been converted to ASR. The combined extraction capacity of the four wells is estimated to be at least 4,333 AFY. Injection capacity of the ASR wells is estimated to exceed 3,250 AFY.

Spreading Basins

There are currently three primary spreading areas, covering more than 1,000 acres within the Central Basin. The details of these facilities are summarized in **Table 3-4**. The gross capacity of the spreading areas is nearly 398,000 AFY but is limited by mounding and other factors. LACDPW spreads runoff, imported water from Metropolitan and recycled water on behalf of WRD for recharge in the Central Basin.

Total average annual spreading at the Rio Hondo and San Gabriel River Spreading Grounds in the Montebello Forebay for the 20-year period between water years 1985/86 and 2004/05 was approximately 135,000 AFY, with a range of approximately 68,000 AFY to more than 205,000 AFY. Spreading utilizes local runoff, untreated imported water, and recycled water. These data are summarized in **Figure 3-5**.

The Regional Board permit for recharge of recycled water limits recycled water spreading to the lesser of 60,000 AFY or an amount not to exceed 50 percent of the total inflow into the Montebello Forebay for that year. In addition, recycled water shall not exceed 150,000 AF in any three-year period or 35 percent of the total inflow to the forebay.

Seawater Intrusion Barriers

The Alamitos Barrier Project consists of 43 wells with a combined injection capacity of 15 cfs and four extraction wells in the Alamitos Gap in Long Beach (DWR, 2005;WRD, 2006d). The barrier utilizes imported water purchased from the City of Long Beach or recycled water from WRD's Leo J. Vander Lans Advanced Water Treatment Facility that went on-line in 2006.

Figure 3-5
Historical Direct Groundwater Recharge in Central Basin

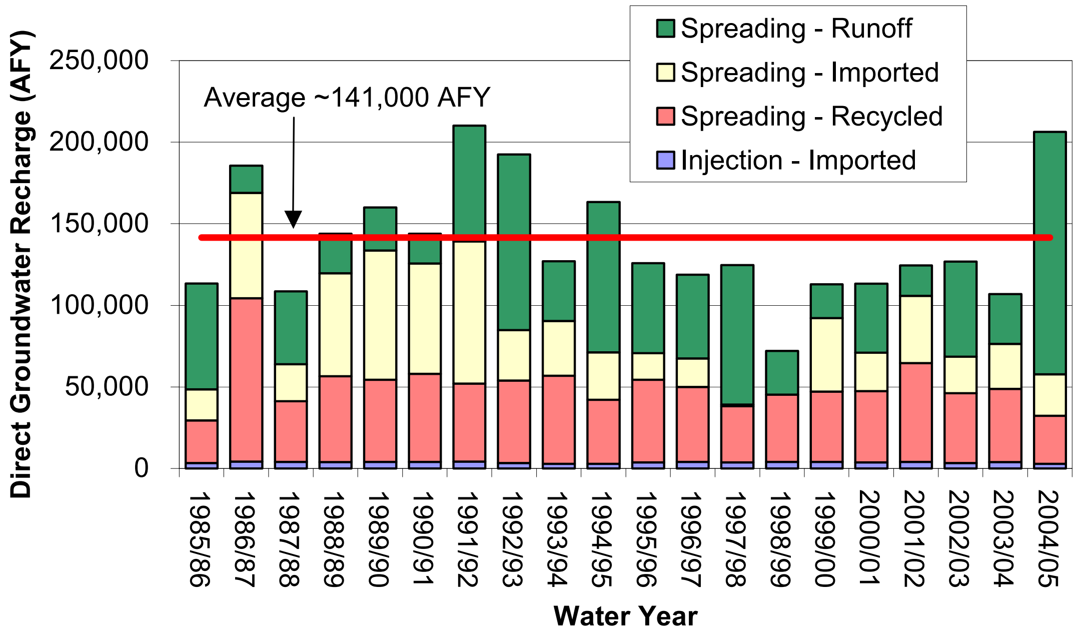


Table 3-4
Summary of Recharge Basins in the Central Basin

Spreading Basin	Area (acres)	Wetted Area (acres)	Recharge Capacity (cfs)	Recharge Capacity (AFY)	Source Water	Owner
Rio Hondo Spreading Grounds	570	430	400	~290,000	Runoff Imported Recycled	LACDPW
San Gabriel River (Basins)	128	96	75	54,000	Runoff Imported Recycled	LACDPW
San Gabriel River (River)	308	308	75	54,000	Runoff Imported Recycled	LACDPW
Total	**1,006**	**834**	**550**	**~398,000**	**--**	**--**

Source: LACDPW, 2006

Injection of imported water at the Alamitos Barrier Project in Central Basin has averaged about 3,711 AFY with a range of 2,800 AFY to 4,200 AFY.

Desalters

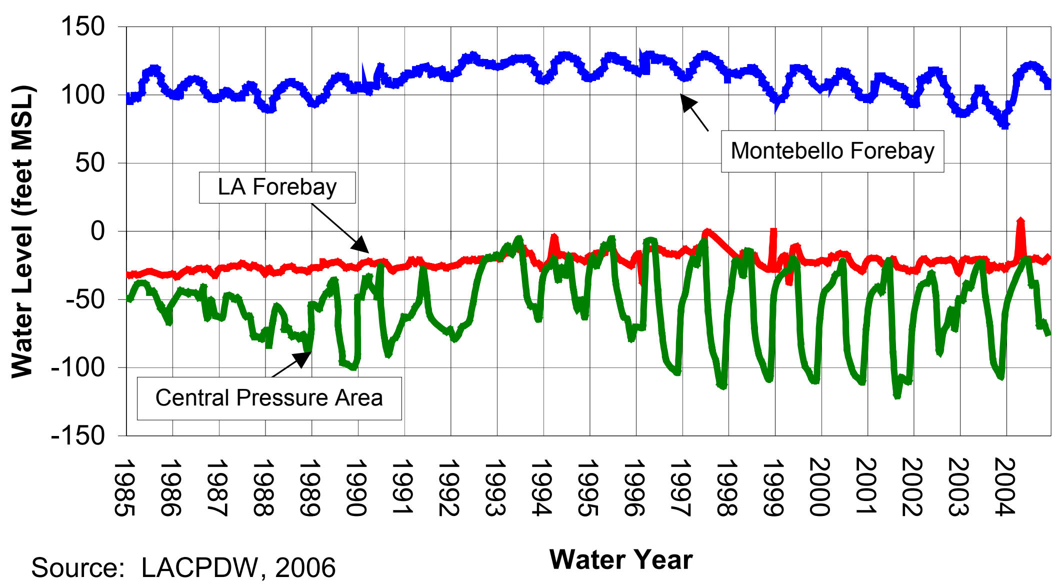
There are no desalters in Central Basin.

GROUNDWATER LEVELS

Historically, groundwater flow in the Central Basin has been from the recharge areas in the northeast toward the Pacific Ocean on the southwest. Pumping patterns have lowered the water level in large portions of the Central Basin. Historical water levels in key wells in various locations in the basin are summarized in **Figure 3-6**. These data, like the precipitation and storage data discussed above, suggest that the water levels have been relatively stable over the past 20 years.

As shown in **Figure 3-7**, in 2005, Central Basin water levels ranged from a high of about 160 feet above mean sea level (MSL) in the northeast portion of the basin upgradient of the spreading grounds to a low of about 90 feet below MSL in the Long Beach area.

Figure 3-6
Historical Water Levels in the Central Basin

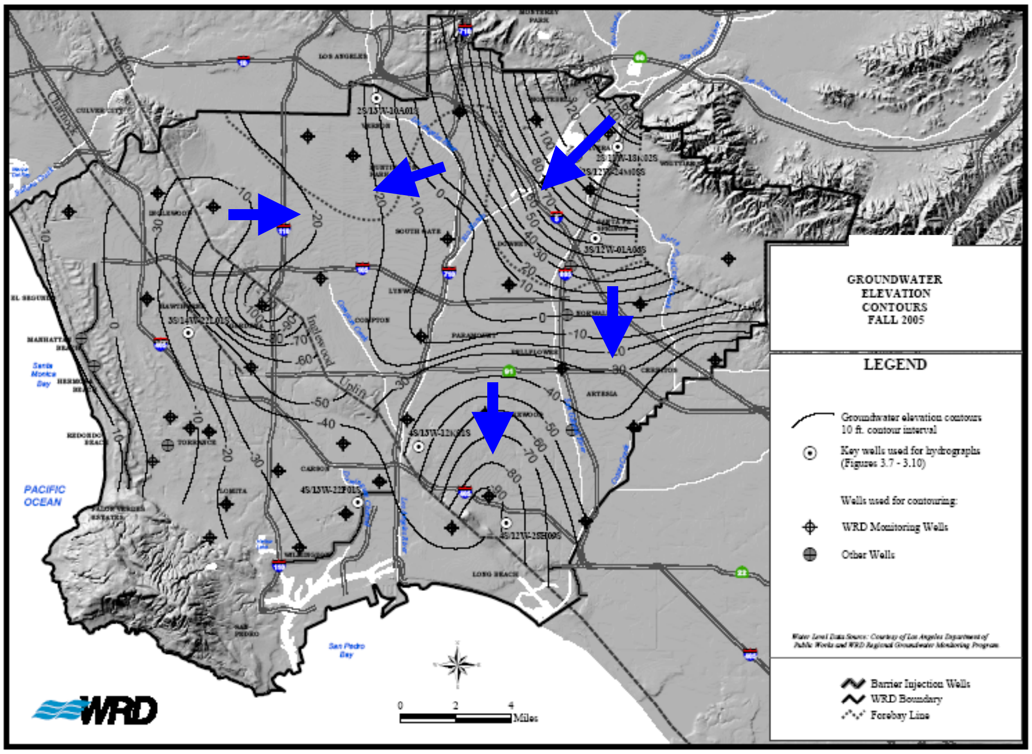


Source: LACPDW, 2006

GROUNDWATER QUALITY

In general, groundwater in the main producing aquifers of the basin is of good quality. Localized areas of marginal to poor water quality exist, primarily on the basin margins and in the shallower and deeper aquifers impacted by seawater intrusion. The following section provides a brief description of the groundwater quality issues in the Central Basin.

Figure 3-7
Groundwater Elevation Contours – Fall 2005



Groundwater Quality Monitoring

In 1995, WRD and the U.S. Geological Survey (USGS) began a cooperative study to improve the understanding of the geohydrology and geochemistry of Central and West Coast Basins. Out of this effort, came WRD's geographic information system (GIS) and the Regional Groundwater Monitoring Program. Twenty-one depth-specific, nested monitoring wells located throughout the basin, allow water quality and groundwater levels to be evaluated on an aquifer-specific basis. Regional Groundwater Monitoring Reports are published by WRD for each water year. Constituents monitored include: TDS, iron, manganese, nitrate, TCE, PCE, arsenic, chromium including hexavalent chromium, MTBE, and perchlorate.

Groundwater Contaminants

As shown in **Table 3-5**, volatile organic compounds (VOCs), primarily tetrachlororoethylene (PCE) and trichloroethylene (TCE), are present in the Central Basin and have impacted many production wells. However, most of the wells that have the VOCs do not exceed drinking water quality standards (WRD, 2006b). Those with higher levels require treatment prior to use as drinking water. Treatment programs in Central Basin are discussed in more detail below.

Table 3-5
Summary of Constituents of Concern in Central Basin

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	170 to 2,770 Average: 500	WRD is conducting studies to identify potential sources of high TDS, which may be caused by localized seawater intrusion or connate and oil field brines. Range in production wells 250 mg/L to 750 mg/L. Higher TDS concentrations located in northern portion of basin.
VOCs (TCE and PCE) TCE MCL = 5 PCE MCL = 5	µg/L	ND to 32 for TCE ND to 8.3 for PCE	Concentrations in 15 wells exceeded MCL for TCE Concentrations in 68 wells exceed MCL for PCE
Perchlorate Notification level =6	µg/L	Less than 6 µg/L	Detected in 5 monitoring wells and three production wells below notification level
Nitrate (as N) MCL = 10	mg/L	ND to 12	Higher concentrations tend to be limited to the uppermost zones and are likely due to localized infiltration and leaching. One production well in the Los Angeles Forebay area has exceed the 10 mg/L MCL. No wells in Silverado aquifer exceeded the 10 mg/L MCL.
Iron and manganese Secondary MCL for iron = 0.3 Secondary MCL manganese = 0.05	mg/L	ND to 8.4 for iron ND to 1.3 for manganese	Some localized wells exceed secondary standard (0.3 mg/L and 0.05, respectively) for iron and manganese.
Chromium MCL = 50	µg/L	Not available	Detected above MCL in one monitoring well and three production wells in the vicinity of the forebay areas

Source: WRD, 2006b

WRD has taken a proactive approach to protecting the basins in the face of emerging water quality issues. Through its monitoring and sampling program and evaluation of current water quality regulations, WRD has determined that the special interest constituents including arsenic, hexavalent chromium, methyl tertiary butyl ether (MTBE), total organic carbon, color and perchlorate do not pose a substantive threat to the basins (WRD, 2006b).

Blending Needs

Data related to blending needs and practices are not available for the Central Basin.

Groundwater Treatment

As discussed above, VOCs including TCE and PCE have been detected and are currently treated in the Central Basin. To mitigate this problem, the WRD established a Safe Drinking Water Program as part of its Clean Water Program in 1991. This program began as a means to provide basin pumpers with wellhead treatment equipment to remove VOCs from the groundwater, allowing affected wells to meet public drinking water standards. The program promotes the cleanup of groundwater resources at specific well locations and is accomplished through partnerships with well owners. The WRD Safe Drinking Water Program also makes local groundwater reserves available that would otherwise be lost to contamination. There are a total of eleven facilities online with several projects in various stages of completion (WRD, 2007).

About 9,200 AF was treated in fiscal year 2004/05 for VOCs, iron and manganese. This represents about five percent of the total water produced in Central Basin during 2004/05. About 330 AF of the water treated in Central Basin in 2004/05 was treated for iron and manganese under Metropolitan's LRP Groundwater Recovery Projects Program (Metropolitan, 2006).

EXISTING STORAGE PROGRAMS

WRD operates an in-lieu replenishment program in the Central Basin. An average of about 21,000 AFY of in-lieu storage was generated through this program between water years 1985/86 and 2004/05. In addition, as discussed below, a few member agencies participate in Metropolitan's conjunctive use storage program. These in-lieu data are summarized in **Figure 3-8**.

Metropolitan has recently implemented three conjunctive programs under the Proposition 13 program in the Central Basin. These include programs in the cities of Long Beach, Lakewood, and Compton. Each of these programs is described in **Table 3-6**. Total storage from these programs is 18,895 AF. About 15,394 AF, or about 80 percent of the programs, is currently in storage under these combined programs.

Figure 3-8
Historical In-lieu Storage for Central Basin

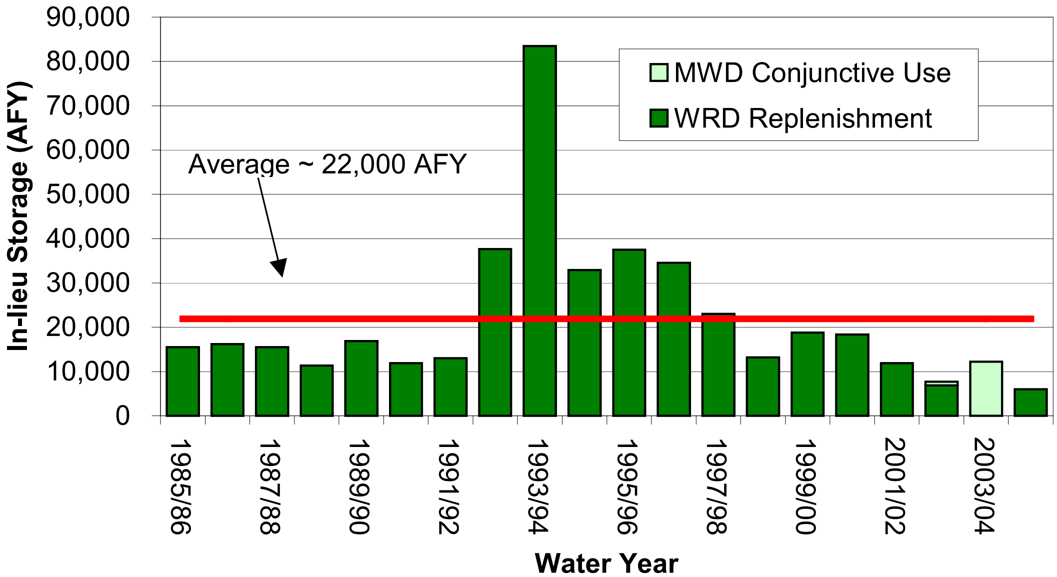


Table 3-6
Conjunctive Use Programs in the Central Basin

Program	**Member Agencies**	**Year Began**	**Total Storage (AF)**	**Amount in storage [1] (AF)**
Long Beach Conjunctive Use Program (Phase 1)	City of Long Beach	2002	13,000	13,000
Long Beach Conjunctive Use Program (Phase 2)	City of Long Beach	2005	3,600	1,800
Compton Conjunctive Use Program	City of Compton	2005	2,295	1,144
Total	**--**	**--**	**18,895**	**15,944**

Notes: 1 Amount in storage at end of fiscal year 2005/06

BASIN MANAGEMENT CONSIDERATIONS

Considerations in the Central Basin include:

- Extraction is limited by the Judgment and the APA. The 20 percent allowed over pumping and carryover is administered by the Watermaster and subject to the provisions of the Central Basin Judgment.
- Disagreements related to the Interim Rules for Conjunctive Use Storage and In-Lieu Exchange and Recovery in the Central and West Coast Basins may limit the ability to store and extract water in the Central Basin. At this time, the approval of storage projects is administered by WRD using the framework defined in the Interim Rules for Conjunctive Use Storage and In-Lieu Exchange and Recovery in the Central and West Coast Basins.
- Spreading of recycled water is regulated by the Regional Board and limits the amount of recycled water that can be spread. The Regional Board permit for recharge of recycled water limits recycled water spreading to the lesser of 60,000 AFY or an amount not to exceed 50 percent of the total inflow into the Montebello Forebay for that year. In addition, recycled water shall not exceed 150,000 AF in any three-year period or 35 percent of the total inflow to the forebay.
- Potential for liquefaction and water quality concerns could limit the ability to store water.

References:

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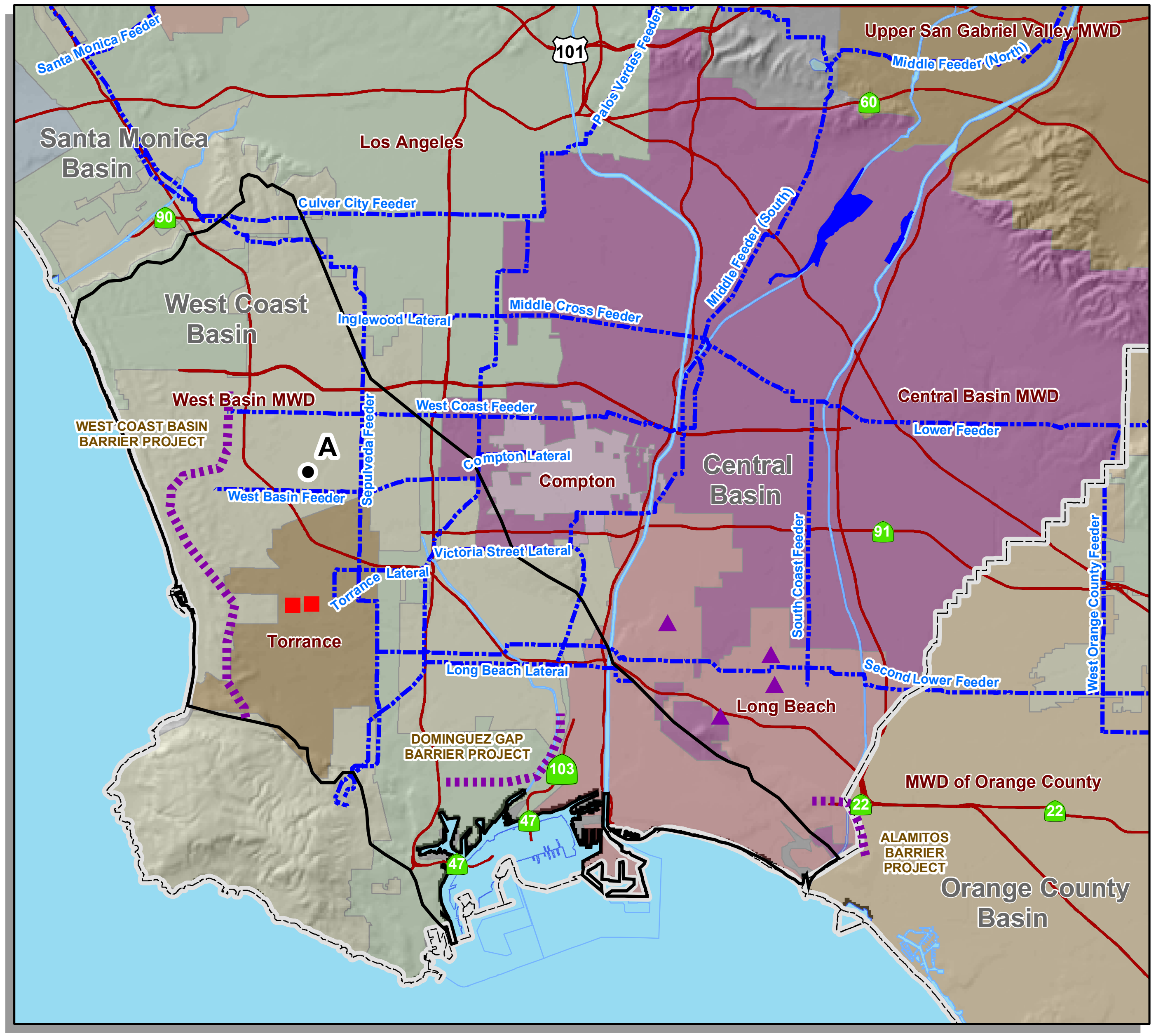
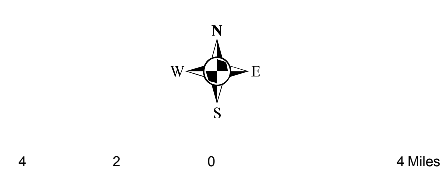


West Coast Basin

A ●	Key Well		Freeways
▲	ASR Wells		Water Body
■	Desalter		MWD Pipeline
	Recharge Basins		Basin
	Seawater Intrusion Barrier		MWD Member Agency Boundary (color varies)
	County		



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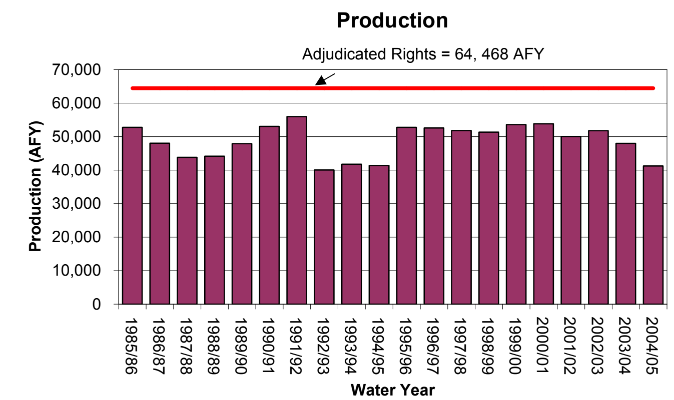
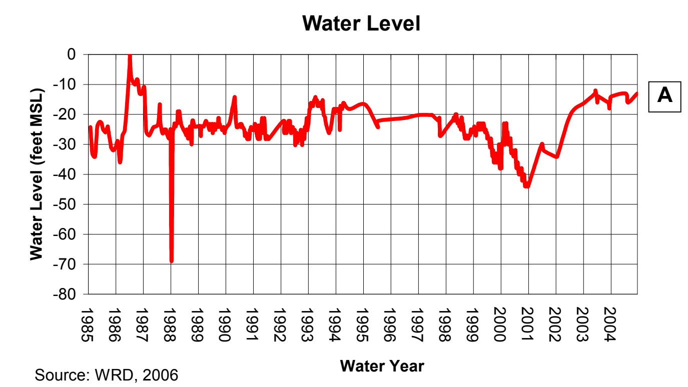
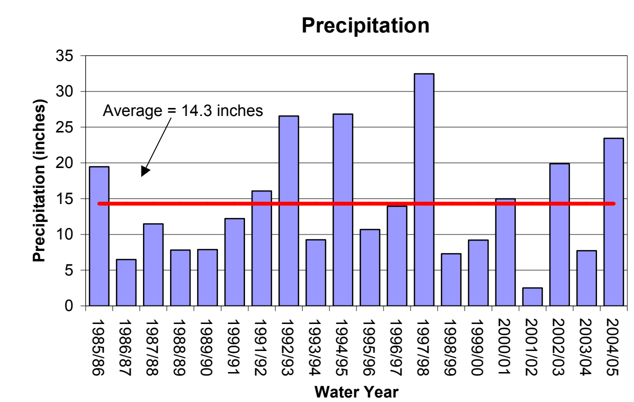
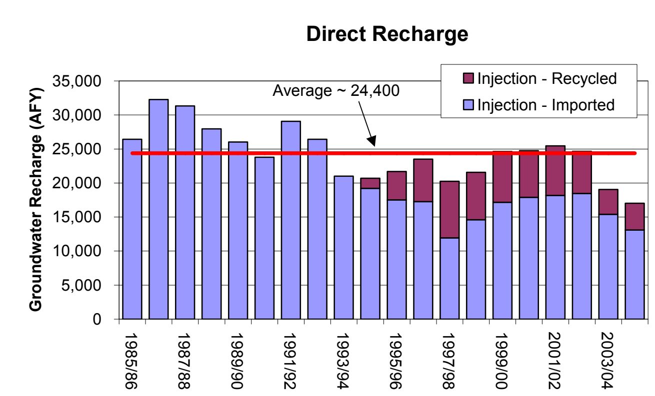




Source: WRD, 2006





BASIN FACTS

West Coast Basin

Description
Location: Los Angeles County
Watershed Surface Area: 142 square miles
Management: Adjudicated
Basin was adjudicated in 1961 with a maximum pumping of 64,468.25 AFY. Department of Water Resources is the Watermaster. The Water Replenishment District of Southern California purchases artificial replenishment water to make up the annual overdraft and has statutory authority to address water quality issues.
MWD Member Agencies:
West Basin MWD
City of Torrance
City of Long Beach
City of Los Angeles

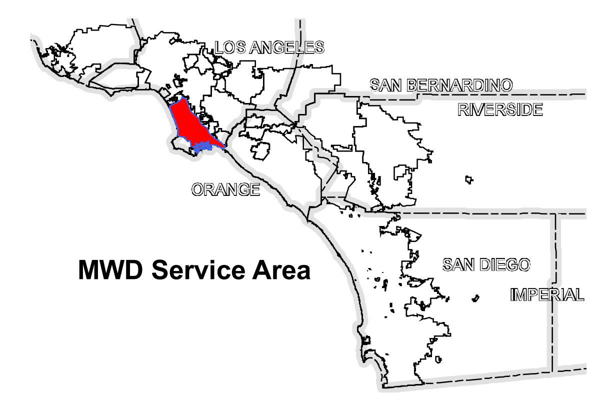
	West Coast Basin
Natural Safe Yield	26,300 AFY
Total Storage	6.5 million AF
Usable Storage Space	1.1 million AF
Portion of Unused Storage Space Available for Storage	120,000 AF

Storage and Extraction Facilities

	West Coast Basin
Production Wells	
Production Capacity	Data not available
Average 1985-2004	~49,000 AFY
Injection Wells	
Injection Capacity	None
Average 1985-2004	None
Spreading Basins	
Spreading Capacity	None
Average 1985-2004	None
Seawater Intrusion Barriers	
Injection Capacity	Not available
Average 1985-2004	~24,000 AFY

Basin Management Considerations

- Extraction is limited by the Judgment
- Regional Board limits the amount of recycled water injected.
- Disagreements related to groundwater storage space allocations in the Central and West Coast Basins may limit the ability to store water in the Central Basin.
- Seawater intrusion and TDS concentrations could prevent full utilization of basin



MWD Service Area

Plate 4-1
Overview of West Coast Basin

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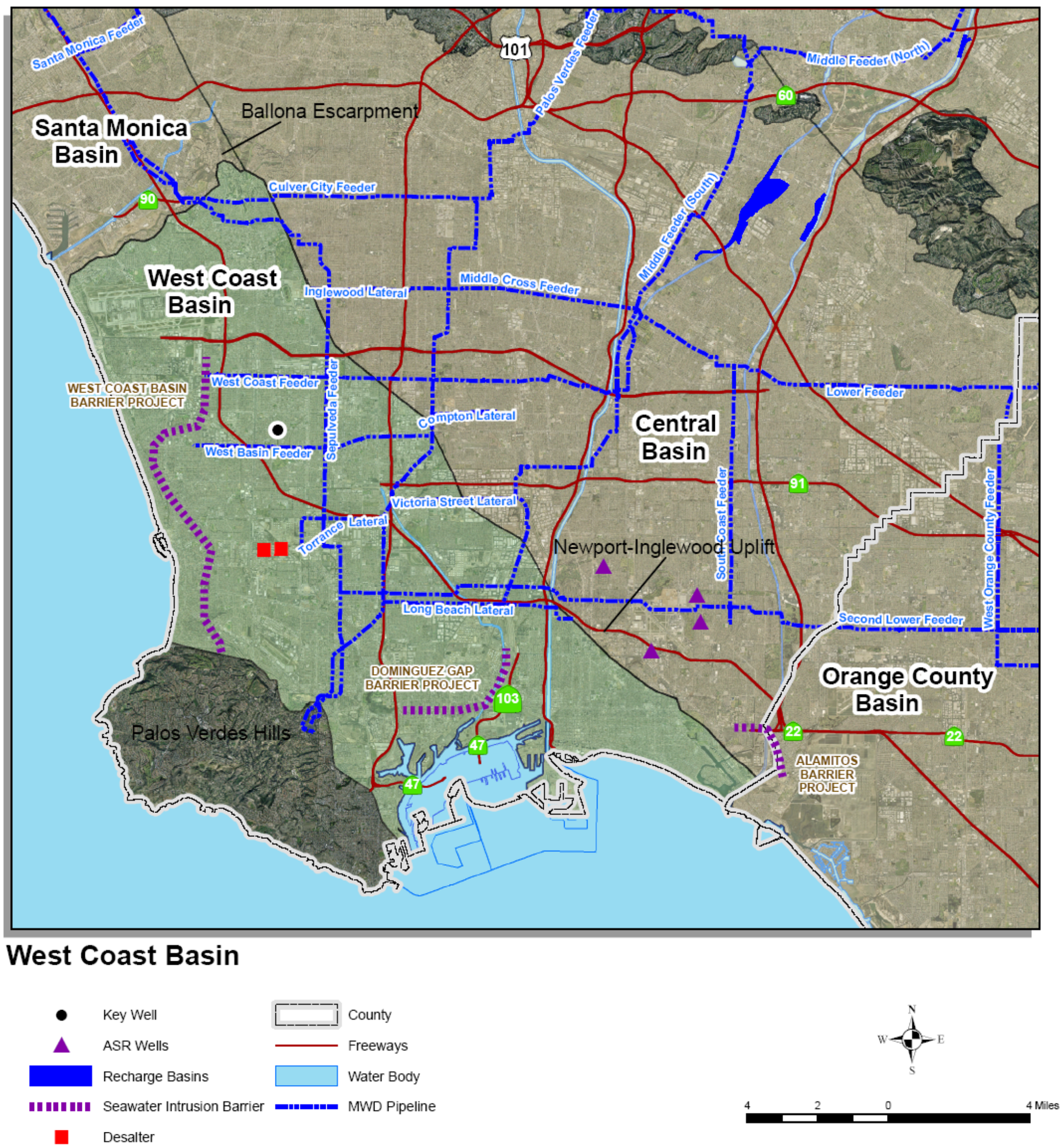
The West Coast Basin lies along the coast in western Los Angeles County. It overlies the service areas of Metropolitan member agencies: West Basin Municipal Water District (WBMWD), City of Los Angeles, City of Torrance, and the City of Long Beach. The cities of El Segundo, Manhattan Beach, Hermosa Beach, Redondo Beach, Torrance, Inglewood, Hawthorne, Gardena, Lomita, Carson and Long Beach overlie the basin. A map of the West Coast Basin is provided in **Figure 4-1**.

Figure 4-1
Map of the West Coast Basin



BASIN CHARACTERIZATION

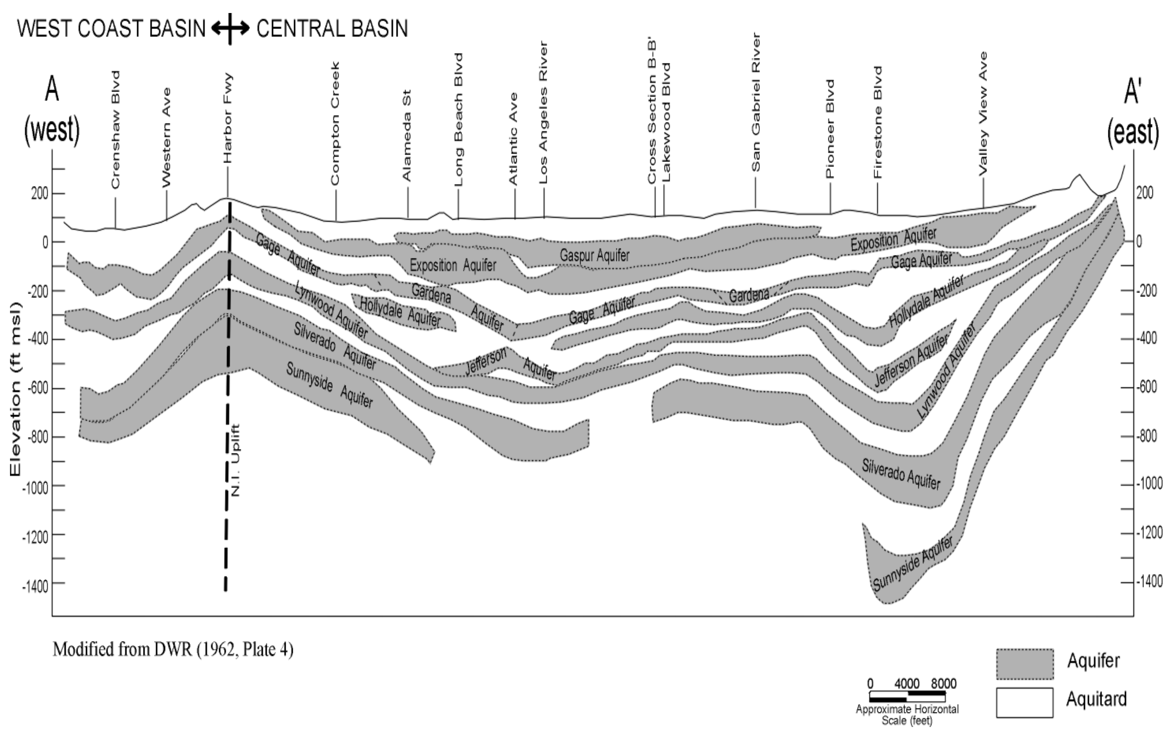
The following section provides a physical description of the West Coast Basin, including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The West Coast Basin is bounded on the south and west by the Pacific Ocean, on the north by the Ballona Escarpment, on the east by the Newport-Inglewood Uplift, and on the south by the Palos Verdes Hills (DWR, 2005). Hydrogeologic parameters for the West Coast Basin are summarized in **Table 4-1**.

Groundwater in the West Coast Basin is generally confined. The Silverado aquifer underlying most of West Coast Basin is the most productive aquifer in the basin. It ranges from 100 to 500 feet thick and yields 80 to 90 percent of the groundwater extracted annually (DWR, 2004). This aquifer generally correlates with the Main aquifer of Orange County. A generalized cross section is shown in **Figure 4-2**. Minor yield also comes from the Gage, or “200-foot sand”, aquifer, the Lynwood, or “400-foot gravel”, aquifer and the Sunnyside, or Lower San Pedro aquifer.

Figure 4-2
Generalized Hydrogeologic Cross Section of West Coast Basin and Central Basin



Source: WRD, 2004

Table 4-1
Summary of Hydrogeologic Parameters of West Coast Basin

Parameter	**Description**
Structure	
Aquifer(s)	Pressure area (confined) • Alluvium (Gaspur and Semi-perched aquifers) • Lakewood Formation (Gardena and Gage "200-foot sand" aquifers) • San Pedro Formation (Lynwood "400-foot gravel", Silverado, and Sunnyside aquifers)
Depth of groundwater basin	~800 to 2,000 feet
Thickness of water-bearing units	Alluvium (up to 180 feet) Lakewood Formation (up to 320 feet) San Pedro Formation (up to 1,050 feet)
Yield and storage	
Natural safe yield	26,300 AFY (WRD, 2006e)
Adjudicated Rights	64,468.25 AFY
Total Storage	6.5 million AF
Unused Storage Space	1.1 million AF
Portion of Unused Storage Space Available for Storage	120,000 AF

Source: WRD, 2006c and 2006e and DWR, 2004.

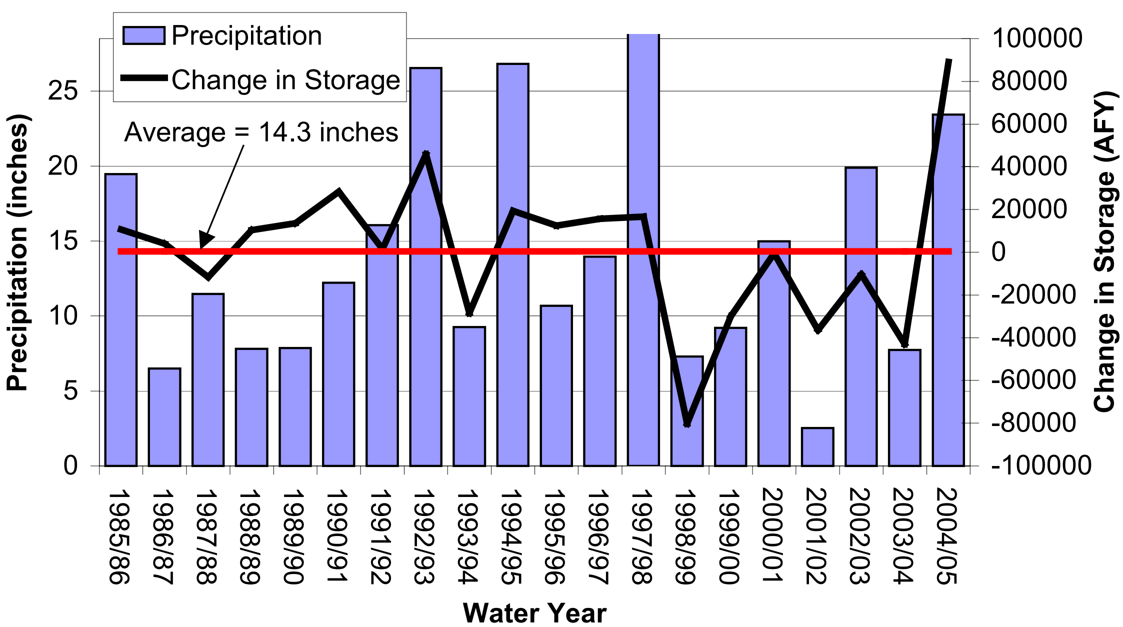
Total storage in the West Coast Basin is estimated to be approximately 6.5 million AF. Unused storage space is estimated to be approximately 1.1 million AF. Of the unused storage space, the amount available for groundwater storage is approximately 120,000 AF assuming that up to 75 feet below the ground surface is actually available (WRD, 2006e).

Safe Yield/Long-Term Balance of Recharge and Discharge

Figure 4-3 shows the historical precipitation as it relates to the change in storage calculated by WRD (2006c). These data show that the average precipitation in the West Coast Basin is approximately 14.3 inches per year. In general, storage in the West Coast Basin increases during wet years and decreases during dry years. The average change in storage in the combined Central and West Coast Basins since 1985 was approximately 1,300 AFY, suggesting that the basins are nearly balanced.

The primary source of natural recharge to the West Coast Basin is subsurface inflow from the Central Basin and surface inflow into the uppermost aquifers from rainfall. This natural safe yield, which represents the yield as a result of native waters alone, of the West Coast Basins has been estimated by WRD to be approximately 26,300 AFY (WRD, 2006e), of which approximately 7,100 AFY is from seawater intrusion (WRD, 2006e). The managed safe yield of West Coast Basin is equal to the 64,468.25 AFY (the adjudicated production limit discussed below), which is substantially higher than the natural safe yield. This higher yield is possible because of artificial recharge maintained by the Water Replenishment District of Southern California (WRD).

Figure 4-3
Historical Precipitation and Change in Storage for West Coast Basin



GROUNDWATER MANAGEMENT

The following section describes how the West Coast Basin is currently managed.

Basin Governance

The West Coast Basin is adjudicated. The West Coast Basin adjudication (Judgment) was finalized in 1961 and capped annual production at 64,468 AFY. The Judgment allows annual carryover of unpumped adjudicated right not to exceed 20 percent and also allows up to 20 percent excess production to be made up by under-production the following year. The Judgment also allows up to 10,000 AF of emergency overpumping under specified conditions. The California Department of Water Resources (DWR) serves as Watermaster. The Water Replenishment District of Southern California (WRD), established in 1959, has the statutory authority to replenish the groundwater basin and address water quality issues. The

Los Angeles County Department of Public Works (LACDPW) owns and operates the West Coast Barrier Project and the Dominguez Gap Barrier Project. WRD procures imported and recycled water to be recharged by LACDPW at these facilities.

Table 4-2 provides a list of the management agencies in the West Coast Basin.

Each year WRD makes a determination of the amount of supplemental recharge that is needed based on an estimation of the ensuing year's groundwater production and an estimation of the annual change in storage based on groundwater levels collected throughout the basin.

The WRD adopted Interim Rules for Conjunctive Use Storage and In-Lieu Exchange and Recovery in the Central and West Coast Basins in May 2005. The rules govern storage in the basins outside and above the adjudicated water rights that would utilize up to 450,000 AF (120,000 AF in West Coast Basin and 330,000 AF in Central Basin) of unused space in the two basins. As of June 2006, the interim rules were the subject of on-going controversy among some groundwater producers in the basins and WRD.

Table 4-2
Summary of Management Agencies in the West Coast Basin

Agency	Role
California Department of Water Resources	Court appointed Watermaster to administer the Judgment
Water Replenishment District of Southern California	Replenish groundwater, address water quality, administer storage in Central and West Coast Basins
Los Angeles County Department of Public Works	Operation of West Coast Barrier Project and Dominguez Gap Barrier Project facilities
California Regional Water Quality Control Board – Los Angeles Region (Regional Board)	Issuance of permit for injection of recycled water in seawater intrusion barriers

Note: WRD's authority to administer storage is the subject of disagreement among basin parties.

Available storage capacity addressed by WRD Interim Rules is 450,000 acre-feet (a portion of this is in Central Basin). This estimated capacity is based upon modeling and takes into account water level requirements but not soil or water quality issues that could reduce the available storage capacity.

Interactions with Adjoining Basins

The Newport Inglewood Uplift is a major structural feature that acts as a partial barrier to groundwater flow between the Central and West Coast Basins. Discontinuities associated with Charnock and Overland faults in West Coast Basin also appear to affect groundwater flow

(USGS, 2003). Approximately 7,100 AFY is estimated to enter the West Coast Basin from the ocean (WRD, 2006e;USGS, 2003). Most of this occurs on the seaward side of the barriers or in areas where production does not occur.

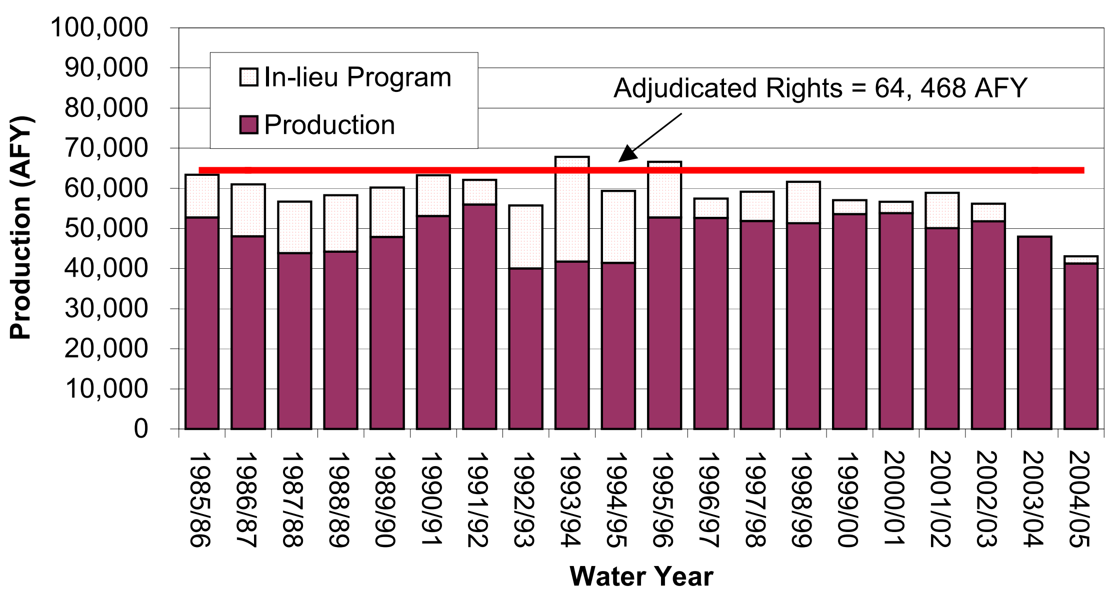
WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the West Coast Basin. Key storage and extraction facilities include 111 production wells and associated facilities, 247 injection wells associated with the Dominguez Gap and West Coast Basin Barrier Projects, 514 monitoring wells and two desalters (DWR, 2005).

Municipal Production Wells

There are currently 111 municipal production wells in the West Coast Basin, 63 active wells and 48 inactive wells (DWR, 2005). There are also 761 other wells in the basin that include groundwater monitoring wells or seawater intrusion barrier wells. These data are provided in **Table 4-3**. Historical production from all sources between water years 1985/86 and 2004/05 is shown in **Figure 4-4**. An average of approximately 48,797 AFY was produced from the West Coast Basin between water years 1985/86 and 2004/05. This average is nearly 16,000 AFY less than the allowable extractions under the Judgment.

Figure 4-4
Historical Groundwater Production in the West Coast Basin



West Coast Basin producers participate in an in-lieu groundwater replenishment programs whereby they receive imported water from Metropolitan in lieu of pumping groundwater.

Between water years 1985/86 and 2004/05, about 9,800 AFY was stored in-lieu. These and other storage programs are discussed in more detail below.

Table 4-3
Summary of Production Wells in the West Coast Basin

<table>
<tr><th>Category</th><th>Number of Wells</th><th>Estimated Production Capacity (AFY)</th><th>Average Production 1985-2004 (AFY)</th><th>Well Operation Cost ($/AF)</th></tr>
<tr><td>Municipal</td><td>111</td><td rowspan="5">Data not available</td><td rowspan="5">48,797</td><td rowspan="5">$65 Pumping Cost</td></tr>
<tr><td>Active</td><td>63</td></tr>
<tr><td>Inactive</td><td>48</td></tr>
<tr><td>Other</td><td>761</td></tr>
<tr><td>Total</td><td>872</td></tr>
</table>

Source: WRD, 2006d and DWR, 2005

Other Production

Production data provided above includes water that is desalted by the Goldsworthy and Brewer desalters. These facilities are discussed in more detail below.

ASR Wells

There are no ASR wells in the West Coast Basin.

Spreading Basin

There are no spreading basins in the West Coast Basin.

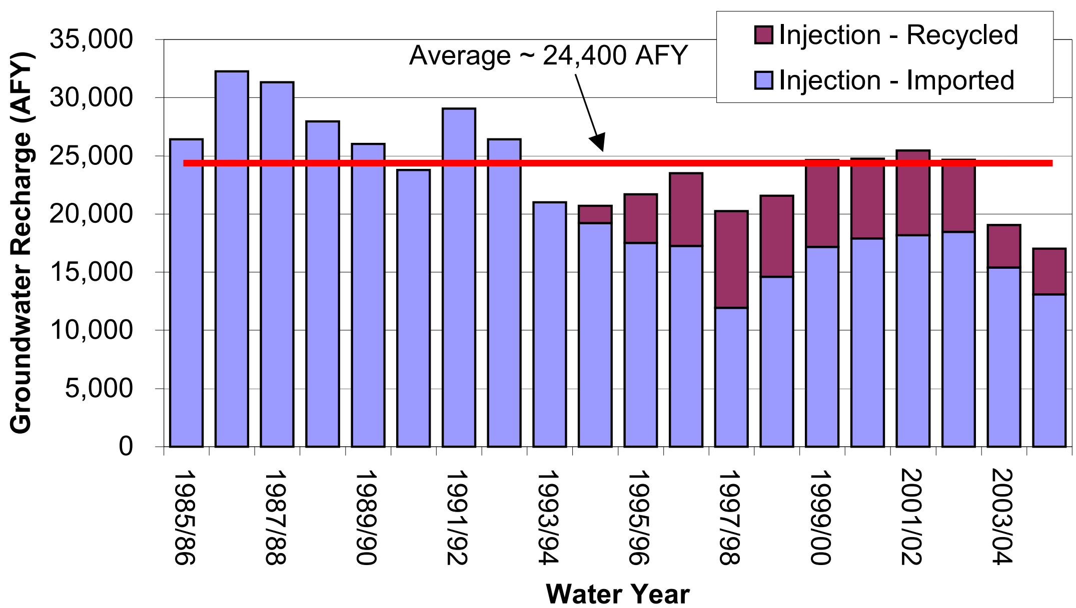
Seawater Intrusion Barriers

There are two seawater intrusion barriers in the West Coast Basin: the West Coast Basin Barrier Project and the Dominguez Gap Barrier Project. Amounts of water injected are summarized in **Figure 4-5**. An average of about 24,400 AFY was injected into these barriers between water years 1985/86 and 2004/05.

The West Coast Basin Barrier Project, which began operation in 1953, is a line of 153 injection wells that parallels the coastline from Los Angeles International Airport to the Palos Verdes Hills. It is owned and operated by the Los Angeles County Department of Public Works. Since 1995, the West Coast Basin Barrier Project has injected an approximate 35 percent blend of imported water from Metropolitan and tertiary (including reverse osmosis) treated wastewater from the Hyperion Plant. It injects water into the “200-foot sand”, Silverado and Lower San Pedro aquifers to impede seawater intrusion (LACDPW, 2006).

The Dominguez Gap Barrier Project began operation in 1971. The barrier currently comprises a line of 41 injection wells and 107 observation wells along the Dominguez Channel to the 110 Freeway in the City of Carson (LACDPW, 2006). Imported water from Metropolitan is currently injected into the "200-foot sand," "400-foot gravel" and Silverado aquifers in this area. WRD, LACDPW, and LADWP initiated delivery of recycled water to this barrier in 2006.

Figure 4-5
Historical Groundwater Recharge in the West Coast Basin



Desalters

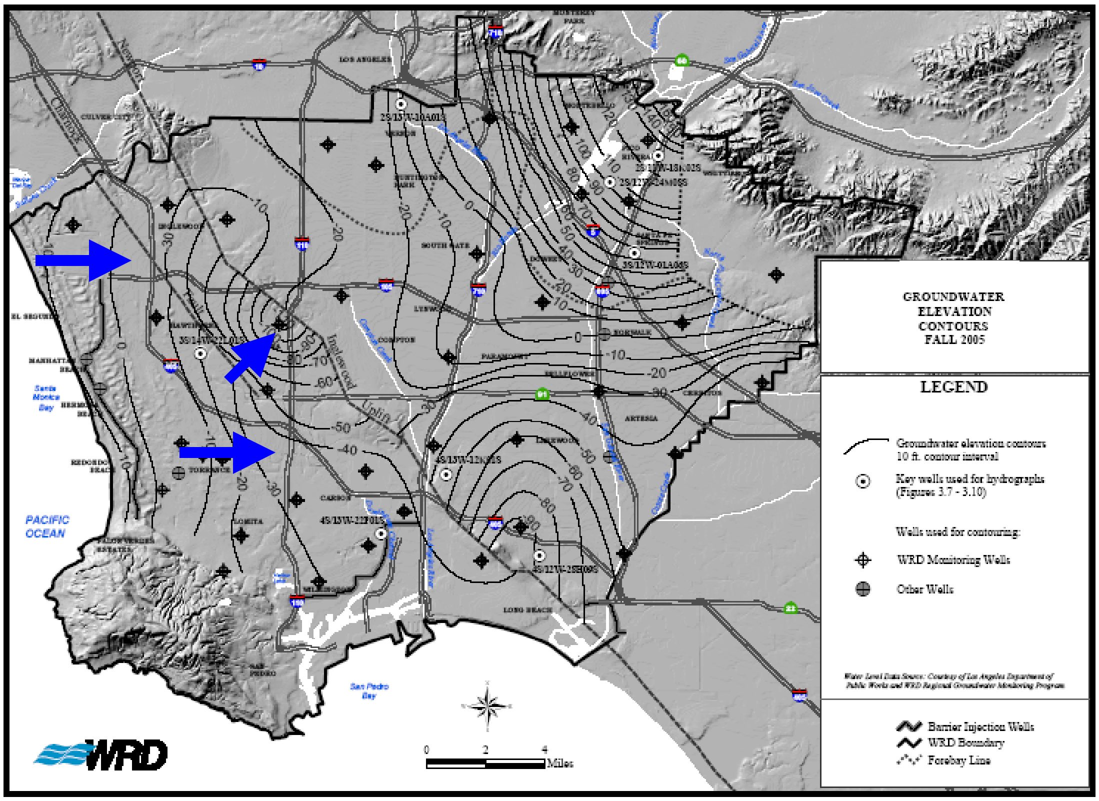
Two desalter projects used to treat brackish groundwater trapped within the Silverado aquifer on the landward side of the West Coast Basin Barrier Project are operating within the City of Torrance: Brewer Desalter and the Goldsworthy Desalter. An average of about 2,500 AFY was treated by the two desalters as of 2004/05. The Brewer Desalter was constructed by WBMWD in 1993 and is now operated by California Water Service Company. The capacity of the Brewer Desalter is 1.5 MGD. The Brewer Desalter was offline during 2004 and 2005 during the construction of a new desalter well.

WRD constructed and has operated the Goldsworthy Desalter since 2001. An average of approximately 1,900 AFY was treated between 2001 and the end of water year 2004/05.

GROUNDWATER LEVELS

As shown in **Figure 4-6** groundwater levels in fall 2005 range from about 10 feet above MSL in the northern part of the basin to more than 110 feet below MSL inland near the community of Gardena. Groundwater levels throughout most of the West Coast Basin are below sea level and generally flow from the west-northwest to the east-southeast. In the key well shown in **Figure 4-7**, water levels increased about 10 feet between water years 1985/86 and 2004/05, which is consistent with the water balance discussed above.

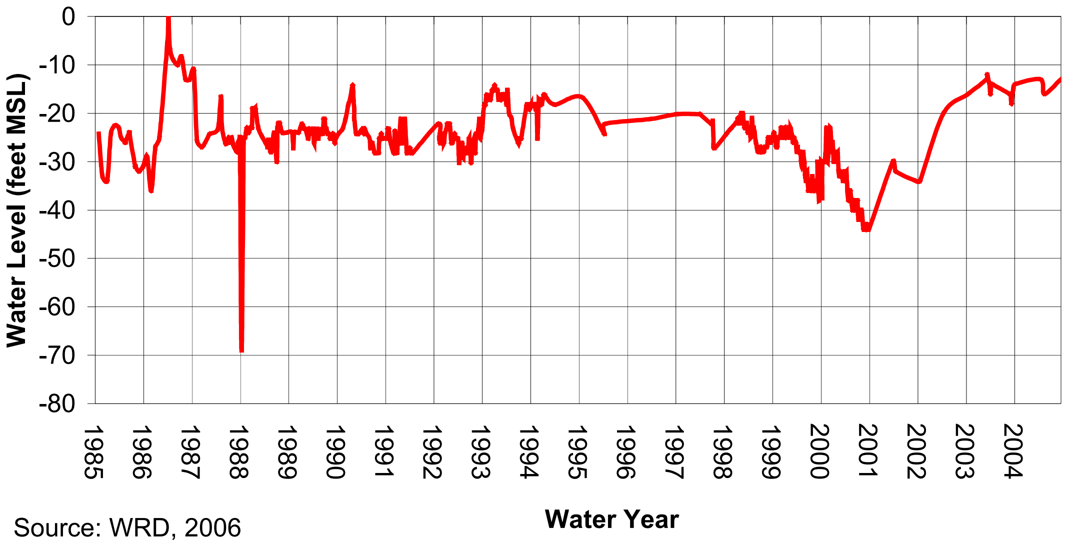
Figure 4-6
Groundwater Contour Map in the West Coast Basin – Fall 2005



GROUNDWATER QUALITY

In general, groundwater in the main producing aquifers of the basins is of good quality with average total dissolved solids (TDS) concentrations around 500 mg/L. Localized areas of marginal to poor water quality exist, primarily on the basin margins and in the shallower and deeper aquifers impacted by seawater intrusion. The following section provides a brief description of the groundwater quality issues in the West Coast Basin.

Figure 4-7
Historical Water Levels in West Coast Basin



Source: WRD, 2006

Groundwater Quality Monitoring

In 1995, WRD and the U.S. Geological Survey (USGS) began a cooperative study to improve the understanding of the geohydrology and geochemistry of Central and West Coast Basins. Out of this effort, came WRD's geographic information system (GIS) and the Regional Groundwater Monitoring Program. Twenty-one depth-specific, nested monitoring wells located throughout the basin allow water quality and groundwater levels to be evaluated on an aquifer-specific basis. Regional Groundwater Monitoring Reports are published by WRD for each water year. Constituents monitored include: TDS, iron, manganese, nitrate, TCE, PCE, arsenic, chromium including hexavalent chromium, MTBE, and perchlorate.

Groundwater Contaminants

Constituents of concern TDS, TCE, PCE, perchlorate, nitrate, iron, manganese and chloride are summarized in **Table 4-4**. Most production wells have TDS concentrations less than 750 mg/L with a range of 150 to 13,600 mg/L in the monitoring wells measured by WRD. Higher TDS concentrations found in production wells in Torrance/Hawthorne area and in monitoring wells within the brackish plume.

Organic constituents of concern (TCE, PCE, or perchlorate) were not detected in concentrations above applicable MCLs in the West Coast Basin. Neither TCE nor PCE were detected in any production well in the West Coast Basin. TCE was detected in three monitoring wells and PCE was detected in one monitoring well.

Nitrate (as nitrogen) concentrations range from non-detect to 12 mg/L in the monitoring wells in the West Coast Basin. Higher concentrations tend to be limited to the uppermost zones and are likely due to localized infiltration and leaching. Production wells have nitrate concentrations less than 3 mg/L.

Table 4-4
Summary of Constituents of Concern in the West Coast Basin

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	150 to 13,600 Average: 500	Most production wells have TDS less than 750 mg/L. Higher TDS concentrations found in production wells in Torrance/Hawthorne area and in monitoring wells within saline plume.
VOCs **(TCE and PCE)** Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	ND to 18 for TCE ND to 0.8 for PCE	TCE nor PCE not detected in production wells. TCE detected in three monitoring wells. PCE detected in one monitoring well.
Perchlorate Notification level = 6	µg/L	Data not available	Detected in three monitoring wells below action level in shallow zones
Nitrate (as N) Primary MCL = 10	mg/L	ND to 12 mg/L	Higher concentrations tend to be limited to the uppermost zones and are likely due to localized infiltration and leaching. Production wells have concentrations less than three mg/L.
Iron and manganese Secondary MCL for iron =0.3 Secondary MCL for Mn = 0.05	mg/L	ND to 1.2 for iron and manganese	Nearly 1/3 of all production wells in northwestern portion of West Coast Basin exceed secondary MCL for iron. 17 of 30 production wells tested had concentrations above secondary MCL for manganese
Chloride Secondary MCL = 500	mg/L	5.8 to 6,180 mg/L	Chloride concentrations exceed chloride MCL in five of 15 nested monitoring wells due to seawater intrusion. One production well had concentrations above MCL.

Source: WRD, 2006b

Iron and manganese were detected in concentrations above the secondary MCL for these constituents in both monitoring wells and production wells in the basin. Nearly one-third of all production wells in northwestern portion of West Coast Basin have concentrations that exceed secondary MCL for iron. Seventeen of 30 production wells tested had concentrations above secondary MCL for manganese.

As discussed above, seawater has invaded the Silverado Aquifer along the coastal stretch of the West Coast Basin and chloride concentrations range from 1,000 to 6,000mg/l. (DWR, 2005). Chloride concentrations exceed the chloride MCL in five of 15 nested monitoring wells due to seawater intrusion. One production well had chloride concentrations above MCL.

Blending Needs

Data related to blending needs and practices are not available for the West Coast Basin.

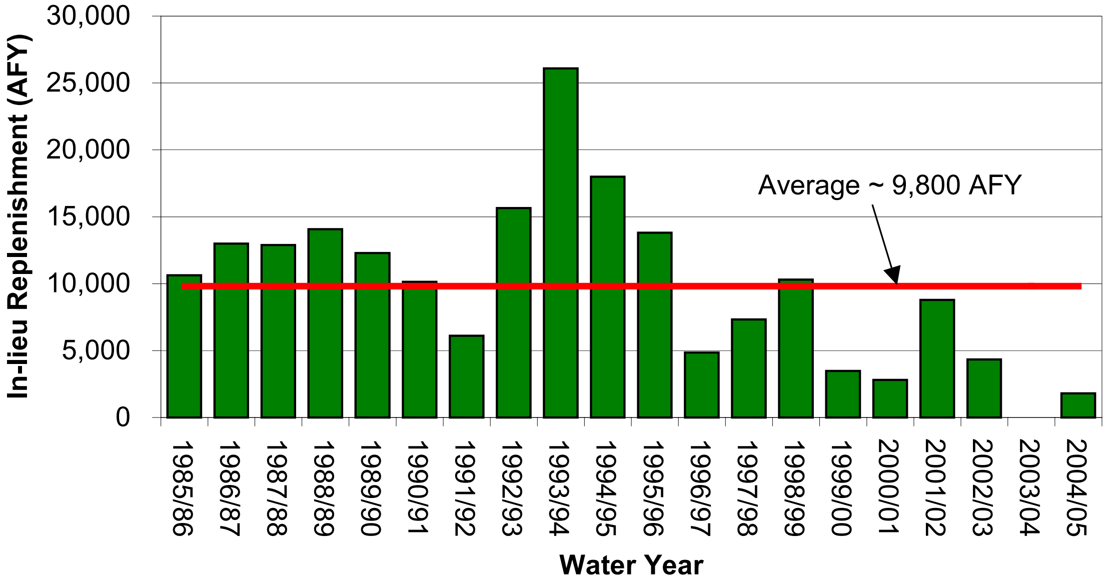
Groundwater Treatment

As discussed above, about 2,500 AFY has been treated by the Brewer and Goldsworthy desalters since 2000. In addition, oil recovery and cleanup programs operated by the oil refineries in the West Coast Basin have treated an average of about 900 AFY since 2000. About 7 percent of the total water produced in 2004/05 in the West Coast Basin was treated. Costs for treatment are not available at this time.

EXISTING GROUNDWATER STORAGE PROGRAMS

WRD operates an in-lieu replenishment program. An average of about 9,800 AFY of in-lieu storage has been generated in the West Coast Basin through this program since 1985. These data are summarized in **Figure 4-8**. No other formal groundwater storage programs are operational in the West Coast Basin.

Figure 4-8
Historical In-lieu Storage for West Coast Basin



BASIN MANAGEMENT CONSIDERATIONS

Management considerations in the West Coast Basin include:

- Extraction is limited by the Judgment to 64,468 AFY.
- The Regional Board regulates injection of recycled water and limits the amount of recycled water that can be injected.
- Brackish water inland of the West Coast Basin Barrier may limit the ability to store and extract water in some parts of the basin. The Brewer and Goldsworthy Desalters have increased the ability to use this part of the basin.
- Because most of the West Coast Basin is confined, there are no identified locations for spreading.
- Disagreements related to the Interim Rules for Conjunctive Use Storage and In-Lieu Exchange and Recovery in the Central and West Coast Basins may limit the ability to store water in the West Coast Basin. At this time, the approval of storage projects is administered by WRD using the framework defined in the Interim Rules for Conjunctive Use Storage and In-Lieu Exchange and Recovery in the Central and West Coast Basins.

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Water Replenishment District of Southern California (WRD), 2006e. Personal communication with Ted Johnson, September 21, 2006.

Santa Monica Basin

Key Well
Freeways
Water Body
MWD Pipeline
Adjacent Basin
Basin
MWD Member Agency Boundary (color varies)

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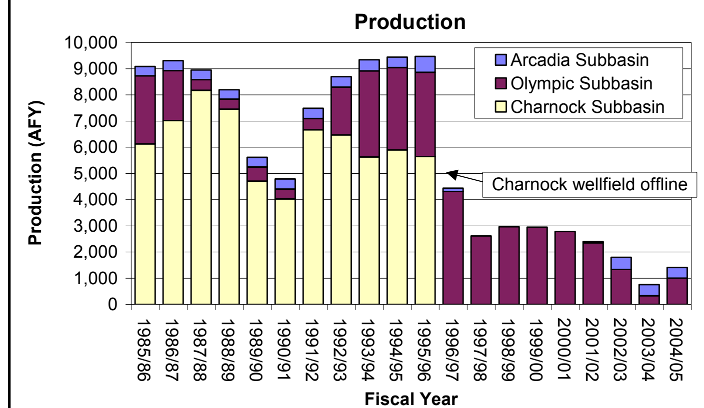
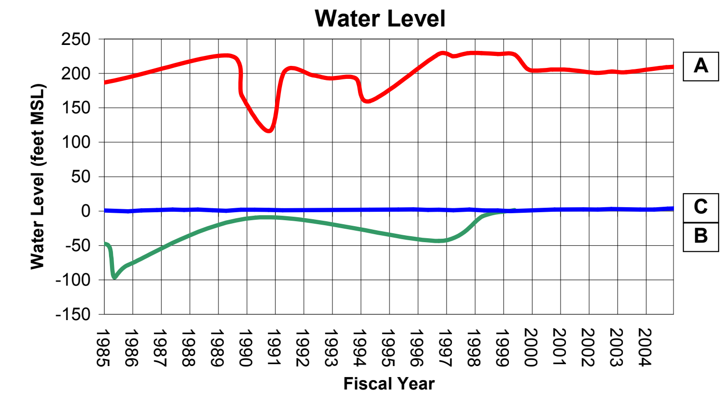
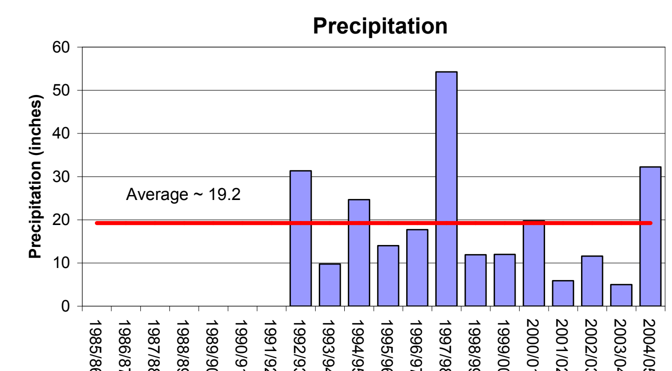






Source: CIMIS, 2006

Direct Recharge
No direct groundwater recharge for this basin

BASIN FACTS

Santa Monica Basin

Description
Location: Los Angeles County
Watershed Surface Area: 50 square miles
MWD Member Agency(s):
City of Santa Monica
City of Los Angeles
City of Beverly Hills
West Basin MWD
Management: Unadjudicated
Basin is not formally managed. Cleanup operations are coordinated by Regional Board

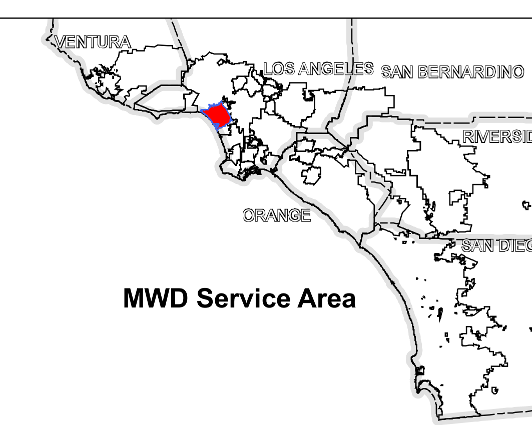
	Santa Monica
Natural Safe Yield	~7,500 AFY
Total Storage	1.1 million AF
Unused Storage Space	Unknown
Portion of Unused Storage Space Available for Storage	Unknown

Storage and Extraction Facilities

	Santa Monica
Production Wells	
Production Capacity	16,150 AFY
Average 2000-2004	1,838 AFY
Injection Wells	
Injection Capacity	None
Average 1985-2004	None
Spreading Basins	
Spreading Capacity	None
Average 1985-2004	None

Basin Management Considerations

- Several wells are offline because of MTBE and TCE contamination, which limits the ability to store and extract in this basin
- Potential for seawater intrusion may limit ability to store and extract water in this basin



MWD Service Area

Plate 5-1
Overview of Santa Monica Basin

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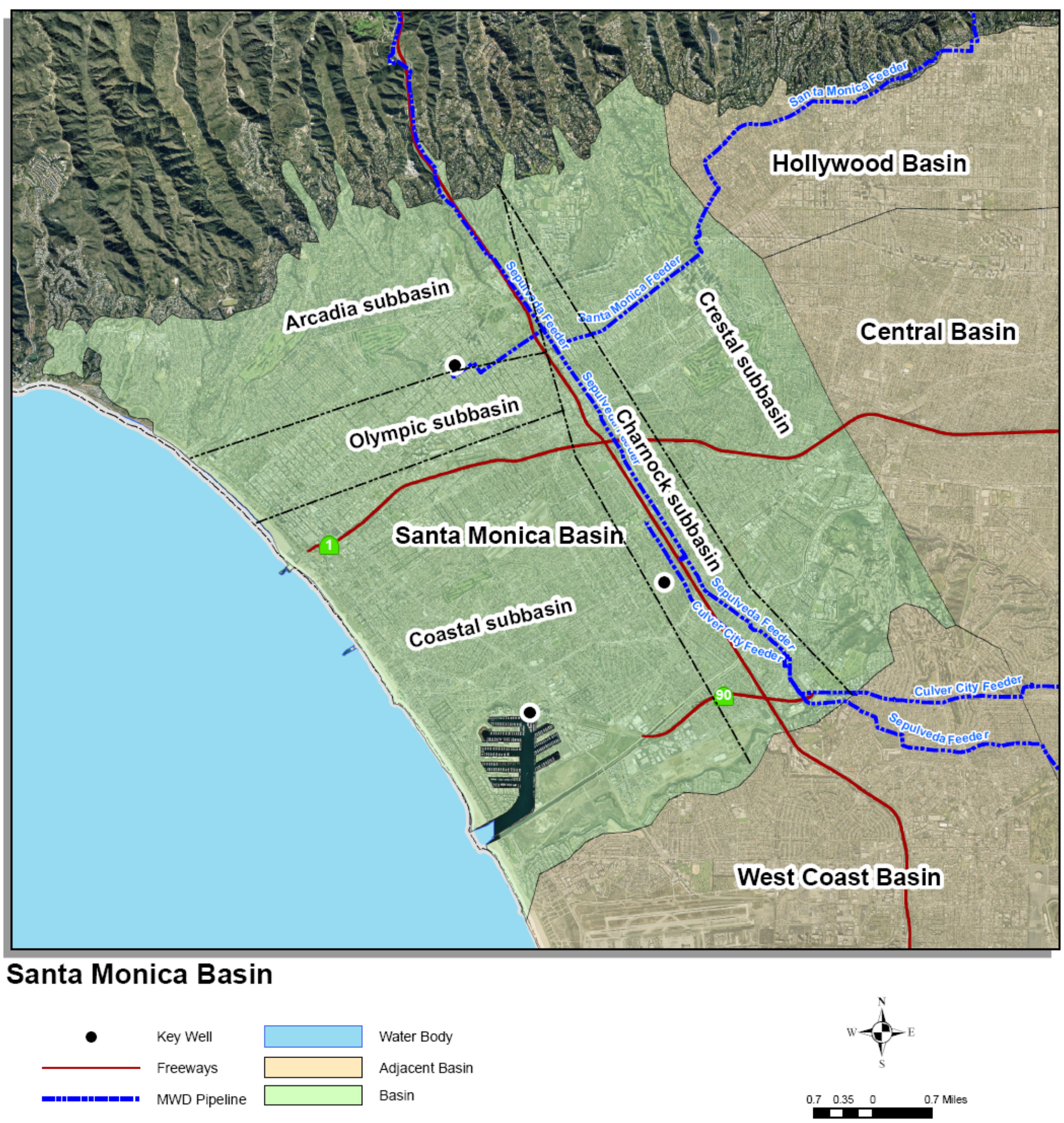
The Santa Monica Basin is located in the northwestern portion of the coastal plain of Los Angeles County. The Santa Monica Basin is within the service areas of the Metropolitan member agencies of the cities of Santa Monica, Los Angeles, Beverly Hills and West Basin Municipal Water District (West Basin MWD) and underlies the cities of Santa Monica, Culver City, and Beverly Hills and the communities of Pacific Palisades, Brentwood, Venice, Marina del Rey, West Los Angeles, Century City and Mar Vista. The Santa Monica Basin is divided into five subbasins: Arcadia, Olympic, Coastal, Charnock, and Crestal. A map of the basin is provided in **Figure 5-1**.

Figure 5-1
Map of the Santa Monica Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Santa Monica Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The basin is bounded by the Santa Monica Mountains to the northwest, the Pacific Ocean to the west and southwest, the Newport-Inglewood fault to the northeast, and the Ballona escarpment and Baldwin Hills to the south and southeast. The Santa Monica Basin is separated from the West Coast Basin by the Ballona Gap. As described above, faults subdivide the Santa Monica Basin into five sub-basins: Arcadia, Olympic, Coastal, Charnock and Crestal. Hydrogeologic data are provided in **Table 5-1**.

Table 5-1
Summary of Hydrogeologic Parameters of Santa Monica Basin

Parameter	**Description**
Structure	
Aquifer(s)	Alluvium (Ballona aquifer) Lakewood Formation San Pedro Formation (Silverado aquifer)
Depth of groundwater basin	Up to 550 feet
Thickness of water-bearing units	Ballona aquifer: 30 to 50 feet Lakewood Formation: 100 feet Silverado aquifer: Up to 280 feet
Yield and Storage	
Natural Safe Yield	~7,500 AFY
Total Storage	1.1 million AF
Unused Storage Space	Unknown
Portion of Unused Storage Space Available for Storage	Unknown

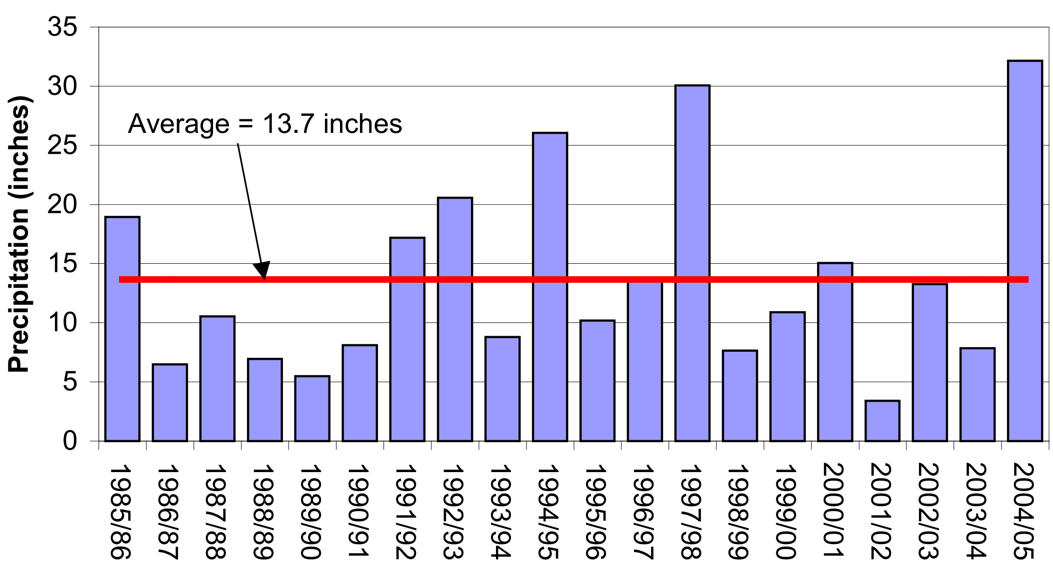
Total depth of the Santa Monica Basin is as much as 500 feet. Groundwater occurrence in the Santa Monica Basin is generally confined with some areas of unconfined or perched groundwater. The primary groundwater-producing zones within the Santa Monica Basin include aquifers within the recent alluvium and the underlying San Pedro Formation of the Los Angeles Coastal Plain. The Recent alluvium reaches a maximum thickness of about 90 feet and includes the clays of the Bellflower aquiclude and the underlying Ballona aquifer, which is also referred to as the "50-foot gravel." Perched groundwater may occur in this unit. The Lakewood Formation, a significant aquifer within other areas of Los Angeles County appears to be present only in the northern half of the basin; wells in the Arcadia and Olympic subbasins utilize this aquifer. Other unnamed sand units also occur. The main potable production aquifer in the Santa Monica Basin is the Silverado aquifer of the San Pedro Formation. This aquifer is up to 280 feet in thickness in the Santa Monica Basin. Additional fresh-water units lie below the San Pedro Formation, but are not widely produced (DWR 1961).

Total storage in the Santa Monica Basin has been estimated to be approximately 1.1 million AF (DWR, 1961). Current storage space is unknown.

Safe Yield/Long-Term Balance of Recharge and Discharge

The primary source of groundwater recharge into the Santa Monica Basin is percolation of precipitation and surface runoff from the Santa Monica Mountains. Water is discharged from the basin via surface runoff and subsurface outflow to the south. Natural recharge from precipitation and runoff is the largest inflow to the basin. **Figure 5-2** provides the historical precipitation data from 1985 to 2004. Average precipitation during this time period was approximately 13.7 inches. Although no formal safe yield determination has been made for the Santa Monica Basin, based upon studies performed by the USGS, the average yield based upon estimated inflows and outflows between 1971 and 2000 was about 7,500 AFY (USGS, 2003).

Figure 5-2
Historical Precipitation in the Santa Monica Basin



WRCC, 2007 (Santa Monica Pier)

GROUNDWATER MANAGEMENT

The following section describes how the Santa Monica Basin is currently managed including a discussion of the governing structure and relationship to adjoining basins.

Basin Governance

The Santa Monica Basin is an unadjudicated basin. The primary producer in the basin is the city of Santa Monica. As discussed below, the groundwater management in the Santa Monica Basin has centered primarily around the cleanup of groundwater contaminated by MTBE, most notably in the Arcadia and Charnock subbasins. The cleanup operations are coordinated/overseen by the Los Angeles Regional Water Quality Control Board.

Table 5-2
Summary of Management Agencies in the Santa Monica Basin

Agency	Role
City of Santa Monica	Primary producer in basin Operation of treatment facilities
California Department of Health Services	Oversight of cleanup of Arcadia and Charnock Wellfields
California Regional Water Quality Control Board – Los Angeles Region	Coordination and oversight of cleanup of Charnock and Arcadia Wellfields.

Interactions with Adjoining Basins

The Santa Monica Basin is adjacent to the Hollywood Basin to the north and east, the West Coast Basin to the south and the Central Basin to the east. The flow into the Hollywood and Central Basins is restricted by the Newport-Inglewood Uplift. Average outflows (1971 to 2000) are estimated to be about 1,000 AFY into the West Coast Basin (USGS, 2003). There are no formal agreements governing this flow.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Santa Monica Basin. Facilities include 12 groundwater production wells and treatment facilities associated with the MTBE and volatile organic compound cleanups in the Arcadia and Charnock subbasins.

Active Production Wells

There are currently 19 production wells (13 drinking water, 6 irrigation) within the Santa Monica Basin. Only five drinking water wells and four irrigation wells are currently in production. Prior to 1996, about 50 percent of the supply within the city of Santa Monica came from groundwater produced from the Arcadia, Charnock and Olympic subbasins. Since 1996, when

Santa Monica's Arcadia and Charnock wellfields were shut down due to MTBE and VOC contamination, about 95 percent of the city's water has been from imported water supplied by Metropolitan. The remainder of city's water comes from the Olympic subbasin wells, which have not been impacted by MTBE contamination (USEPA, 2006). Total existing capacity of active wells is approximately 3,300 gpm (Santa Monica, 2005).

Historical production within the Santa Monica Basin is summarized in **Figure 5-3**. Average production between 2000 and 2004 was approximately 1,800 AFY compared to a high of about 10,300 AFY in 1995 when contamination was discovered. Between 1985 and 1996, about 6,100 AFY was produced from the Charnock subbasin. Since 1996, production from this basin has been limited.

Table 5-3
Summary of Production Wells in the Santa Monica Basin

Subbasin	Number of Wells	Estimated Production Capacity [1] (AFY)	Average Production 1999/00 - 2004/05 (AFY)	Well Operation Cost ($/AF)
Arcadia	5 wells: 3 drinking (active) 2 irrigation (inactive)	450	261	Data not available
Charnock	7 drinking wells (inactive)	12,800	0	
Coastal	0	0	0	
Crestal	4 irrigation wells (active)	0	0	
Olympic	3 drinking wells 2 active 1 inactive	2,900	1,577	
Total	**19 wells** **9 active** **10 inactive**	**Active Wells 3,350 AFY** **Inactive Wells 12,800 AFY**	**1,838**	

Source: Santa Monica, 2000b, 2005, 2006
[1]Maximum annual production in past 5 years or rated pump capacity in Charnock subbasin

Other Production

All production in the Santa Monica Basin is designated for municipal use.

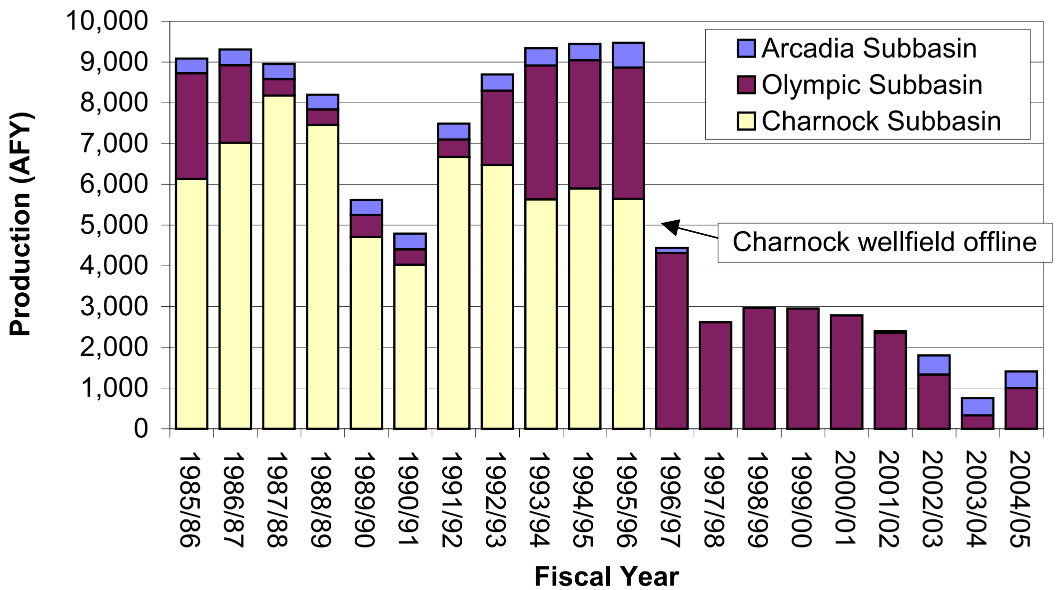
ASR Wells

There are no currently active ASR wells in the Santa Monica Basin. During the 1980s, the city of Santa Monica injected up to 2,148 AFY of imported water from Metropolitan into the Charnock subbasin (DBS & A, 1999). This injection was stopped in 1990.

Spreading Basins

There are no spreading basins in the Santa Monica Basin.

Figure 5-3
Historical Groundwater Production in the Santa Monica Basin



Source: City of Santa Monica, December 2006

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Santa Monica Basin.

Desalters

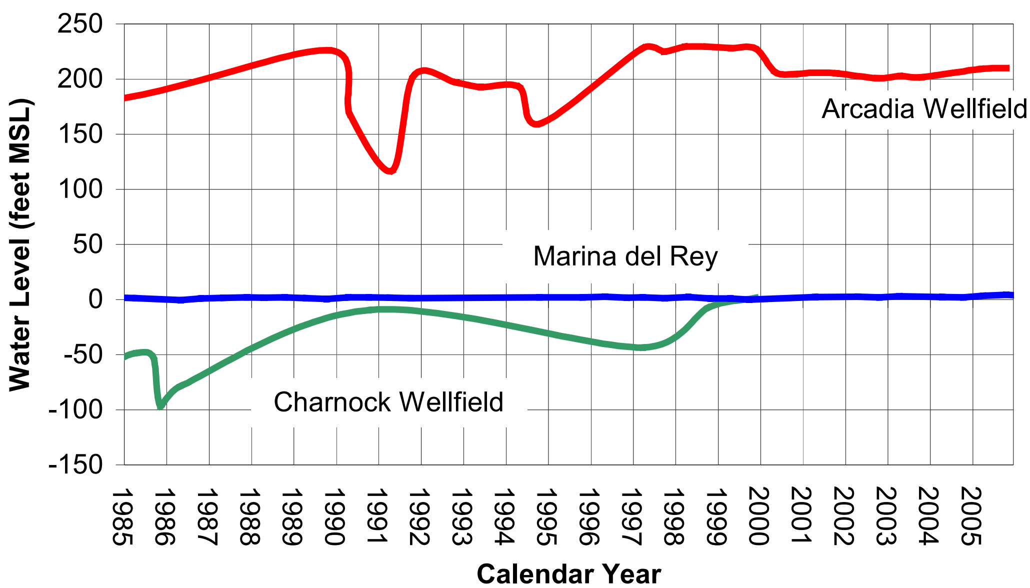
There are no desalters in the Santa Monica Basin.

GROUNDWATER LEVELS

Groundwater flow is generally from the Santa Monica Mountains in the north toward the West Coast Basin to the south. **Figure 5-4** shows representative hydrographs for key wells throughout the basin. In general, water levels in the Arcadia subbasin ranged from about

100 feet above MSL to 230 feet above MSL between 1985 and 2005. Well production in the Coastal subbasin is limited, in part, because water levels in this area are at or below sea level. The risk for seawater intrusion in this area is high. Water levels in the Charnock subbasin were as low as 100 feet below MSL prior to 1996 when the wells in this area were turned off because of MTBE contamination. Water levels in this area are currently at or near sea level.

Figure 5-4
Historical Water Levels in the Santa Monica Basin



GROUNDWATER QUALITY

The following section describes the groundwater quality issues within the Santa Monica Basin. Groundwater quality in the Santa Monica Basin is generally fair to poor with total dissolved solids (TDS) concentrations ranging from 729 to 1,156 mg/L (DWR, 2004). MTBE contamination in production wells has been a primary concern for the Santa Monica Basin.

Groundwater Quality Monitoring

Groundwater quality samples are collected from active production wells within the Santa Monica Basin in accordance with California DHS requirements as specified in Title 22 of the California Code of Regulations. In addition, groundwater quality has been evaluated as part of the cleanup operations in the Charnock subbasin. No basin-wide monitoring program has been established.

Groundwater Contaminants

Groundwater constituents of concerns for the Santa Monica Basin include: TDS, nitrate, VOCs, and MTBE. Perchlorate has not been detected in the Santa Monica Basin. A summary of the range and extent of these constituents is provided in **Table 5-4**.

Table 5-4
Summary of Constituents of Concern in Santa Monica Basin

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	Arcadia:664 to 738 Olympic:800 to 960 Charnock: 650 to 1,251	TDS ranges from 664 to 1,251 mg/L.
Nitrate (as N) MCL = 10	mg/L	Arcadia: 1.1 to 6.8 Olympic: ND to 9.1 Charnock: ND to 5	Nitrate concentrations meet drinking water standards.
VOCs **(TCE and PCE)** TCE MCL = 5 PCE MCL = 5	µg/L	Arcadia: TCE: ND to 7.8 PCE: ND Olympic: TCE: ND to 100 PCE: ND to 23.9 Charnock: TCE: ND to 17.7 PCE: ND	PCE only detected in 1 well in Olympic subbasin TCE has ranged from non-detect to 100 µg/L
Perchlorate Notification level =6	µg/L	Arcadia: ND Olympic: ND Charnock: ND	Perchlorate not detected
MTBE Secondary MCL = 5	µg/L	Arcadia: ND to 86.5 Olympic: ND Charnock: ND to 610	Cleanup in underway in Arcadia and Charnock subbasins. Wells in Charnock subbasin remain offline.
1,4-dioxane Notification level = 3	µg/L	Olympic: ND to 20	The City of Santa Monica has detected 1,4-dioxane in its Olympic production wells.

Source: Regional Board, 2006 (data from 1990-2002); Santa Monica, 2006

TDS concentrations in the Santa Monica Basin exceed the secondary standard of 500 mg/L for TDS. Blending or treatment is required to meet drinking water standards.

Trichloroethylene (TCE) was detected in the Olympic subbasin in 1979 with maximum detections up to 190 µg/L. Air strippers were installed in the wells in this subbasin in the mid 1980s (Santa Monica, 2000b). More recently, the City of Santa Monica has detected 1,4-dioxane in its Olympic production wells.

MTBE, a chemical in reformulated gasoline was first detected in groundwater extracted from production wells at the Charnock and Arcadia subbasins in 1995. In 1996, all water supply wells in the Charnock well field were shut down due to persistent and increasing levels of volatile organic contaminants and MTBE.

Blending Needs

While the City of Santa Monica blends various source waters prior to disinfection and distribution, the City is not permitted to utilize blending as a treatment option for contaminated groundwater.

Groundwater Treatment

A summary of the groundwater treatment activities is provided in **Table 5-5**.

Table 5-5
Summary of Groundwater Treatment in the Santa Monica Basin

Subbasin	Constituent Treated	Treatment Type	Average Amount Treated (AFY)
Arcadia	None	None	Not applicable
Charnock	MTBE	To be determined	To be determined
Olympic	TCE	Mechanical surface aeration	1,450
Total	**--**	**--**	**1,450**

Source: Santa Monica, 2006

A shallow aquifer and vadose remediation system (SAVRS) and lower aquifer remediation system (LARS) were installed at the Arcadia wells to remediate the MTBE-affected zones (Santa Monica, 2005).

In November 1999, Shell Oil Company began operating a groundwater extraction and treatment system on Tuller Avenue south of Venice Boulevard. This system is extracting and treating shallow and deep groundwater from wells on both the west side and east side of the 405 freeway along with wells on and adjacent to an operating Shell gas station. This system, which has a treatment capacity of approximately 300 gallons per minute, increased its operations to approximately 450 gallons per minute as of January 2002. USEPA and the Regional Board have required periodic adjustments in the operation of this system in order to clean up the area around the Venice and Sepulveda intersection (USEPA, 2006).

In December 2003, the city of Santa Monica and some of the companies responsible for the MTBE contamination of the Charnock subbasin received court approval for a settlement under which the companies will fund construction and operation of a treatment plant at the City's Charnock Wellfield. This treatment plant will clean up residual regional MTBE contamination. Because the treatment plant will provide a protective remedy, EPA does not plan to undertake additional remedy selection at the site. The Regional Board will remain the lead agency to insure that all individual source site cleanups are properly completed. DHS in consultation with the Regional Board will oversee the permitting, construction and operation of the treatment plant provided for in the settlement. (USEPA).

To date, over 100 million gallons of contaminated groundwater has been treated in the Charnock subbasin, over 17,000 pounds of hydrocarbons have been removed using soil vapor extraction (SVE), and over 4100 cubic yards of contaminated soil has been excavated and removed (USEPA, 2006).

CURRENT GROUNDWATER STORAGE PROGRAMS

There are no current groundwater storage programs in the Santa Monica Basin.

BASIN MANAGEMENT CONSIDERATIONS

Considerations that could limit the ability to store and extract water in the Santa Monica Basin are based upon water quality concerns. They include:

- Several wells are offline because of MTBE and TCE contamination, which limits the ability to store and extract in this basin
- Potential for seawater intrusion may limit ability to store and extract water in this basin

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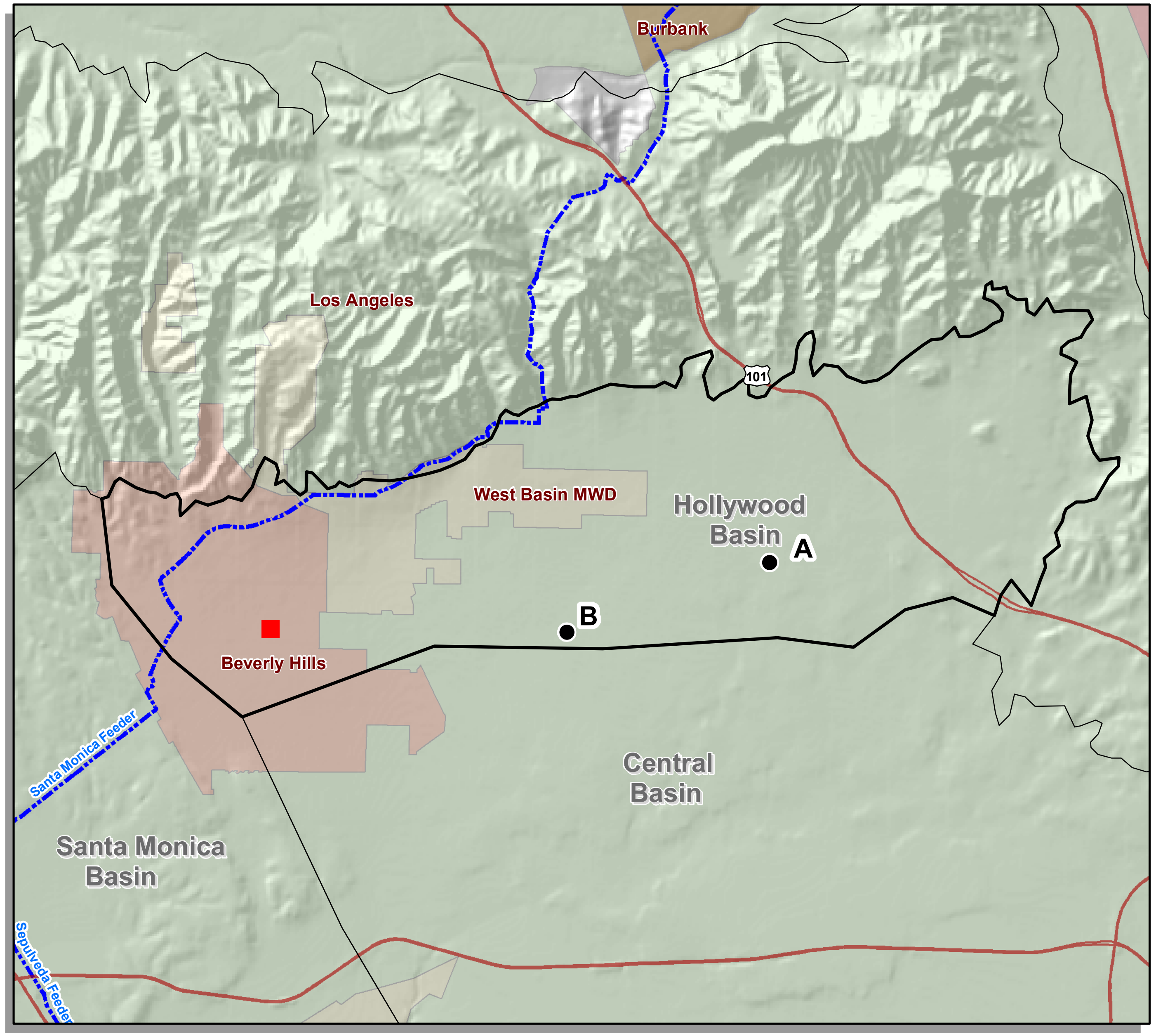

Hollywood Basin

A ●	Key Wells		MWD Pipeline
■	Desalter		MWD Member Agency Boundary (color varies)
	Freeways		Basin

N W E S

1 0.5 0 1 Miles

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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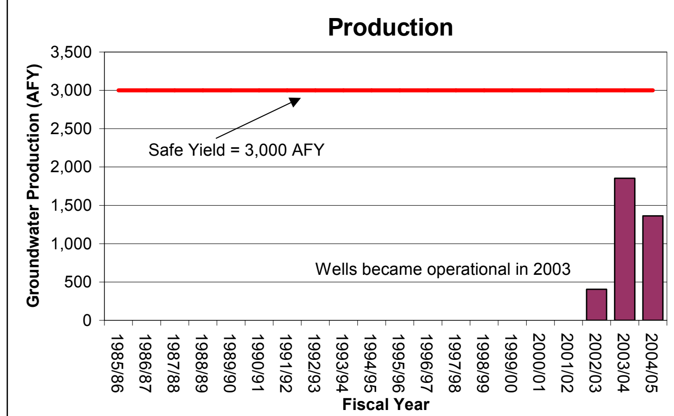
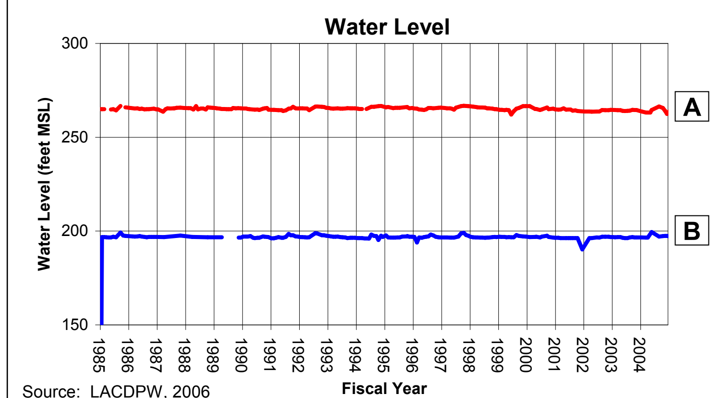
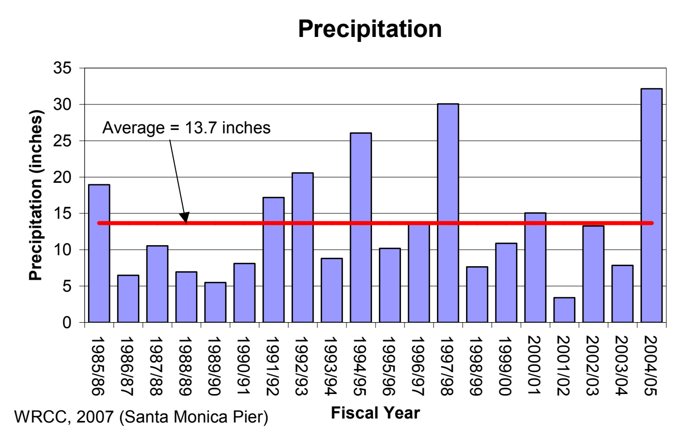
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).





Source: LACDPW, 2006



WRCC, 2007 (Santa Monica Pier)

Direct Recharge

No direct recharge data are available for this basin.

BASIN FACTS

Hollywood Basin

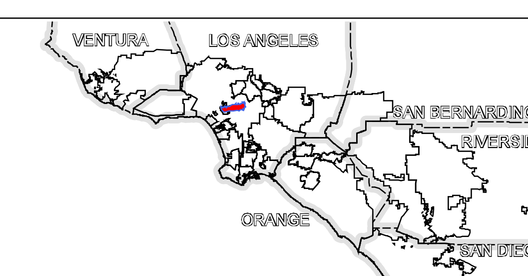
Description
Location: Los Angeles County
Watershed Surface Area: 16.4 square miles
Management: Unadjudicated
Only producer is City of Beverly Hills.
MWD Member Agencies:
City of Beverly Hills
West Basin MWD
City of Los Angeles

	Hollywood
Natural Safe Yield	3,000 AFY
Total Storage	400,000 AF
Unused Storage Space	Unknown
Portion of Unused Storage Space Available for Storage	Unknown

Storage and Extraction Facilities

	Hollywood
Production Wells	
Production Capacity	~1,850 AFY
Average 2002/03-2004/04	~1,200 AFY
Injection Wells	
Injection Capacity	None
Average 1985/06-2004/05	None
Spreading Basins	
Spreading Capacity	None
Average 1985/86-2004/05	None

Basin Management Considerations
- Shallow groundwater may limit ability to store water
- Groundwater must be treated to meet drinking water standards
- Basin receives limited natural recharge



MWD Service Area

Plate 6-1
Overview of Hollywood Basin

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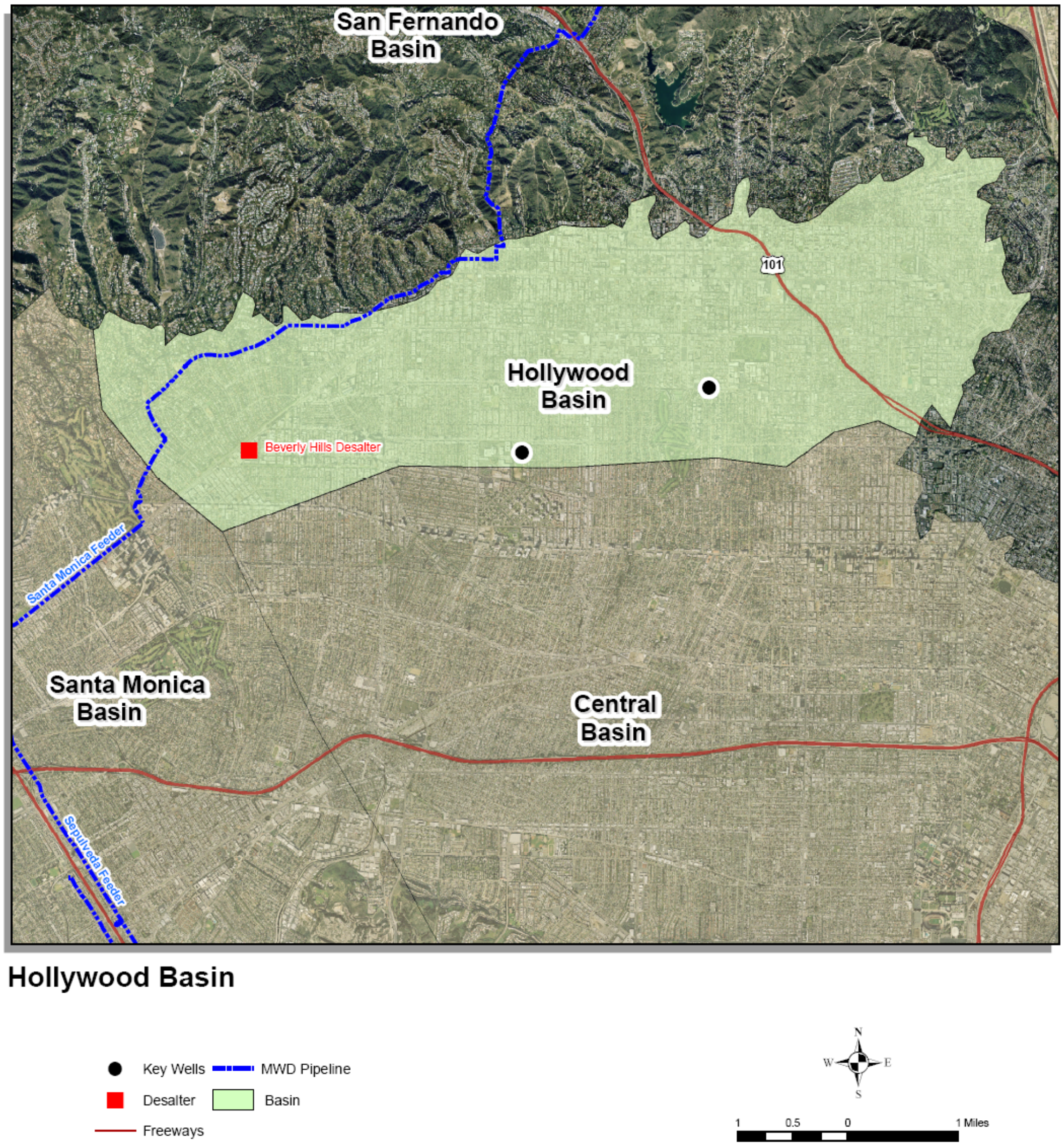
The Hollywood Basin is located within Los Angeles County adjacent to the Santa Monica Mountains. It underlies the service areas of Metropolitan member agencies the City of Beverly Hills, West Basin Municipal Water District (West Basin MWD) and the City of Los Angeles. Overlying cities include Beverly Hills, West Hollywood and Los Angeles. The location of the Hollywood Basin is shown in **Figure 6-1**.

Figure 6-1
Map of the Hollywood Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Hollywood Basin and its hydrogeologic character.

Basin Producing Zones and Storage Capacity

The Hollywood Basin underlies the northeastern portion of the Los Angeles Coastal Plain. The basin is bounded on the north by the Santa Monica Mountains and the Hollywood fault, on the east by the Elysian Hills, the west by the Newport-Inglewood Uplift and the south by the La Brea high, an area of shallow bedrock (DWR, 2004). A summary of the general hydrogeologic characteristics of the basins is provided in **Table 6-1**.

Table 6-1
Summary of Hydrogeologic Parameters of Hollywood Basin

Parameter	Description
Structure	
Aquifer(s)	• Alluvium • Lakewood Formation (Exposition and Gage aquifers) • San Pedro Formation (Jefferson, Lynwood, Silverado, and Sunnyside aquifers)
Depth of groundwater basin	Up to 660 feet
Thickness of water-bearing units	Alluvium (up to 60 feet) Lakewood Formation (up to 175 feet) San Pedro Formation (up to 100 feet)
Yield and Storage	
Natural Safe Yield	3,000 AFY
Total Storage	400,000 AF
Unused Storage Space	Unknown
Portion of Unused Storage Available for Storage	Unknown

Source: DWR, 2004; DWR 1961; Beverly Hills 2006.

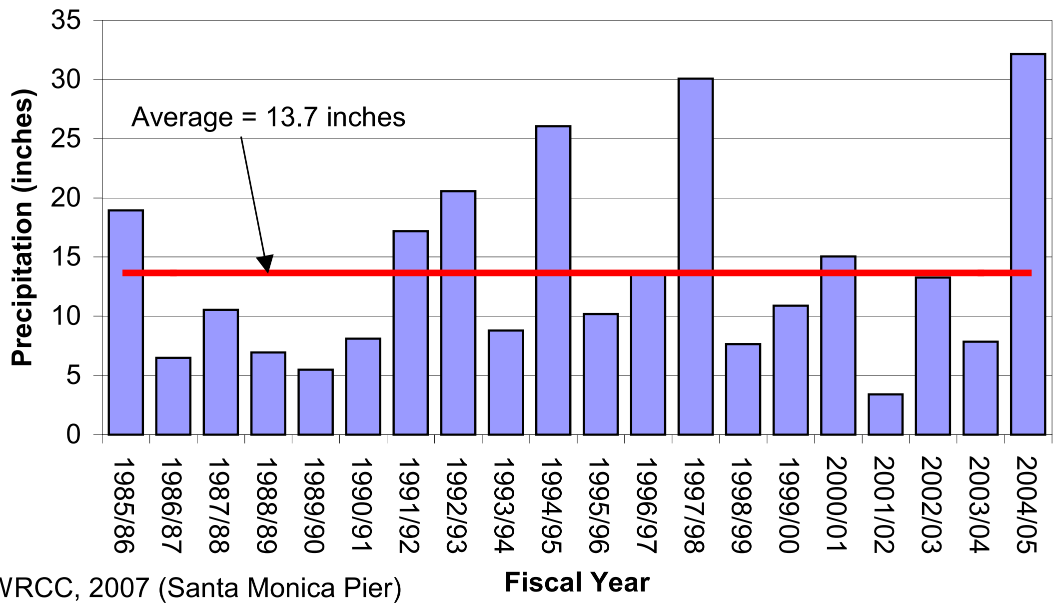
The depth of the Hollywood Basin is as much as 660 feet (DWR, 1961). Semi-perched groundwater may occur in the alluvium, which ranges in thickness from five to 35 feet and covers about half of the basin. Limited groundwater is produced from this zone but it is still an important component of basin management as water from this zone can percolate into the underlying aquifers. The main potable production aquifers include the deeper aquifers of the San Pedro Formation (including from top to bottom, the Jefferson, Lynwood, Silverado and

Sunnyside aquifers) and the shallower aquifers of the Lakewood Formation (including aquifers Exposition and Gage). The San Pedro Formation is only found in the westernmost portion of the basin in the Beverly Hills area. The Gage aquifer of the Lakewood Formation is the major water-bearing member of the Hollywood Basin (DWR, 1961). However, in general, aquifers in the Hollywood Basin are not highly transmissive and do not yield significant groundwater except in the western portion where the basin is deeper.

Safe Yield/Long-Term Balance of Recharge and Discharge

Groundwater in the Hollywood Basin is replenished by percolation of precipitation and stream flow from the Santa Monica Mountains to the north. Historical precipitation at the nearby Santa Monica Pier is summarized in **Figure 6-2**. Urbanization in this area has decreased the surface area open to direct percolation. Therefore, natural recharge is somewhat limited. The natural safe yield of the basin is estimated to be approximately 3,000 AFY (Beverly Hills, 2006).

Figure 6-2
Historical Precipitation near the Hollywood Basin



WRCC, 2007 (Santa Monica Pier)

Total storage in the Hollywood Basin has been estimated to be approximately 400,000 AF. The usable storage in the basin is unknown. However, current depths to water are generally less than 20 feet in the central and eastern portions of the basin, which suggests limited storage space available in these areas. The depth of the static water level in wells in the City of Beverly Hills in the western portion of the basin ranges from 227 feet to 313 feet from the top of the well head to the water table, indicating potential for more storage in this portion of the basin.

GROUNDWATER MANAGEMENT

The following section provides a brief description of the groundwater management activities and governing structure for the Hollywood Basin.

Basin Governance

The Hollywood Basin is unadjudicated. It is presently managed by the city of Beverly Hills through municipal ordinances. These municipal ordinances regulate the production of groundwater, prohibit waste, protect water quality and require dewatering activities to mitigate adverse impacts on the Hollywood Basin. **Table 6-2** summarizes the groundwater management structure in the Hollywood Basin.

The primary producer from the basin is the city of Beverly Hills. The city has historically produced significant quantities of groundwater from the Hollywood Basin, and in some years produced more than 7,000 AF. In 1976, the city of Beverly Hills discontinued producing groundwater from the Hollywood Basin for a variety of reasons, reserving its rights to return to groundwater as necessary to satisfy its water supply requirements. In the 1990s, the city chose to reevaluate the use of groundwater in the Hollywood Basin and elected to resume groundwater production. Since that time, four groundwater wells and a groundwater treatment facility have been activated (SA Associates, 2005).

Table 6-2
Summary of Management Agencies in the Hollywood Basin

Agency	Role
City of Beverly Hills	Manager of production, use and discharge of groundwater through a series of municipal ordinances. Primary producer in basin and operation of reverse osmosis treatment facility

Interactions with Adjoining Basins

The Hollywood Basin is adjacent to the Central Basin and the Santa Monica Basin. The USGS (USGS, 2003) has estimated that the flow from the Hollywood Basin into the Central Basin is approximately 5,900 AFY (based upon 1971 to 2000). There are no formal agreements regarding this flow. The flow into the Santa Monica Basin is restricted by the Newport-Inglewood Uplift.

WATER SUPPLY FACILITIES AND OPERATIONS

Facilities in the Hollywood Basin include four active production wells and a desalter facility. Each of these is discussed below.

Active Production Wells

The city of Beverly Hills currently owns and operates four groundwater production wells in the Hollywood Basin. These wells have a combined capacity of 2,025 gpm and are treated by the city's reverse osmosis desalter discussed below. Details of the treated well production are summarized in **Table 6-3**. Historical treated production since the wells and treatment facility came online in 2003 is shown in **Figure 6-3**. An average of about 1,200 AFY of groundwater was used to meet local demands between 2003 and the end of fiscal year 2004/05.

Figure 6-3
Historical Groundwater Production in the Hollywood Basin

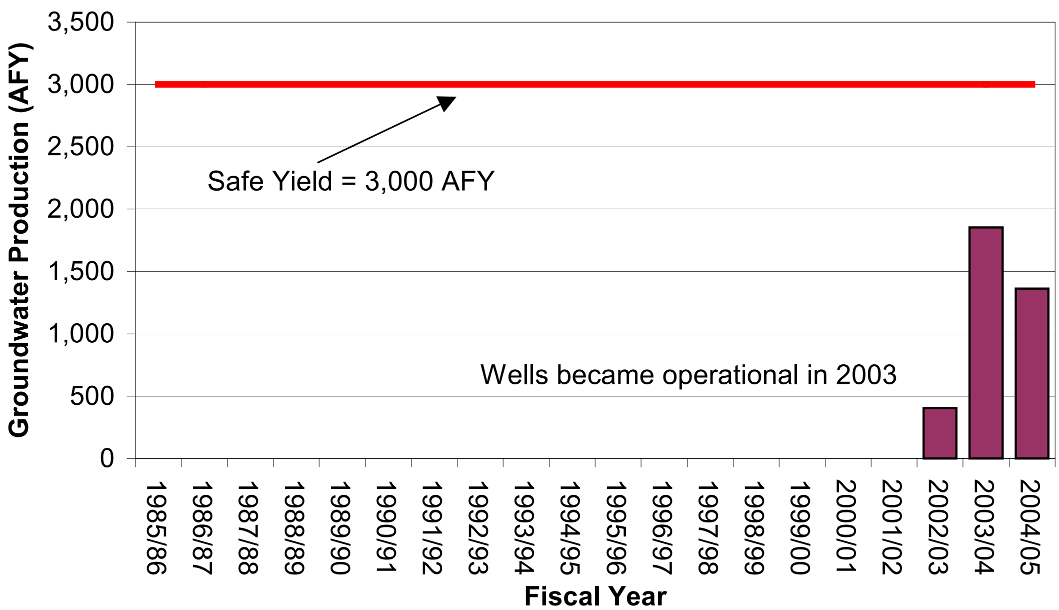


Table 6-3
Summary of Production Wells in the Hollywood Basin

Category	Number of Active Wells	Estimated Production Capacity [1] (AFY)	Average Production 2002/3-2004/5 (AFY)	Well Operation Cost ($/AF)
Municipal	4	1,850	1,207	Data not available

Note: 1. Production capacity is based upon maximum annual production since 2003.
Source: SA Associates, 2005.

Other Production

There is no other documented production in the Hollywood Basin.

ASR Wells

There are no ASR wells in the Hollywood Basin.

Spreading Basins

There are no spreading basins in the Hollywood Basin.

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Hollywood Basin.

Desalters

The City of Beverly Hills currently treats up to 3 mgd of groundwater via reverse osmosis from the Hollywood Basin at the Beverly Hills Desalter. The project pumps and treats brackish water from the City of Beverly Hills. The desalter facilities include extraction wells, a collector pipeline, a treatment plant and a brine line to deliver waste to the Hyperion Wastewater Treatment Plant. This facility is designed to produce about 2,600 AFY of treated water and discharge about 336 AFY to the brine line (Metropolitan, 2006).

GROUNDWATER LEVELS

Groundwater generally flows from east to west across the Hollywood Basin. Representative hydrographs are shown for inactive wells in **Figure 6-4**. These data suggest that the inflows and outflows in the Hollywood Basin are generally balanced and there is limited effect from natural recharge (i.e. annual variations are only a few feet). Limited production has occurred in the basin during this 20-year period.

GROUNDWATER QUALITY

The following section describes the water quality issues in the Hollywood Basin. Water quality is generally fair with TDS concentrations ranging from 519 to 788 mg/L.

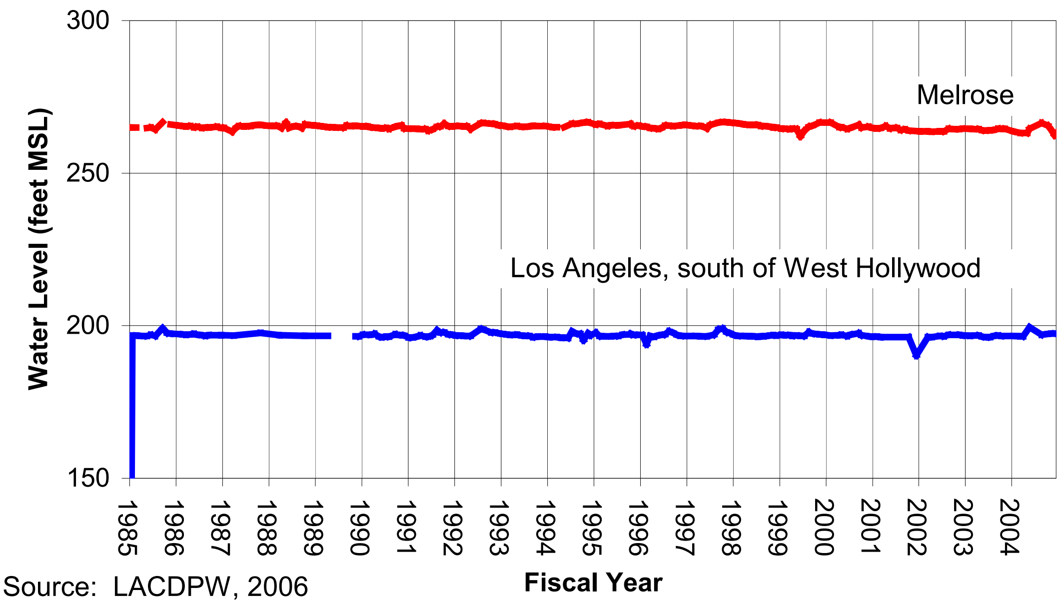
Groundwater Quality Monitoring

Water quality not been measured on a regular basis because the production wells have been inactive since the 1970s. Current production wells are sampled in accordance with Title 22.

Groundwater Contaminants

Constituents of concern for the Hollywood Basin include total dissolved solids (TDS). These constituents are summarized in **Table 6-4**. In addition, constituents of regional concern (nitrate, volatile organic compounds, or VOCs, and perchlorate) are also included for reference.

Figure 6-4
Historical Water Levels in the Hollywood Basin



Source: LACDPW, 2006

Limited historical data are available because wells have not been active. TDS concentrations in the Hollywood Basin generally ranged from 357 to 970 mg/L between 2002 and 2006 (Regional Board, 2007). Based upon data from the four active wells between 2002 and 2006, about 85 percent of the samples collected exceeded the secondary standard of 500 mg/L for TDS.

Blending Needs

There is no information related to blending needs in the Hollywood Basin.

Groundwater Treatment

As discussed above, wells are treated by reverse osmosis at the Beverly Hills Desalter. All groundwater pumped in the Hollywood Basin is treated.

CURRENT GROUNDWATER STORAGE PROGRAMS

There are no current groundwater storage programs in the Hollywood Basin.

Table 6-4
Summary of Constituents of Concern in Hollywood Basin

Constituent	Units	Range 2002/03-2005/06	Description
TDS Secondary MCL = 500	mg/L	357 to 970	Based upon data collected between 2002 and 2006, 85 percent of all samples collected had TDS concentrations above 500 mg/L.
Nitrate (as N) Primary MCL = 10	mg/L	ND	Nitrate has not been detected in the Hollywood Basin
VOCS (TCE and PCE) Primary MCL for TCE = 5 Primary MCL for PCE = 5	μg/L	ND	TCE and PCE have not been detected in the Hollywood Basin
Perchlorate Notification level = 6	μg/L	ND	Perchlorate has not been detected in the Hollywood Basin.

Source: Regional Board, 2007

BASIN MANAGEMENT CONSIDERATIONS

Management considerations in the Hollywood Basin include:

- Shallow groundwater may limit ability to store water. As discussed above, depth to groundwater is less than 20 feet in central and eastern portions of the basin, which would limit the ability to store water.
- Groundwater must be treated to meet drinking water standards. As discussed above, TDS concentrations exceed the secondary standard of 500 mg/L.
- Basin receives limited natural recharge because of urbanization. The safe yield is only about 3,000 AFY.

References:

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CHAPTER IV

GROUNDWATER BASIN REPORTS

SAN GABRIEL VALLEY BASINS

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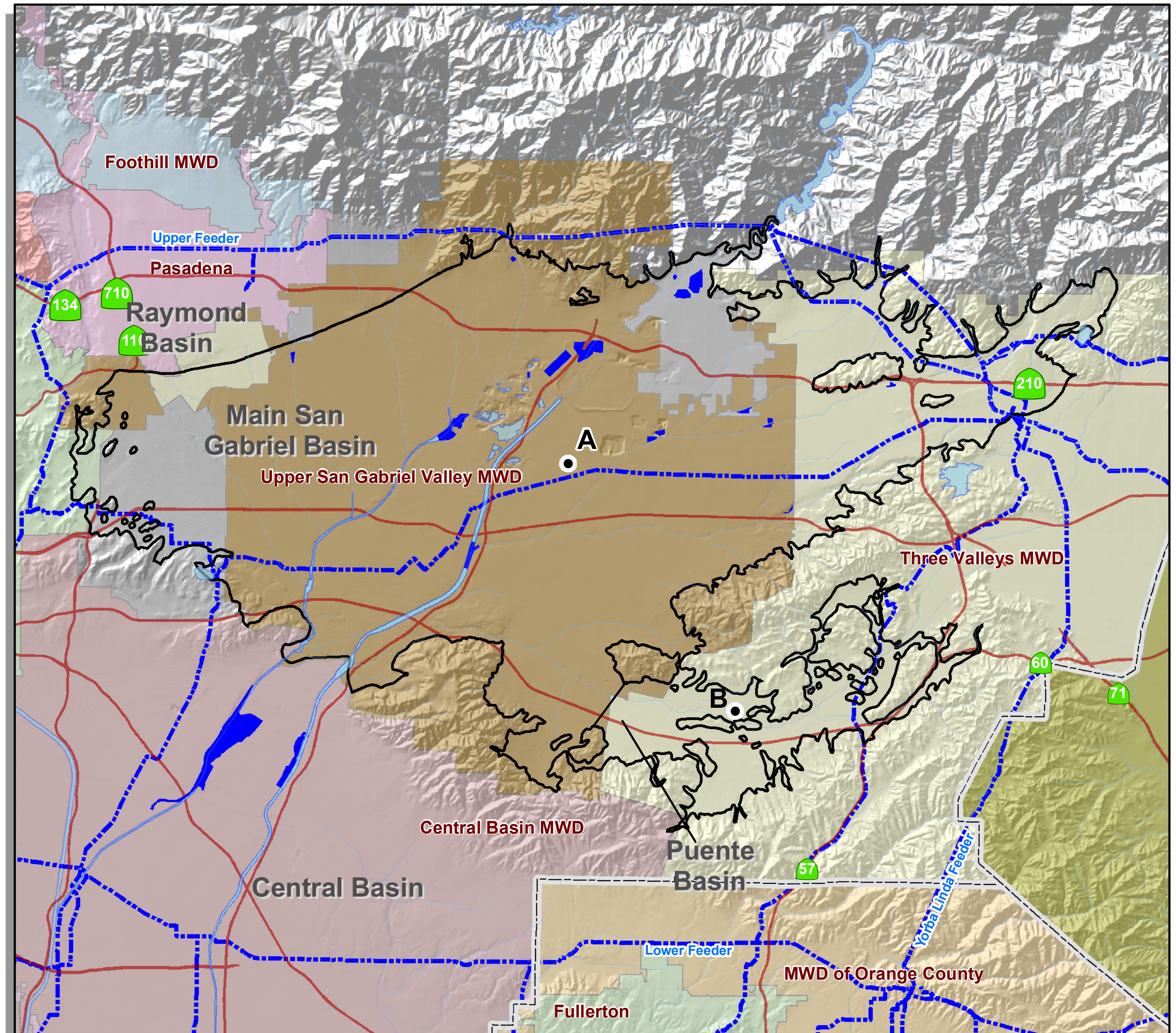

Main San Gabriel and Puente Basins

A ● Key Well
Freeways
Stream
MWD Pipeline
County
MWD Member Agency Boundaries (colors vary)
Recharge Basins
Water Body
Groundwater Basin

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).

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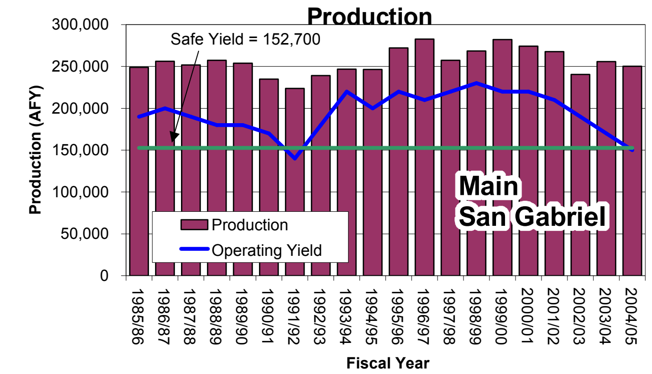
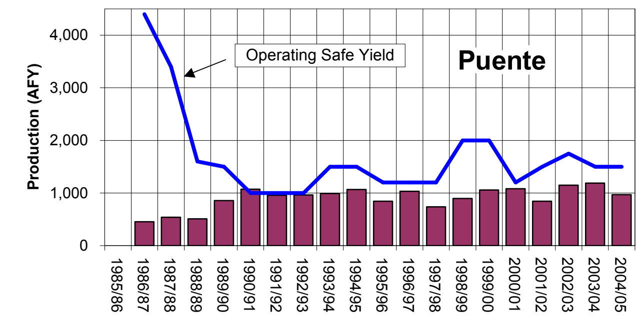
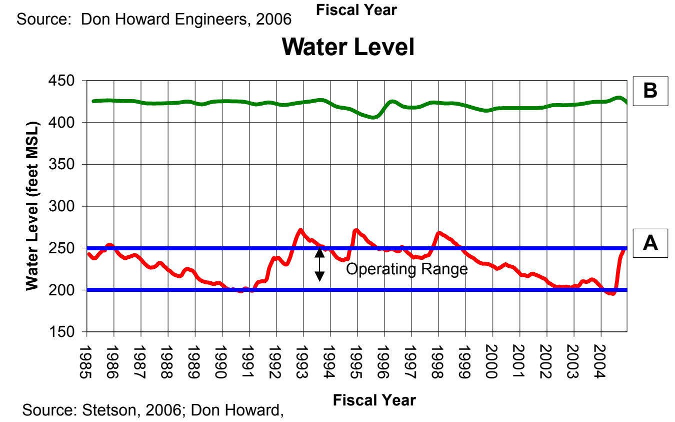
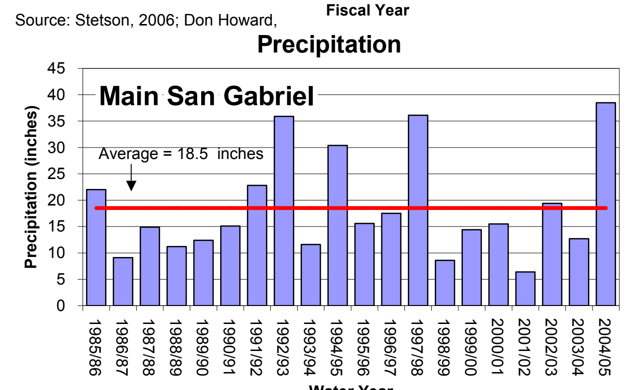




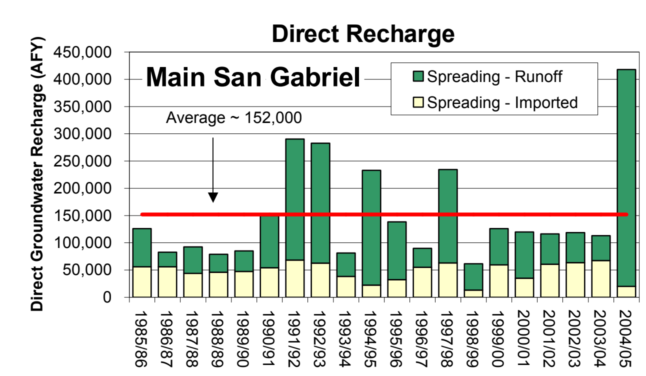
Source: Don Howard Engineers, 2006



Source: Stetson, 2006; Don Howard,



Source: Stetson, 2005



Source: Stetson, 2006

BASIN FACTS

Main San Gabriel and Puente Basins

Description
Location: Los Angeles County
Watershed Surface Area: 167 square miles
Subbasins:
Main Basin
Puente Basin
Management: Adjudicated
Main Basin adjudicated in 1973. Puente Basin adjudicated in 1986.
MWD Member Agencies:
San Marino
Three Valleys MWD
Upper San Gabriel Valley MWD

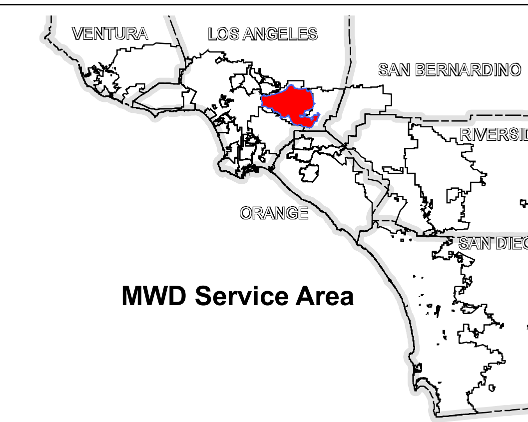
	Main	Puente
Natural Safe Yield	152,700 AFY	4,400 AFY
Operating Safe Yield (2005/06)	240,000 AFY	1,530 AFY
Total Storage	8.6 million AF	979,650 AF
Usable Storage	800,000 AFY	Unknown
Storage Space Available	None	Unknown

Storage and Extraction Facilities

	Main	Puente
Production Wells		
Production Capacity	~500,000 AFY	300-600 gpm
Average 1985-2004	~256,000 AFY	905 AFY
Injection Wells		
Injection Capacity	None	None
Average 1985-2004	None	None
Spreading Basins		
Spreading Capacity	~620,000 AFY	None
Average 1985-2004	~152,000 AFY	None

Basin Management Considerations

- Pumping subject to adjudication in Main and Puente Basins
- Cannot store supplemental imported water in Main Basin when the key well groundwater elevation exceeds 250 feet MSL
- Must have a Cyclic Storage Agreement with Main Basin Watermaster to store imported water in Main Basin
- Puente Basin Judgment has no provisions for storage
- Perchlorate and various chlorinated solvent contaminants associated with the USEPA Operable Units could limit ability to store and extract water
- Nitrate concentrations in eastern portion of the Main Basin could limit ability to store and extract water



MWD Service Area

Plate 7-1
Overview of Main San Gabriel and Puente Basins

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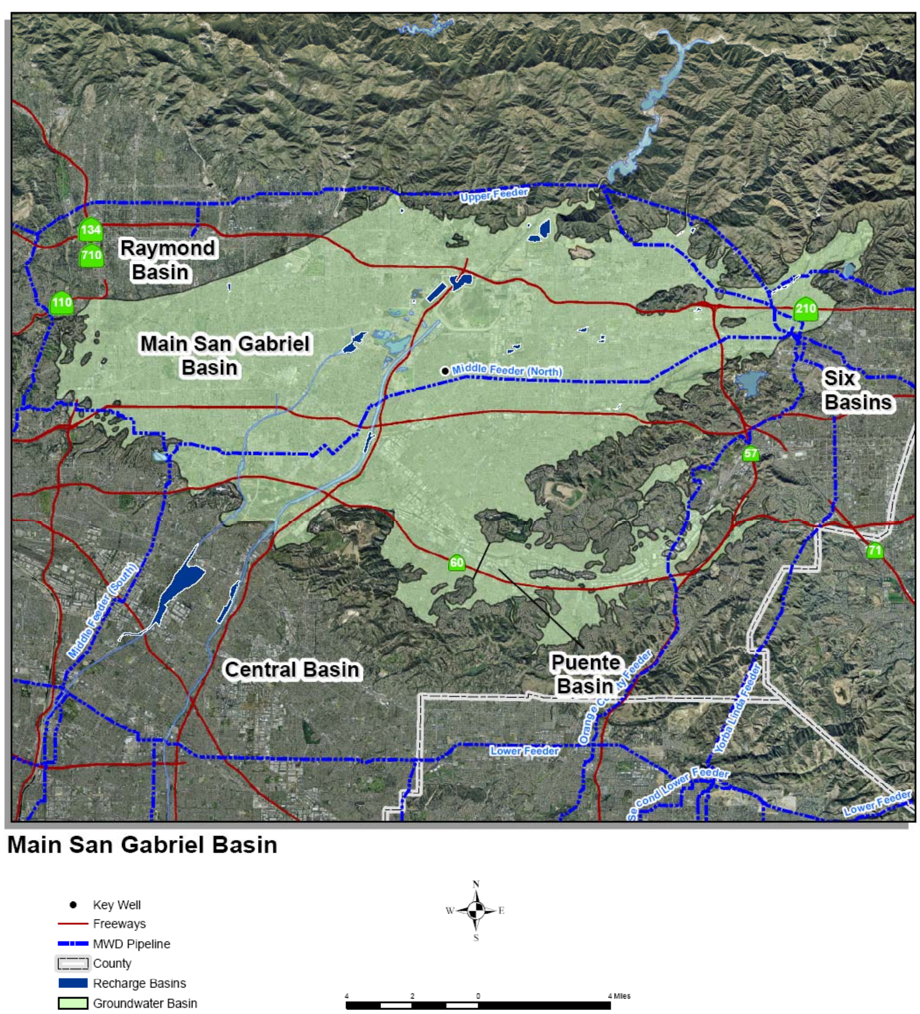
The Main San Gabriel and Puente Basins lie in eastern Los Angeles County, California. The hydrologic basin or watershed coincides with a portion of the upper San Gabriel River watershed, and the aquifer or groundwater basin underlies most of the San Gabriel Valley. Metropolitan member agencies overlying the Main San Gabriel Basin (or Main Basin) include: Upper San Gabriel Municipal Water District (Upper District), Three Valleys Municipal Water District (Three Valleys) and the City of San Marino. The service areas of three member agencies (cities of Azusa, Alhambra and Monterey Park) of the State Water Project contractor, San Gabriel Valley Municipal Water District (SGVMWD), also overlie the Main San Gabriel Basin. The Metropolitan member agency overlying the Puente Basin is Three Valleys. Overlying communities include: Arcadia, Azusa, Baldwin Park, Bradbury, Covina, Duarte, El Monte, Glendora, Industry, Irwindale, La Puente, Monrovia, Rosemead, San Gabriel, San Marino, South El Monte, South Pasadena, Temple City, Walnut, and West Covina. A map of the Main San Gabriel and Puente Basins is provided in **Figure 7-1**.

Figure 7-1
Map of the Main San Gabriel and Puente Basins



BASIN CHARACTERIZATION

The following section provides a physical description of the Main San Gabriel and Puente Basins including geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The Main San Gabriel and Puente Basins are bounded by the San Gabriel Mountains to the north, San Jose Hills to the east, Puente Hills to the south, and by a series of hills and the Raymond Fault to the west. The watershed is drained by the San Gabriel River and Rio Hondo, a tributary of the Los Angeles River.

The physical groundwater basin is divided into two main parts, the Main Basin and the Puente Basin. The Puente Basin, lying in the southeast portion of the map above, is tributary to the Main Basin and hydraulically connected to it, with no barriers to groundwater movement. Each basin is separately adjudicated and managed by a watermaster. **Table 7-1** provides a summary of the hydrogeologic parameters of the Main San Gabriel and Puente Basins. Each basin is discussed separately in the following section.

Table 7-1
Summary of Hydrogeologic Parameters of Main San Gabriel and Puente Basins

Parameter	Main San Gabriel Basin	Puente Basin
Structure		
Aquifer(s)	Unconfined	Unconfined
Depth of groundwater basin	800 to 1,600 feet MSL	25 to 1,300 feet
Thickness of water-bearing units	300 to 2,000 feet	70 to 200 feet
Yield and Storage		
Natural Safe Yield	152,700 AFY	4,400 AFY
Operating Yield	FY 2005/06: 240,000 AFY	FY 2006/07: 1,530 AFY
Total Storage	8.6 million AF	979,650 AF
Unused Storage Space	~500,000 AF	Unknown
Portion of Unused Storage Available for Storage (in 2005/06)	None	Unknown

Sources: Stetson, 2006 and Main San Gabriel Basin Watermaster, 2006
Puente Basin Watermaster, 2006; Ecological Systems Corporation, 1975; Geotechnical Consultants, Inc, 1979; CH2MHill, 1997. Main San Gabriel Basin

Main San Gabriel Basin

The Main San Gabriel Basin occupies most of the San Gabriel Valley and encompasses a surface area of more than 73,000 acres. Principal water-bearing formations of the Main Basin are unconsolidated and semi-consolidated unconfined alluvial sediments that range in size from coarse gravel to fine-grained sands. Total thickness of water-bearing sediments ranges from about 300 feet to more than 2,000 feet (Stetson, 2006).

The total amount of water in storage for the Main San Gabriel Basin is approximately 8.6 million AF (Main San Gabriel Watermaster, 2006b). Usable storage within the operating range is approximately 800,000 AF while the unused storage space is about 500,000 AF (Stetson, 2006). Supplemental imported water cannot be stored in the Main San Gabriel Basin when the groundwater elevation at the key well exceeds 250 feet MSL. Water levels at this time are near or above the target level. Therefore, available storage space for supplemental water is currently limited.

Puente Basin

The Puente Basin occupies the western end of the San Jose Valley and contains nearly 8,870 acres. For the most part, the basin is relatively shallow, and in several locations, bedrock is found at the surface. Boundaries of the Puente Basin are formed on the north and south by the nonwater-bearing rocks of the San Jose and Puente Hills. The eastern boundary is contiguous with the western boundary of the Spadra Basin and is defined by a bedrock ridge and groundwater divide. As discussed above, the Puente Basin is bounded by the Main San Gabriel Basin to the west. Groundwater freely flows from the Puente Basin into the Main San Gabriel Basin. (Engineering Science, Inc, 1979).

Primary water-bearing sediments include weathered alluvium from the adjacent hills and recent deposits within San Jose Creek. The alluvial fill in the Puente Basin tends to be finer-grained and has higher clay content than the sediments in the Main Basin and ranges in depth from 25 feet to 1,300 feet (CH2MHill, 1997). Water-bearing sediments range in thickness between 70 and 120 feet throughout most of the basin but increase in thickness toward the west (maximum thickness of about 500 feet near the boundary with the Main Basin (Engineering Science, Inc, 1979; Ecological Systems Corporation, 1975). Well depths range from about 75 feet to 300 feet in the Puente Basin (Engineering Science, Inc, 1979). Total storage within the Puente Basin has been estimated to be approximately 979,650 AF (Engineering Science Inc, 1979).

Safe Yield/Long-Term Balance of Recharge and Discharge

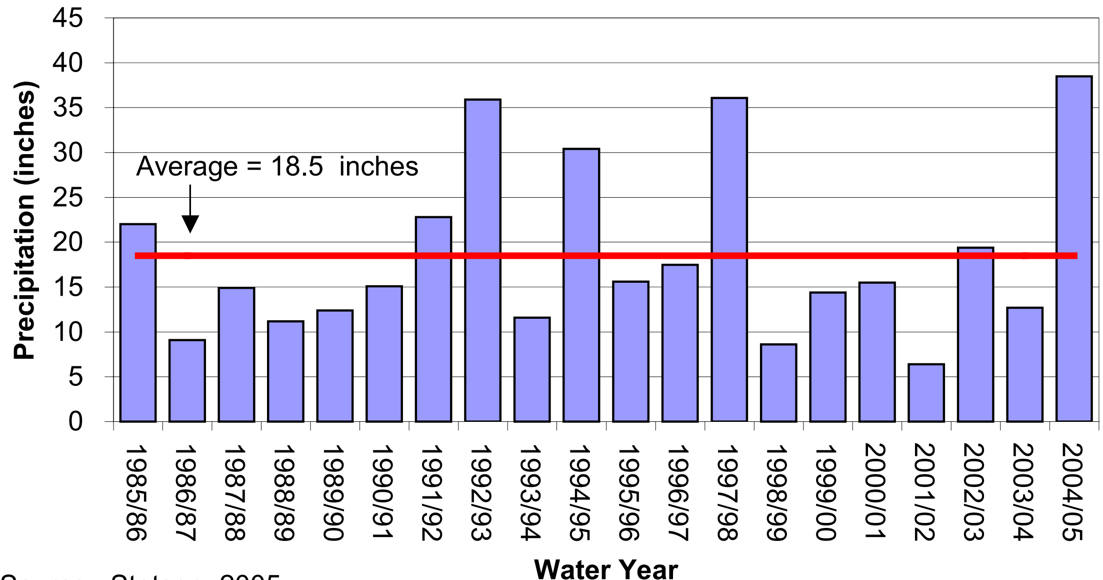
The natural sources of recharge and long-term balance for the Main San Gabriel and Puente Basins are discussed separately in the following section.

Main San Gabriel Basin

The major sources of natural recharge to the Main San Gabriel Basin are infiltration of rainfall on the valley floor and percolation of runoff from the adjacent mountains. Historical precipitation in the Main San Gabriel Basin is summarized in **Figure 7-2**. The average precipitation over the past 20 years is approximately 18.5 inches. The basin also receives imported water and return flow from applied water.

According to the Main San Gabriel Basin Judgment (discussed below), the natural safe yield of the Main San Gabriel Basin is defined as 152,700 AFY (Main San Gabriel Basin Judgment, 1989).

Figure 7-2
Historical Precipitation in the Main San Gabriel Basin



Source: Stetson, 2005

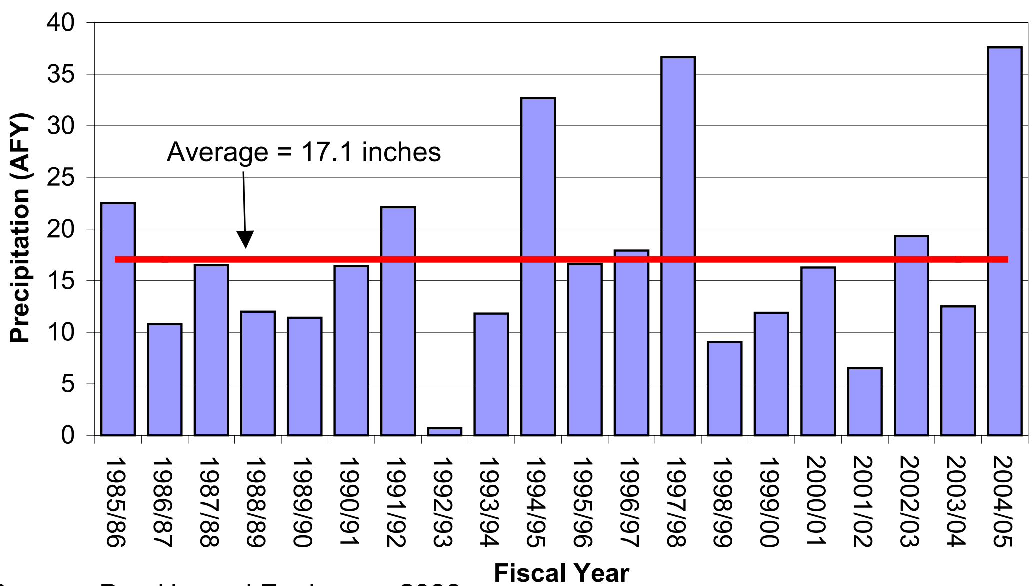
The Operating Safe Yield (OSY) is the quantity of water that the Main San Gabriel Basin Watermaster (Watermaster) determines may be pumped from the Basin in a fiscal year, without Replacement Water assessments. Watermaster considers a wide range of data in setting the OSY, including provisions of the Main San Gabriel Basin Judgment, key well water level, current hydrologic conditions in the basin such as precipitation, storage of local runoff in surface reservoirs, conservation of local runoff, amount of water in cyclic storage accounts, carryover rights and others. In accordance with the Main San Gabriel Basin Judgment, Watermaster at its regular meeting in May of each year determines the OSY applicable to the succeeding fiscal year (July 1 through June 30) and estimates the OSY for the next succeeding four fiscal years. On May 11, 2005, Watermaster adopted an OSY of 240,000 AF for fiscal year 2005-06 and an estimated OSY of 210,000 AF for fiscal year 2006-07.

Since 1975, Watermaster has used cyclic storage accounts to store imported water against future replenishment requirement. Three current cyclic storage accounts (Metropolitan Water District on behalf of its member agencies (140,000 AF) and San Gabriel Valley Municipal Water District (40,000 AF), totaling 180,000 AF of potential water storage capacity are maintained for providing supplemental water to the basin. These accounts allow delivery of imported water when it is available and the water is stored in the basin for sale to Watermaster at a later date.

Puente Basin

The major sources of natural recharge to the Puente Basin are infiltration of rainfall on the valley floor and percolation of runoff from the adjacent mountains. In addition, water is imported into the basin from the Pomona Water Reclamation Plant (recycled water) and from Metropolitan via the Rowland and Walnut water districts (CH2MHill, 1997). Historical precipitation in the Puente Basin is summarized in **Figure 7-3**. The average precipitation over the past 20 years has been approximately 17.1 inches, lower than the long-term average of about 18 inches per year. The basin also receives imported water and return flows from applied water.

Figure 7-3
Historical Precipitation in the Puente Basin



Source: Don Howard Engineers, 2006

According to the Puente Basin Judgment (discussed below), the declared safe yield of the Puente Basin is 4,400 AFY (Puente Basin Judgment, 1986). However, the basin is managed on the basis of Operating Safe Yield determined annually by the Watermaster and has averaged 1,666 AFY since 1988.

The Operating Safe Yield (OSY) is the quantity of water that the Puente Basin Watermaster (Watermaster) determines may be pumped from the basin in a fiscal year. Watermaster determines the OSY in consideration of five factors specified in the Judgment: water levels, Puente Narrows Agreement, subsurface flows, cost of availability of alternate sources of water, and groundwater pumping. In accordance with the Puente Basin Judgment, Watermaster makes the preliminary determination of OSY by the first Monday in April for upcoming fiscal year and estimates the OSY for the next succeeding four fiscal years. On April 27, 2006, Watermaster adopted an OSY of 1,530 AF for fiscal year 2006-07 and an estimated OSY of 1,500 AF for the subsequent four years.

GROUNDWATER MANAGEMENT

The following section describes how the Main San Gabriel and Puente Basins are currently managed. This includes a discussion of the governing structure and relationship with adjoining basins.

Basin Governance

The following section describes the governing structure and adjudication of the Main San Gabriel and Puente Basins. A summary of the agencies contributing to the management of each basin is provided in **Table 7-2.**

Main San Gabriel Basin

The Main San Gabriel Basin is an adjudicated basin. On January 4, 1973, after extensive negotiations, a stipulated Judgment in this case was entered (Main San Gabriel Basin Judgment) that created Watermaster, governing body and specified a program for management of water in the Main Basin. Since the Main San Gabriel Basin Judgment was originally entered, there have been subsequent amendments to it that extend and clarify Watermaster's role.

The Watermaster is a nine-person board appointed by the Los Angeles County Superior Court that administers and enforces the provisions of the Main San Gabriel Basin Judgment, which established water rights and responsibility for efficient management of the quantity and quality of the Basin’s groundwater. The Watermaster manages and controls the withdrawal of groundwater/surface water and replenishment of imported water supplies in the basin and determines the amount that can be safely extracted. The Watermaster coordinates imported water deliveries and recharge. Watermaster coordinates local involvement in efforts to preserve and restore the quality of groundwater in the basin. The Watermaster assists and encourages regulatory agencies to enforce water quality regulations affecting the basin; collects production, water quality, and other relevant data from producers; prepares an annual report of pumping and diversions; and a Five Year Plan to address water quality management.

The Main San Gabriel Basin Judgment allows a producer to pump or divert more water than its share, but the producer must pay for replenishment water for any amount produced above its water rights. Producers can carryover up to 100 percent of their water rights for only one year.

Any entity, public or private, desiring to spread and store supplemental water within the basin for subsequent recovery and use for Watermaster credit must have a cyclic storage agreement pursuant to Watermaster's Rules and Regulations. Cyclic storage agreements are for a term of five years and may extend for additional terms, not to exceed five years. The cyclic storage agreement notes the maximum amount of supplemental water that may be stored at any point in time by a particular storing entity.

Table 7-2
Summary of Management Agencies in the Main San Gabriel and Puente Basins

Agency	Role
Main San Gabriel Basin	
Main San Gabriel Basin Watermaster	Court appointed Watermaster to manage water quantity/quality; coordinate U.S. EPA Operable Unit cleanup.
Upper San Gabriel Valley Municipal Water District	Delivery of Supplemental Water
Three Valleys Municipal Water District	Delivery of Supplemental Water
San Gabriel Valley Municipal Water District	Delivery of Supplemental Water
County of Los Angeles, Department of Public Works (LACDPW)	Recharge local runoff/supplemental water
San Gabriel Basin Water Quality Authority	Obtain funding for Basin clean up activities
San Gabriel River Watermaster	Calculates credits/debits between Main San Gabriel Basin and Central Basin
Puente Basin	
Puente Basin Watermaster	Appointed by the Principal Parties to the Judgment to determine the annual Operating Safe Yield and Annual Pumping Rights and components.
Puente Narrows Watermaster	Calculates credits/debits between Puente Basin and Main Basin.
Los Angeles County Department of Public Works	Monitors water levels in Puente Basin
Los Angeles Regional Water Quality Control Board	Oversees clean-up in Puente Basin of groundwater contamination
U.S. Environmental Protection Agency	Oversees remediation of Puente Valley Operable Unit component of the San Gabriel Valley Superfund Site.
Three Valleys Municipal Water District	Delivery of supplemental imported water
County Sanitation Districts of Los Angeles County	Provider of recycled water for landscape irrigation.
Walnut Valley Water District Rowland Water District	Puente Basin water quality sampling since 1992

Puente Basin

The Puente Basin was adjudicated in 1986. Under the Judgment, a management plan was executed by the Principal Parties to the Judgment and is administered by a three-person Watermaster. The three Watermasters are nominated and appointed by the Principal Parties according to directives of the Judgment. The Judgment specifies the duties of the Watermaster to include determining Operating Safe Yield and notifying the Court and Principal Parties of Annual Pumping Rights and components thereof. Import return flow credits are calculated separately from Operating Safe Yield. The Judgment provides for up to 100 percent carryover of unpumped water rights for one year, up to 10 percent excess pumping, restricts exportation of groundwater, and makes no provisions for storage of surplus supplies within the groundwater basin.

Interactions with Adjoining Basins

The Long Beach Judgment (City of Long Beach v. San Gabriel Valley Water Company) guarantees the Lower Area (Central and West Coast Basin) an average annual water supply of approximately 98,000 AFY through Whittier Narrows and is administered by the three-person court appointed San Gabriel River Watermaster. As part of that Judgment, subsurface flow from the Main San Gabriel Basin into Central Basin is calculated and is included in the determination of usable water provided to Lower Area.

Subsurface outflow from the Puente Basin into the Main San Gabriel Basin is governed and calculated pursuant to the provisions of the Puente Narrows Agreement between Puente Basin Water Agency (comprised of Walnut Valley Water District and Rowland Water District) and Upper San Gabriel Valley Municipal Water District. The Puente Narrows Agreement is Exhibit F to the Puente Basin Judgment. The Agreement calls for an average Base Underflow of 580 acre-feet per year from Puente Basin to the Main San Gabriel Basin, with credits and debits accumulating. Credit is also given to the Puente Basin Water Agency for pumping associated with some water quality clean-up operations pursuant to the Clean-Up Production Agreement that discharge treated water to the concrete-lined San Jose Creek.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Main San Gabriel and Puente basins. Key storage and extraction facilities include more than 300 production wells and associated facilities and 17 spreading basins for groundwater recharge.

Municipal Production Wells

Table 7-3 provides a summary of the production wells in the Main San Gabriel and Puente basins.

Main San Gabriel Basin

In the Main San Gabriel Basin, there are 305 wells in the basin (250 active wells and 55 inactive wells). About 10 of these wells (less than 3 percent) are projected to be replaced or rehabilitated in the next 5 years (Stetson, 2006). Historical production in the Main San Gabriel Basin is summarized in **Figure 7-4**. Between fiscal years 1985/86 and 2004/05, production ranged from about 224,000 AFY to 283,000 AFY with an average of 255,525 AFY. The groundwater production exceeded the operating yield, which has ranged from 140,000 AFY to 240,000 AFY during the same period. Therefore, producers must provide for replacement water.

Table 7-3
Summary of Production Wells in the Main San Gabriel and Puente Basins

<table>
<tr><th>Category</th><th>Number of Wells</th><th>Estimated Production Capacity (AFY)</th><th>Average Production 1985-2004 (AFY)</th><th>Well Operation Cost ($/AF)</th></tr>
<tr><td>Main San Gabriel Basin</td><td></td><td rowspan="4">~500,000 AFY (active wells) [1]
~80,000 AFY (inactive wells)</td><td rowspan="4">255,525</td><td rowspan="4">$85
Power
$1.74
Disinfection
$2.50
O&M
Total [2]
$89.24</td></tr>
<tr><td>Municipal</td><td>250</td></tr>
<tr><td>Other</td><td>55</td></tr>
<tr><td>Total Main San Gabriel Basin</td><td>305</td></tr>
<tr><td>Puente Basin
Non-potable-supply</td><td>5</td><td>300 to 600 gpm</td><td>905</td><td></td></tr>
</table>

Notes: 1 Stetson, 2006
2 Does not include treatment costs

Puente Basin

There are five production wells in the Puente Basin. (Don Howard Engineers, December 2006). Due to the poor quality of the Puente Basin groundwater, groundwater is used for non-potable purposes including blending with reclaimed water, construction water, and irrigation (Puente Watermaster, April 2006). Historical production in the Puente Basin is shown in **Figure 7-5**.

Figure 7-4
Historical Groundwater Production in the Main San Gabriel Basin

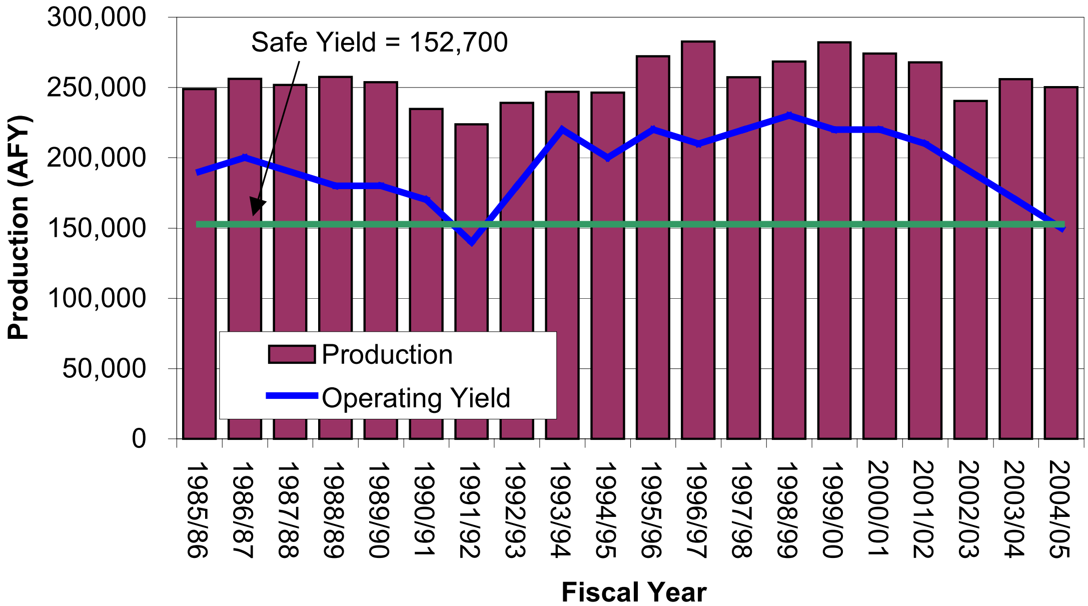
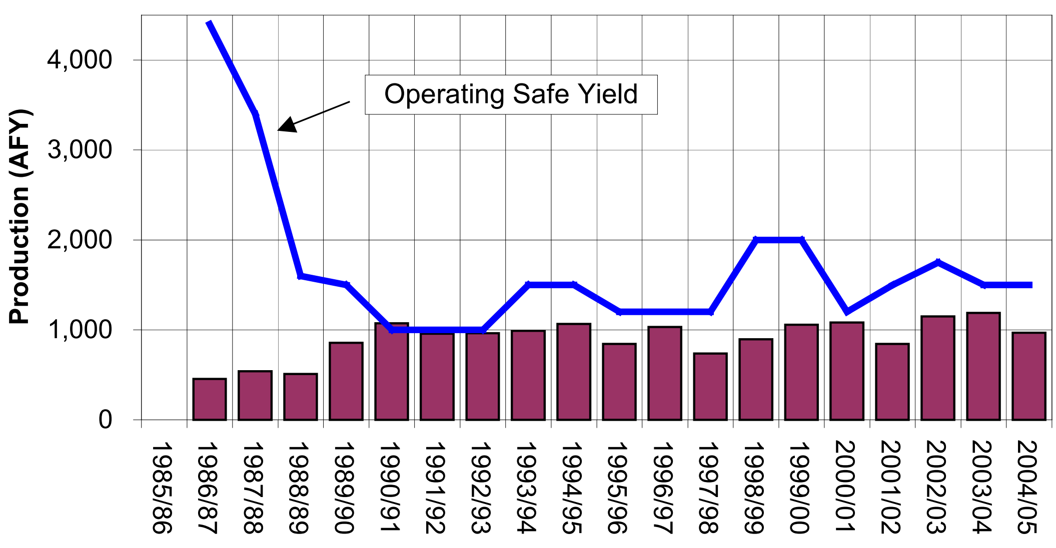


Figure 7-5
Historical Groundwater Production in the Puente Basin



Source: Don Howard Engineers, 2006

Other Production

There are approximately 55 non-municipal wells in the Main San Gabriel Basin. Approximately 50 percent of the non-municipal production is for agricultural purposes and nearly 50 percent is for either industrial or domestic purposes (Stetson, 2006).

ASR Wells

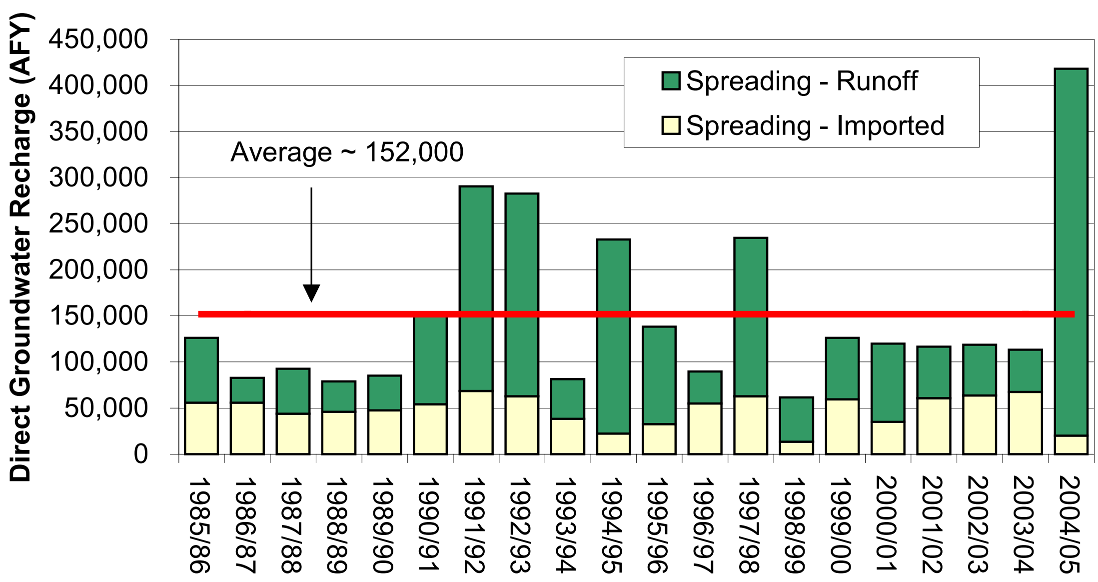
There are no ASR wells in the Main San Gabriel and Puente Basins.

Spreading Basins

Main San Gabriel Basin

There are currently 17 spreading basins, covering more than 1,100 acres, either operated by LACDPW or other agencies that are capable of capturing stormwater runoff from the adjacent canyons or imported water. The details of these facilities are summarized in **Table 7-4**. The historical recharge data are presented in **Figure 7-6**.

Figure 7-6
Historical Groundwater Recharge in the Main San Gabriel Basin



Source: Stetson, 2006

LACDPW spreads imported water from Metropolitan and SGVMWD in the San Gabriel Valley on behalf of the SGVMWD, Upper San Gabriel Valley Municipal Water District, and the Three Valleys Municipal Water District. The spreading capacity of the existing facilities is more than 600,000 AFY. However, the amount of imported water that can be spread is limited because space in the basins must be reserved for the capture of runoff during storm events. Between fiscal years 1985/86 and 2004/05, from 62,000 and

417,000 AFY, with an average of approximately 152,000 AFY was recharged in the Main San Gabriel Basin.

Table 7-4
Summary of Spreading Basins in the Main San Gabriel Basin

Spreading Basin	Area (acres)	Wetted Area (acres)	Recharge Capacity (cfs)	Recharge Capacity (AFY)	Source Water	Owner
Ben Lomond	24	17	30	21,681	Runoff	LACDPW
Big Dalton	24	8	12	8,672	Runoff	LACDPW
Buena Vista	10	6	6	4,336	Runoff	LACDPW
Citrus	19	15	28	20,236	Runoff	LACDPW
Eaton Basin	16	10	10	7,227	Runoff	LACDPW
Fish Canyon	6	4	7	5,059	Runoff	California-American Water Company
Forbes	21	10	5	3,614	Runoff Imported	LACDPW
Irwindale/Manning	62	30	60	43,362	Runoff Imported	LACDPW
Little Dalton	14	5	15	10,841	Runoff Imported	LACDPW
Peck Road	157	105	25	18,068	Runoff	LACDPW
San Dimas Canyon	22	11	12	8,672	Runoff	LACDPW
San Gabriel Canyon	165	140	50	36,135	Runoff Imported	LACDPW
San Gabriel River	196	196	180	130,086	Runoff Imported	LACDPW
Santa Fe	338	168	400	289,080	Runoff Imported	LACDPW
Sawpit	12	4	12	8,672	Runoff	LACDPW
Valley Rubber Dam	60	60	0	0	Runoff Imported	LACDPW
Walnut	16	8	5	3,614	Runoff	LACDPW
Total	**1162**	**797**	**857**	**619,355**		

Source: LACDPW, 2006

Puente Basin

There are no spreading basins in Puente Basin.

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Main San Gabriel and Puente Basins.

Desalters

There are no desalters in the Main San Gabriel and Puente Basins.

GROUNDWATER LEVELS

The following section provides a description of groundwater levels in the Main San Gabriel and Puente Basins.

Main San Gabriel Basin

As shown in **Figure 7-7**, groundwater flow in the Main San Gabriel Basin is generally from the east to the west across the basin and southward into the Central Basin. In addition, groundwater typically flows northward from the Puente Basin into the Main San Gabriel Basin. Current groundwater levels range from about 1,200 feet MSL in the east portion of the basin along the San Gabriel Mountains to 110 feet MSL in the Alhambra area (referred to as the Alhambra pumping hole).

A key well located in Baldwin Park is used as an indicator of the amount of water in storage. As shown in **Figure 7-8**, the typical basin operating range is for basin water levels between 200 and 250 feet MSL. As discussed above, imported water cannot be spread when the key well groundwater level is above 250 feet. After reaching a historic low water level of 195.5 feet MSL in December 2004, water levels increased in the Baldwin Park key well to 251 feet MSL in June 2005. Water level in April 2006 was approximately 246 feet MSL.

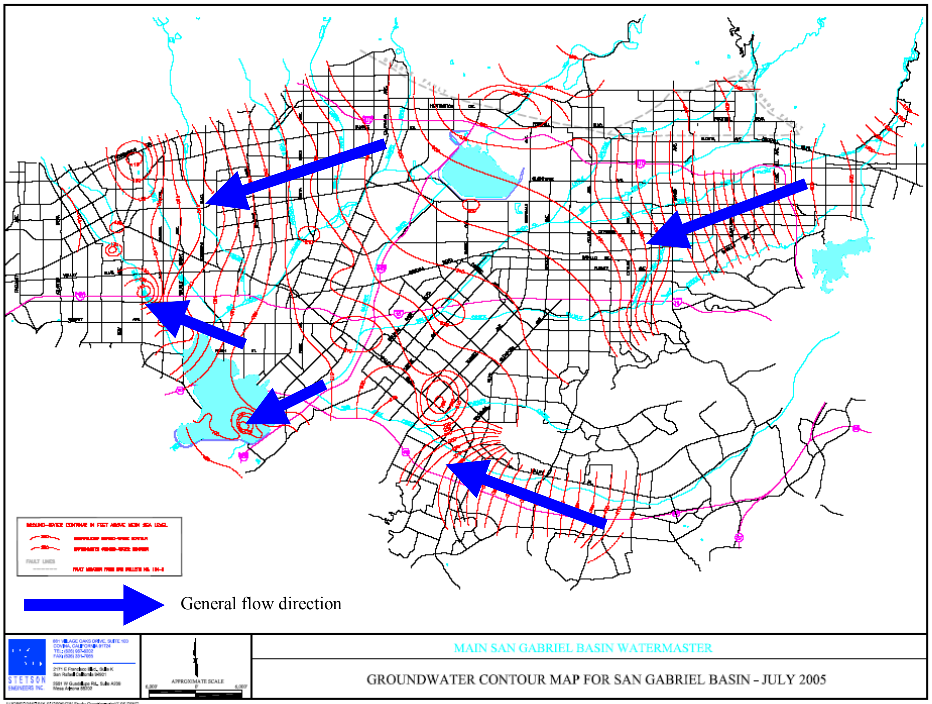
Puente Basin

Groundwater movement within the Puente Basin is generally controlled by topographic highs (i.e. The surrounding hills). Faults that may potentially affect groundwater movement have not been identified within the Puente Basin (CH2MHill, 1997). Because the Puente Basin is constrained on the north and south by bedrock, groundwater generally flows toward the west and northwest. As shown in **Figure 7-9**, water levels have been relatively stable-in the Puente Basin since 1985 with an overall fluctuation of less than 25 feet.

GROUNDWATER QUALITY

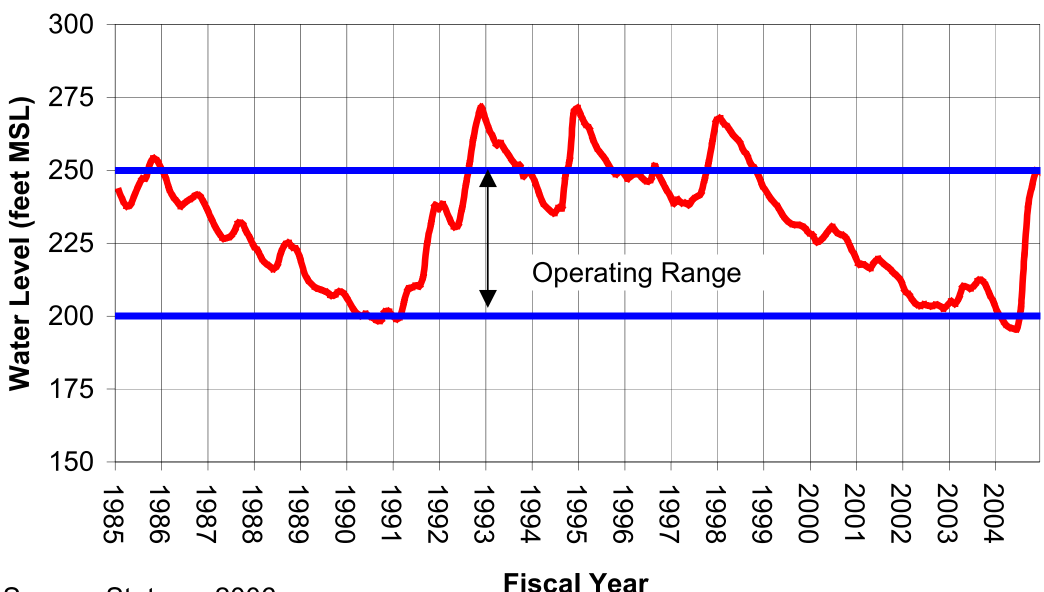
The following section provides a brief description of the groundwater quality issues in the Main San Gabriel and Puente Basins.

Figure 7-7
Groundwater Contour Map of the Main San Gabriel and Puente Basins – Summer 2005



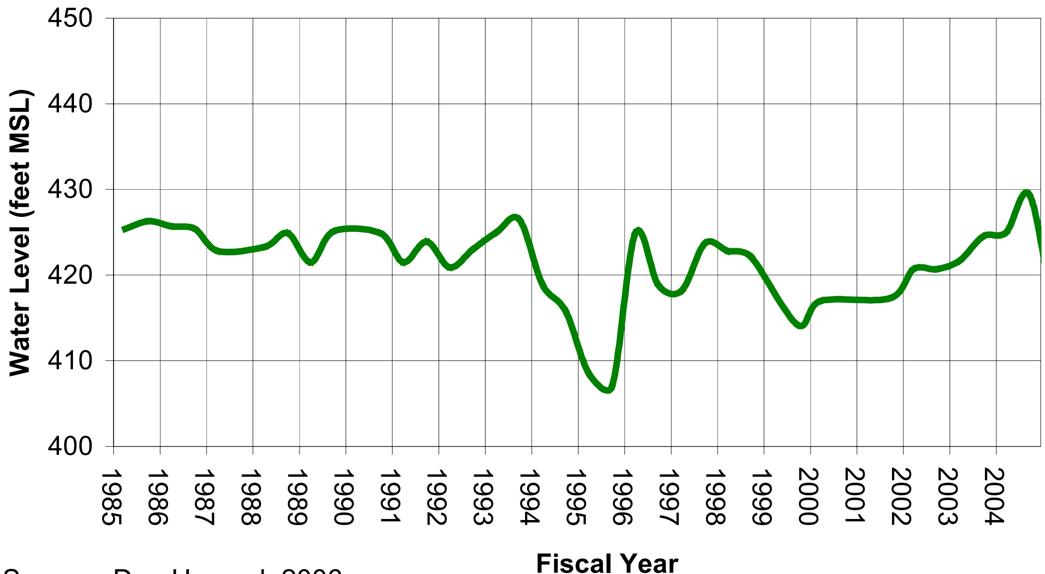
Source: Stetson, 2006

Figure 7-8
Historical Water Levels in the Main San Gabriel Basin



Source: Stetson, 2006

Figure 7-9
Historical Water Levels in the Puente Basin



Source: Don Howard, 2006

Groundwater Quality Monitoring

The Main San Gabriel Basin Watermaster currently coordinates the Title 22 sampling of approximately 200 active wells in the basin. In addition, groundwater quality is monitored by Watermaster at least once per year for nitrate and volatile organic compounds (VOCs) as part of the Basinwide Ground Water Quality Monitoring Program. The project is designed to facilitate the coordination of existing monitoring done by other agencies under one comprehensive program.

In the Puente Basin, general water quality was monitored by the Los Angeles County Department of Public Works for 1986 and ending in 1992. Since then, water quality monitoring has been performed by Walnut Valley Water District and Rowland Water District. Walnut Valley Water District quarterly monitors and reports total dissolved solids (TDS) concentrations, and Rowland Water District analyzes for a wider range of water quality constituents. The data are reported in the Puente Basin Watermaster's annual report.

Groundwater Contaminants

Table 7-5 provides a summary of groundwater constituents of concern for Main San Gabriel and Puente Basins.

Table 7-5
Summary of Constituents of Concern in the Main San Gabriel and Puente Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	Main Basin: 90 to 4,288 Average ~ 367	Main Basin: Data from municipal production wells indicate a range of 172 to 914 mg/L with an average of 318 mg/L.
		Puente Basin: 1,100	Puente Basin: as measured at Rowland Water District well.
Nitrate (as N) MCL = 10	mg/L	Main Basin: ND to 27.8	Main Basin: Exceed nitrate MCL in eastern portion of basin.
		Puente Basin: 8.44	Puente Basin: as sampled by Rowland Water District
VOCs **(TCE and PCE)** TCE MCL = 5 PCE MCL = 5	μg/L	Main Basin: ND to 499 for TCE ND to 330 for PCE	Main Basin: 64 wells are currently treated for a variety of VOCs associated with prior land use in the basin. Much of the basin is unaffected.
		Puente Basin: TCE: ND to 28 PCE: ND to 4.7	Puente Basin: To be addressed by Superfund cleanup of Puente Valley Operable Unit overseen by USEPA. Concentrations reported in remedial design progress report Aug 2006.
Perchlorate Notification level = 6	μg/L	Main Basin: ND to 183	Main Basin: In January 2002, 22 wells were removed from service due to unacceptable levels of perchlorate. Perchlorate treatment facilities are currently online.
		Puente Basin: ND	Puente Basin: as measured at Rowland WD well

Table 7-5 (continued)
Summary of Constituents of Concern in the Main San Gabriel and Puente Basins

Constituent	Units	Range	Description
NDMA Notification level = 2	ppt	Main Basin: ND to > 2 ppt	Main Basin: During 1998, eight local wells were found to contain levels of NDMA above the action level of 2 ppt. Three facilities are currently in operation to treat NDMA.
		Puente Basin: ND	Puente Basin: as measured at Rowland WD well

Sources: Main San Gabriel BasinWatermaster, 2004 and DWR, 2004
Puente Basin Watermaster, September, 2006.
GeoTrans, Inc., August 10, 2006

Main San Gabriel Basin

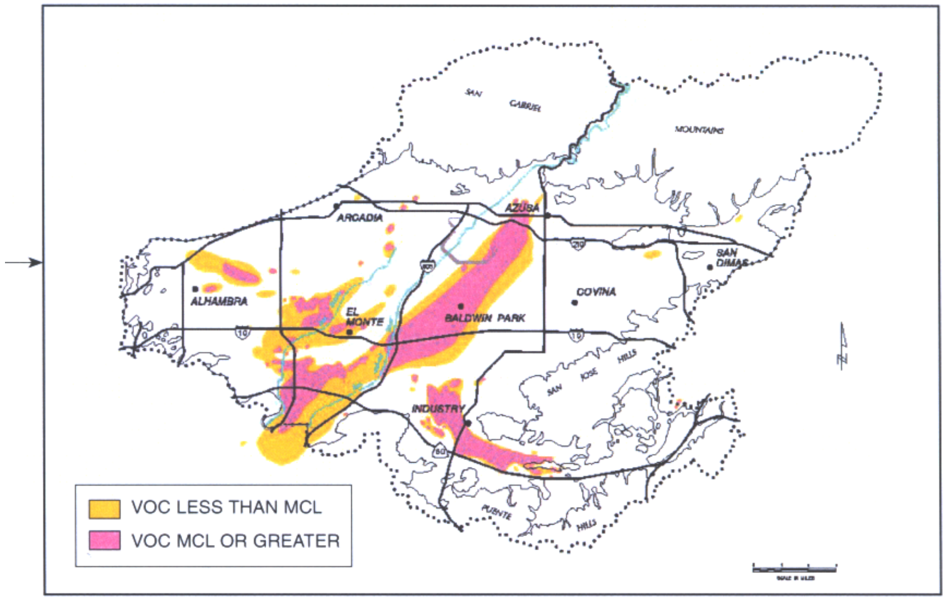
Water quality within the Main San Gabriel Basin is good in most areas. TDS concentrations range from 90 to 4,288 mg/L and average about 367 mg/L in the Main San Gabriel Basin (DWR, 2004). Concentrations in the Puente Basin average above 1,200 mg/L (DWR, 2004). Key constituents of concern for the Main San Gabriel Basin are summarized in **Table 7-5**. These constituents include: TDS, nitrate, VOCs, perchlorate and NDMA.

During the late 1970s and early 1980s, significant groundwater contamination associated with various VOCs was discovered in the Main San Gabriel Basin. The USEPA established Operable Units for areas within the basin that have been contaminated by VOCs and require groundwater cleanup (defined as Area 3, Whittier Narrows, Puente, Baldwin Park, El Monte and South El Monte Operable Units). Cleanup operations are currently underway in Whittier Narrows, Puente, Baldwin Park, El Monte and South El Monte Operable Units. A remedial investigation to identify the extent of contamination is currently underway in the Area 3 Operable Unit. VOC concentrations are shown in **Figure 7-10**.

Nitrate is also an issue for the Main San Gabriel Basin. As shown in **Figure 7-11**, nitrate concentrations exceed the nitrate MCL in eastern portion of basin. Water contaminated with nitrates is either blended with other sources or not used (Watermaster, 2004).

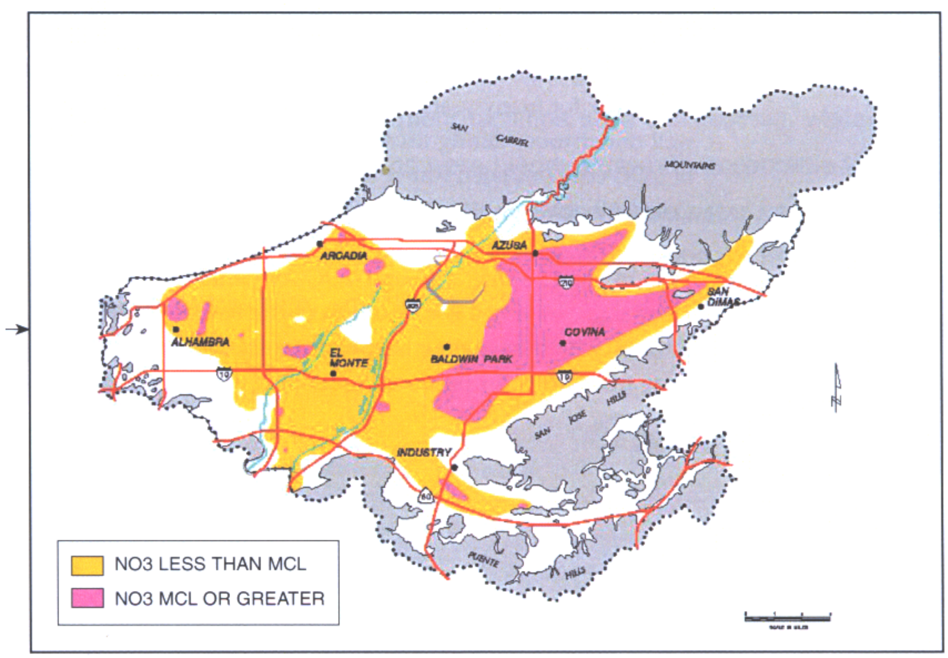
In addition to VOCs and nitrate, perchlorate and NDMA have been detected in concentrations above applicable notification levels in wells from the Main San Gabriel Basin. In January 2002, 22 wells were removed from service due to unacceptable levels of perchlorate. Perchlorate treatment facilities are currently online. During 1998, eight local wells were found to contain levels of NDMA above the action level of 2 ppt. Three facilities are currently in operation to treat NDMA.

Figure 7-10
Location of VOC Plumes in the Main San Gabriel and Puente Basins



Source: Main San Gabriel Basin Watermaster, 2004

Figure 7-11
Location of Nitrate Plumes in the Main San Gabriel and Puente Basins



Source: Main San Gabriel Basin Watermaster, 2004

Puente Basin

The western portion of the Puente Basin in the vicinity of the Puente Narrows lies within the U.S. Environmental Protection Agency's Puente Valley Operable Unit of the San Gabriel Valley Superfund Site. The cleanup of the Puente Valley Operable Unit will involve cleanup of VOCs including TCE and PCE within the shallow groundwater. As of August 2006, remediation wells had been drilled and design of the remedial action was underway. Remediation of other VOC leaks in the Puente Basin are overseen by the Los Angeles Regional Water Quality Control Board.

Blending Needs

As discussed above, many wells in the Main San Gabriel Basin are blended to meet nitrate standards. Due to the high TDS of Puente Basin groundwater, Puente Basin groundwater is blended with recycled water to allow its use for landscape irrigation.

Groundwater Treatment

The following section describes groundwater treatment activities in the Main San Gabriel basin. As shown in Table 7-6, about 93 wells are currently treated for VOCs, perchlorate or NDMA with a total treatment volume of about 79,000 AFY (about 30 percent of the total produced groundwater). Nearly 490,000 AF has been treated for VOCs as part of the USEPA cleanup since 1984 (Watermaster, 2005a).

EXISTING GROUNDWATER STORAGE PROGRAMS

In the Main San Gabriel Basin, three current cyclic storage accounts (Metropolitan Water District on behalf of its member agencies and San Gabriel Valley Municipal Water District), totaling 180,000 AF of potential water storage capacity are maintained for providing supplemental water to the basin. These accounts allow delivery of imported water when it is available and the water is stored in the basin for sale to Watermaster at a later date. Metropolitan pre-delivers replenishment water to Main San Gabriel Basin. Metropolitan later sells stored water to Three Valleys Municipal Water District and Upper District at replenishment rate. The cyclic storage balance at the end of fiscal year 2004/05 was approximately 91,000 AF (Watermaster, 2005a).

There are no existing storage programs in the Puente Basin.

BASIN MANAGEMENT CONSIDERATIONS

The following section identifies issues or considerations that are important for groundwater management in the Main San Gabriel and Puente Basins.

Table 7-6
Summary of Groundwater Treatment in Main San Gabriel Basin

Treatment Type	Number of Wells	Constituents(s) of Concern	Treatment Target	Treatment Cost ($/AF)	Amount Treated (AFY)
Air Stripping	39	VOCs	ND	$25	47,000
Liquid Phase GAC	16	VOCs	ND	Varies	14,000
Ultra-Violet/Oxidation	9	1,4-Dioxane	ND	$100	6,000
Ion Exchange	17	Perchlorate	ND	$200	6,000
Ultra-Violet	12	NDMA	ND	$100	6,000
Total	**93**	**--**	**ND**	**--**	**79,000**

Source, Stetson, 2006.

Main San Gabriel Basin

Storage and extraction in the Main San Gabriel Basin are limited by the following factors.

- Pumping subject to adjudication and limits the amount of water that could be produced.
- Cannot store supplemental imported water when the key well groundwater elevation exceeds 250 feet MSL. Water levels at this time are near or above the target level. Therefore, storage of supplemental water is currently limited.
- Must have a cyclic storage agreement with Watermaster to store supplemental imported water
- Perchlorate and various chlorinated solvent contaminants associated with the USEPA operable units may limit ability to store and extract water.
- Nitrate concentrations in eastern portion of the Basin may limit ability to store and extract water.

Puente Basin

Storage and extraction in the Puente Basin are limited by the following factors.

- Pumping subject to adjudication and limits the amount of water that could be produced
- The Puente Basin Judgment does not provide for storage of surplus water supplies for later extraction.

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Main San Gabriel Basin

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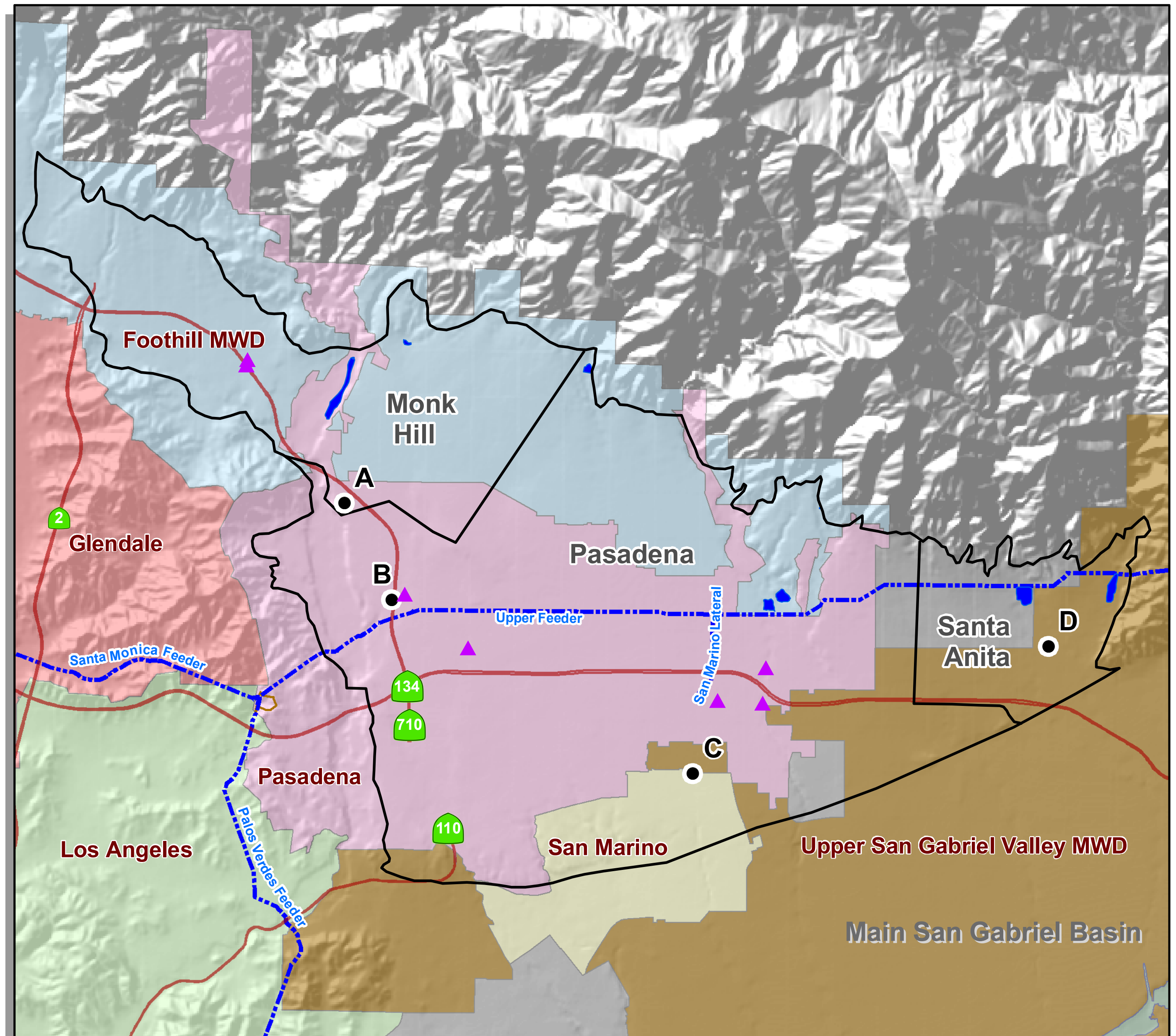
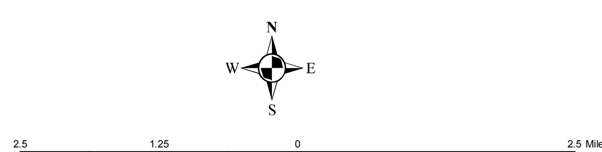


Raymond Basin

- A ● Key Wells
- ▲ Injection-ASR Wells
- Recharge Basins
- Freeways (TBM)
- Water Body
- MWD Pipeline
- ▲ MWD Facility
- Basin
- MWD Member Agency Boundary (color varies)



Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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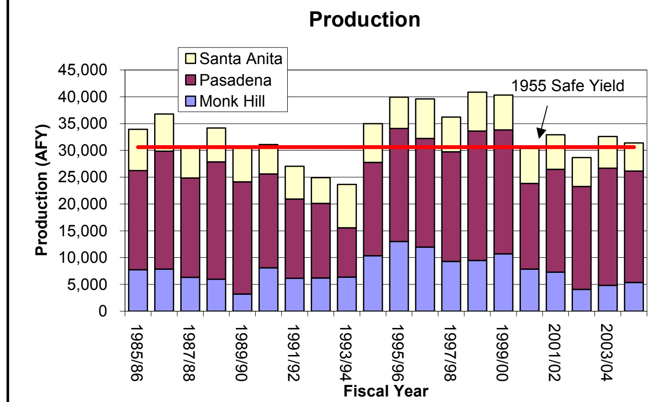
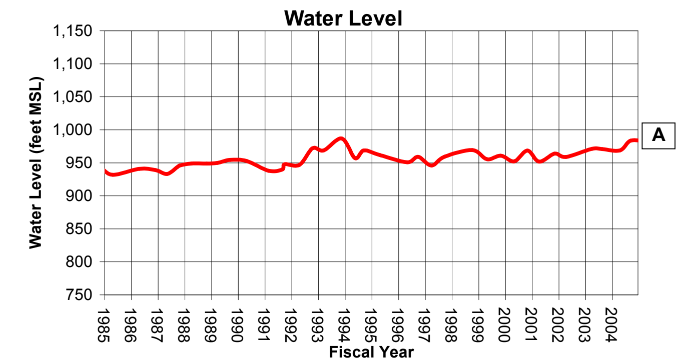
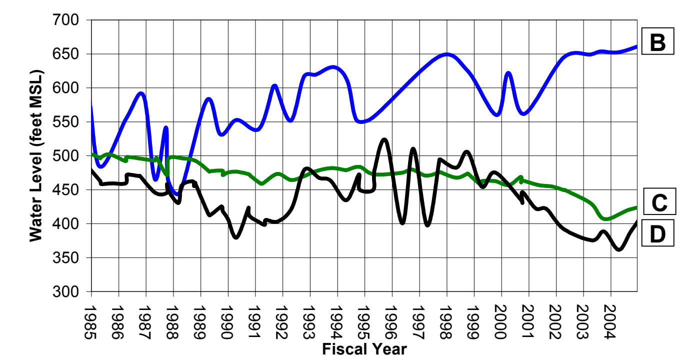
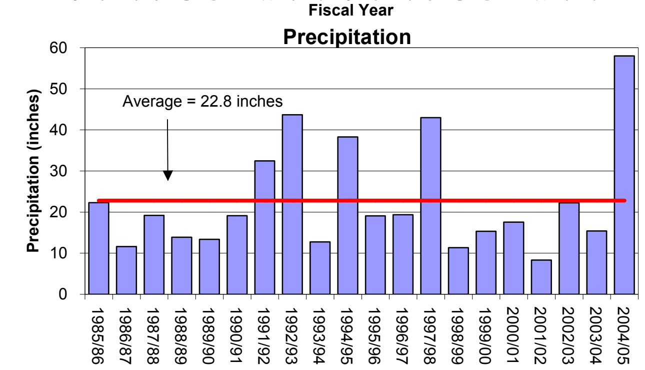
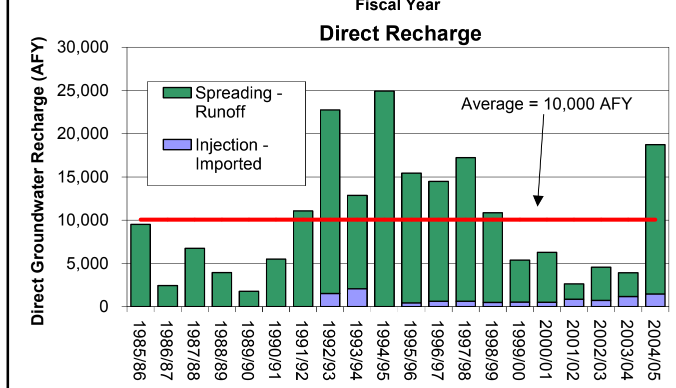
Additional Data Source(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).











BASIN FACTS

Raymond Basin

Description
Location: Los Angeles County
Watershed Surface Area: 40 square miles
Subbasins:
Monk Hill
Pasadena
Santa Anita
Management: Adjudicated
Adjudicated in 1955 and managed by the Raymond Basin Management Board
MWD Member Agencies:
Foothill MWD
City of San Marino
City of Pasadena
Upper San Gabriel Valley MWD

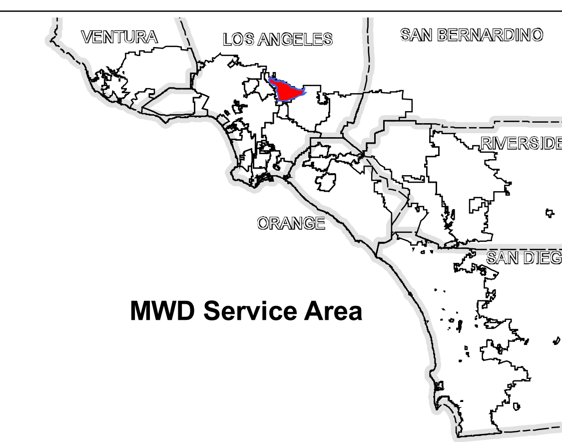
	Monk Hill	Pasadena	Santa Anita
Safe Yield	7,489 AFY	17,843 AFY	5,290 AFY
Total Storage		1.37 million AF	
Unused Storage Space (2003)		570,000 AF	
Portion of Unused Storage Space Available (2003)		At least 250,000 AF	

Storage and Extraction Facilities

	Monk Hill	Pasadena	Santa Anita
Production Wells			
Production Capacity	17,500 AFY	72,500 AFY	7,600 AFY
Average 1985-2004	8,065 AFY	18,588 AFY	6,315 AFY
Injection Wells			
Injection Capacity	2,500 AFY	8,000 AFY	None
Average 1985-2004	263 AFY	181 AFY	None
Spreading Basins			
Spreading Capacity	13,000 AFY	10,100 AFY	14,400 AFY
Average 1985-2004	4,654AFY	3,570 AFY	1,279 AFY

Basin Management Considerations

- The Judgment limits the amount of groundwater that a party may extract from the Basin each year.
- Storage space is allocated by producer and must be approved by Raymond Basin Management Board.
- Perchlorate, VOC and nitrate cotamination could limit ability to store and extract water.



MWD Service Area

Plate 8-1
Overview of Raymond Basin

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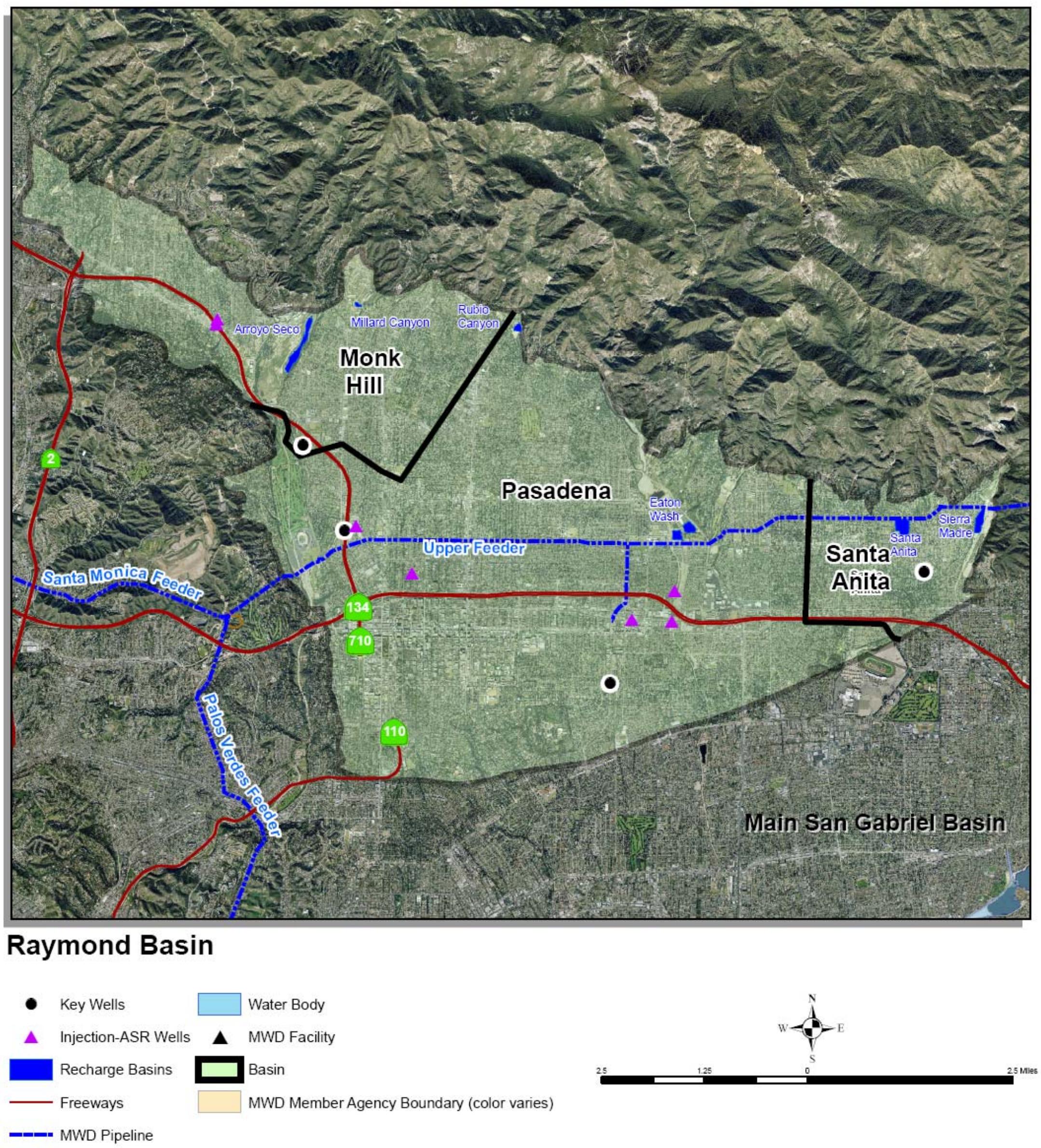
The Raymond Basin is located in the northwestern portion of the San Gabriel Valley in Los Angeles County. The Raymond Basin includes the communities of Sierra Madre, Arcadia, Pasadena, La Cañada Flintridge and unincorporated areas of Los Angeles County, and includes 16 separate water purveyors. The Raymond Basin underlies the service areas of the Metropolitan member agencies of Foothill Municipal Water District (Foothill MWD), Upper San Gabriel Valley Municipal Water District (Upper District), City of Pasadena and City of San Marino. The City of Sierra Madre is a member agency of San Gabriel Valley Municipal Water District, a State Water Project Contractor. A map of the basin is provided in **Figure 8-1**.

Figure 8-1
Map of the Raymond Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Raymond Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The Raymond Basin is bounded by the San Gabriel Mountains to the north, the San Rafael Hills to the west and the Raymond fault to the south and southeast. The Raymond Basin is divided into three subareas because of differences in elevation and groundwater flow directions (Monk Hill in the northwest, Pasadena in the central portion, and Santa Anita in the eastern portion).

Hydrogeologic data are provided in **Table 8-1**. The Raymond Basin is generally classified as an unconfined to semi-confined aquifer system. The base of the water bearing zones is considered bedrock with elevations ranging from approximately 500 feet below sea level to 2,000 feet above mean sea level. Depth to bedrock ranges from 450 to 750 feet below ground surface (bgs) in the Monk Hill and Santa Anita subareas to more than 1,200 feet bgs in the Pasadena subarea/central portion of the Raymond Basin. The total storage capacity of the Raymond Basin is estimated to be approximately 1.37 million AF (Geoscience, 2004). Amount of water in storage in 2003 was approximately 800,000 AF, with an unused storage space of about 570,000 (Geoscience, 2004).

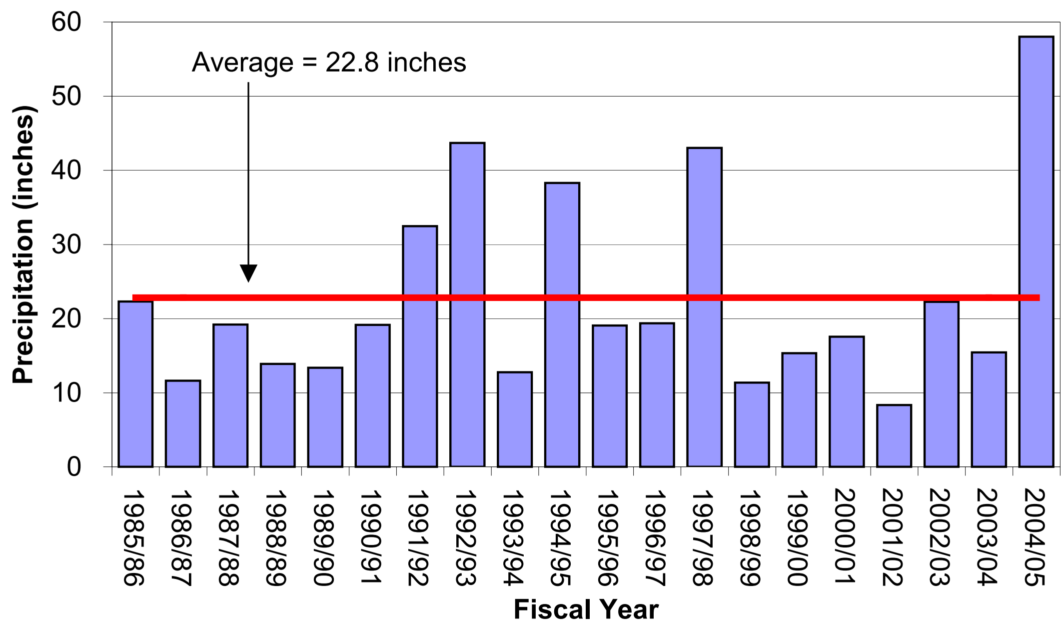
Table 8-1
Summary of Hydrogeologic Parameters of Raymond Basin

Parameter	Description
Structure	
Aquifer(s)	Unconfined to semi-confined
Depth of groundwater basin	450 to 750 feet in Santa Anita and Monk Hill More than 1,200 feet in Pasadena
Thickness of water-bearing units	
Yield and Storage	
Natural Safe Yield	Monk Hill: 7,489 AFY Pasadena: 17,843 AFY Santa Anita: 5,290 AFY Total 30,622 AFY
Total Storage	1.37 million AF
Unused Storage Space	570,000 AF
Portion of Unused Storage Space Available for Storage	At least 250,000 AF

Safe Yield/Long-Term Balance of Recharge and Discharge

Natural groundwater recharge to the Raymond Basin occurs through infiltration and percolation of rainfall and surface runoff from the San Gabriel Mountains. Groundwater discharge occurs through pumping and subsurface outflow into the Main San Gabriel Basin across the Raymond fault. Natural recharge from precipitation and runoff is the largest inflow to the basin. **Figure 8-2** provides the historical precipitation data from 1985 to 2004 based upon the average of several precipitation stations within the basin (RBMB, 2005). Average precipitation in the basin during this 20-year period was approximately 22.8 inches.

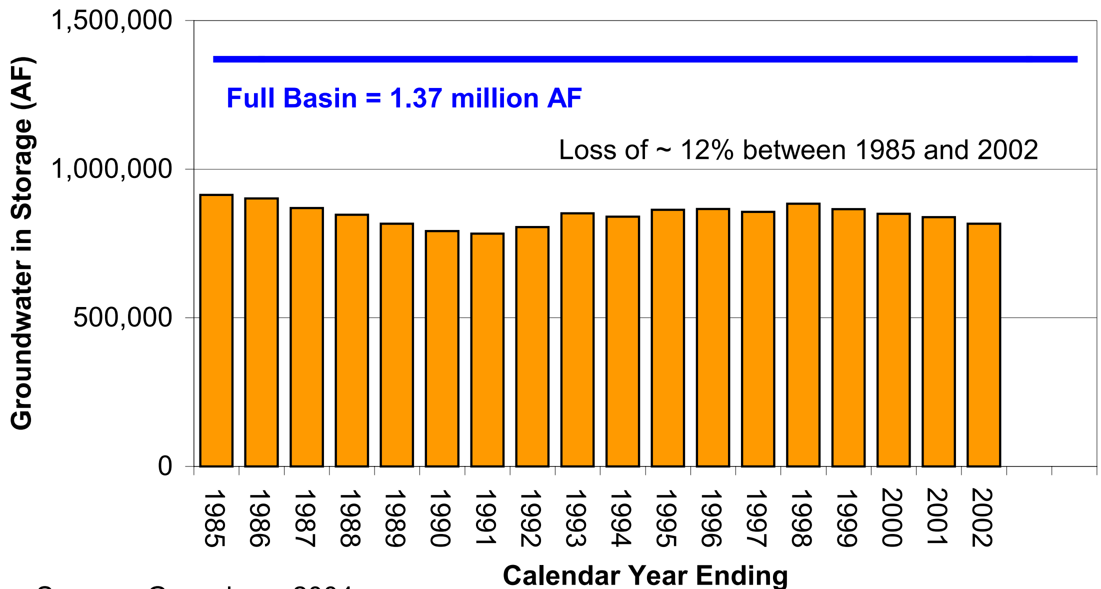
Figure 8-2
Historical Precipitation in Raymond Basin



The Raymond Basin safe yield, which is based upon native recharge and returns from use alone, was defined as 30,622 AFY in 1955. The distribution of the safe yield by subarea is provided in **Table 8-1**. As described below, this natural safe yield can be increased by groundwater recharge operations.

Figure 8-3 shows the estimated amount of groundwater in storage between 1985 and 2002 based upon estimates made by Geoscience (2004). In this time period groundwater in storage decreased from about 913,000 AF at the end of 1985 to 816,000 AF at the end of 2002. Despite a moderate recovery between 1992 and 1998, the net decrease in storage was about 100,000 AF, or about 12 percent. Data are not available beyond 2002. However, based upon water levels discussed below, the storage would be expected to continue to decline through 2005. The basin producers are aware of the decline and are currently in the process of addressing the issue.

Figure 8-3
Historical Groundwater in Storage Estimates for the Raymond Basin



Source: Geosciece, 2004

GROUNDWATER MANAGEMENT

The following section describes how the Raymond Basin is currently managed.

Basin Governance

The Raymond Basin is adjudicated. The Raymond Basin was adjudicated in 1944 by the Los Angeles County Superior Court. The Raymond Basin Management Board (RBMB) administers and enforces the provisions of the Judgment (Pasadena v. City of Alhambra), which established water rights and responsibility for management of the quantity of the basin's groundwater. RBMB coordinates local involvement in efforts to preserve and restore the quality of groundwater in the basin. RBMB also assists and encourages regulatory agencies to enforce water quality regulations affecting the basin, collects production, water quality, and other relevant data from producers and prepares an annual report of pumping and diversions. **Table 8-2** provides a list of management agencies in the Raymond Basin.

The Judgment limits the amount of groundwater that a party may extract from the basin each year. Each party's extraction is restricted to a specific hydrologic unit (Western Unit: Pasadena and Monk Hill Subareas; Eastern Unit; Santa Anita Subarea), and its Decreed Rights. Exceptions are that a party may extract ten percent of any unused Decreed Right in any year (not cumulative), and the RBMB may allow more to be carried over in an emergency or another reasonable cause. Parties may also enter into a Long Term Storage Account to add or extract groundwater during the year subject to the RBMB adopted Groundwater Storage Policies.

Imported water is provided by Foothill Municipal Water District to several parties in-lieu of pumping to meet demand.

The Judgment provisions also allow parties to increase their annual extractions by performing groundwater recharge operations. A more detailed discussion of groundwater recharge is described below.

Table 8-2
Summary of Management Agencies in the Raymond Basin

Agency	Role
Raymond Basin Management Board	Watermaster for 1944 Judgment to manage water quantity/quality
Los Angeles County Department of Public Works	Operation of Eaton Wash, Santa Anita, and Arroyo Seco Spreading Grounds
City of Pasadena	Owns Arroyo Seco Spreading Grounds
City of Sierra Madre	Operation of Sierra Madre Spreading Grounds
NASA/Jet Propulsion Laboratory(JPL)	Coordination and implementation of EPA cleanup in Monk Hill

Interactions with Adjoining Basins

The Raymond Basin is hydraulically connected to the Main San Gabriel Basin to the south and east along the Raymond fault. Approximately one percent of the total water in storage in the Raymond Basin is lost across the Raymond fault (Geoscience, 2004). Parties who store water in the Raymond Basin are assessed this 1 percent loss. No other formal agreements govern this flow.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Raymond Basin.

Active Production Wells

There are about 45 active groundwater extraction wells (RBMB, 2005) in the Raymond Basin with an estimated total well capacity of approximately 97,600 AFY based upon maximum month extractions during fiscal year 2004/05 or production capacity data available from individual producers. Average extractions have been approximately 33,000 AFY for municipal use between fiscal years 1985/86 and 2004/05. Historical production data by subbasin are provided in **Figure 8-4**.

Twelve wells within the basin have had detections of perchlorate (> 4 ug/L). These wells are located downstream of the Jet Propulsion Laboratory (JPL) Superfund site within the

Arroyo Seco (Geoscience, 2004). Most of these wells are inactive or are blended with other wells to decrease the concentration of perchlorate.

Other Production

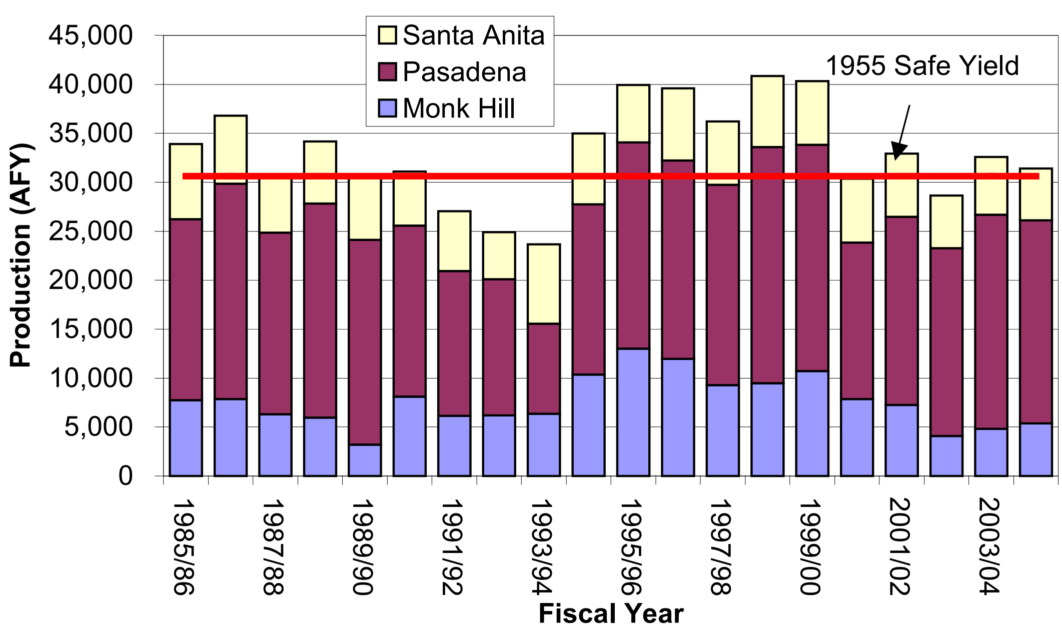
All production in the Raymond Basin is designated for municipal use.

Table 8-3
Summary of Production Wells in the Raymond Basin

Basin	Number of Active Wells	Estimated Production Capacity [1] (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Monk Hill	11 [2]	17,500	8,065	Not available
Pasadena	25	72,500	18,588	
Santa Anita	9	7,600	6,315	
Total	**45**	**97,600**	**32,969**	

Source: Number of wells based upon RBMB, 2005
1. Estimated based upon maximum monthly production in 2004/05 or known capacities
2. Does not include City of Pasadena wells

Figure 8-4
Historical Groundwater Production in the Raymond Basin



ASR Wells

There are currently seven ASR wells in the Raymond Basin. The details of the wells are provided in **Table 8-4**. Total groundwater recharge is summarized in **Figure 8-5**. Valley Water Company currently has two wells capable of injecting water in the Monk Hill subarea. Valley Water Company has recharged approximately 5,300 AF of water using these wells since 1994. The City of Pasadena currently has five wells capable of injecting water. The City of Pasadena has recharged approximately 3,600 AF of water in the Pasadena subarea using three of the injection wells between late 1992 and 1996. The City of Pasadena wells have not been used for injection since 1996.

Table 8-4
Summary of ASR Wells in the Raymond Basin

Basin	Number of ASR Wells	Estimated Injection Capacity [1] (AFY)	Average Injection 1985-2004 (AFY)	Well Operation Cost ($/AF)
Monk Hill	2	2,500	263	Data not available
Pasadena	5	8,000	181	
Santa Anita	0	0	0	
Total	**7**	**10,500**	**444**	

Source: Number of wells based upon RBMB, 2005
1. Estimated based upon maximum monthly production or known capacities

Foothill MWD is currently in the process of converting an additional three wells in the Monk Hill subarea to ASR. The City of Pasadena is currently considering construction of three additional ASR wells in the Pasadena subarea.

Spreading Basins

More than 90 percent of the annual spreading in the Raymond Basin has taken place at the Arroyo Seco, Eaton Wash, Santa Anita and Sierra Madre spreading basins. The remainder occurs at the Millard Canyon, Pasadena Glen, Pasadena Sludge Ponds and Rubio Canyon spreading basins. The total recharge capacity of the four major recharge basins is approximately 37,500 AFY as shown in **Table 8-5**. The combined smaller recharge basins have an estimated annual capacity of approximately 3,000 AFY. Historical groundwater recharge (including both spreading and injection) is shown in **Figure 8-5**.

Seawater Intrusion Barriers

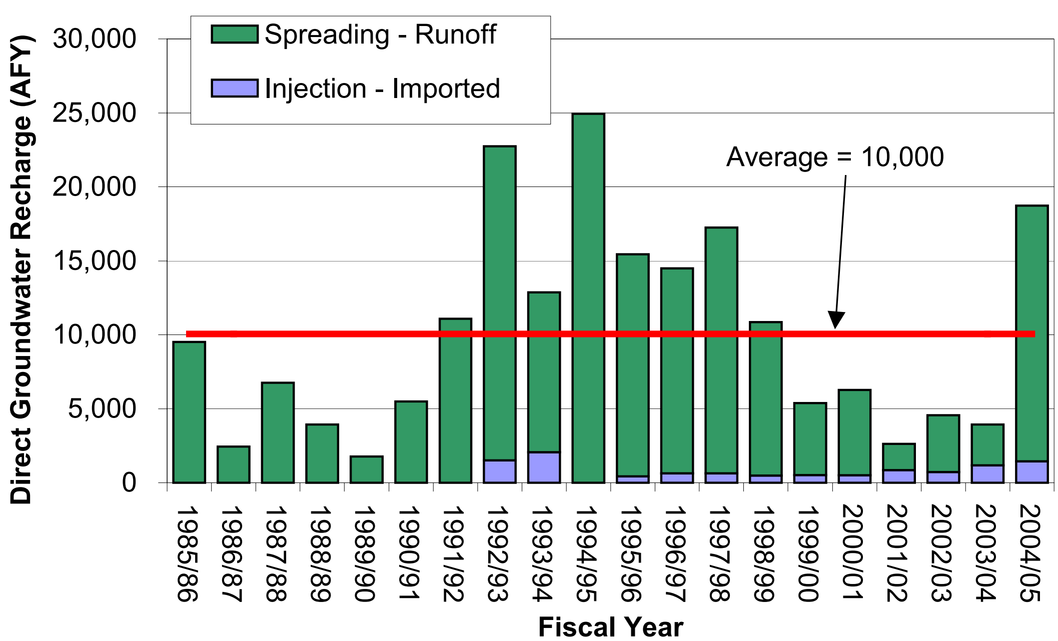
There are no seawater intrusion barriers in the Raymond Basin.

Table 8-5
Summary of Spreading Basins in the Raymond Basin

Basin	Area (acres)	Wetted Area (acres)	Recharge Capacity (cfs)	Recharge Capacity (AFY)	Source Water	Owner
Arroyo Seco	24	15.1	18	13,000	Runoff	City of Pasadena
Eaton Wash	28	25.4	14	10,100	Runoff	LACDPW
Sierra Madre	22	9	15	10,800	Runoff	City of Sierra Madre
Santa Anita	28	8.5	5	3,600	Runoff	LACDPW
Total	**102**	**58**	**52**	**37,500**	--	--

Source: LACDPW, 2006, Geoscience, 2004 and Stetson, 2006

Figure 8-5
Historical Groundwater Recharge in the Raymond Basin



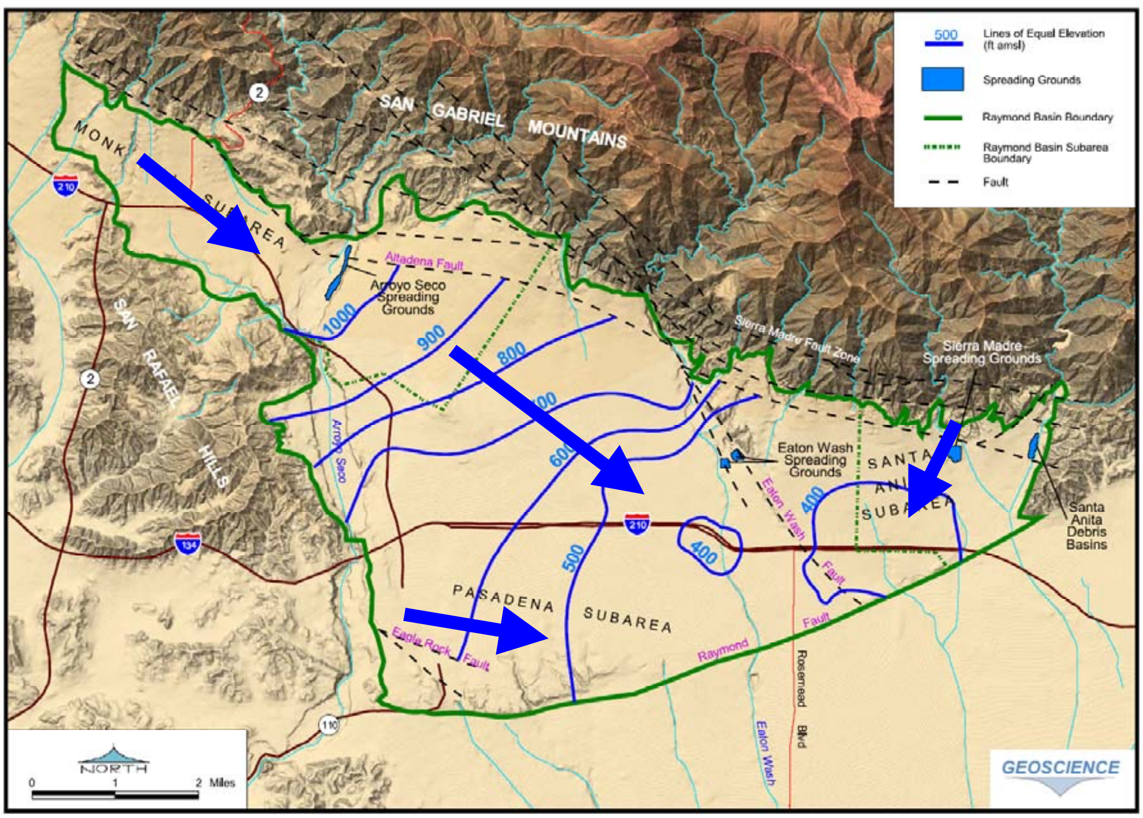
Desalters

There are no desalters in the Raymond Basin.

GROUNDWATER LEVELS

As shown in **Figure 8-6**, groundwater generally flows southeast from the Monk Hill subarea in the northwest to Raymond fault in the southeast. Historical groundwater levels from key wells in the Raymond Basin are summarized in **Figure 8-7.** Key well locations are shown on **Figure 8-1.** Groundwater levels in the Raymond Basin range from about 350 feet above MSL in Santa Anita subarea to more than 1,100 feet above MSL in the Monk Hill subarea.

Figure 8-6
Raymond Basin Groundwater Elevation Contours – Fall 2005

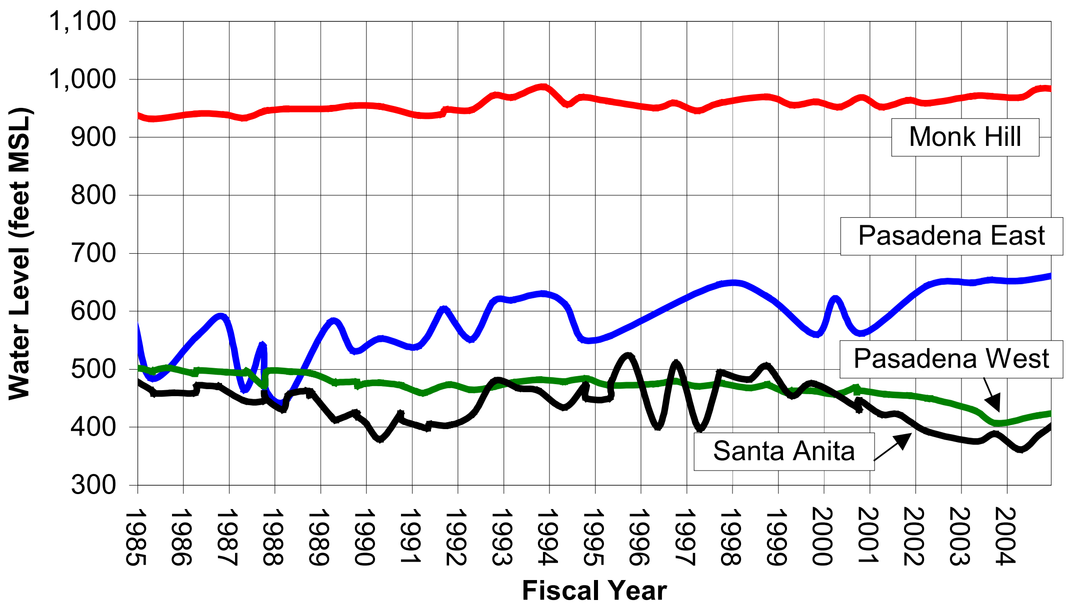


Source: RBMB, 2006

As shown in **Figure 8-7**, water levels in the Monk Hill area of the groundwater basin have increased about 50 feet in the key well between fiscal years 1985/86 and 2004/05, largely due to decreased production because of perchlorate. Similarly, groundwater levels in the western portion of the Pasadena subarea have increased more than 150 feet between 1985/86 and 2004/05 because of inactive wells in this area.

As shown in **Figure 8-7**, groundwater levels in the southeastern portion of the Pasadena subarea and the Santa Anita subarea have decreased substantially in the past 10 years. Water levels have decreased as much as 14 feet per year in these portions of the basin. Some wells in the Santa Anita subbasin have lost production because of low water levels. Thee data are consistent with the decline in storage estimates discussed previously.

Figure 8-7
Historical Water Levels in the Raymond Basin



GROUNDWATER QUALITY

Groundwater quality in the Raymond Basin is generally good to fair in most areas. Groundwater concentrations of total dissolved solids (TDS) typically range from 350 to 700 mg/L in the central and southern portions of the Pasadena subarea and in the Monk Hill subarea (Geoscience, 2004). Along the mountains in Sierra Madre in the Santa Anita subbasin, concentrations of TDS are generally below 300 mg/L. Further south in the Santa Anita subbasin, TDS concentrations are above 300 mg/L (Geoscience, 2004).

Groundwater Quality Monitoring

Groundwater quality samples are collected from active production wells within the Raymond Basin in accordance with California DHS requirements as specified in Title 22 of the California Code of Regulations. No basin-wide monitoring program has been established.

Groundwater Contaminants

As summarized in **Table 8-6**, the primary contaminants of concern in the Raymond Basin include: nitrate, perchlorate, and VOCs (specifically chlorinated solvents PCE and TCE). The wells impacted by these constituents are provided in **Figure 8-8**.

Table 8-6
Summary of Constituents of Concern in the Raymond Basin

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	Less than 300 to 730	Concentrations 350 to 730 mg/L in the central and southern portions of the Pasadena subarea and in the Monk Hill subarea. Along the mountains in the Santa Anita subarea, concentrations are generally less than 300 mg/L.
Nitrate (as N) MCL = 10	mg/L	ND to 16	Nitrate concentrations are highest in the shallow areas below former agricultural areas in Monk Hill and in the southeastern portion of the Pasadena unit. Twelve wells have had concentrations above the MCL of 10 mg/L.
VOCs **(TCE and PCE)** TCE MCL = 5 PCE MCL = 5	µg/L	ND to 9 for TCE ND to 17 for PCE	PCE and TCE have been detected above the MCL in 7 wells in Monk Hill, southeastern Pasadena and in Santa Anita. Treatment for PCE and TCE is online in Monk Hill.
Perchlorate Notification level = 6	µg/L	ND to 26	Seven wells along the Arroyo Seco are currently offline or limited in production because of perchlorate. Treatment for perchlorate is online in Monk Hill.

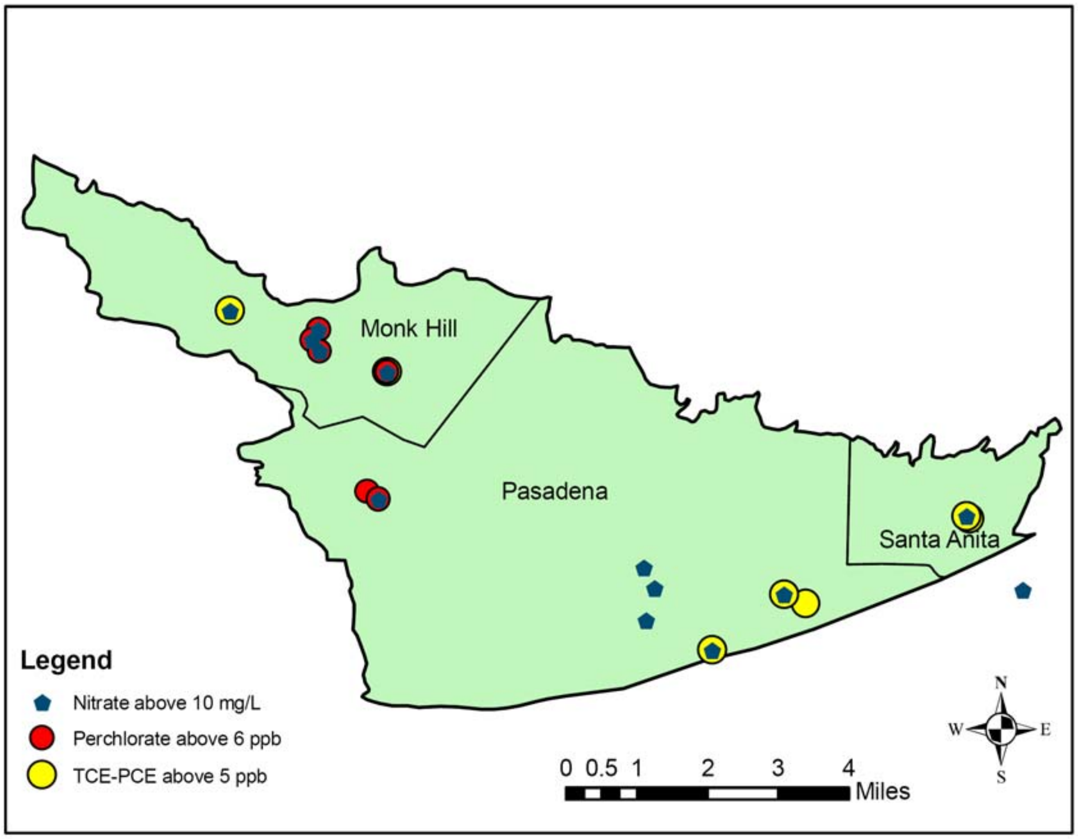
Source: Geoscience, 2004

Various wells throughout the basin have been impacted by nitrate, a result of historical agricultural practices and septic tank effluent. Most of the higher concentrations of nitrate are found in the shallower portions of the Raymond Basin. Nitrate concentrations are highest in the shallow areas below former agricultural areas in Monk Hill and in the southeastern portion of the Pasadena unit. Twelve wells have had nitrate (as N) concentrations above the MCL of 10 mg/L (Geoscience, 2004).

In the 1940s and 1950s, liquid wastes from materials used at JPL were disposed of into seepage pits, a practice common at that time. While these disposal practices were discontinued by the early 1960s, some chemicals, such as perchlorate and volatile organic compounds, have been found in groundwater beneath JPL and in areas adjacent to JPL, to the east and southeast. In

1992, the JPL site was characterized as a Superfund site. Cleanup of VOCs and perchlorate have been ongoing. PCE and TCE have been detected above the MCL for TCE and PCE in seven wells in Monk Hill, southeastern Pasadena and in Santa Anita. Treatment for PCE and TCE is online in Monk Hill. Seven wells within the Monk Hill and Pasadena subareas along the Arroyo Seco are currently inactive because of perchlorate.

Figure 8-8
Locations of Water Quality Issues in the Raymond Basin



Source: Geoscience, 2006

Blending Needs

Some wells in the Monk Hill subarea must be blended with imported water from Metropolitan to meet the nitrate MCL. The historical injection program has decreased the nitrate concentrations in the groundwater produced, allowing for less blending.

Groundwater Treatment

The City of Pasadena, Lincoln Avenue Water Company and Valley Water Company have installed wellhead treatment for VOC and perchlorate removal in Monk Hill (RBMB, 2005). In July 2004, Lincoln Avenue Water Company completed construction of a 2,000 gpm treatment plant for VOCs and perchlorate. About 1,940 AF has been treated to date (RBMB, 2005). JPL and the City of Pasadena are currently planning to construct another 10 MGD capacity treatment facility to treat the City of Pasadena's wells in the Arroyo Seco area. The current groundwater treatment facilities are listed in **Table 8-7**.

Table 8-7
Summary of Groundwater Treatment in the Raymond Basin

Number of Wells	Treatment Type	Constituents of Concern	Treatment Target	Treatment Cost ($/AF)	Amount Treated (AFY)
2	Liquid phase GAC Ion-Exchange	VOCs, Perchlorate	ND	Data not available	2,000 gpm 1,940 (2004/05)
2	GAC	VOCs	ND	Data not available	Data not available
4 (proposed)	Liquid phase GAC Ion-Exchange	VOCs, Perchlorate	ND	$517	6,000

Source:JPL, 2006 and RBMB, 2005

CURRENT GROUNDWATER STORAGE PROGRAMS

In 2003, the RBMB approved a 9,000 AF conjunctive use program between Foothill MWD and Metropolitan. Under this program, up to 9,000 AF of imported water from Metropolitan would be stored by Foothill MWD agencies in the Monk Hill subarea via injection or in-lieu methods. Upon Metropolitan's call in the future, up to 3,000 AFY could be extracted. To date, approximately 2,940 AF has been stored under this program.

Metropolitan, Foothill MWD and the City of Pasadena are currently considering a similar conjunctive use program of up to 66,000 AF in the Pasadena subarea. In January 2006, the RBMB adopted a resolution of support for this program.

BASIN MANAGEMENT CONSIDERATIONS

Basin management considerations include the following:

- The Raymond Basin is adjudicated and annual production is restricted to the adjudicated rights. In addition, since 1992 use of long-term storage space in the basin is subject to approval by the RBMB.

- Perchlorate, VOC and nitrate contamination could limit the ability to store and extract water.

- Treated imported water from Metropolitan is available for storage from Metropolitan's Upper Feeder (a blend of Colorado River and State Water Project sources from Metropolitan's Weymouth plant). The Regional Board has established specific water quality objectives for the Raymond Basin for TDS, chloride, sulfate and boron. Imported water via the Upper Feeder does not always meet these water quality objectives. Therefore, direct recharge via spreading and/or injection could be limited.

- There has been a significant loss in storage in the Raymond Basin since 1985. The RBMB is currently investigating options to address this issue.

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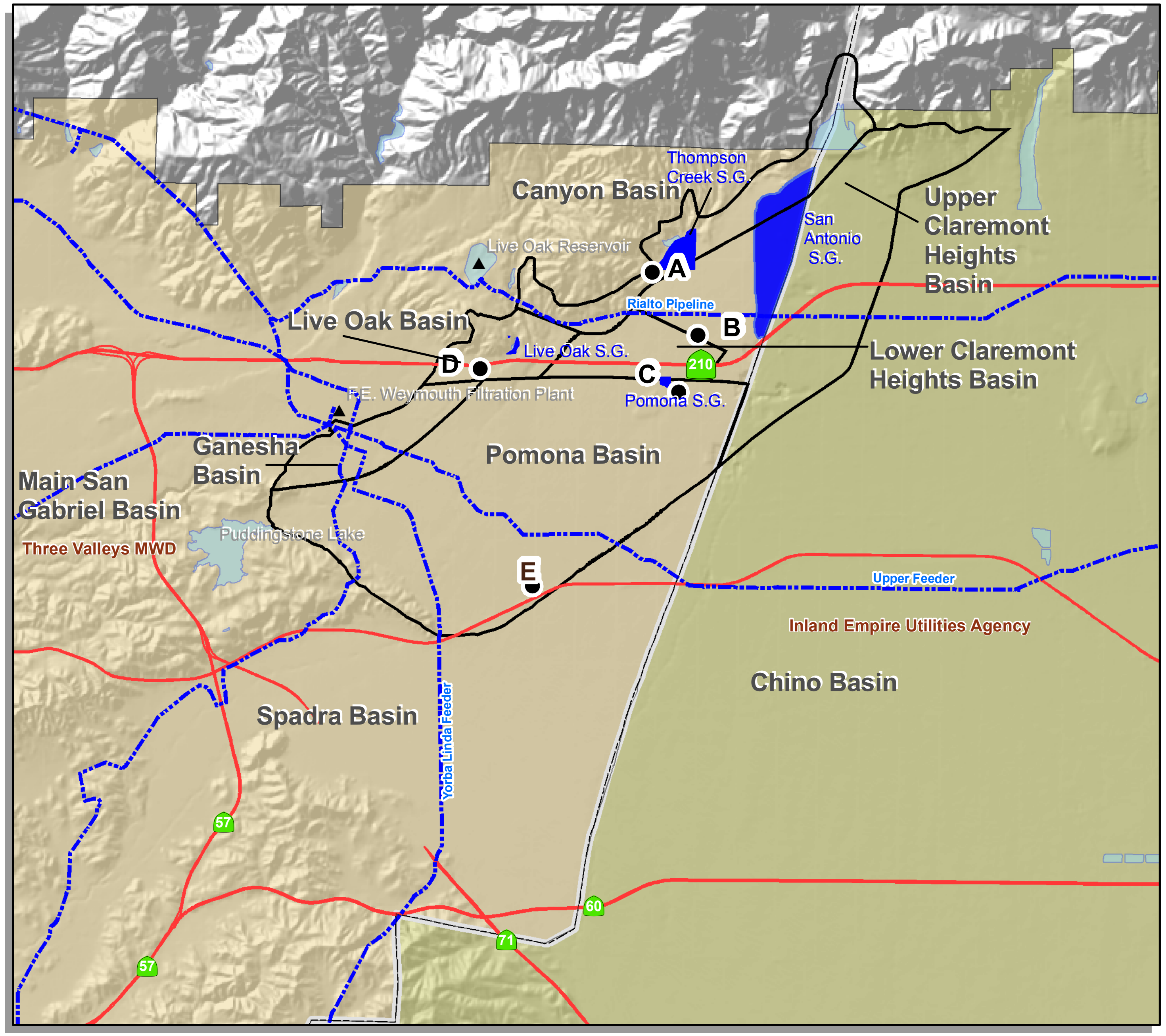

Six Basins

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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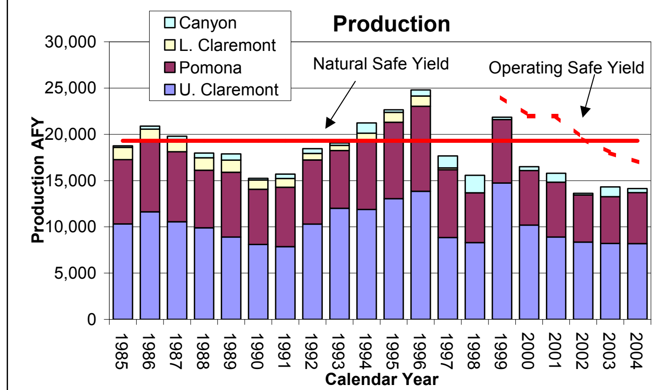
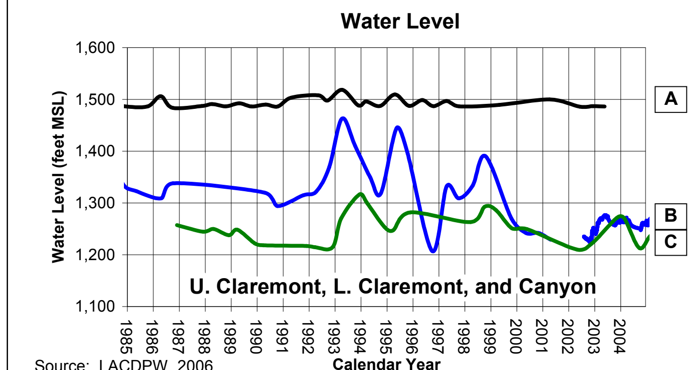
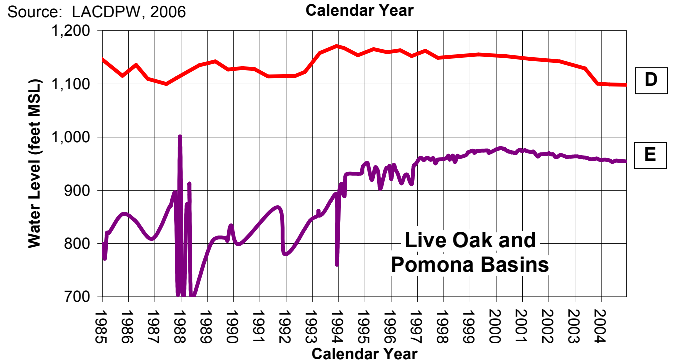
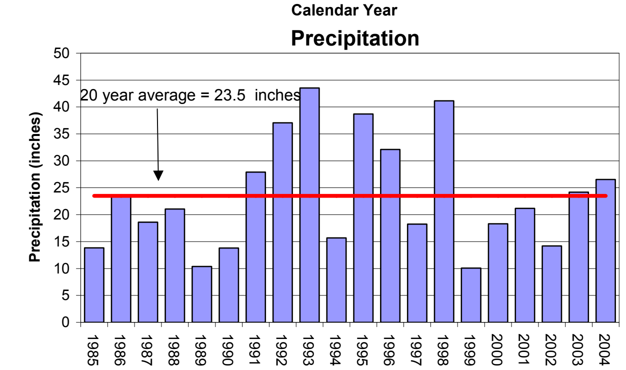
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).

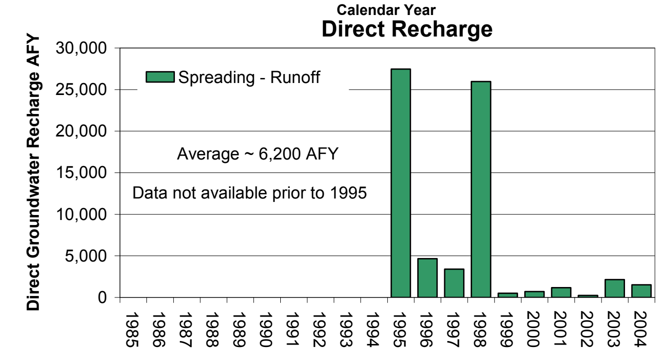




Source: LACDPW, 2006







Source: Three Valleys MWD,

BASIN FACTS

Six Basins

Description
Location: Los Angeles and San Bernardino Counties
Surface Area: ~16 square miles
Subbasins:
Upper Claremont Heights
Lower Claremont Heights
Canyon
Live Oak
Ganesha
Pomona
Management: Adjudicated
Adjudicated in 1999. Court-appointed Watermaster manages water quantity and quality, defines annual operating yield for four of the six basins (Live Oak and Ganesha not included)
MWD Member Agencies:
Three Valleys MWD
IEUA

	Six Basins
Natural Safe Yield	19,300 AFY
Operating Safe Yield (2005)	18,000 AFY
Total Storage	335,000 AF
Unused Storage Space	Unknown
Portion of Unused Storage Space Available for Storage (2005)	20,000 AF

Storage and Extraction Facilities

	Six Basins
Production Wells	
Production Capacity	Data not available
Average 1985-2004	18,164 AFY
Injection Wells	
Injection Capacity	None
Average 1985-2004	None
Spreading Basins	
Spreading Capacity	>18,000 AFY
Average 1985-2004	~1,200 AFY

Basin Management Considerations
- Pumping subject to adjudication
- Nitrate and VOC concentrations in various areas of the basins could limit ability to store and extract water
- Rising groundwater in Pomona Basin could limit ability to store water upstream

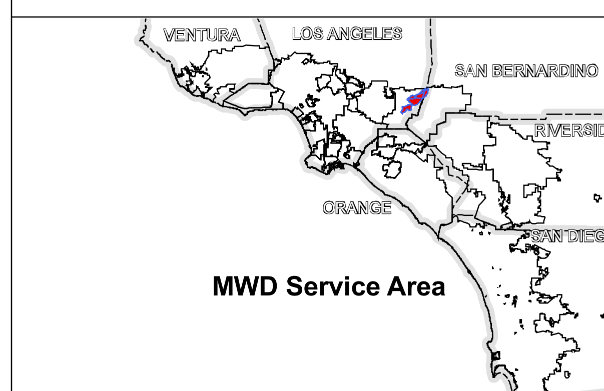


Plate 9-1
Overview of Six Basins

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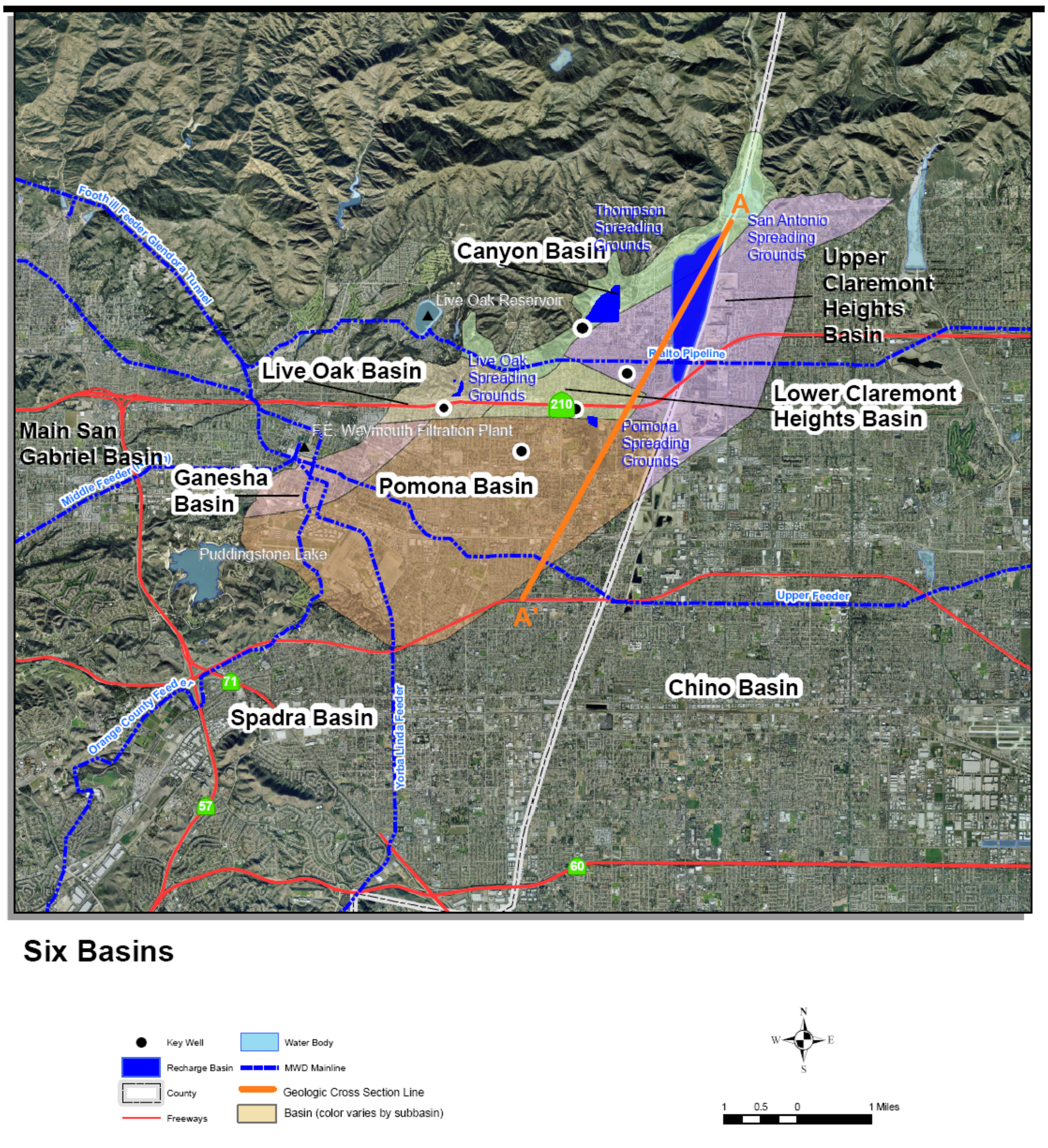
The Six Basins are located in the eastern Los Angeles County and western San Bernardino County, bounded on the southwest by the San Jose Hills, on the north by the San Gabriel Mountains, on the south and east by the Chino Basin and on the west by the Main San Gabriel Basin. The Six Basins are comprised of the Canyon, Upper and Lower Claremont Heights, Pomona, Live Oak, and Ganesha Basins. They underlie the service areas of Three Valleys Municipal Water District (Three Valleys) and Inland Empire Utilities Agency (IEUA). These Six Basins underlie the cities of Claremont, La Verne, Pomona and northern Upland. A map of the basin is provided in **Figure 9-1**.

Figure 9-1
Map of the Six Basins



BASIN CHARACTERIZATION

The following section describes the physical properties of the Six Basins, including its hydrogeologic characteristics and analysis of inflows and outflows.

Basin Producing Zones and Storage Capacity

Individual subbasins within the Six Basins are defined by faults and physical boundaries. The Indian Hills fault separates the Live Oak, Upper and Lower Claremont Heights, and Canyon basins (herein referred to as upper basins) to the north from the Pomona and Ganesha Basins (herein referred to as lower basins) to the south (Three Valleys, 2004). The Canyon Basin is separated from the other basins by the Sierra Madre-Cucamonga fault. The Ganesha and Pomona Basins are separated by the San Antonio fault. These faults do not appear to be barriers to flow. The San Jose fault separates the Six Basins from the Chino Basin. This boundary is not a complete barrier to flow and groundwater appears to flow at least to some extent between the basins.

Table 9-1 summarizes the hydrogeologic characteristics of the Six Basins. Studies are currently underway to reevaluate the basin geology. Changes to the basin structure as part of these studies were not available at the time of this report. In addition, limited data are available for the Ganesha and Live Oak Basins so data are provided for the four basins: Canyon, Upper Claremont Heights, Lower Claremont Heights and Pomona Basins (herein referred to as Four Basins Area). A geologic cross section through the Six Basins area from north to south is provided in **Figure 9-2**. Maximum basin depths range from about 200 feet in Canyon Basin to about 1,200 feet in the Pomona Basin. As shown in **Figure 9-2**, bedrock is offset by faulting, thereby increasing the basin depth toward the south.

Groundwater in Six Basins occurs under both unconfined and confined conditions. In the upper basins where material is generally coarser and mostly younger alluvium, the groundwater is unconfined. In the lower basins, fine-grained silts and clays overlie more permeable materials and groundwater can be confined. For example, the Pomona Basin consists of at least two aquifers. Most of the production from the Pomona Basin is from the underlying confined aquifers. Issues related to rising groundwater occur in the upper unconfined aquifer in the Pomona Basin. These issues are discussed in more detail below.

Total storage estimates range from about 15,000 AF of storage in the Canyon Basin to more than 200,000 AF of storage in the Pomona Basin. Total storage in the Four Basins Area is estimated to be about 335,000 AF (Three Valleys, 2004). Available storage space is estimated to be approximately 20,000 AF in 2005/06 (Three Valleys, 2006). Groundwater in storage in the upper basins has decreased from a high of about 74,500 AF in 1999 to about 65,200 AF in early 2004, a decrease of about 9,300 AF. Groundwater in storage increased by over 20,000 AF as a result of the near record rainfall in 2005.

Safe Yield/Long-Term Balance of Recharge and Discharge

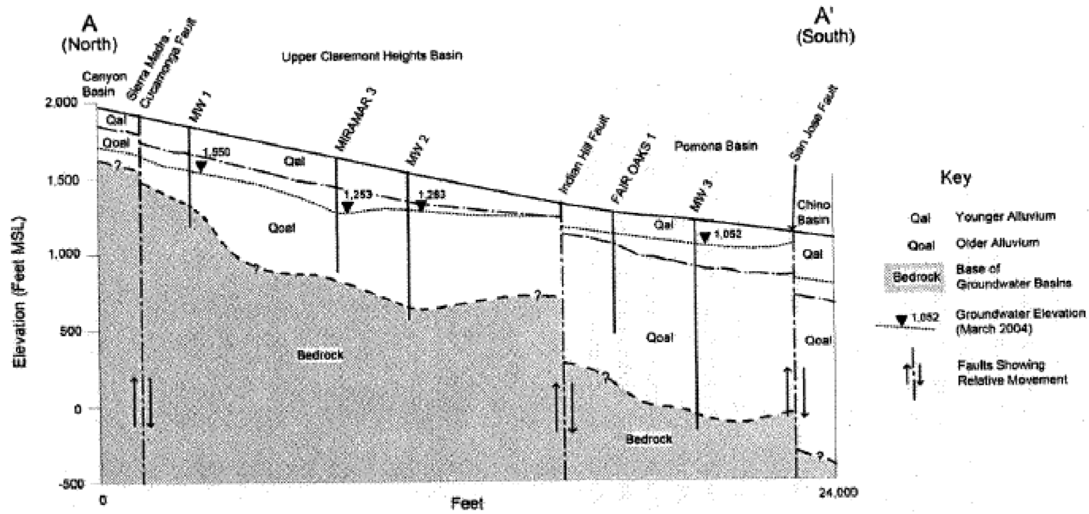
Water supply to Six Basins is greatly affected by precipitation in the area and in the watershed of San Antonio Canyon. **Figure 9-3** shows the historical annual average rainfall in the Six Basins area measured at San Antonio Dam. (Six Basins, 2005) The historical annual rainfall average for the period between 1985 and 2004 at this location is approximately 23.5 inches. The long-term precipitation averages range from about 40 inches in the upper reaches of San Antonio Canyon to 24 inches at the mouth of the canyon, and 17 inches at the southerly edge of the Pomona Basin. Much of the precipitation in the higher elevation falls as snow with the beneficial effect of delayed runoff. This creates a base flow of surface water, which is available for direct diversion or for surface spreading. (Six Basins, 2005)

Table 9-1
Summary of Hydrogeologic Parameters of the Six Basins

Parameter	Description
Structure	
Aquifer(s)	Unconfined alluvium in upper basins Confined to semi-confined in lower basins
Depth of groundwater basin	0 to 1,200 feet
Thickness of water-bearing units	Canyon: Up to 200 feet Upper Claremont Heights: Up to 1,000 feet Lower Claremont Heights: Up to 700 feet Pomona: Up to 1,200 feet
Yield and Storage	
Natural Safe Yield	19,300 AFY
Operating Safe Yield (Calendar Year 2005)	18,000 AFY
Total Storage	Canyon: 15,000 AF Upper Claremont Heights: 100,000 AF Lower Claremont Heights: 20,000 AF Pomona: 200,000 AF **Total: 335,000 AF**
Unused Storage Space	Unknown
Portion of Unused Storage Space Available for Storage (in 2005/06)	~20,000 AF

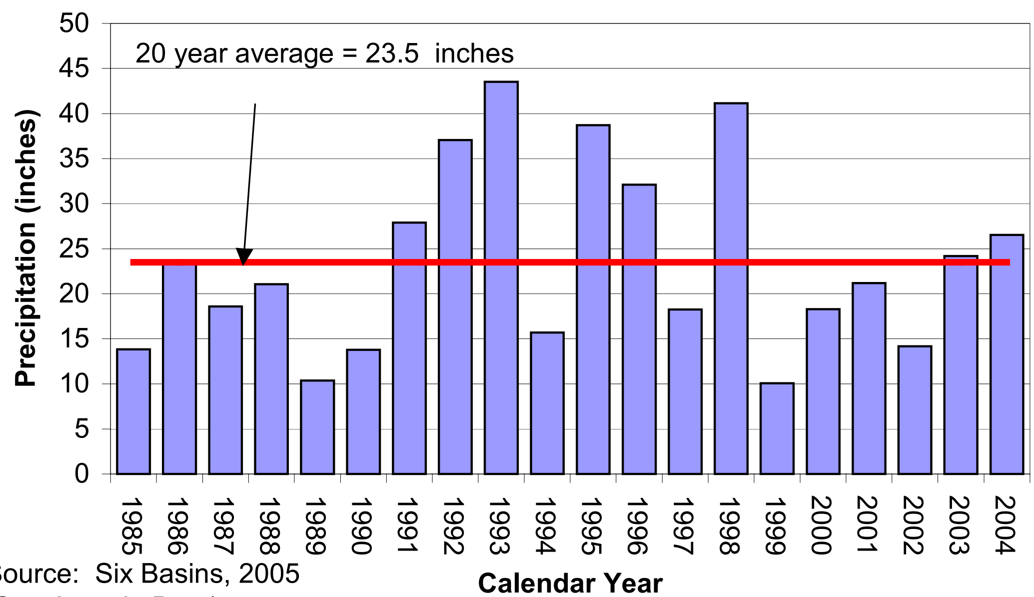
Source: Three Valleys, 2004; 2006

Figure 9-2
Generalized Hydrogeologic Cross Section in the Six Basins



Source: Three Valleys, 2004

Figure 9-3
Historical Precipitation in Six Basins Area



Source: Six Basins, 2005
(San Antonio Dam)

Groundwater generally flows from the upper basins to the lower basins. Therefore, the primary source of recharge to the lower basins is subsurface flow from the upper basins. The long term natural safe yield for all groundwater supplies within the Six Basins area, including the benefits of historical augmentation is estimated to be approximately 19,300 AFY. The operating safe yield for the Four Basins Area, which is updated annually, is dependent on rainfall and groundwater recharge of surface water runoff from the local mountains. Since 1999, when the basins were adjudicated, the operating safe yield has ranged from 17,000 AFY to 24,000 AFY. In 2005, the operating safe yield was established at 18,000 AFY.

GROUNDWATER MANAGEMENT

The following section describes how the Six Basins area is currently managed.

Basin Governance

The Six Basins are adjudicated. The Six Basins were adjudicated in 1999 and administrated by Three Valleys MWD, through a contract with the Six Basins Watermaster Board of Directors. The Board is comprised of nine parties representing producers and interests in the basins. The Board of Directors rotates board positions on a yearly basis. Each party is represented on the governing Watermaster Board of Directors. A summary of the management agencies in the Six Basins is provided in **Table 9-2**.

Table 9-2
Summary of Management Agencies in the Six Basins

Agency	Role
Six Basins Watermaster Board of Directors	Governance and Oversight of Adjudicated Basins
Golden State Water Company	Major Party and Producer
City of Pomona	Major Party and Producer Operates Pomona Spreading Grounds pursuant to storage and recovery agreement with Watermaster
City of Upland	Major Party and Producer
City of La Verne	Major Party and Producer
Pomona College	Minor Party and Producer
City of Claremont	Minor Party and Producer (Sells rights to Golden State Water Company)
San Antonio Water Company	Major Party and Producer
Three Valleys MWD	Minor Party and Administrator (Storage & Recovery only)
Pomona Valley Protective Association (PVPA)	Operates San Antonio and Thompson Creek Spreading Grounds
Los Angeles County Department of Public Works (LACDPW)	Operates Live Oak Spreading Grounds

In accordance with the adjudication, pumping is limited to the annual operating safe yield within the Four Basins Area. Pumping is not limited in the Ganesha or Live Oak Basins. According to the adjudication, annual over-pumping in the Four Basins Area is allowed with no specified upper limit but incurs replenishment obligation of equal amount. Carryover of 25 percent of the original annual allocation or unused balance, whichever is less, is allowed. Additional storage is allowed with no specified upper limit but only pursuant to a storage and recovery agreement between Watermaster and a single party. Imported water deliveries are allowed for replenishment obligation or Storage/Recovery account (Six Basins, 2005). However, facilities to spread and store imported water are not yet available in the Six Basins area.

Criteria for monitoring of the basin include monthly monitoring and groundwater modeling of water levels and monthly reporting and groundwater modeling of production. Pumping rights are allocated to each producer in the Four Basins Area based on the percentages in the Judgment. The Base Annual Production percentage owned by each producer is applied to the current Operating Safe Yield, and the resulting allocation is the pumping allowance available to each party without incurring a replacement water obligation (Six Basins, 2005)

Interactions with Adjoining Basins

Subsurface outflow to the Chino Basin across the San Jose fault has not been estimated but is considered to be very low (Three Valleys, 2004). The quantity of flow is not currently known with enough certainty for a formal exchange agreement to be made. Future studies have been proposed to better quantify this outflow.

Under the adjudication, Six Basins producers are allowed to export water upon approval by the Watermaster. For example, production from the western edge of the Pomona Basin is exported to the Main San Gabriel Basin. In addition, production by the City of La Verne is exported outside the boundaries of the Live Oak and Ganesha Basins (Three Valleys, 2004).

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Six Basins. Facilities for groundwater supply and storage include approximately 68 production wells and nearly 700 acres of recharge basins.

Municipal Production Wells

Table 9-3 provides details of the production wells within the Six Basins area. There are approximately 68 municipal production wells in the Six Basins area. Fourteen municipal wells are inactive. The total production capacity of active municipal wells is at least 35,000 AFY (Three Valleys, 2007). It is important to note that groundwater demand is only about 24,000 AFY. Approximately seven wells are anticipated to be replaced in the next five years (Six Basins, 2006).

Figure 9-4 summarizes the historical production data in the Four Basins Area. Data from the Live Oak and Ganesha Basins were not available at the time of this report. However, because of water quality issues in these two basins, production is limited but still significant. Most of the groundwater production in the Six Basins area is from the Upper Claremont Heights Basin and the Pomona Basin. Between 1985 and 2004, pumping in the Upper Claremont Heights Basin ranged from 7,857 AFY to 14,732 AFY with an average of 9,890 AFY. Production in this basin generally correlates with precipitation. There has been limited pumping in the Lower Claremont Heights Basin after 1998, and extractions from the Canyon Basin are a result of precipitation because it responds quickly to runoff from San Antonio Canyon. Production from the Pomona Basin ranged from 5,028 AFY to 9,195 AFY between 1985 and 2004. Production from the Pomona Basin has been less than the adjudicated allowance because of water quality issues in this basin. However, in recent years, production from the Pomona Basin has increased as facilities to remove contaminants from the groundwater are constructed.

Table 9-3
Summary of Production Wells in the Six Basins

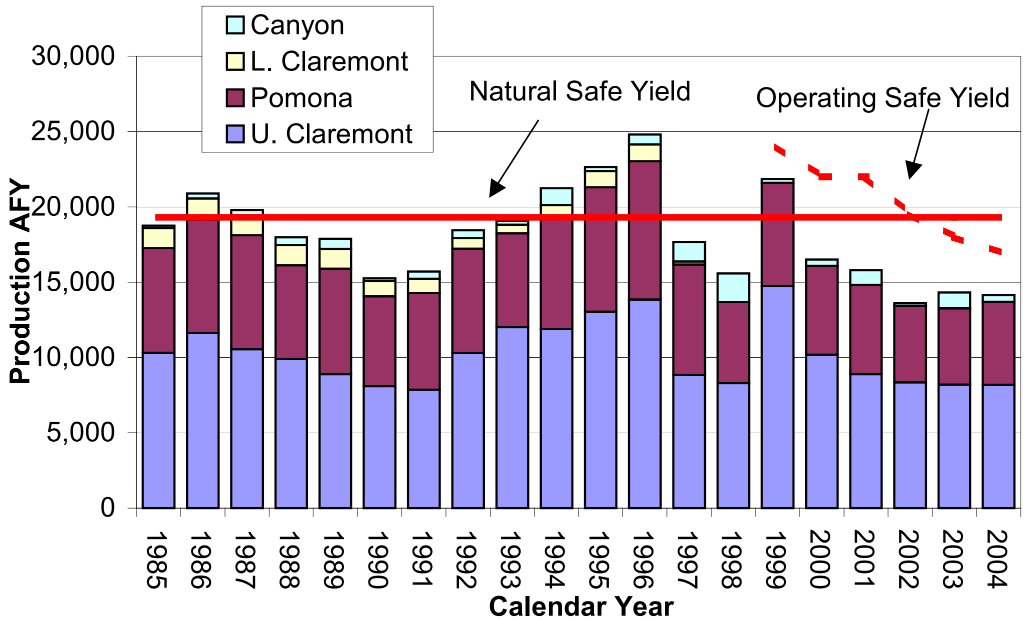
Basin	Number of Wells	Estimated Production Capacity (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Canyon	54 Active 14 Inactive	At least 35,000	595	$60-175 (average of $125) Power only
Upper Claremont Heights			10,199	
Lower Claremont Heights			723	
Pomona			6,649	
Ganesha			Data not available	
Live Oak			Data not available	
Total	**68**	35,000	18,164	

Source: Three Valleys, 2006

Other Production

Other non-municipal production has not been reported for the Six Basins. Non-municipal production is included in production data discussed above.

Figure 9-4
Historical Groundwater Production in the Six Basins



ASR Wells

There are no ASR wells in the Six Basins.

Spreading Basins

There are four spreading basin areas in the Six Basins area. These include: San Antonio, Thompson Creek, Live Oak and Pomona. Each of these is discussed below and summarized in **Table 9-4**. **Figure 9-5** summarizes the historical groundwater recharge spreading operations in the Six Basins. An average of about 6,200 AFY has been recharged in the Six Basins area between 1995 and 2004. During the wet years of 1995 and 1998 more than 25,000 AFY was recharged.

The San Antonio Spreading Grounds consist of about 600 acres of spreading grounds in the Upper Claremont Heights Basin. This facility is owned and operated by the Pomona Valley Protective Agency (PVPA). The primary source of water for this facility is runoff from San Antonio Creek by way of controlled releases from San Antonio Dam by the Army Corps of Engineers. Imported water from Metropolitan will also spread at this facility as part of the Upper Claremont Heights Conjunctive Use Program discussed below. Facilities to spread imported water have not been constructed yet. Although larger volumes of water have been spread in the San Antonio Spreading Grounds historically, the recharge capacity of the San Antonio Spreading Grounds has been estimated by Bookman-Edmonston to range from about 13,000 to 18,000 AFY taking into consideration adjustments to avoid impacts of high groundwater (Three Valleys, 2004).

The Live Oak Spreading Grounds consist of about five acres of spreading facilities in the Live Oak Basin. This facility is owned an operated by LACDPW. The primary source of water is runoff from the Live Oak Dam. Imported from Metropolitan is also recharged at this facility as part of the Live Oak Conjunctive Use Program discussed below.

Table 9-4
Summary of Recharge Basins in Six Basins

Basin	Area (acres)	Wetted Area (acres)	Recharge Capacity (cfs)	Recharge Capacity (AFY)	Source Water	Owner
San Antonio	600	Data not available	Data not available	13,000 to 18,000 [1]	Runoff	Pomona Valley Protection Agency
Thompson Creek	53	5	15	Data not available	Runoff	Pomona Valley Protection Agency
Live Oak	5	3	13	Data not available	Runoff Imported	LACDPW
Pomona	8	Data not available	Data not available	Data not available	Runoff	City of Pomona

Source: Three Valleys, 2004; LACDPW, 2006
1. Spreading capacity as determined by Bookman Edmonston (Three Valleys, 2004)

The Pomona spreading groundwater facilities are owned by the City of Pomona adjacent to its Pedley Water Treatment Plant pursuant to a storage and recovery agreement with Watermaster.

The Thompson Creek Spreading Grounds consist of about 53 acres of spreading facilities in the Canyon Basin. The primary source of recharge is runoff from the adjacent drainages upstream of the facilities.

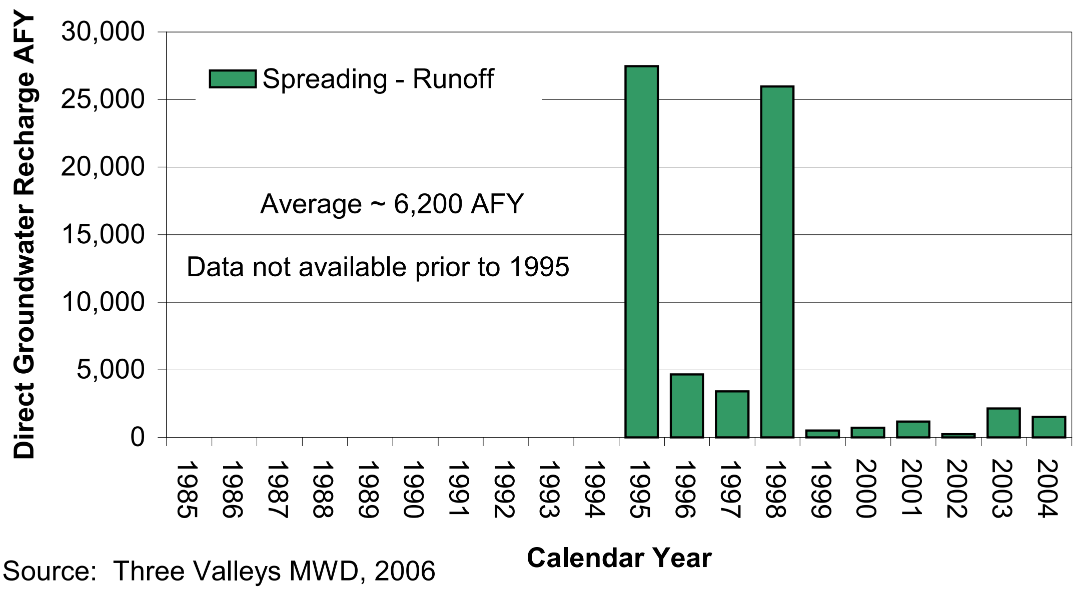
Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Six Basins area.

Desalters

There are no desalters in the Six Basins area.

Figure 9-5
Historical Groundwater Recharge in Six Basins Area



Source: Three Valleys MWD, 2006

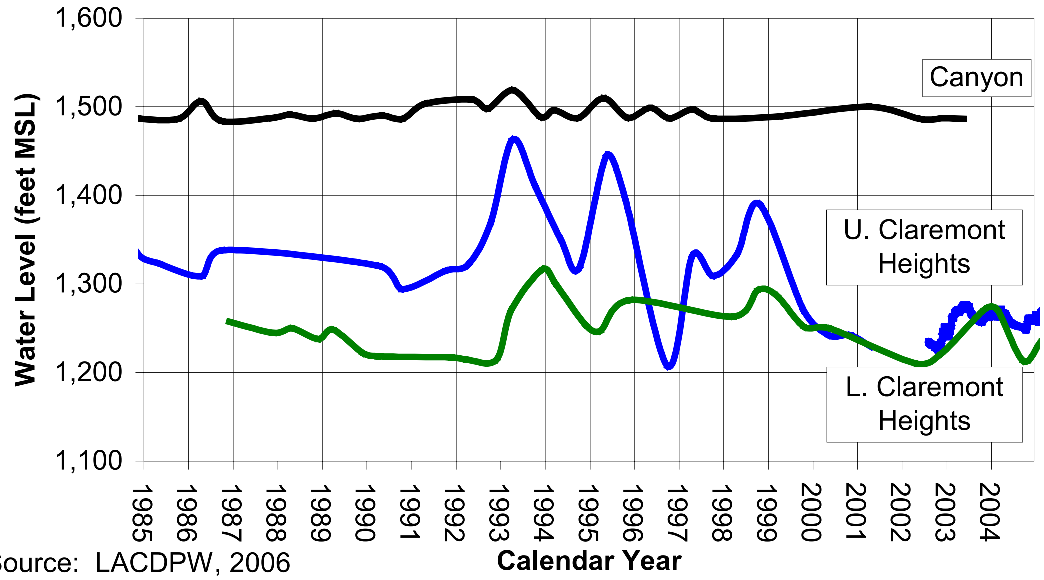
GROUNDWATER LEVELS

The general direction of groundwater flow is south to southwest from the upper basins to the lower basins. Historical water levels for the Six Basins area are shown in **Figure 9-6**. Water levels generally decreased in each basin between1985 and 2004. Decreases have ranged from slight decreases in the Canyon Basin to more than 80 feet (between 1985 and 2004) in the Upper Claremont Heights Basin. However, since the heavy rains of early 2005, water levels have recovered and, during 2005 and 2006 are near historical highs.

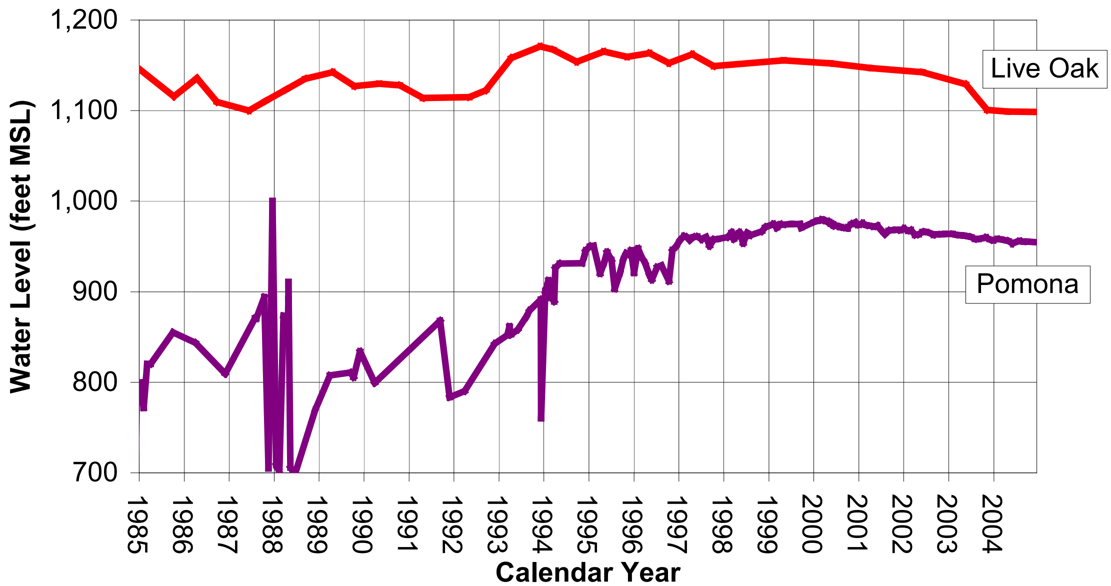
Despite the overall decrease after 1985, water levels in the Pomona Basin increased between 1990 and 1994 because wells were shutdown due to water quality issues in this basin. Water levels have remained higher since that time. Unlike the three upper basins, water levels in the Pomona Basin are above desired levels (Six Basins, 2005). Areas of rising groundwater (cienegas) are present in various locations in the Pomona Basin and are a concern for management of the basin. The approximate locations of known cienegas are provided in **Figure 9-7.**

Basin water levels must be closely managed to avoid rising water and property damage. Canyon Basin and Upper Claremont Heights Basin both experienced rising groundwater conditions in early 2005. In 1993, James M. Montgomery Consulting Engineers (JMM) developed a spreadsheet model to evaluate spreading conditions. Based upon the model assumptions, water is not to be spread when the Index Water Level (weighted average of 5 wells in Upper Claremont Heights Basin) approaches or reaches an elevation of 1,455 feet MSL. Since 1993, the index water level has ranged from 1262.3 feet MSL to 1,342.4 feet MSL. The index water level in March 2004 was 1,296.1 feet MSL (Six Basins, 2005). In 2006, CDM developed a new spreadsheet model, which utilizes data from nine dedicated monitoring wells in the Six Basins. The new threshold index for this model is 1,475 feet MSL.

Figure 9-6
Historical Water Levels in the Six Basins

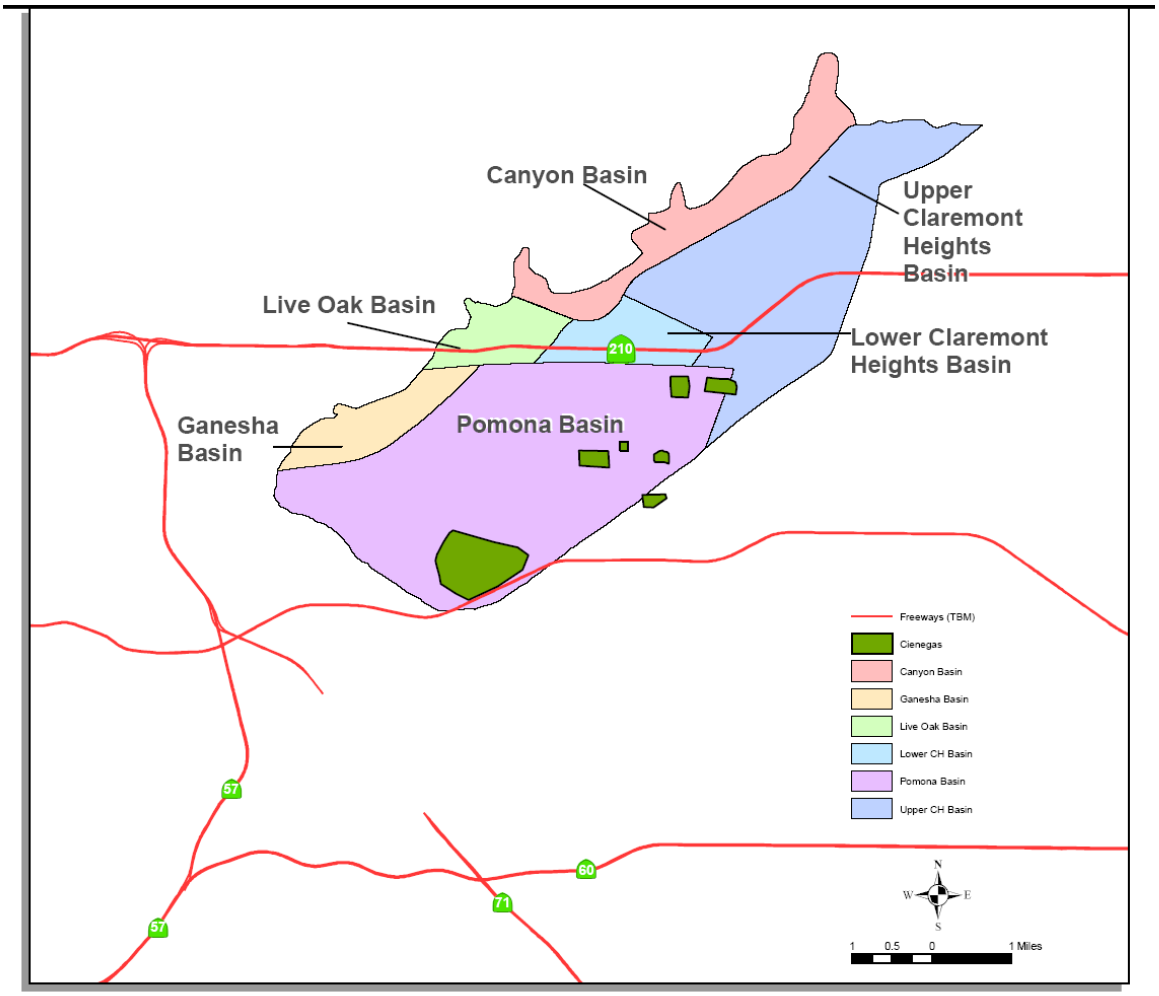


Source: LACDPW, 2006



Source: LACDPW, 2006

Figure 9-7
Locations of Cienegas in the Six Basins Area



GROUNDWATER QUALITY

The following section describes the overall water quality considerations for the Six Basins. Fourteen wells, particularly in the Live Oak and Pomona Basins are offline because of water quality issues.

Groundwater Quality Monitoring

Basin water quality assessments utilize Title 22 reporting for production wells. There is no formal groundwater quality-monitoring program established for the Six Basins.

Groundwater Contaminants

General water quality information was collected from the various water agencies in the Six Basins Area to conduct an assessment of water quality conditions in the area. The water quality analysis was collected for 2005/06. **Table 9-5** provides summary of the primary constituents of concern in the Six Basins areas. Constituents of concern include: total dissolved solids (TDS), nitrate, volatile organic compounds, or VOCs (trichloroethylene, or TCE, tetrachloroethylene, or PCE), and perchlorate. A brief discussion of water quality conditions for each of the compounds of potential concern is presented below.

Nitrate is a main water quality concern in the Live Oak Basin and the westerly portion of the Pomona Basin, where most of the wells currently exceeding the MCL (13 of the 44 wells reported). Nitrate concentrations in some of the city of La Verne wells are 20 to 22 mg/L as N, over twice the current MCL. The eastern half of the Pomona Basin and the Upper Claremont Basin experience lower nitrate concentrations with most of the wells below 50 percent MCL. **Figure 9-8** illustrates nitrate concentrations for the reporting wells in the Six Basins area.

TDS information was obtained for only 14 of the producing wells in the area. TDS is currently not an issue of concern as none of the wells exceed the secondary MCL of 500 mg/L; further, 11 of the 14 wells showed concentrations below 50 percent MCL. **Figure 9-8** illustrates TDS concentrations for the reporting wells in the Six Basins area.

The Pomona Basin also contains VOCs at four wells above the appropriate MCL. As described below, the City of Pomona has constructed VOC treatment/removal facilities in the Pomona Basin. TCE is an issue of concern at two primary locations in the Pomona Basin. In the vicinity of the historical Del Monte Cienega there are 2 wells with TCE concentrations exceeding MCL. Similarly, the there are 2 wells located east of the Palomares Cienega with elevated concentrations of TCE. These four wells are treated or blended to meet drinking water standards. **Figure 9-9** illustrates PCE and TCE concentrations for the reporting wells in the Six Basins area. Some levels of perchlorate have also been observed, but below notification levels.

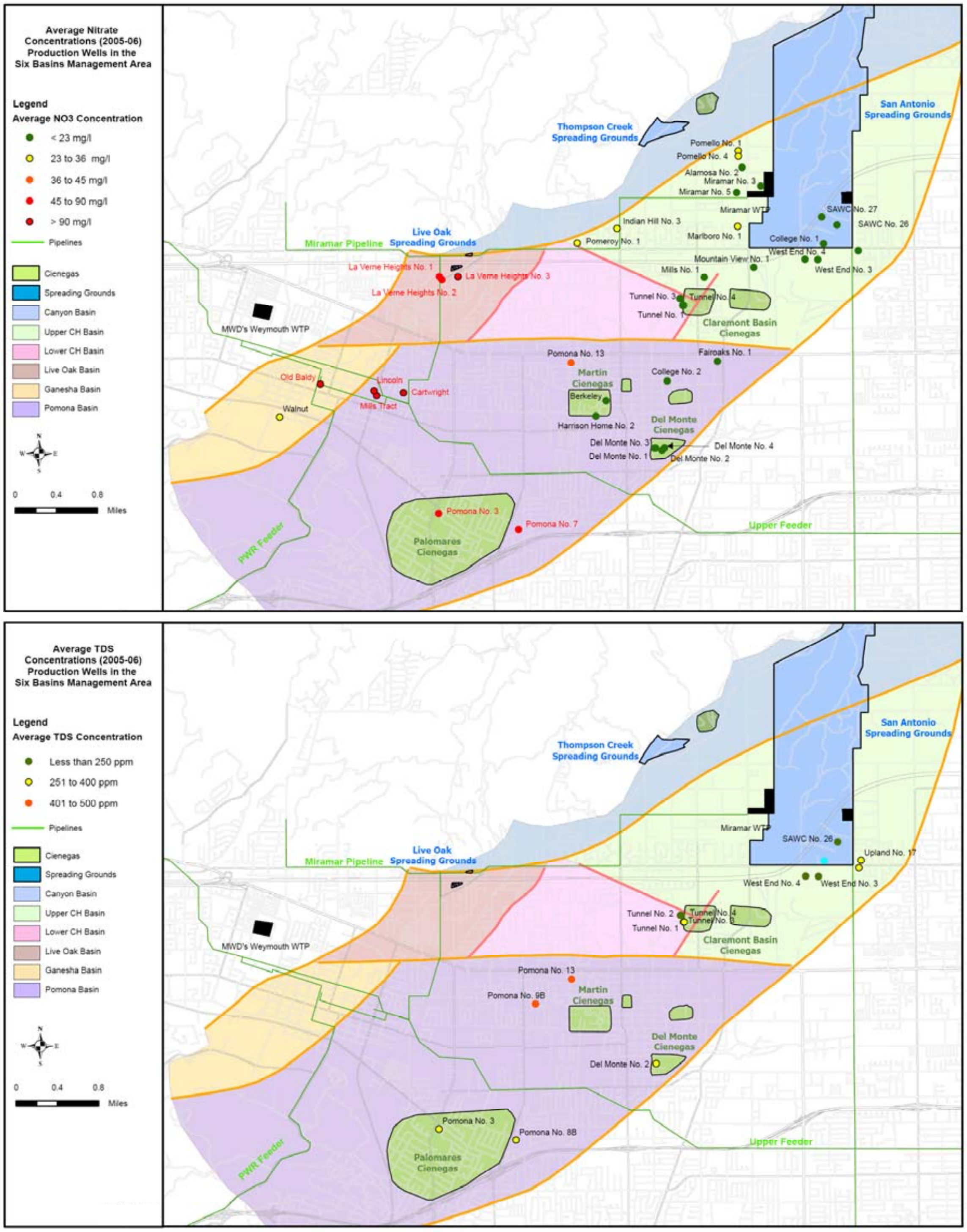
Blending Needs

The City of Pomona blends 60 percent of imported SWP water with treated groundwater to improve nitrate concentrations. The Golden State Water Company also blends with imported SWP water to improve nitrate concentrations. Blending needs are summarized in **Table 9-6**.

Groundwater Treatment

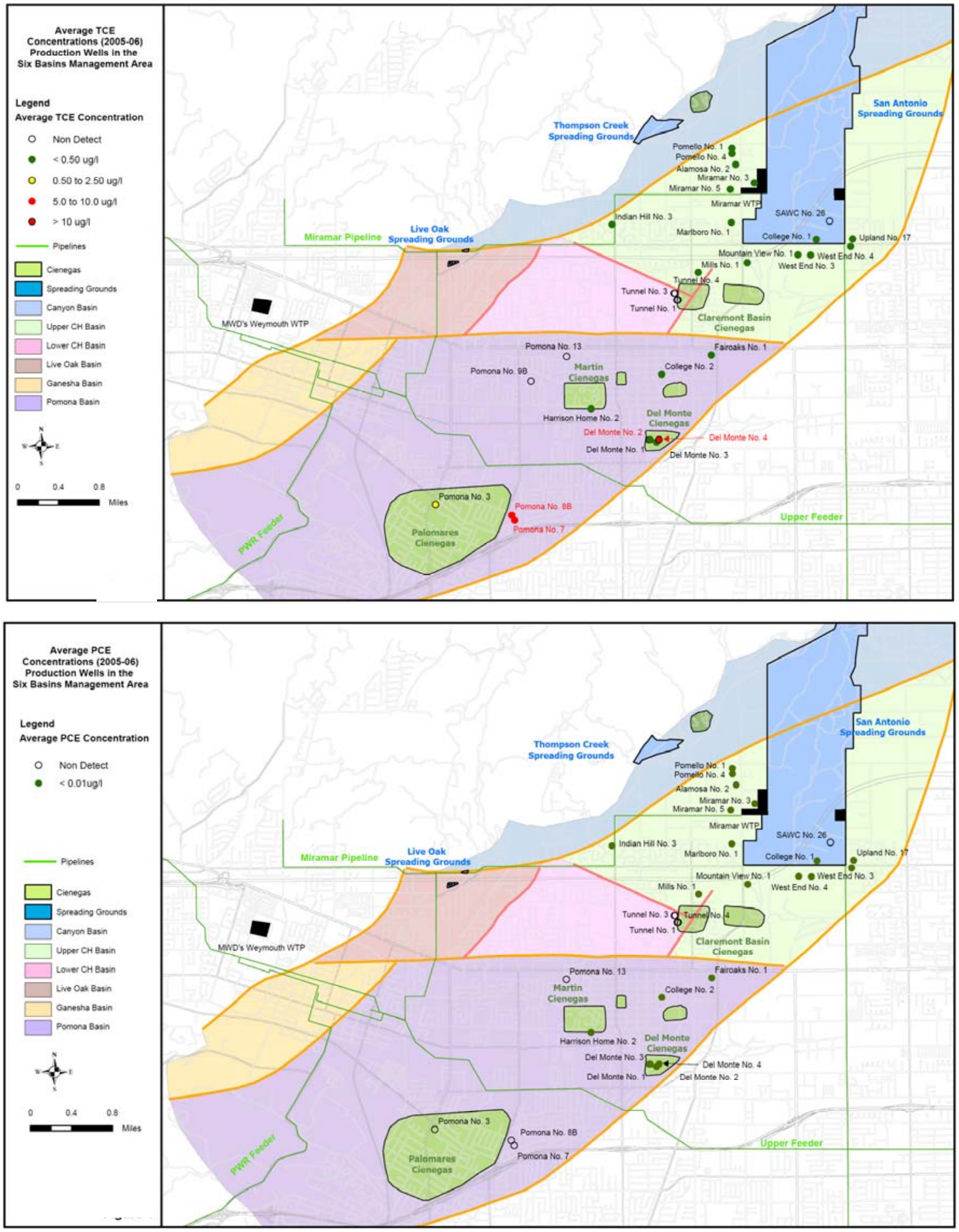
Table 9-7 summarizes the treatment type and constituents of concern for Six Basins. In addition, the city of La Verne is currently constructing ion exchange facilities for removal of nitrates in Live Oak Basin. It is estimated that up to 5,000 AFY additional production capacity can be achieved with groundwater treatment facilities over and above those mentioned here. (Three Valleys, 2006).

Figure 9-8
Nitrate and TDS Concentrations in the Six Basins



Source: Three Valleys, 2007

Figure 9-9
Volatile Organic Compound Concentrations in the Six Basins



Source: Three Valleys, 2007

Table 9-5
Summary of Constituents of Concern in Six Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	190 to 480	Below MCL of 500 in all basins (14 of 14 wells)
Nitrate (as N) Primary MCL = 10	mg/L	ND to 22	Above MCL in some portions of Pomona, Lower Claremont Heights and Live Oak Basins (13 of 44 wells exceed MCL and 24 of 44 wells are less than 50 percent of MCL)
VOCs (TCE and PCE) Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	ND to > 10 for TCE ND to < 0.01 for PCE	Above MCL in some portions of Pomona Basin. VOC treatment occurs in Pomona Basin (4 of 32 wells exceed MCL for TCE and no wells exceed MCL for PCE – 28 of 32 well had TCE concentrations less than 50 percent of MCL and all wells had PCE concentration less than 50 percent of MCL)
Perchlorate Notification level = 6	µg/L	< 6	No reported exceedances of notification level found in Six Basins

Source: Three Valleys, 2007

CURRENT GROUNDWATER STORAGE PROGRAMS

Metropolitan has recently implemented two conjunctive programs under the Proposition 13 program in the Six Basins. These include programs in the Live Oak and Upper Claremont Heights Basins. Each of these programs is described in **Table 9-8**. Total storage from these programs is 6,000 AF. As of June 30, 2006, about 610 AF was in storage under these combined programs.

Table 9-6
Summary of Blending Needs in the Six Basins

Purveyor	Constituent Blended	Average Groundwater Blended (AFY)
City of Pomona	Nitrate (blended with imported water)	1,363
Golden State Water Company	Nitrate (blended with imported water)	648
Total		**2,011**

Source: Three Valleys, 2006

Table 9-7
Summary of Groundwater Treatment in the Six Basins

# Wells	Treatment Type	Constituents of Concern	Treatment Target	Treatment Cost	Amount Treated (AFY)
3	Air-Strippin g	1,1-DCE PCE TCE	ND	$70/AF	1,363
2	GAC	VOC	ND	$81/AF	460

Source: Three Valleys, 2006

Live Oak Basin Conjunctive Use Project

Metropolitan, Three Valleys, and the City of La Verne executed the Live Oak Basin Conjunctive Use Project agreement on October 21, 2002. The Live Oak Conjunctive Use Project will allow the storage of up to 3,000 AF of water. Surplus water will be stored when available and during dry, drought, or emergency periods. Metropolitan will be able to recover 1,000 AF of water per year.

Table 9-8
Summary of Conjunctive Use Programs in the Six Basins

Program	Member Agencies	Year Began	Total Storage (AF)	Amount in storage [1] (AF)
Live Oak Conjunctive Use Program	Three Valleys	2002	3,000	610
Upper Claremont Heights Conjunctive Use Program	Three Valleys	2005	3,000	0

[1]As of June 30, 2006

Upper Claremont Heights Conjunctive Use Program (San Antonio Spreading Grounds Conjunctive Use Project)

In October 2005, Three Valleys entered into an agreement with Metropolitan to store up to 3,000 AF in the Upper Claremont Heights Basin. Three Valleys plans to construct a production well to take advantage of the available storage capacity in the Upper Claremont Heights Basin. Three Valleys has available storage within this basin as a part of an agreement with the Six Basins Watermaster. The Watermaster agreement provides Three Valleys with an annual storage account of up to 1,000 AF and an extraction limit of up to 3,500 AF that would be used for the program. Facilities to store water have not yet been completed for this program. Facility construction is expected to be completed by the end of 2007.

BASIN MANAGEMENT CONSIDERATIONS

Potential constraints to groundwater storage and extraction include:

- Because the shallower upstream basins production ability is largely dependent upon natural recharge, during dry years, these basins produce very little.
- Production limits as a result of the adjudication may limit ability to extract water from the Four Basins Area.
- Spreading may be limited in the Upper Claremont Heights Basin if water level index exceeds 1,475 feet MSL. New CDM model calculates amount of storage available for recharge based upon the 1,475 index. Additional monitoring wells wills be needed to monitor water levels.
- Rising groundwater conditions in the Pomona Basin may limit the ability to store water in the upstream basins.

- Groundwater quality, particularly nitrate and VOCs in the Live Oak, Pomona and Lower Claremont Basins may limit ability to store and extract water.

- In the event that there is imported water in storage that prohibits the spreading of local runoff, provisions in the Judgment would reduce the amount of imported water spreading by an equivalent amount of local surface water that could not be spread. Imported water would be the first stored water lost in the event that surface water could not be spread. As such, groundwater accounting would be affected.

References:

California Department of Water Resources (DWR), 2004. California's Groundwater Bulletin 118 – San Gabriel Valley Groundwater Basin.

Six Basins Watermaster (Six Basins), 2004. Preliminary Determination of Operating Safe Yield for calendar year 2005.

Six Basins Watermaster (Six Basins). 2005. Annual Report.

Three Valleys Municipal Water District (Three Valleys), 2004. Initial Study/Mitigated Negative Declaration - Imported Water Spreading at San Antonio Spreading Grounds.

Three Valley Municipal Water District (Three Valleys), 2006 Groundwater Study Questionnaire.

Three Valley Municipal Water District (Three Valleys), 2007. Comments from Mike Sovich on Draft Groundwater Assessment Study, March 2007 dated June 12, 2007.

CHAPTER IV

GROUNDWATER BASIN REPORTS

ORANGE COUNTY BASINS

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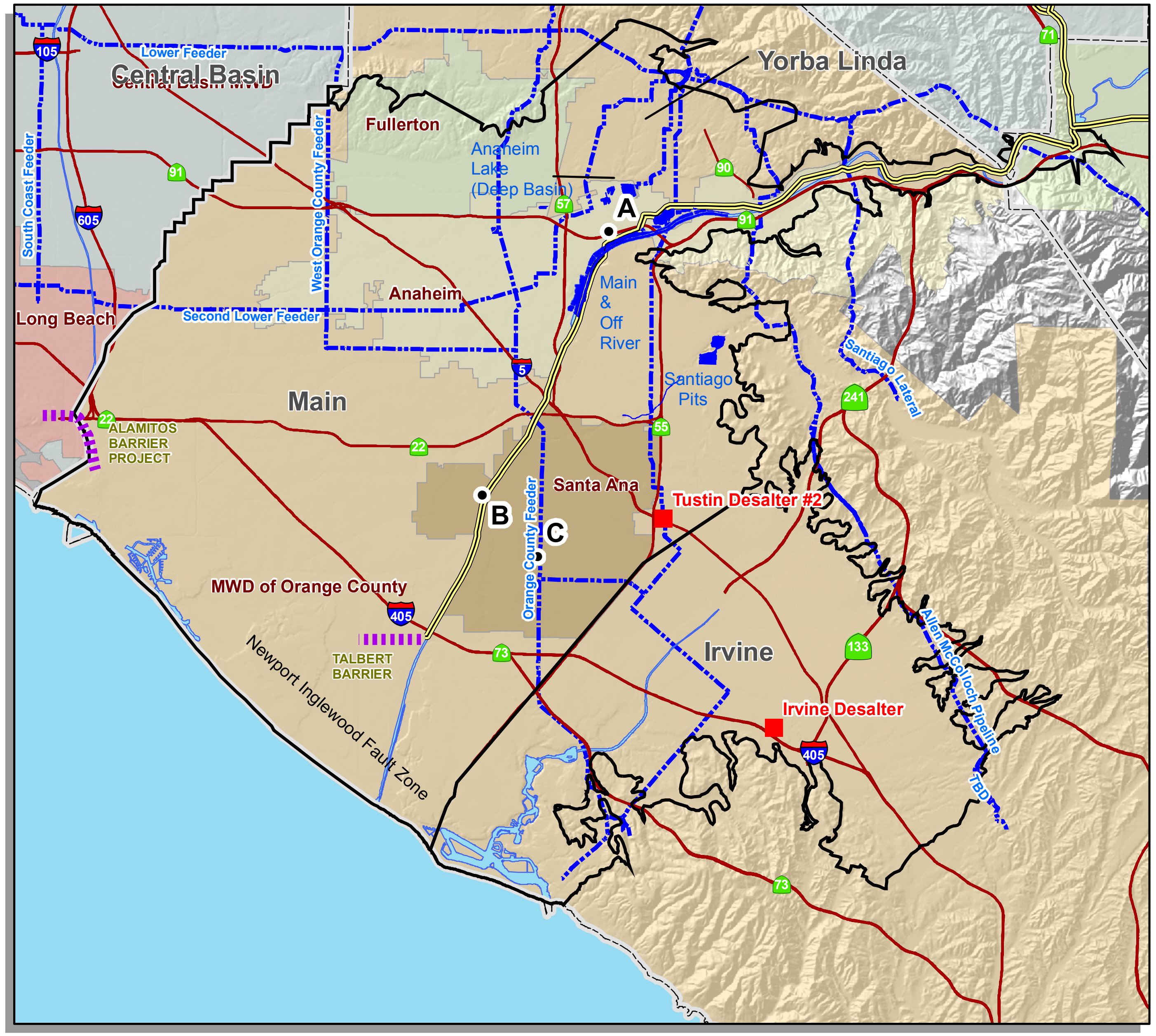

Orange County Basin

A • Key Well	Water Body
Desalter	MWD Pipeline
Recharge Basin	Santa Ana Regional Interceptor Line
Seawater Barrier	Basin
County	MWD Member Agency Boundary (color varies)
Freeways	

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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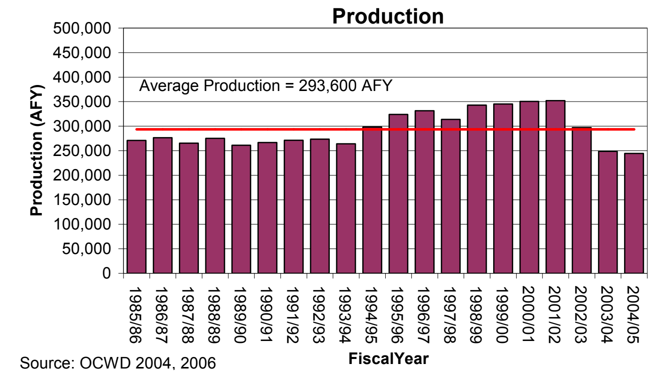
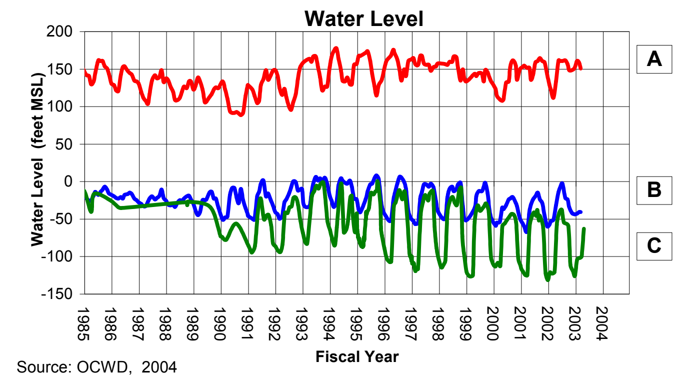
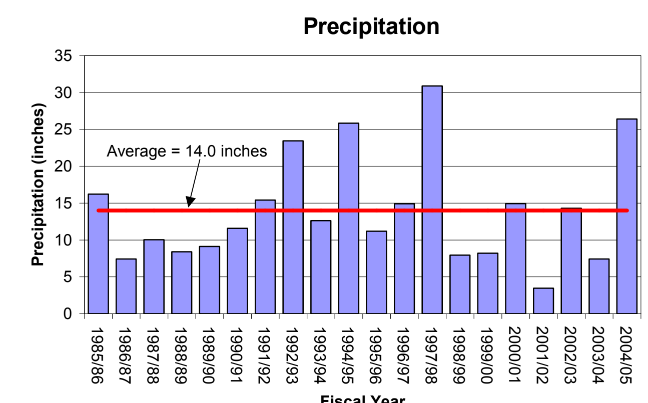
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).



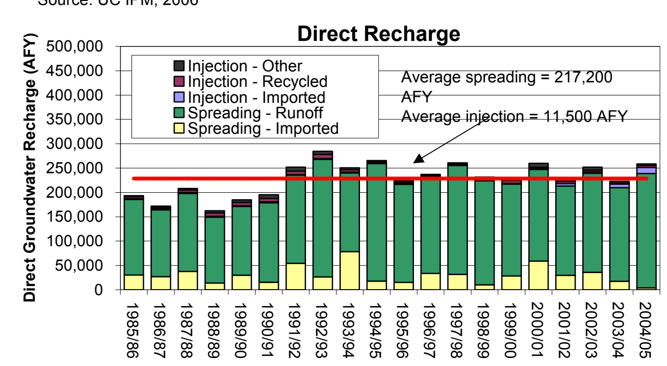
Source: OCWD 2004, 2006



Source: OCWD, 2004



Source: UC IPM, 2006



BASIN FACTS

Orange County Basin

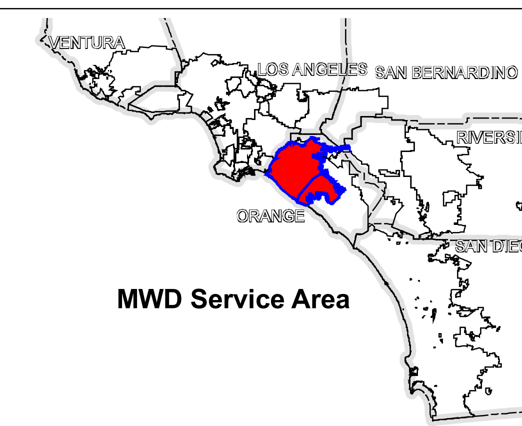
Description
Location: Orange County
Watershed Surface Area: 350 square miles
Subbasins:
Main
Irvine
Yorba Linda
MWD Member Agencies:
Municipal Water District of Orange County
Management: Managed
Since 1933, OCWD has managed basin. OCWD manages production, water quality, spreading operations, and seawater intrusion barrier operations.

	Orange County
Natural Safe Yield	70,500 AFY
Basin Production Percentage (BPP) for 2005/06	64 percent
Total Storage	66 million AF
Unused Storage Space	Data not available
Portion of Unused Storage Space Available for Storage (2006)	135,000 AF (100,000 AF reserved wet-year storms)

Storage and Extraction Facilities

	Orange County
Production Wells	
Production Capacity	420,000 to 440,000 AFY
Average 1985/86-2004/05	293,645 AFY
Seawater Intrusion Barriers	
Injection Capacity	53,000 AFY
Average 1985/86-2004/05	11,495 AFY
Non-barrier Injection Wells	
Injection Capacity	None
Average 1985/06-2004/05	None
Spreading Basins	
Spreading Capacity	250,000 AFY
Average 1985/86-2004/05	217,225 AFY

Basin Management Considerations
- Artificial recharge is a key management strategy for the Orange County Basin.
- Pumping in the basin is limited by the BPP, which is established annually by OCWD.
- The potential for seawater intrusion could limit the utilization of the basin unless additional seawater barrier facilities are constructed
- Water quality issues such as high TDS and nitrate in Irvine subbasin and colored water in the Lower aquifer system could limit ability to store and extract water from some portions of the aquifer.



MWD Service Area

Plate 10-1
Overview of Orange County Basin

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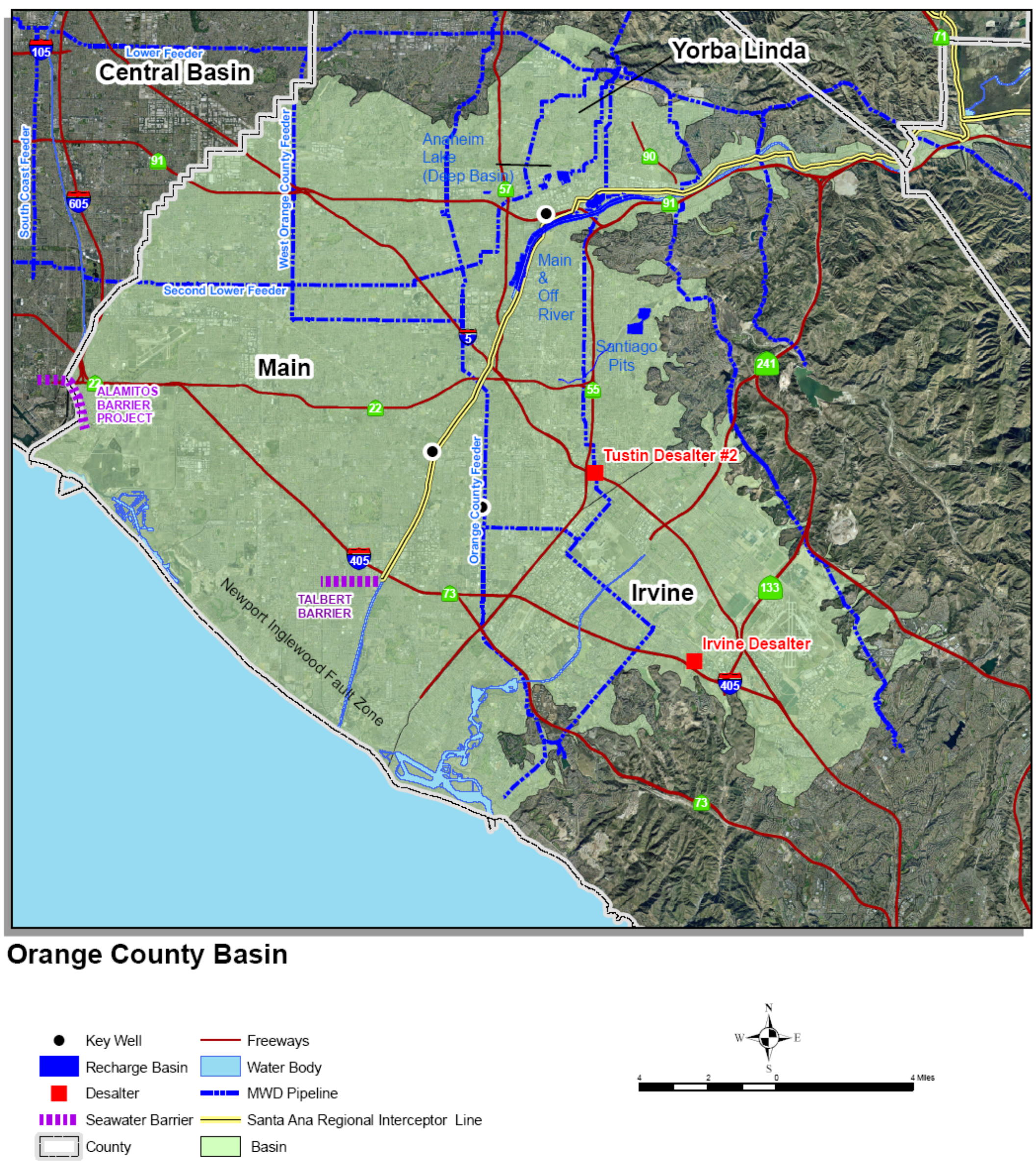
The Orange County Basin is located in north and central Orange County within the lower Santa Ana River watershed. Member agencies within the Orange County Basin include Anaheim, Fullerton, Santa Ana and the Municipal Water District of Orange County. It includes the communities of Anaheim, Buena Park, Costa Mesa, Cypress, 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. The Orange County Basin has been divided into three subbasins: Yorba Linda, Main and Irvine. A map of the basin is provided in **Figure 10-1**.

Figure 10-1
Map of Orange County Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Orange County Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The Orange County Basin is bounded by the Coyote and Chino Hills on the north, the Santa Ana Mountains on the northeast, the San Joaquin Hills on the south, and the Pacific Ocean and the Newport-Inglewood fault zone on the southwest (OCWD, 2004). The Orange County Basin is separated from the Central Basin along Coyote Creek and the County line, although there is no physical barrier between the two basins. The Newport-Inglewood fault zone acts as a complete barrier to flow from the ocean along most of its length in Orange County except at ancient river-crossing gaps, most notably the Alamitos Gap along the Los Angeles County line and the Talbert Gap in Huntington Beach and Costa Mesa. At these two locations, permeable river deposits cross the fault barrier providing the opportunity for seawater to flow into the Orange County Basin. As discussed in more detail below, a series of injection wells are utilized to halt the seawater intrusion at these locations.

As discussed above, the Orange County Basin includes three subbasins: Yorba Linda, Main and Irvine. These subbasins are managed by OCWD as a whole and are described herein for informational purposes.

The Yorba Linda subbasin is located north of the Anaheim Forebay recharge area, within the cities of Yorba Linda and Placentia. It is part of the basin, but currently has little groundwater pumping due to its low transmissivity and high TDS concentrations (Mills, 1987). Groundwater from the Yorba Linda subbasin flows southward into the Main Basin since the limited groundwater production is less than the natural replenishment from the adjacent Chino Hills.

The Irvine subbasin, bounded by the Santa Ana Mountains and the San Joaquin Hills, forms the southern-most portion of the basin. The Costa Mesa Freeway and Newport Boulevard approximate the subbasin's boundary with the Main Basin. Irvine-area aquifers are thinner and contain more clay and silt deposits than aquifers in the main portion of the basin. Groundwater typically flows out of the Irvine subbasin westerly into the Main Basin.

The hydrogeology of the Orange County Basin is characterized by a deep structural alluvial basin containing a thick accumulation of interbedded sand, silt and clay. **Table 10-1** provides a summary of hydrogeologic parameters for the Orange County Basin. The Orange County Basin contains three defined aquifer units: the Upper, Principal (or Middle) and Lower aquifers. In the northern portions of the Orange County Basin, referred to as the Forebay area, many of these aquifers are merged and allow for direct recharge into the deeper aquifers. In the area referred to as the Pressure Area, these aquifers are less hydraulically connected and create confined aquifer conditions. A conceptual geologic cross section across the Orange County Basin is provided in **Figure 10-2**.

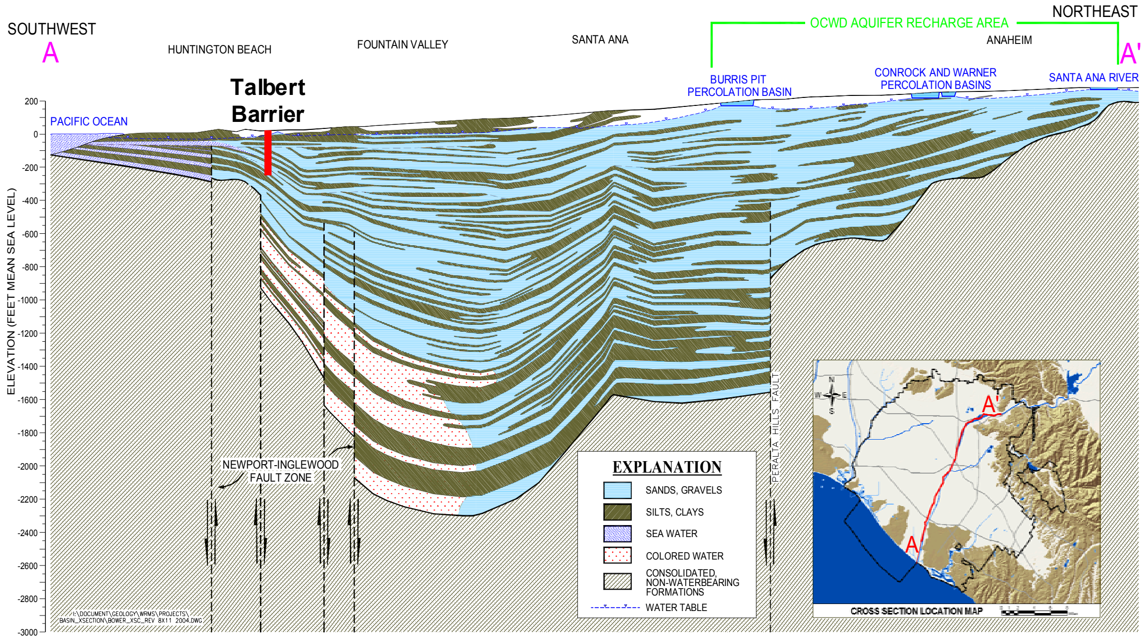
Table 10-1
Summary of Hydrogeologic Parameters of Orange County Basin

Parameter	Description
Structure	
Aquifer(s)	Forebay areas (unconfined) Pressure areas (confined) • Upper aquifer system • Principal aquifer system • Lower aquifer system
Depth of groundwater basin	> 2,000 feet
Depth of producing zones or screen intervals	200 to ~2,000 feet
Thickness of water-bearing units	Upper aquifer: Up to 300 feet (average ~200 feet) Principal aquifer: 500 to > 1,600 feet (average ~ 1,000 feet) Lower aquifer: ~300 to 1,000 feet
Yield and Storage	
Natural Safe Yield (Natural Incidental Recharge) [1]	70,500 AFY
Basin Production Percentage (2005/06) [2]	64 percent
Total Storage	Upper aquifer: 5 million AF Principal aquifer: 32.9 million AF Lower aquifer: 25.1 million AF Aquitards: 3 million AF 66 million AF
Unused Storage Space	Data not available
Portion of Unused Storage Space Available for Storage (June 2006) [3]	100,000 AF (reserved for wet year stormwater) 35,000 AF 135,000 AF total available

Source: DWR, 2004; OCWD, 2004

1. Natural safe yield includes infiltrated precipitation, irrigation, and other incidental recharge. Referred incidental recharge by OCWD.
2. Basin Production Percentage (BPP) is percentage of groundwater production out of the total water demand. BPP is set annually by OCWD. Historically, BPP has ranged from 64 to 80 percent.
3. Use of storage space is subject to approval by OCWD consistent with objectives for basin management

Figure 10-2
Hydrogeologic Cross Section of the Orange County Basin



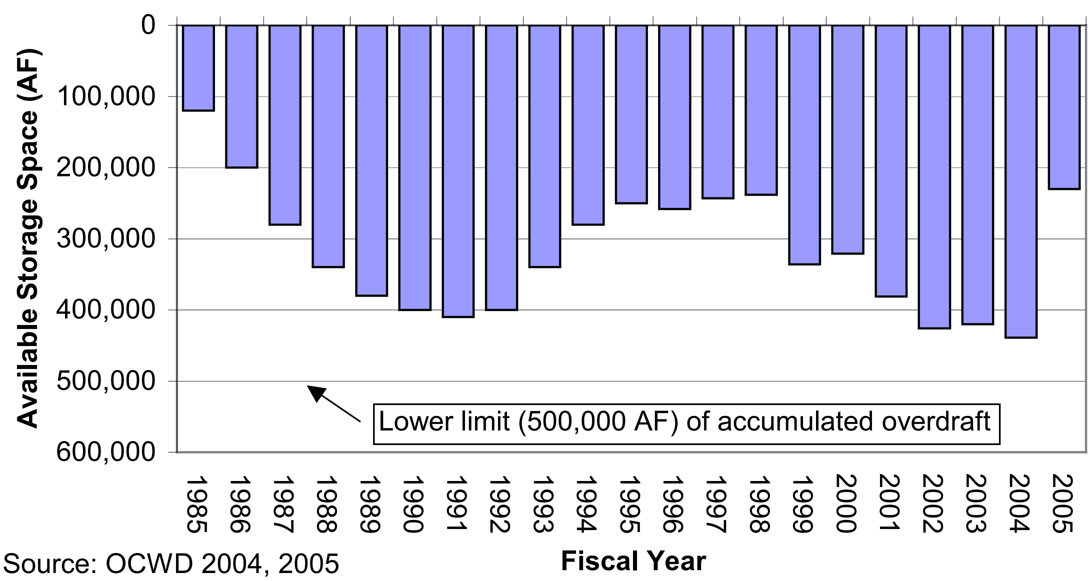
The Upper aquifer system, which averages approximately 200 feet in thickness, consists of alluvial sediments and includes the Talbert aquifer and recent alluvium. The total storage of this aquifer system is estimated to be approximately five million AF (OCWD, 2004). However, only about five percent of the total basin production comes from this aquifer because of lower production rates and poorer water quality than the underlying aquifers.

The Principal aquifer system averages approximately 1,000 feet in thickness and is the primary source of production in the Orange County Basin. The principal aquifers are located approximately 200 to 1,200 feet below ground surface (fbgs). This aquifer is correlative with portions of the Lakewood Formation and the San Pedro Formation of the Central and West Coast Basins in Los Angeles County. Orange County Water District (OCWD) estimates the total storage in this aquifer system is approximately 32.9 million AF (OCWD, 2004).

Deeper aquifers below the principal aquifer system comprise the Lower aquifer system (DWR, 2004), with a thickness of about 300 to 1,000 feet. Few wells produce from this aquifer because of the increased depth and the potential presence of colored water.

The total estimated volume of fresh groundwater capable of being stored in the Orange County Basin when it is completely full is estimated to be approximately 66 MAF by OCWD (2004). Based upon review of historical data, OCWD has established basin water contour levels, which represent a full basin. Volume in storage indicates how much storage space is available for use (defined as accumulated overdraft) within the Orange County Basin. OCWD estimates that between 400,000 and 500,000 AF of the total basin storage is actually usable (OCWD, 2004) in terms of emptying and filling operations. If groundwater levels are allowed to drop below the lower limit (i.e. >400,000 AF of accumulated overdraft) there is an increased potential for seawater intrusion, increased potential for colored water upwelling, and increased potential for subsidence. However, the basin can be operated on a short-term emergency basis with an accumulated overdraft up to approximately 500,000 AF without causing irreversible seawater intrusion or land subsidence (OCWD, 2004 and 2006). If groundwater levels are allowed to rise to near-full conditions, outflow to the Central Basin can increase, local near-surface groundwater levels may occur, and there would be a decreased potential for capturing large amounts of recharge if it were to become available. Historical data are shown in **Figure 10-3**. As shown in **Figure 10-3**, the accumulated overdraft increased more than 100,000 AF between 2000 and 2004 to more than 400,000 AF as a result of a six-year drought on the Santa Ana River. Due to recent heavy rains and basin management activities, as of June 2006, the accumulated overdraft or available storage space was 135,000 AF. Of this amount, 100,000 AF is kept in reserve for capture of stormwater runoff during a potentially wet year and 35,000 AF would be available for other storage purposes. It is also important to note that storage varies substantially from year to year in the Orange County Basin.

Figure 10-3
Historical Available Storage Space in Orange County Basin



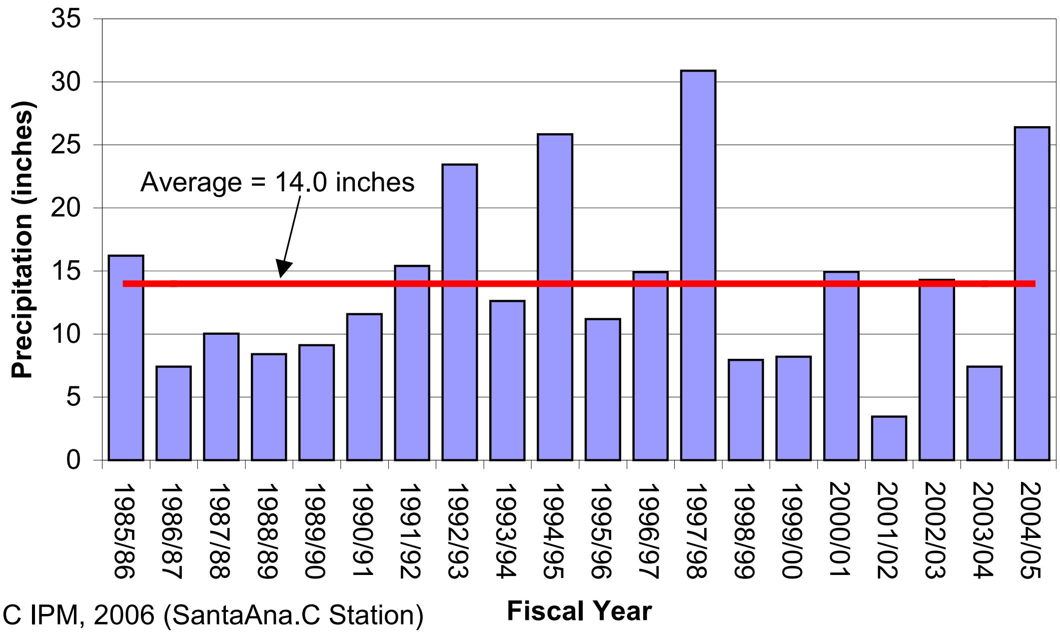
Source: OCWD 2004, 2005

Safe Yield/Long-Term Balance of Recharge and Discharge

Recharge to the Orange County Basin is primarily by direct percolation of Santa Ana River water through highly permeable sands and gravels within the forebay areas. Recharge also occurs as a result of injection through wells at the Talbert and Alamitos seawater barriers, use of imported water for groundwater replenishment, wastewater reclamation and other water conservation practices. The natural yield of the Orange County Basin, which includes infiltrated precipitation, irrigation, and other native incidental recharge, has been estimated to be approximately 70,500 AFY (OCWD, 2004). Active recharge in the Orange County Basin significantly increases the yield of the basin. For example, total recharge amounts (inclusive of natural incidental recharge and all active recharge) to the basin can vary between 300,000 AFY to 400,000 AFY and change annually depending upon the hydrology of the Santa Ana River, the amount of imported Metropolitan replenishment water that is purchased, the amount of water injected into the seawater barriers, and other incidental recharge. It is important to note that the Orange County Basin is not managed on a safe yield basis every year, but rather, as discussed below, is managed to maintain basin balance over the long-term.

Precipitation falling on the watershed contributing recharge to the Orange County Basin varies between the low lands and the flanking mountains depending on elevation. As measured at the Santa Ana Fire Station, approximately in the center of the basin, the average yearly precipitation over the 1985 through 2005 period is about 14 inches. **Figure 10-4** provides the historical precipitation data from the Santa Ana Fire Station over that period.

Figure 10-4
Historical Precipitation in the Orange County Basin



UC IPM, 2006 (SantaAna.C Station)

Groundwater pumping is the primary outflow from the basin. Groundwater production from the basin is managed by OCWD. As described below, the amount of groundwater producers can use is set annually and changes depending upon the management goals at that time. In fiscal year 2006/07, pumping is expected to be about 330,000 AFY. Annual pumping is expected to increase with the development of the Groundwater Replenishment System to 380,000 to 400,000 AFY.

GROUNDWATER MANAGEMENT

The following section describes how the Orange County Basin is currently managed. It includes a discussion of the governing structure within the basin and relationships with other adjoining basins.

Basin Management

The Orange County Basin is a managed basin. OCWD has managed the Orange County Basin since 1933 pursuant to a special act of the State legislature (West's Annotated California Codes, Water Code Appendix Chapter 50 as amended and Deering's California Codes Annotated Water Uncodified Acts.Act 5683). OCWD has managed the basin based upon the principle of seeking to increase supply rather than restricting access and to provide for uniformity of cost.
Table 10-2 provides a list of other agencies that OCWD may interact with in carrying out its mission.

The basin groundwater pumping is not operated on a safe-yield basis each year. Rather, the goal is to maintain an approximate balance over a period of several years. The amount of production from the basin is governed through financial incentives based on establishing an annual Basin Production Percentage (BPP), which is the percentage of groundwater production out of the total water demand for the Orange County Basin. Pumping up to the BPP is charged a fee on a per AF basis, i.e., the Replenishment Assessment (RA). Groundwater production above the BPP is charged the RA plus the Basin Equity Assessment (BEA). The BEA is typically set so that the cost of groundwater production above the BPP is similar to the cost of purchasing alternative supplies. Pumping agencies do not accrue individual storage rights if they pump less than the BPP, which is a major difference compared to most adjudicated basins. Additionally, agencies cannot transfer groundwater-pumping rights.

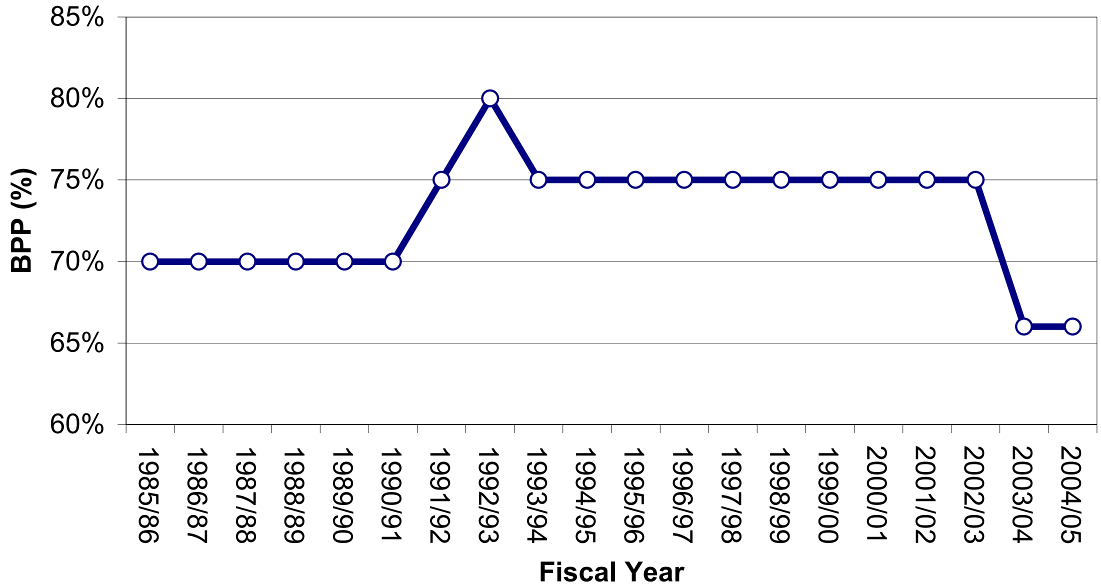
The basin is managed to provide approximately three years of drought supplies for the region. The accumulated overdraft target of 100,000 AF was in part set to meet this goal. If Santa Ana River supplies decline and/or Metropolitan replenishment water is not available, OCWD can generally sustain high pumping rates by overdrafting the groundwater basin for a three-year period down to an accumulated overdraft of 400,000 to 500,000 AF. The 100,000 AF target also provides sufficient storage space to capture excess water supplies that become available during very wet winters.

Figure 10-5 shows the historical BPP between 1985/86 and 2004/05. During this period, the BPP ranged from 66 percent to 80 percent. For the last 6 years of this period, Santa Ana River flows were significantly less than average. For the first four years of the drought (1998/99 through 2002/03) the BPP was maintained at 75 percent, which allowed for normal pumping levels. However, groundwater storage was reduced by approximately 230,000 AF during this period. Due to the continued drought conditions and seawater intrusion concerns, the BPP was reduced in fiscal year 2003/04 to 66 percent for two years and then lowered to 64 percent in fiscal year 2005/06. This lower BPP and heavy rainfall over the past few years has refilled the basin. As such, the BPP was raised to 69 percent for fiscal year 2006/07 and will be raised to 74 percent in fiscal year 2007/08.

Table 10-2
Summary of Water-Related Agencies in the Orange County Basin

Agency	Role
Orange County Water District	Basin Manager. Establishes and assesses production fees Monitors water levels and quality. Oversees recharge and seawater barriers operations.
Santa Ana Water Project Authority (SAWPA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the Santa Ana River Watershed.
Municipal Water District of Orange County (MWDOC)	Provides imported water for direct recharge. Regional planning agency.
Orange County Sanitation District	Provides recycled water for injection at Talbert Barrier and spreading at the forebay
Santa Ana River Watermaster	Court-appointed oversight of 1969 Judgment governing Santa Ana River flows
Orange County Resources Development and Management Department	Operation of Placentia and Raymond recharge basins Coordinates operation of Santa Ana River
Los Angeles County Department of Public Works (LACDPW)	Operation of Alamitos Barrier Project
United States Army Corps of Engineers	Operation of Prado Dam
California Regional Water Quality Control Board – Santa Ana Region (Regional Board)	Sets and enforces Basin Water Quality Objectives. Issues permits for discharges to Santa Ana River. Oversees injection operations using recycled water.

Figure 10-5
Historical Basin Production Percentage in Orange County Basin



Interactions with Adjoining Basins

The Orange County Basin is downstream of Prado Dam in the Lower Santa Ana River area. On April 17, 1969, the Orange County Superior Court entered a Stipulated Judgment in Case No. 117628 involving the Orange County Water District vs. City of City of Chino et al.

The Judgment, which became effective October 1, 1970, contains a declaration of rights of the entities in the lower Santa Ana River area (i.e. OCWD) versus those in the upper Santa Ana River area (i.e. San Bernardino Valley Municipal Water District, or SBVMWD, Chino Basin MWD, now called IEUA, and Western MWD). The Judgment is administered by the Santa Ana River Watermaster, a committee of five members (one each from SBVMWD, IEUA and Western MWD and two from OCWD). Under this Judgment, purveyors upstream of Prado Dam have the right to use all surface and groundwater supplies originating above Prado Dam without interference from water purveyors downstream of Prado Dam, provided that the average adjusted base flow at Prado Dam is at least 42,000 AFY. Baseflows have ranged from approximately 38,000 AFY in 1970 to approximately 170,000 AFY in 2002. (Santa Ana River Watermaster, 2003). SBVMWD has an obligation to ensure an average annual adjusted base flow of 15,250 AFY at Riverside Narrows. IEUA and Western MWD have a joint obligation to ensure average annual adjusted base flow of 42,000 AFY at Prado Dam. OCWD is allocated all other flows reaching Prado Dam in addition to the average annual adjusted base flow of 42,000 AFY. Further, SBVMWD, IEUA and Western MWD are prohibited from exporting water from the lower area to the upper area while OCWD is prohibited from exporting water or causing water to flow from the upper area to the lower area (Santa Ana River Watermaster, 2003).

Approximately 1,000 to 14,000 AFY underflow or outflow from the Orange County Basin can occur northwestward across political boundaries into the Central Basin in Los Angeles County depending on the groundwater elevations on either side of the political line. Modeling by OCWD indicated that, assuming groundwater elevations in the Central Basin remain constant, underflow to Los Angeles County increases approximately 7,500 AFY for every 100,000 AF of increased groundwater storage in the Orange County Basin.

OCWD has purchased water from the area of high groundwater in Bunker Hill Basin from San Bernardino Valley Municipal Water District. This water is spread in the recharge facilities along the Santa Ana River. A total of 7,084 AF of this water has been recharged since 2000.

OCWD also purchases water from the Arlington Desalter in the Arlington Basin for groundwater recharge in the Orange County Basin. This water is spread in the recharge facilities along the Santa Ana River. An average of approximately 3,800 AFY has been recharged since the Arlington Desalter came online in 1990. As demands increase in the Riverside and Norco areas, this supply source is likely to decline in the future. Brine from the Arlington Desalter is also delivered to the Orange County Sanitation District treatment facilities via the Santa Ana Regional Interceptor (SARI) line for treatment and discharge to the ocean.

OCWD has worked extensively with the United States Army Corps of Engineers (USACE) regarding the operations of Prado Dam to conserve Santa Ana River storm flows. During the winter storm season, the USACE will store water up to elevation 498 feet MSL, which creates a pool of approximately 13,000 AF. Beginning on March 15th of every year the USACE will store water up to elevation 505 feet MSL, which creates a pool of approximately 26,000 AF. The OCWD coordinates its recharge operations to empty these pools as quickly as possible without losing water to the Pacific Ocean to create storage space for future storms.

WATER SUPPLY FACILITIES AND OPERATIONS

The following section describes the water supply facilities within the Orange County Basin. Facilities include nearly 500 production wells, 800 monitoring wells, more than 1,000 acres of recharge ponds in the Forebay areas, two seawater intrusion barriers, three desalters, the Groundwater Replenishment System, the Prado wetlands and Prado Dam. OCWD has constructed numerous projects to support increases in basin pumping. These investments have resulted in a doubling of the basin’s yield over the past 30 years.

Active Production Wells

Groundwater extraction from the Orange County Basin occurs from nearly 500 production wells. Average production in the Orange County Basin for the past 20 years was nearly 294,000 AFY. Approximately 97 percent of the production is municipal water supplied through approximately 200 large capacity wells. For example, groundwater production (excluding Metropolitan in-lieu supplies received) totaled 244,370 AF for the 2004/05 water year; of that amount 240,978 AF was for non-irrigation use. These data are summarized in **Table 10-3**.

Table 10-3
Summary of Production Wells in the Orange County Basin

Category	Number of Active Wells	Estimated Production Capacity[1] (AFY)	Average Production 1985/86-2004/05[2] (AFY)	Well Operation Cost ($/AF)
Non-Irrigation Wells (large and small capacity)	~300	420,000 to 440,000	293,645	O&M $65 Energy $56 **Total $111**
Irrigation Wells	~200			
Total	**~500**			

Source: OCWD, 2005 and Herndon, 2006
1. Based on analysis and estimates by MWDOC
2. Excludes Metropolitan long-term in-lieu replenishment water deliveries

Figure 10-6 shows historical production in the Orange County Basin. In the five-year period between 2000/01 and 2004/05, groundwater production declined from about 350,000 AFY in fiscal year 2000/01 to less than 245,000 AFY because, as discussed above, the BPP was adjusted to increase the amount of water stored in the basin (see **Figure 10-5**).

Orange County Basin producers participate in a variety of in-lieu groundwater storage programs whereby they receive imported water from Metropolitan in lieu of pumping groundwater. Historically, these programs have included Metropolitan's, short-term shift (seasonal), cyclic water, replenishment water and conjunctive use programs. The long-term in-lieu storage (cyclic, replenishment or conjunctive use programs) amounts are included in **Figure 10-5**. Short-term shift totals, since they are seasonal in nature, are not shown in this figure. Between fiscal years 1985/86 and 2004/05, on average, about 28,000 AFY was stored via long-term in-lieu. These and other storage programs are discussed in more detail below.

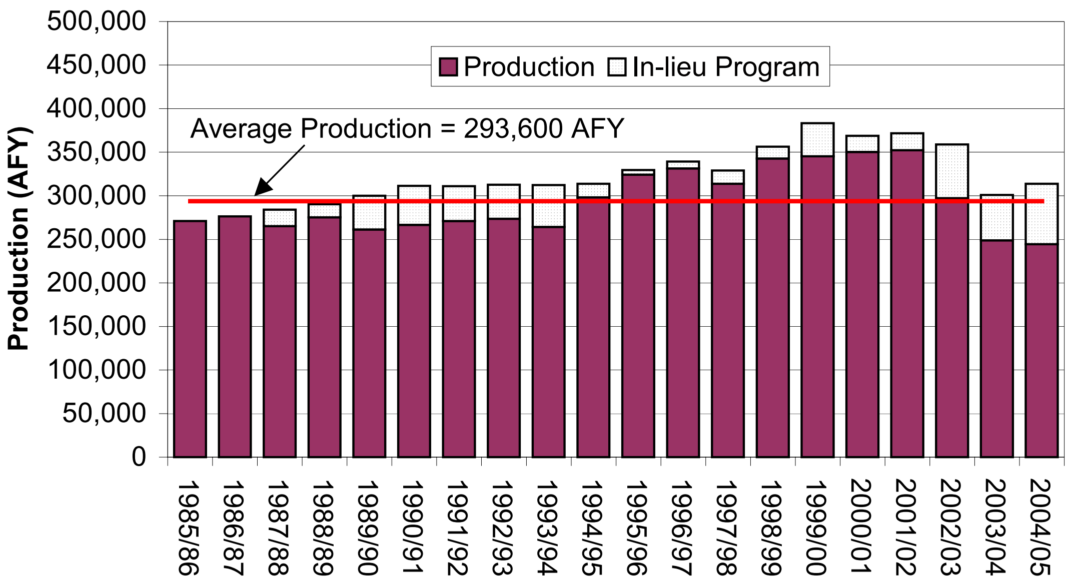
Other Production

The primary groundwater production in the Orange County Basin, other than municipal usage, is for agricultural irrigation as summarized in **Table 10-3**. The volume of agricultural production has been steadily declining with increasing urban development of agricultural lands.

ASR Wells

There currently are no ASR wells in the Orange County Basin.

Figure 10-6
Historical Groundwater Production in the Orange County Basin



Source: OCWD 2004, 2006

Spreading Basins

The OCWD currently owns and operates more than 1,000 acres of ponds in and adjacent to the Santa Ana River and Santiago Creek, as shown on **Figure 10-1**. **Table 10-4** provides details of the recharge basins size and spreading capacity, which can vary significantly depending upon their cleanliness. Over a few months, the bottom of the recharge basins can become clogged with fine silts, which greatly diminishes their spreading capacity. These facilities currently provide for the infiltration of approximately 250,000 AFY (OCWD, 2004). Water sources used for recharge include Santa Ana River baseflow and stormflow, Santiago Creek flows, imported water from Metropolitan and from the upper Santa Ana River Watershed, and previously treated water from OCWD's Water Factory 21 and now the Groundwater Replenishment (GWR) System. **Figure 10-7** shows historical groundwater recharge in the Orange County Basin. OCWD spread an average of approximately 217,000 AFY between fiscal years 1985/86 and 2004/05.

Wetlands

OCWD owns 1,400 acres of land behind Prado Dam. Approximately 400 acres have been developed into wetlands. About 50 percent of the Santa Ana River base flows (up to 120 cfs) are diverted through the wetlands where they receive natural treatment that significantly reduces nitrate concentrations. These wetlands provide a significant water quality benefit to the Orange County Basin.

Table 10-4
Summary of Spreading Basins in the Orange County Basin

Recharge Basin/System	Area (acres)	Recharge Capacity (cfs)[1]	Source water	Owner
Main Santa Ana River	245	80 to 130	Runoff[2] Imported	OCWD
Off-River	126	15 to 40	Runoff[2] Imported	OCWD
Deep Basin	285	90 to 390	Runoff[2] Imported	OCWD and OC Resources Development and Management Department
Burris Pits/ Santiago Basin	378	110 to 220	Runoff[2] Imported	OCWD
Total	**1,034**	**313 average[3]**	**--**	**--**

Source: OCWD, 2004
[1]Percolation rate range represents clogged and clean capacities
[2]The primary source of recharge water enters the facilities from the Santa Ana River downstream of Prado Dam.
[3]Average for period 1989 to 2005

Seawater Barriers

The portion of the basin within 5 miles of the coast, particularly in the geologic gaps previously discussed, is sensitive to seawater intrusion due to lower groundwater levels. To protect the fresh groundwater in the basin from seawater intrusion, OCWD injects water into the Talbert and Alamitos barriers, which are shown on **Figure 10-1**. Details of the barriers are provided in **Table 10-5.** The total annual volume of water injected into the barriers is included in **Figure 10-7**. During the 2004/05 fiscal year about 19,800 AF of water was injected into the barriers (OCWD, 2006). An average of approximately 11,500 AFY was injected into the barriers between fiscal years 1985/86 and 2004/05.

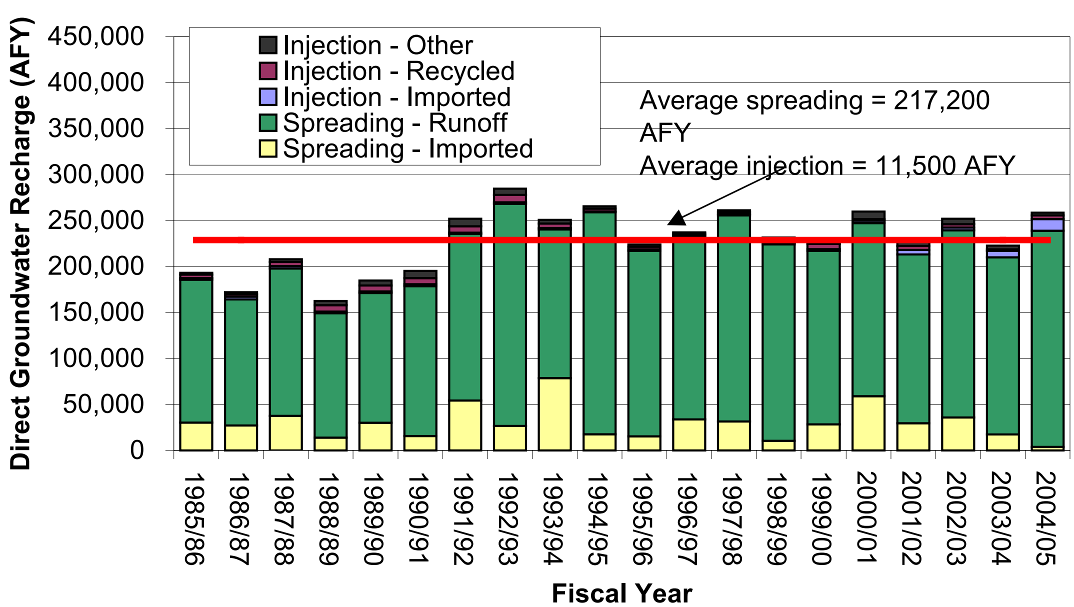
The Talbert Barrier, in operation since 1975, is composed of a series of 26 injection wells that span the 2.5 mile wide Talbert Gap in Fountain Valley. Historically, a mixture of wastewater treated at Water Factory 21 and deep well water was pumped to the wells and injected into the shallow aquifer systems. Since 2003, imported water from Metropolitan has also been injected.

Water Factory 21 was decommissioned in 2004 and is being replaced with the GWR System, which will include 12 new wells and increase the injection capacity to 40 MGD. The GWR System will produce a total of 72,000 AFY of new water supplies. Up to half of the water will be annually injected into the Talbert Barrier. The remaining supplies will be pumped to OCWD's spreading facilities in Anaheim for recharge in the Forebay area (OCWD, 2004). The GWR System is expected to be constructed and fully on line by September 2007.

Table 10-5
Summary of Seawater Intrusion Barriers in the Orange County Basin

Seawater Barrier	Number of wells	Injection capacity (AFY)	Source water	Owner
Talbert Barrier	38	40,000	Recycled Groundwater Imported	OCWD
Alamitos Barrier Project	43	11,000	Recycled Imported	LACDPW OCWD
Total	**69**	**53,000**	--	--

Figure 10-7
Historical Groundwater Recharge in the Orange County Basin



The Alamitos Barrier Project consists of 43 wells with a combined injection capacity of 15 cfs and 4 extraction wells in the Alamitos Gap in Long Beach and Seal Beach (DWR, 2005;WRD, 2006d). The barrier straddles the political boundary between the Central and Orange County basins and is operated by LACDPW in cooperation with OCWD and Water Replenishment District of Southern California (WRD). Up to 11,000 AFY could be injected. The barrier utilizes imported water purchased from the City of Long Beach or recycled water from WRD's Leo J. Vander Lans Advanced Water Treatment Facility. Prior to 2005, recycled water was not injected in the Alamitos Barrier Project. WRD began delivering recycled water for injection in water year 2005/06.

Desalters

The Irvine Desalter is a joint groundwater quality restoration project by the Irvine Ranch Water District (IRWD), OCWD, MWDOC, Metropolitan, and the United States Navy to employ two water purification plants to address a shallow plume of VOCs that exists beneath the former El Toro Marine Corp Air Station, which is moving toward the Main Orange County Basin. One plant removes TDS and VOCs from the contaminated groundwater and the treated water is used for irrigation and recycled water purposes (OCWD, 2004). The second plant removes TDS and nitrate from the shallow groundwater aquifer outside the former El Toro Marine Corps Air Station plume to provide a new drinking water source (OCWD, 2004).

The Tustin Seventeenth Street Desalter is operated to reduce primarily shallow groundwater with high nitrate and TDS levels produced from the Seventeenth Street Wells Nos. 2, 4 and Tustin's Newport Well. The treated water is blended back with produced native water producing up to 3,000 AFY of potable water (OCWD, 2004).

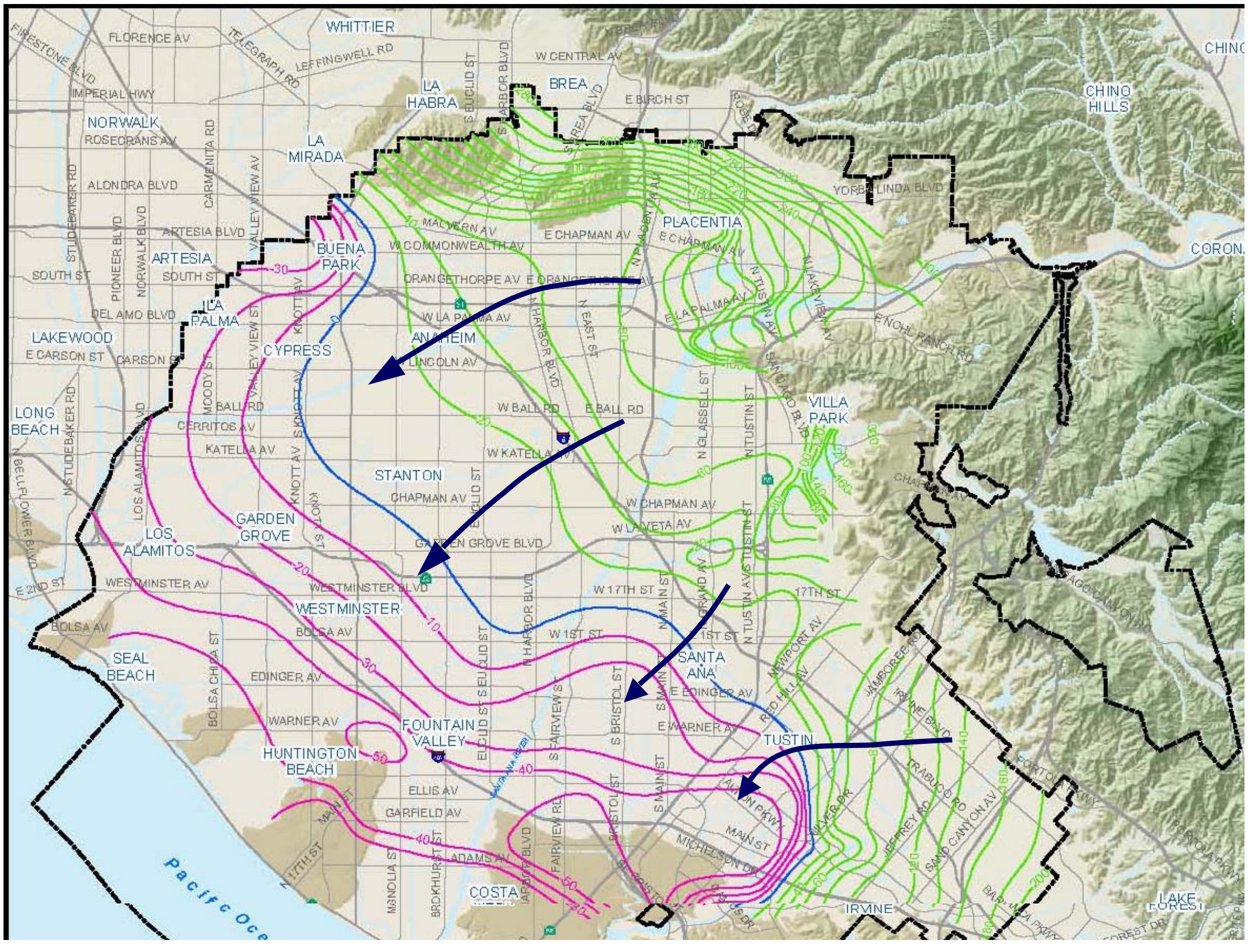
GROUNDWATER LEVELS

Historically, groundwater flow in the Orange County Basin has been from the recharge areas in the north toward the Pacific Ocean. As shown in **Figure 10-8**, in November 2005, Orange County Basin water levels ranged from a high of about 300 feet above mean sea level (MSL) in the north portion of the basin upgradient of the spreading grounds to a low of about 80 feet below MSL in the coastal areas.

Historical water levels in key wells in various locations in the basin are summarized in **Figures 10-9 and 10-10**. The locations of the wells plotted are shown in **Figure 10-1**. These data show that water levels in the Forebay area where the aquifers are merged generally experience higher water levels and are relatively stable with annual variations on the order of 50 feet. In the Pressure area, water levels in the underlying aquifers are generally below sea level. Water levels generally correlate with the change in storage discussed above. Seasonal variations in water level in the Pressure area are as much as 100 feet. Water levels in the key well in south-central pressure area decreased up to 70 feet between 1985 and 2004. Water levels in other key wells are essentially unchanged in this same period.

Land subsidence due to groundwater withdrawal is common in groundwater basins. Slight subsidence has been observed in Santa Ana, which may be due to groundwater withdrawal, and in the Huntington Beach area, likely due to oil withdrawal (OCWD, 2004). In the period between 1993 and 1999, land surface elevations declined about 0.5 inches per year in Santa Ana (OCWD, 2004). Despite the indications of land subsidence in the Orange County Basin, there has been no indication that these decreases have resulted in damage. By managing groundwater levels and storage, the potential for land subsidence can be reduced (OCWD, 2004).

Figure 10-8
Groundwater Elevation Contours – November 2005

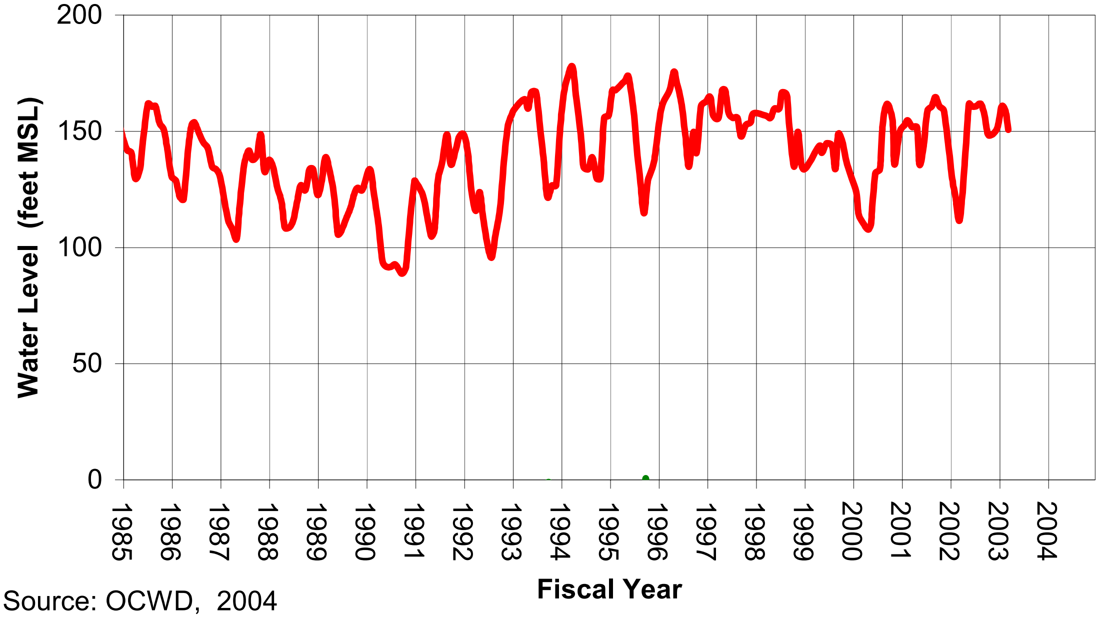


Source: Herndon, 2006

GROUNDWATER QUALITY

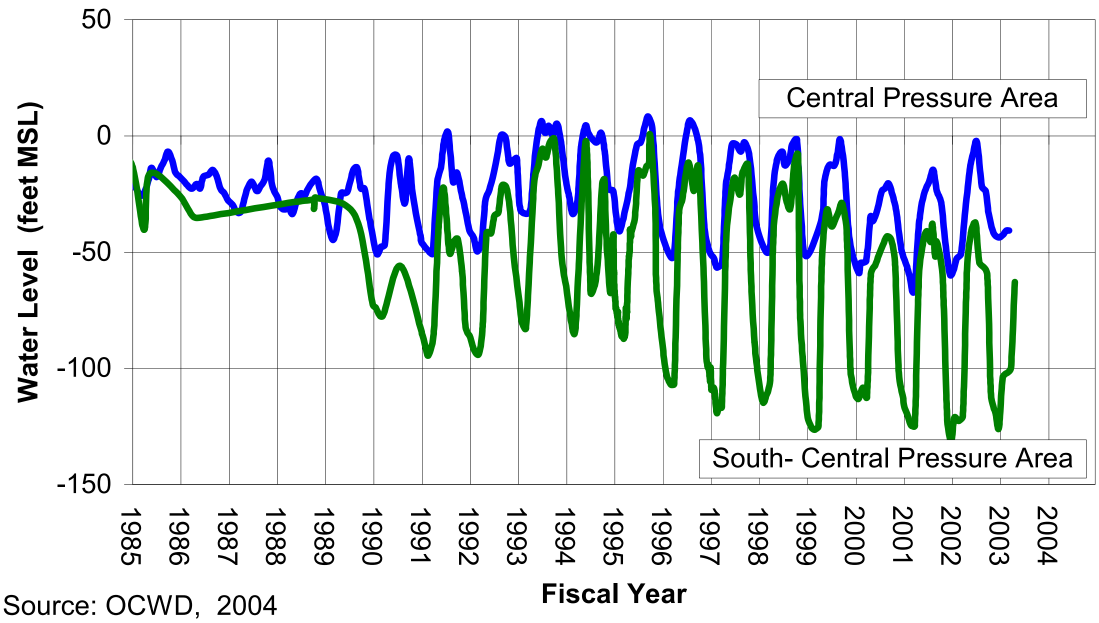
In general, groundwater in the main producing aquifers of the basins is of good quality with an average concentration of total dissolved solids (TDS) in the basin of 441 mg/L (OCWD, 2006). Ninety to 95 percent of basin pumping is from the main aquifers. A few localized areas of shallow contamination exist in the basin, however, very little water is pumped from the shallow aquifers. Additionally, OCWD has implemented active projects and programs to remove contaminants from the shallow aquifers before they can migrate into the main producing aquifers.

Figure 10-9
Historical Water Levels in the Forebay Area



Source: OCWD, 2004

Figure 10-10
Historical Water Levels in the Pressure Area



Source: OCWD, 2004

The following section provides a brief description of groundwater quality issues in the Orange County Basin. The discussion includes a description of current monitoring program, constituents of concern, and treatment operations in the basin.

Groundwater Contaminants

Key constituents of concern for the Orange County Basin include: total dissolved solids, nitrate, volatile organic compounds (VOCs), perchlorate, colored water, and NDMA. The nitrate and VOC contaminants are located in the shallow aquifers and none of these contaminants have significantly impacted the groundwater basin's operation. In many portions of the groundwater basin, shallow water is prevented from migrating into deeper aquifers due to aquitards (impervious formations). Additionally, OCWD has aggressively initiated programs to address contaminants of concern before they become larger issues. A summary of these constituents is provided in **Table 10-6**.

TDS concentrations range from 221 mg/L in Seal Beach area to more than 1,000 mg/L in portions of the Irvine subbasin (OCWD, 2006). Increasing concentrations in forebay areas of the Main basin are shown in **Figure 10-11**, which have led to management approaches such as using low TDS groundwater replenishments and desalters. Areas of high TDS (>1,000 mg/L) in the Irvine subbasin areas are shown in **Figure 10-12**.

Nitrate concentrations generally range from 4 to 7 mg/L in Forebay and 1 to 4 mg/L in the Pressure area with an average of about 2.2 mg/L (OCWD, 2004; OCWD, 2006). Areas with concentrations above 10 mg/L are located in inland areas. Nitrate concentrations that exceed the MCL occur only in a small number of areas in the Orange County Basin (OCWD, 2004). Nitrate plumes that are generally located in the shallow aquifers in the basin are shown in **Figure 10-12**.

Localized shallow aquifer areas, as shown in **Figure 10-12**, are also affected by high concentrations of volatile organic compounds (VOCs), most notably trichloroethylene (TCE) and tetrachloroethylene (PCE). OCWD has active remediation projects to remove these VOC and nitrate contaminants before they reach the Principal aquifer system.

Perchlorate has primarily been detected in the Forebay area and in only one well in the Orange County Basin at concentrations at or below the current State notification level of 6 μg/L.

As discussed above, the presence of colored water is significant in the Orange County Basin. However, colored groundwater is limited to the Lower aquifer system primarily near the coast and ranges from 25 color units to 230 color units. The area of colored groundwater is shown in **Figure 10-13**. Most production wells along the coast pump from the Principal aquifer, which is above the colored water.

Blending Needs

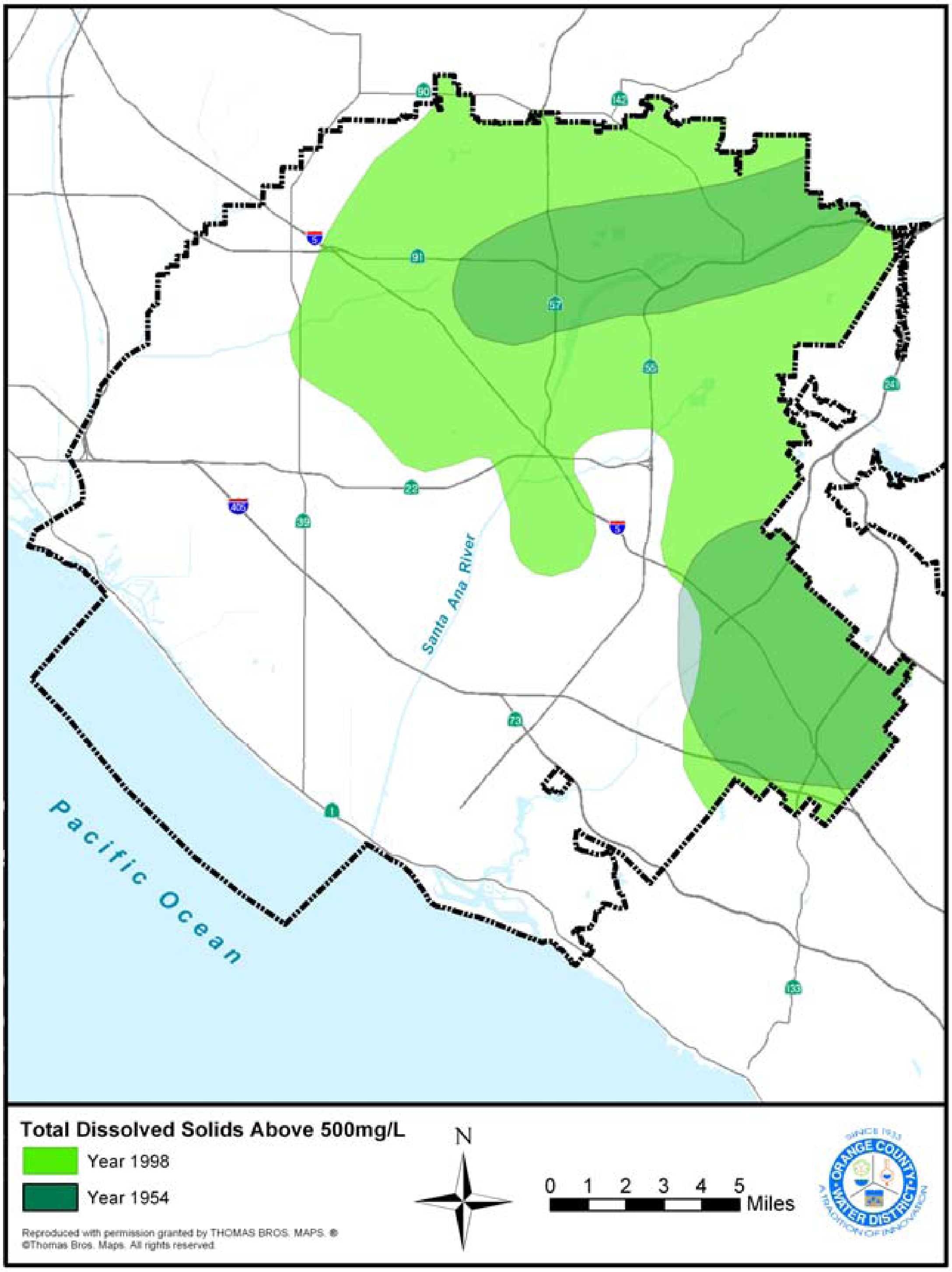
The local retail producers serve a blend of groundwater and MWD imported water supplies. The blend percentage primarily depends upon the BPP. The average TDS of blended water in agency systems ranges from 315 mg/L to 560 mg/L with an average of 450 mg/L. Nitrate concentrations of blended water range from 0.1 to 3.5 mg/L with an average of 1.4 mg/L (OCWD, 2006).

Table 10-6
Summary of Constituents of Concern in the Orange County Basin

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	221 to > 1,000 Average ~ 441	Range from 221 mg/L in Seal Beach area to more than 1,000 mg/L in portions of Irvine subbasin. Increasing concentrations in Forebay areas.
Nitrate (as N) MCL = 10	mg/L	ND to >10 Average ~ 2.2	Associated with former agricultural activities. Concentrations range from 4 to 7 mg/L in Forebay and 1 to 4 mg/L in the pressure areas. Localized shallow aquifer areas with concentrations above 10 mg/L are located in inland areas. No production wells are impacted by nitrate.
VOCs **(TCE and PCE)** TCE MCL = 5 PCE MCL = 5	µg/L	ND to >5 for TCE ND to 5.5 for PCE	VOCs found beneath El Toro Marine Corps Air Station and central Irvine in 1985. Found in Forebay areas in 1989. Limited to shallow zones in Forebay. PCE found in well in Santa Ana.
Perchlorate Notification level =6	µg/L	ND to 6	Occurs primarily in Forebay area and one well in Santa Ana. No production wells are impacted by perchlorate.
Color Secondary MCL =3	Units	ND to 230	Colored groundwater is limited to Lower aquifer system near the coast. Range in colored water zone ranges from 25 color units to 230 color units.
NDMA Notification level = 10	ng/L	ND to >10	One well along the coast is treated for NDMA

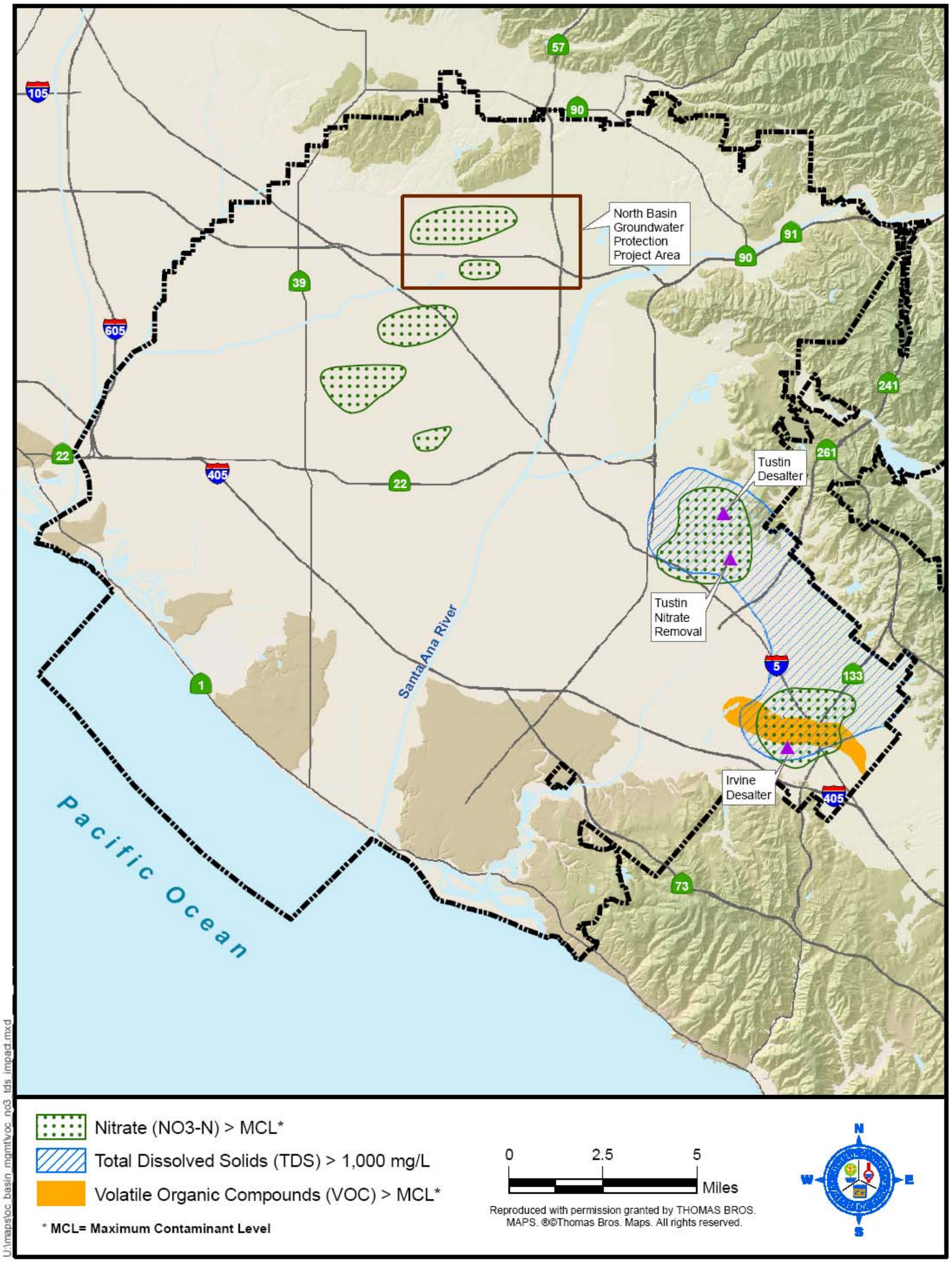
Source: OCWD, 2004, 2006

Figure 10-11
Areas Containing TDS above 500 mg/L in Orange County Basin



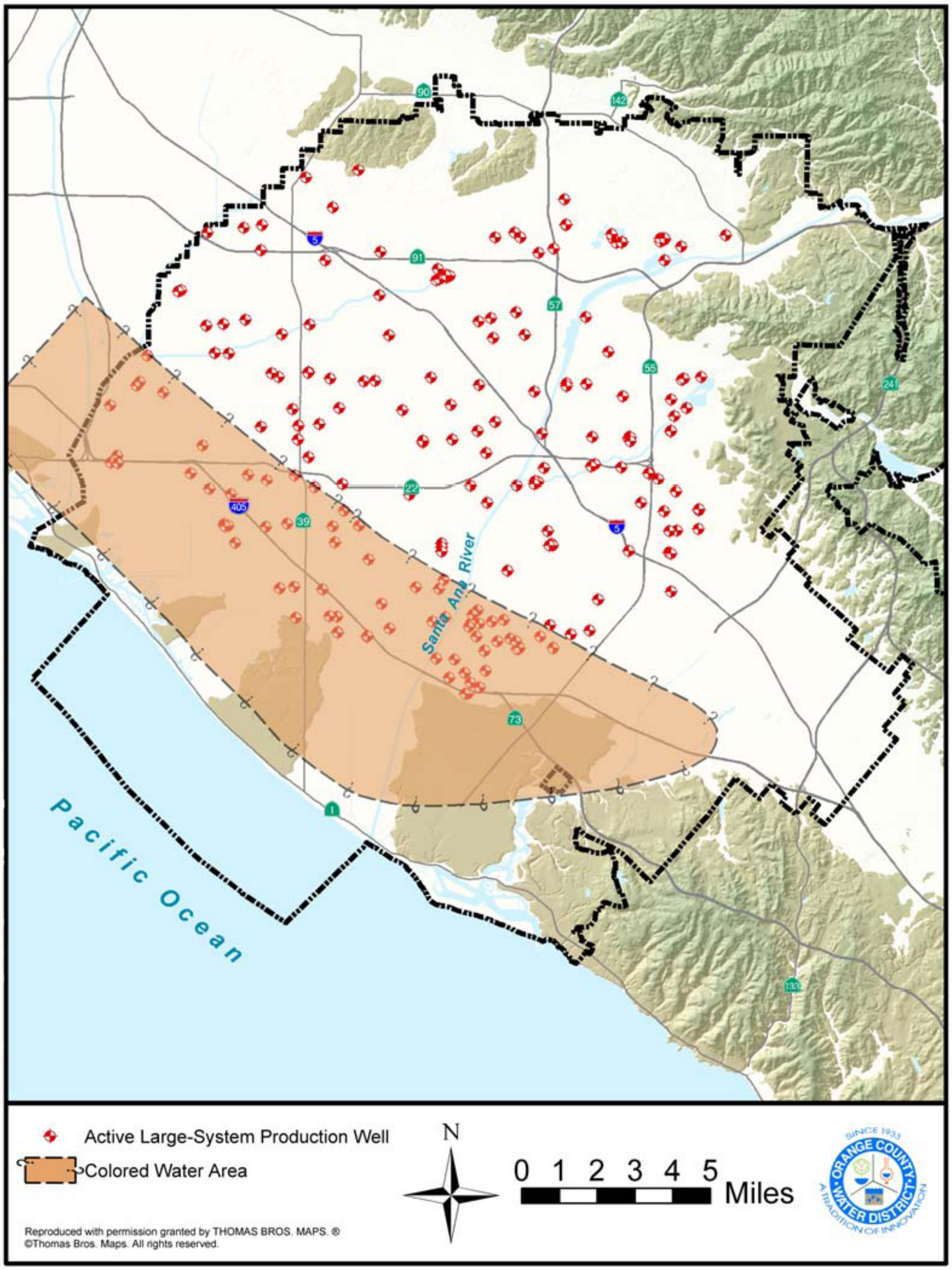
Source: OCWD, 2004

Figure 10-12
Areas Impacted by Nitrates, Salts, and VOCs in Orange County Basin



Source: OCWD, 2007

Figure 10-13
Areas of Colored Water in the Orange County Basin



Source: OCWD, 2004

Groundwater Treatment

Six treatment projects are in effect to lower nitrate, TDS, VOC, iron and manganese, NDMA and color to acceptable levels in groundwater produced from several wells totaling approximately 20,000 AF in 2006. The locations of the treatment facilities are shown in **Figure 10-14**.

CURRENT GROUNDWATER STORAGE PROGRAMS

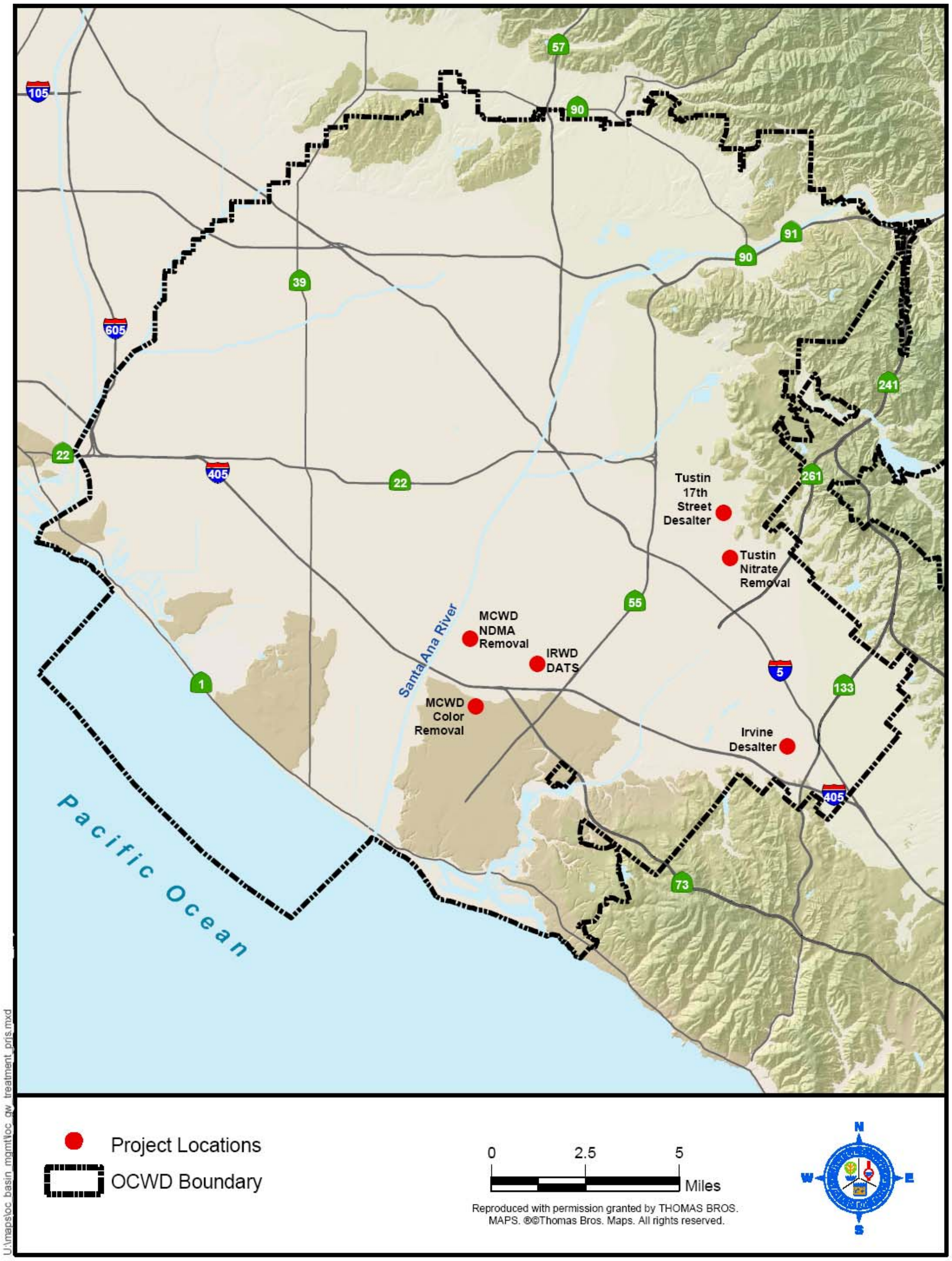
Orange County Basin producers have participated in a variety of groundwater storage programs with Metropolitan since 1985. These include Metropolitan's short-term shift, cyclic water, and replenishment water programs for purchase of imported water for recharge and in-lieu. Direct recharge volumes are discussed above.

In-lieu deliveries are summarized in **Figure 10-15**. An average of approximately 27,800 AFY was stored in-lieu in the Orange County Basin between fiscal years 1985/86 and 2004/05. On average about 15,500 AFY of short-term seasonal shift water (i.e. stored and extracted in same year) was also delivered.

In June 2003, OCWD and Metropolitan entered into an agreement for the Orange County Conjunctive Use Program (Orange County CUP). The Orange County CUP allows Metropolitan to store up to 66,000 AF in the basin to be taken later by Metropolitan in-lieu of providing imported supplies during water shortage events. The balance at the end of fiscal year 2005/06 was approximately 35,500 AF.

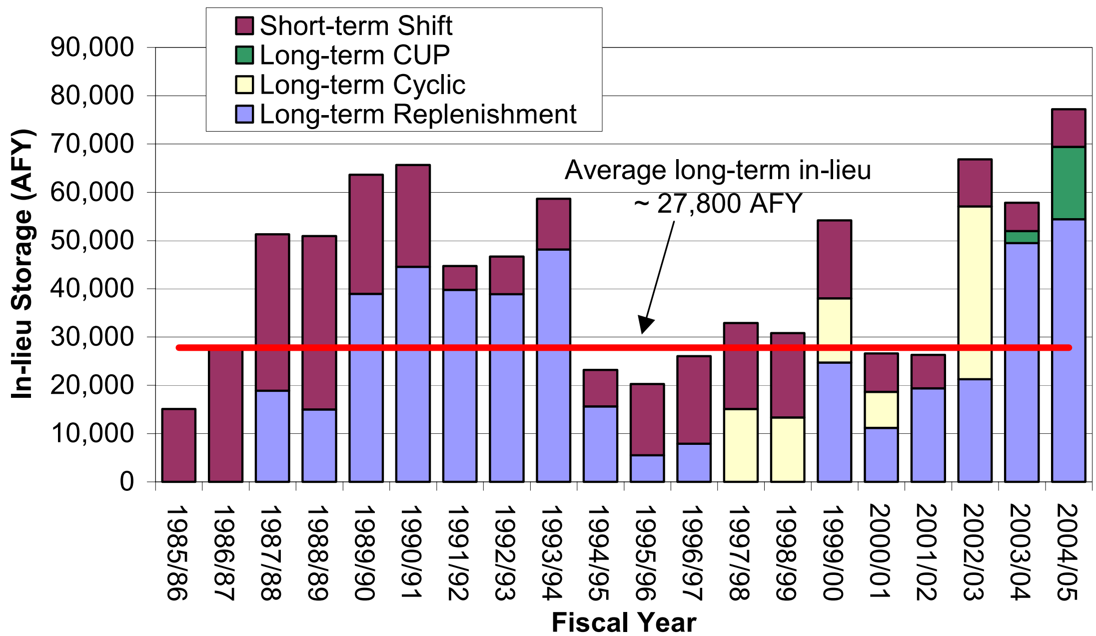
In addition to replenishment and CUP storage, Metropolitan and MWDOC entered into an agreement in late 2005 for delivery of supplemental storage water. After a combined 80,000 AF had been taken via the replenishment and CUP programs, MWDOC could purchase additional imported water for storage in the Orange County Basin at a discounted rate before June 30, 2006. This water would be stored in the Orange County Basin for five years. Metropolitan could call the water during this time period. After five years, this water would revert to the Orange County Basin. 16,000 AF of water was placed into this account.

Figure 10-14
Locations of Groundwater Treatment Projects in the Orange County Basin



Source: OCWD, 2007

Figure 10-15
Historical In-Lieu Storage in the Orange County Basin



Source, MWD 2006

BASIN MANAGEMENT CONSIDERATIONS

The following describes the basin management considerations in the Orange County Basin. Considerations include:

- The basin is managed to provide a sustainable yield of groundwater to the OCWD region.
- Recharge via spreading or injection is a key management strategy for the Orange County Basin. An average of about 229,000 AFY was recharged between 1985 and 2004.
- Groundwater production in the basin is limited by the BPP. OCWD sets the BPP each year to manage the groundwater basin. The BPP has ranged from 64 percent to 80 percent of total water demand.
- The potential for seawater intrusion primarily limits the utilization of the basin unless additional seawater barrier facilities are constructed. Current groundwater improvement projects and the construction of the GWR System at the Talbert Barrier have increased the groundwater utilization.

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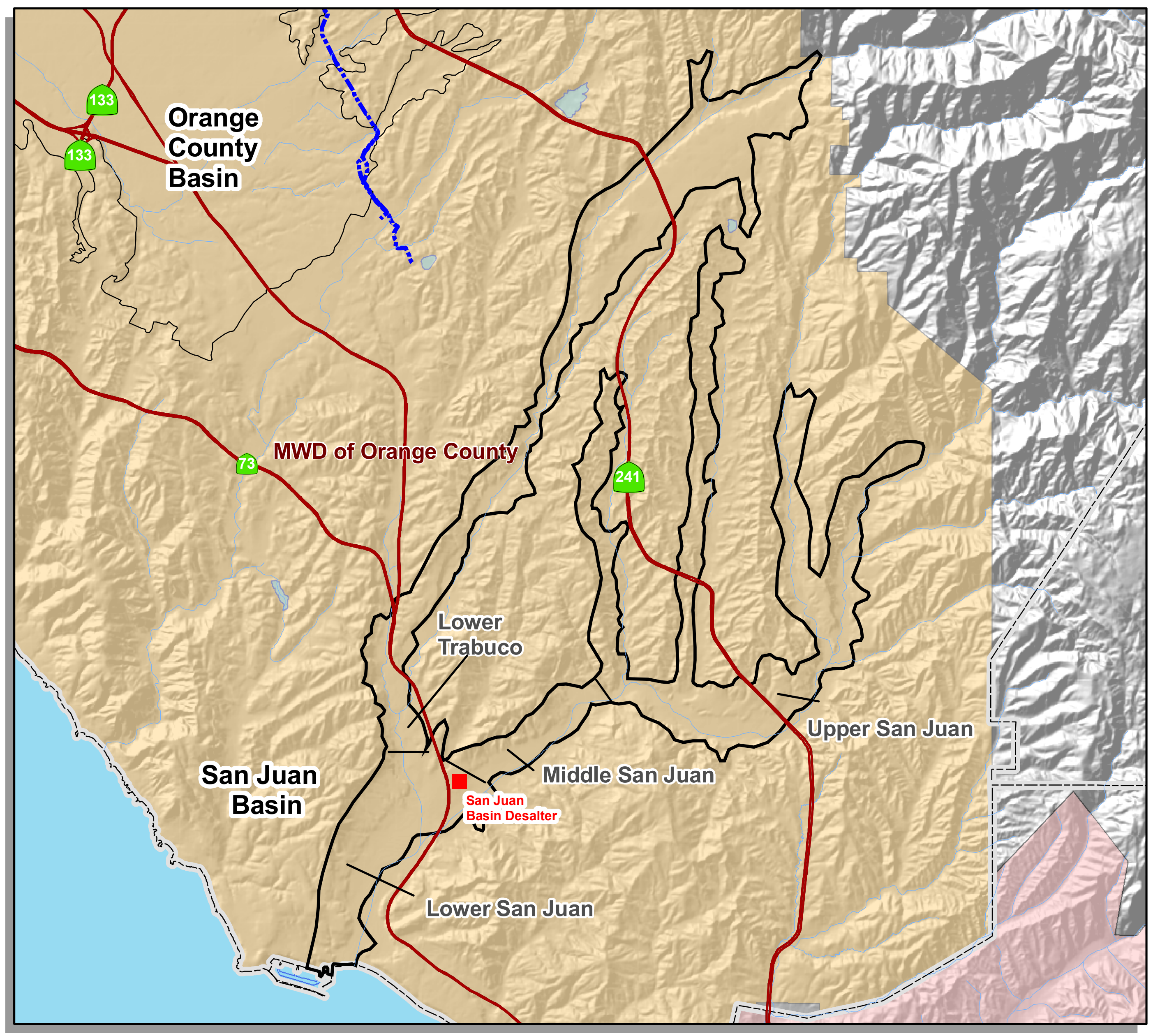
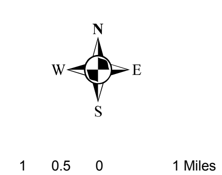


San Juan Basin



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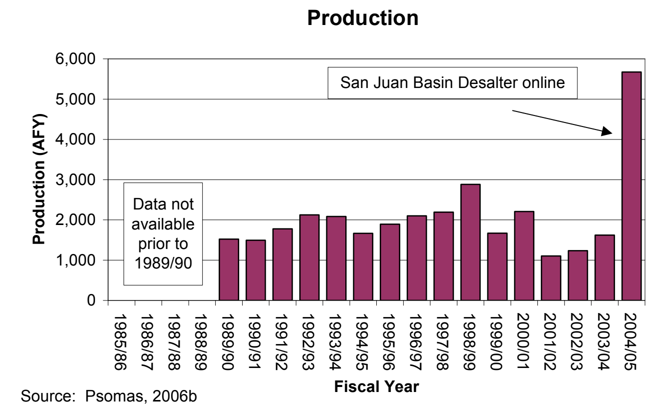
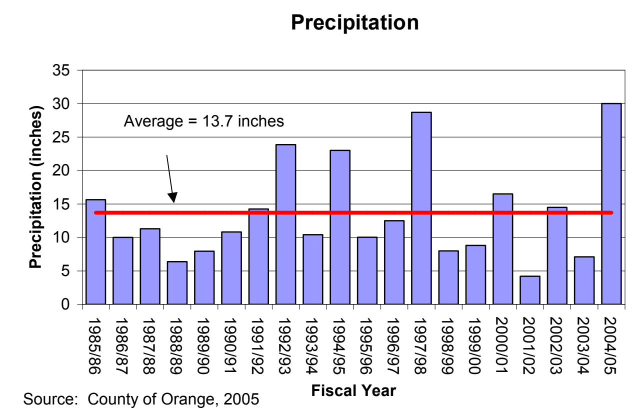
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).



Source: Psomas, 2006b



Source: County of Orange, 2005

Direct Recharge
No direct groundwater recharge for this basin

BASIN FACTS

San Juan Basin

Description
Location: Southern Orange County
Watershed Surface Area: 26 square miles
MWD Member Agency(s):
Municipal Water District of Orange County
Management: Unadjudicated
Groundwater managed by the San Juan Basin Authority since 1971.

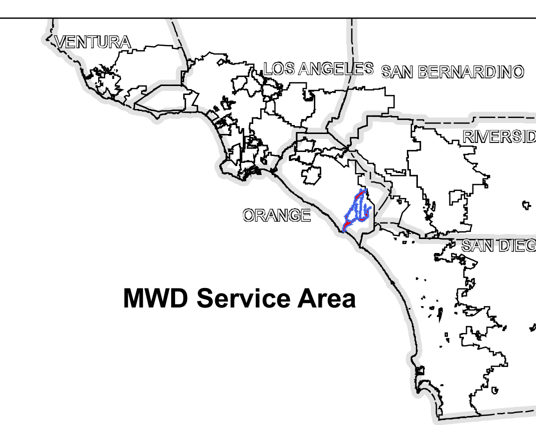
	San Juan
Safe Yield	7,300 to 7,800 AFY
Total Storage	90,000 AF
Unused Storage Space	Unknown
Portion of Unused Storage Space Available for Storage	Unknown

Storage and Extraction Facilities

	San Juan
Production Wells	
Production Capacity	~14,800 AFY
Average 1989/90-2004/05	2,079 AFY
Injection Wells	
Injection Capacity	None
Average 1985/86-2004/05	None
Spreading Basins	
Spreading Capacity	None
Average 1985/86-2004/05	None

Basin Management Considerations

- Allowable quantities of water that may be diverted and pumped are specified in the water rights permits administered by the State Water Resources Control Board.
- Except for the Upper San Juan, the TDS of most of the groundwater in storage in the main part of the groundwater basin is too high for domestic water use. Groundwater is treated by the San Juan Basin Desalter, which increases the usability of the basin in the future.
- Shallow groundwater limits the ability to store significant supplies.



MWD Service Area

Plate 11-1
Overview of San Juan Basin

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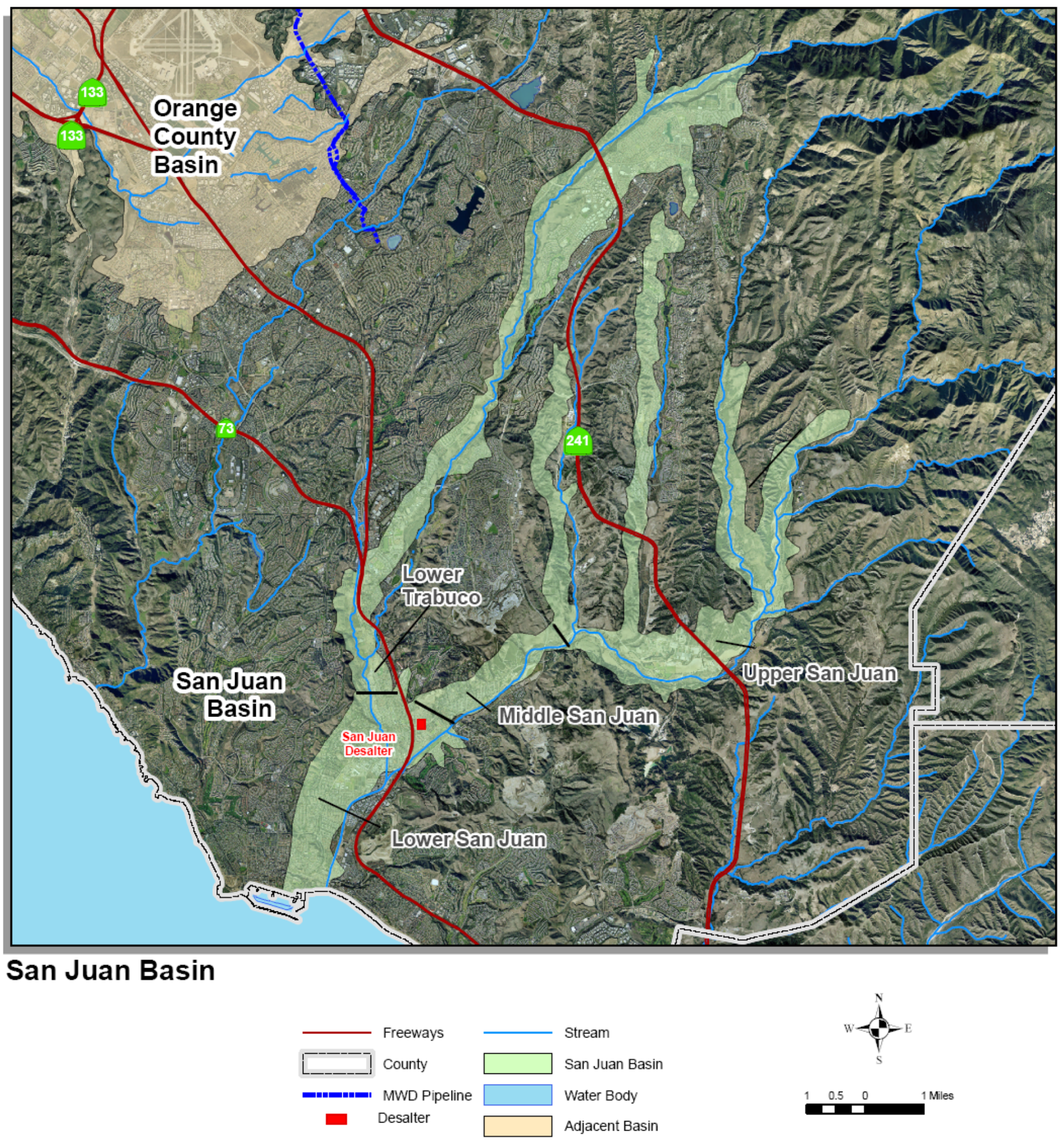
The San Juan Basin is located in southern Orange County within the San Juan Creek Watershed. The basin is comprised of four subbasins: Upper San Juan, Middle San Juan, Lower San Juan and Lower Trabuco. The San Juan Basin is within the service area of Metropolitan member agency Municipal Water District of Orange County (MWDOC) and underlies portions of the communities of Mission Viejo, San Juan Capistrano, Dana Point, and unincorporated areas of southern Orange County. A map of the basin is provided in **Figure 11-1**.

Figure 11-1
Map of the San Juan Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the San Juan Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

Groundwater exists in generally narrow, shallow unconfined alluvium that has been deposited in the San Juan Canyon area and its tributaries: Arroyo Trabuco, Oso, and other smaller canyons. The basin is bounded on the southwest by the Pacific Ocean and otherwise by Tertiary marine sedimentary rocks, which underlie the surrounding hills and the alluvium. The alluvium consists of a heterogeneous mixture of sand, silt, and gravel in the eastern portion of the basin, to coarse sand near the center, to silts, clays, coarse sand, fine gravel and sediments in the southern portion of the basin (DWR, 2004, MWDOC, 2006a). The alluvium ranges in depth from about 200 feet at the coast to essentially zero at the upper ends of the small alluvial tributaries to the main canyons (NBS Lowry, 1994). A summary of the basin characteristics is provided in **Table 11-1**.

Table 11-1
Summary of Hydrogeologic Parameters of San Juan Basin

Parameter	Description
Structure	
Aquifer(s)	Unconfined alluvium; confined zones near the coast.
Depth of groundwater basin	< 20 feet to >200 feet
Yield and Storage	
Safe Yield	7,300 to 7,800 AFY
Total Storage	63,220 to 90,000 AF
Unused Storage Space	Unknown
Portion of Unused Storage Available for Storage	Unknown

Sources: County of Orange, 2006; DWR, 1972; NBS Lowry, 1994

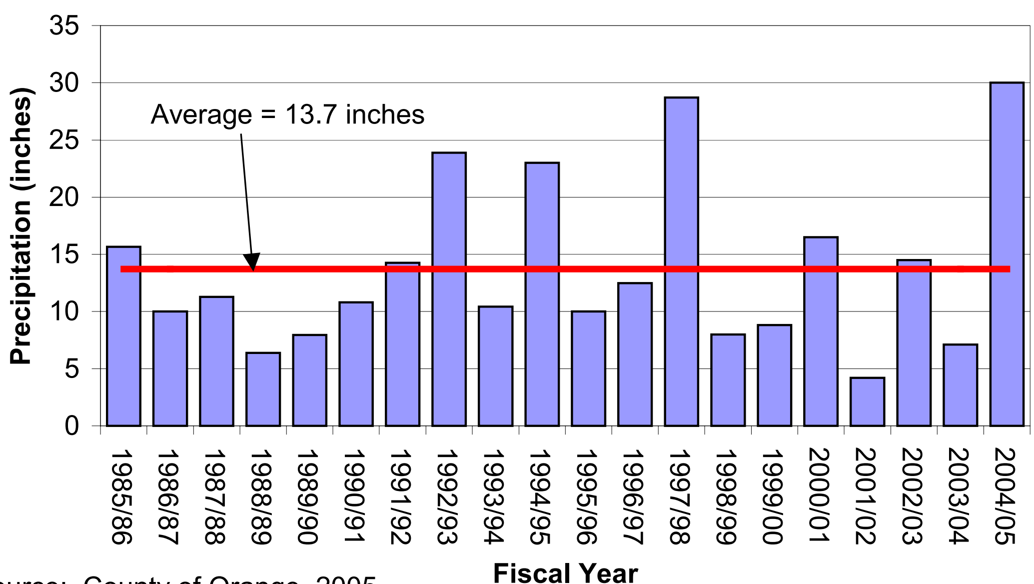
The main structural feature influencing groundwater movement is the Cristianitos Fault, which crosses San Juan Canyon in a north-south direction where it forms a narrow section at the confluence of San Juan Creek and Canada Chiquita. At the fault and canyon narrows, groundwater is forced to the surface, and the Upper Basin is separated from the Lower Basins. As shown on **Figure 11-1**, the Lower Basins include the Lower Trabuco, Middle San Juan, and the Lower San Juan subbasins.

Total storage capacity estimates range from 63,220 AFY to 90,000 AF (NBS Lowry, 1994; DWR, 1972). Useable groundwater storage is approximately 60,000 AF (MNWD, 2006). Unused storage capacity is unknown. However, following the heavy rains of the 1997/98 winter season, the basin was essentially full (USACE, 2002). Water levels in various locations in the basin since 2004 are less than 50 feet below ground surface. As a result, available storage space is limited in most areas (Psomas, 2006).

Safe Yield/Long-Term Balance of Recharge and Discharge

Recharge consists of streambed percolation from the mainstream San Juan and Arroyo Trabuco Creeks, rainfall infiltration and subsequent deep percolation to the water table, deep percolation of applied water from landscape and agricultural irrigation, and subsurface inflow from the tributary alluvial stream areas. The average annual precipitation in the lower portion of the basin ranges from 11 to 15 inches (DWR, 2004). **Figure 11-2** provides the historical precipitation data in the lower portion of the basin for the fiscal years from 1985/86 to 2004/05. Average precipitation during this time period was about 13.7 inches. It is important to note that precipitation is highly variable in this basin with lower rainfall in the lower basins and higher rainfall in the upper basins. For example, the 40-year average precipitation (1965 to 2004) in the upper portions of the basin is as much as 20 inches (County of Orange, 2005).

Figure 11-2
Historical Precipitation in the San Juan Basin



Source: County of Orange, 2005
Station 186

Discharge from the basin includes well extractions, losses to transpiration by phreatophytes, rising groundwater resulting in surface discharge to the ocean and subsurface outflow to the

Pacific Ocean. Extractions of water from the lower reaches of the basin were limited due to poor water quality until the San Juan Desalter came online in 2004.

In 1993, the sustained yield for the basin was estimated to be 7,800 AFY (NBS Lowry, 1994; USACE, 2002). More recently, the County of Orange has used a 2005 estimate of 7,300 AFY of safe yield in their planning (County of Orange, 2006).

GROUNDWATER MANAGEMENT

The following describes how the San Juan Basin is currently managed. This section includes a discussion of the governing structure and agreements with adjacent basins.

Basin Governance

The San Juan Basin is managed by the San Juan Basin Authority (SJBA), which was created in 1971 as a joint powers authority for the purpose of carrying out water resources development of the San Juan Basin. The members of the SJBA are the Santa Margarita Water District (SMWD), the Moulton Niguel Water District (MNWD), South Coast Water District, and the City of San Juan Capistrano.

Table 11-2 provides a list of management agencies in the San Juan Basin.

Table 11-2
Summary of Management Agencies for the San Juan Basin

Agency	Role
San Juan Basin Authority (SJBA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the San Juan Basin. Operates San Juan Basin Desalter
City of San Juan Capistrano (SJC)	Retail Water Provider and SJBA Member
Santa Margarita Water District (SMWD)	Retail Water District and SJBA Member
Moulton Niguel Water District (MNWD)	Retail Water District and SJBA Member
South Coast Water District (SCWD)	Retail Water District and SJBA Member
Municipal Water District of Orange County (MWDOC)	Wholesale imported water supplier and regional planning agency
California Regional Water Quality Control Board – San Diego Region (RWQCB)	Issuance of permits for discharges
State Water Resources Control Board	Issuance of water rights permits for diversion/extraction of water from the San Juan Basin.

The San Juan Basin has been categorized as subterranean flowing stream, and therefore groundwater extractions are within the scope of water rights regulations of the State Water Resources Control Board. Permits require the monitoring of groundwater quality and quantity in storage within the groundwater basin and other factors, including potential seawater intrusion and environmental issues. The SJBA conducts the monitoring activities that are needed to comply with its permits and also actively pursues the development of projects within the basin (MNWD, 2006).

Interactions with Adjoining Basins

No subsurface flow has been quantified between the San Juan Basin and adjoining basins. Water not captured by production wells or lost to evapotranspiration flows out of the basin into the ocean.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the San Juan Basin. Facilities include 13 groundwater production wells and a desalter.

Active Production Wells

A summary of the municipal production wells within the San Juan Basin is provided in **Table 11-3**. Private wells are not included on this table. Wells in the San Juan Basin typically produce from 450 to 1,000 gpm (DWR, 2004). Historical production for the period between fiscal years 1989/90 and 2004/05 is shown in **Figure 11-3**. The average production during this time period was approximately 2,079 AFY. It is important to note that production increased in 2004/05 as a result of the operation of the San Juan Desalter discussed below.

Groundwater is used principally for agricultural, horticultural, glass sand mining, golf course irrigation and for domestic uses. There are only three agencies within the SJBA actively pumping groundwater for municipal use (City of San Juan Capistrano, TCWD, and Santa Margarita Water District). More than 90 percent of the municipal groundwater production is for domestic use with less than 10 percent for non-domestic use.

Other Production

Data related to the private wells in the basin are not available.

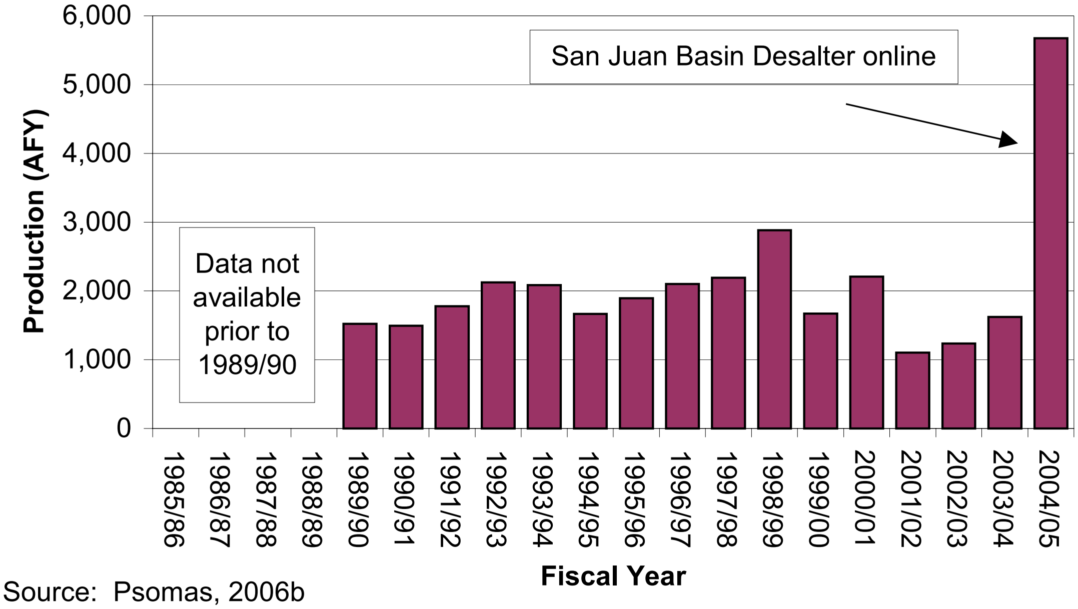
ASR Wells

Currently there are no ASR wells operating within the basin.

Spreading Basins

There are no spreading basins in the San Juan Basin. Recharge occurs mainly in natural streambeds and flood control channels (MNWD, 2006). SJBA plans to develop recharge basins to enhance capture of surface runoff.

Figure 11-3
Historical Groundwater Production in the San Juan Basin



Source: Psomas, 2006b

Table 11-3
Summary of Production Wells in the San Juan Basin

Category	Number of Active Wells	Estimated Production Capacity (AFY)	Average Production 1989/90-2004/05 (AFY)	Well Operation Cost ($/AF)
Municipal	7	10,000	1,949	Data not available
Desalter [1]	6	4,800	130	
Total	**13**	**14,800**	**2,079**	--

Source: Psomas, 2006b
[1]Desalter came online in 2004.

Seawater Barriers

There are no seawater barriers in the San Juan Basin.

Desalters

There is one existing desalter in the San Juan Basin. The San Juan Basin Desalter was constructed by the City of San Juan Capistrano pursuant to the terms of the 1998 San Juan Basin Desalter Project Groundwater Recovery Program Agreement between Metropolitan, MWDOC, and the SJBA, and as modified by First Amendment dated October 15, 2002. The San Juan Basin Desalter was completed in December 2004 and has capacity of about 5 MGD and can currently treat about 4,800 AFY. The plant is currently supplied by six wells located in the Lower San Juan subbasin. The brackish water from these wells is conveyed to the plant where it is treated by reverse osmosis (County of Orange, 2006). Approximately 4,800 AF was produced from the six operating wells during the period December 2004 through December 2005 (Psomas, 2006).

A second desalter, referred to as the Capistrano Beach Desalter Project, is currently under construction in the City of Dana Point by South Coast Water District. This desalter would treat up to 1,300 AFY from the San Juan Basin. Construction is estimated to be completed by March 2007.

GROUNDWATER LEVELS

Groundwater generally flows in a southwesterly direction to the ocean. The SJBA measures the water level in monitoring wells on a regular basis. Groundwater levels within the lower San Juan Creek are relatively close to the ground surface. Depth to water levels measured during 2004 and 2005 were typically less than 20 feet in the Lower and Middle San Juan subbasins. Drops in water levels of about 20 feet were observed in the vicinity of the San Juan Basin Desalter since it began operation. Water levels in the Lower Trabuco subbasin were deeper with an average depth to water of about 50 feet.

Monitoring wells recently installed in the basin are used to measure both water level and electric conductivity. The goal of the SJBA is to produce enough data to determine how the basin can be more effectively used as a water storage facility to increase the use of the groundwater for domestic uses. Water levels in basin wells show seasonal cycles with average declines related to drought cycles that recover during more plentiful seasons (DWR, 2004).

GROUNDWATER QUALITY

The following section describes the existing groundwater quality issues in the San Juan Basin. In general, the groundwater quality of the San Juan Basin ranges from good to poor. For example, although the Upper San Juan subbasin is shallower, it is has lower total dissolved solids (TDS) concentrations (less than 500 mg/L) than the lower basins. The lower basins are generally deeper with more abundant supply, but they are brackish and require treatment for use.

Groundwater Quality Monitoring

Active groundwater production wells within the San Juan Basin are sampled in accordance with Title 22. In addition, as described above, monitoring wells installed in the basin are used to measure both water level and electric conductivity in the field and various inorganic constituents in the laboratory on a semi-annual basis.

Groundwater Contaminants

The following section describes the concentrations of key constituents of concern (TDS, iron, manganese, and sulfate) in the San Juan Basin. Concentrations are summarized in **Table 11-4**. In general, TDS content in groundwater increases from below 500 mg/L in the upper stream channels valleys to above 2,000 mg/L near the coast (NBS Lowry, 1994; Psomas 2006a).

Table 11-4
Summary of Constituents of Concern in the San Juan Basin

Constituent	Units	Range (1999-2005)	Description
TDS Secondary MCL = 500	mg/L	390 to 2,200	TDS in production wells ranges from 390 to 1,250 mg/L. Average is 657 mg/L.
Nitrate (as N) Primary MCL = 10	mg/L	ND to 2	Average in production wells is approximately 0.6 mg/L.
VOCs **(TCE and PCE)** Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	ND	VOCs are not detected in the San Juan Basin.
Perchlorate Notification level = 6	µg/L	ND	Perchlorate is not detected in the San Juan Basin.
Iron and manganese Secondary MCL for iron = 300 Secondary MCL for manganese = 50	µg/L	Iron ND to 700 Manganese ND to 200	Only 2 groundwater production wells have detections of iron and manganese.
Sulfate Secondary MCL = 250	mg/L	71 to 840	Sulfate in production wells ranges from 71 to 225 mg/L with an average of 150 mg/L.

Source: Regional Board, 2006; Psomas, 2006a

Seawater intrusion could also be a potential problem in the coastal portions of the basin. It is believed that much of the salt content in the groundwater comes from the marine sediments that underlie much of the basin principally from Trabuco Creek (USACE, 2002).

Blending Needs

Blending is not applicable to the San Juan Basin (MNWD, 2006).

Groundwater Treatment

Groundwater is treated by the San Juan Basin Desalter as discussed above. Approximately 2,075 AF was treated in 2004/05, about 58 percent of the total groundwater production.

CURRENT GROUNDWATER STORAGE PROGRAMS

There are currently no groundwater storage programs in the San Juan Basin.

BASIN MANAGEMENT CONSIDERATIONS

Basin management considerations:

- Allowable quantities of water that may be diverted and pumped are specified in the water rights permits administered by the State Water Resources Control Board.

- Except for the Upper San Juan, the TDS of most of the groundwater in storage in the main part of the groundwater basin is too high for domestic water use. Groundwater is treated by the San Juan Basin Desalter, which increases the usability of the basin in the future.

- Shallow groundwater limits the ability to store significant supplies.

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CHAPTER IV

GROUNDWATER BASIN REPORTS

INLAND EMPIRE BASINS

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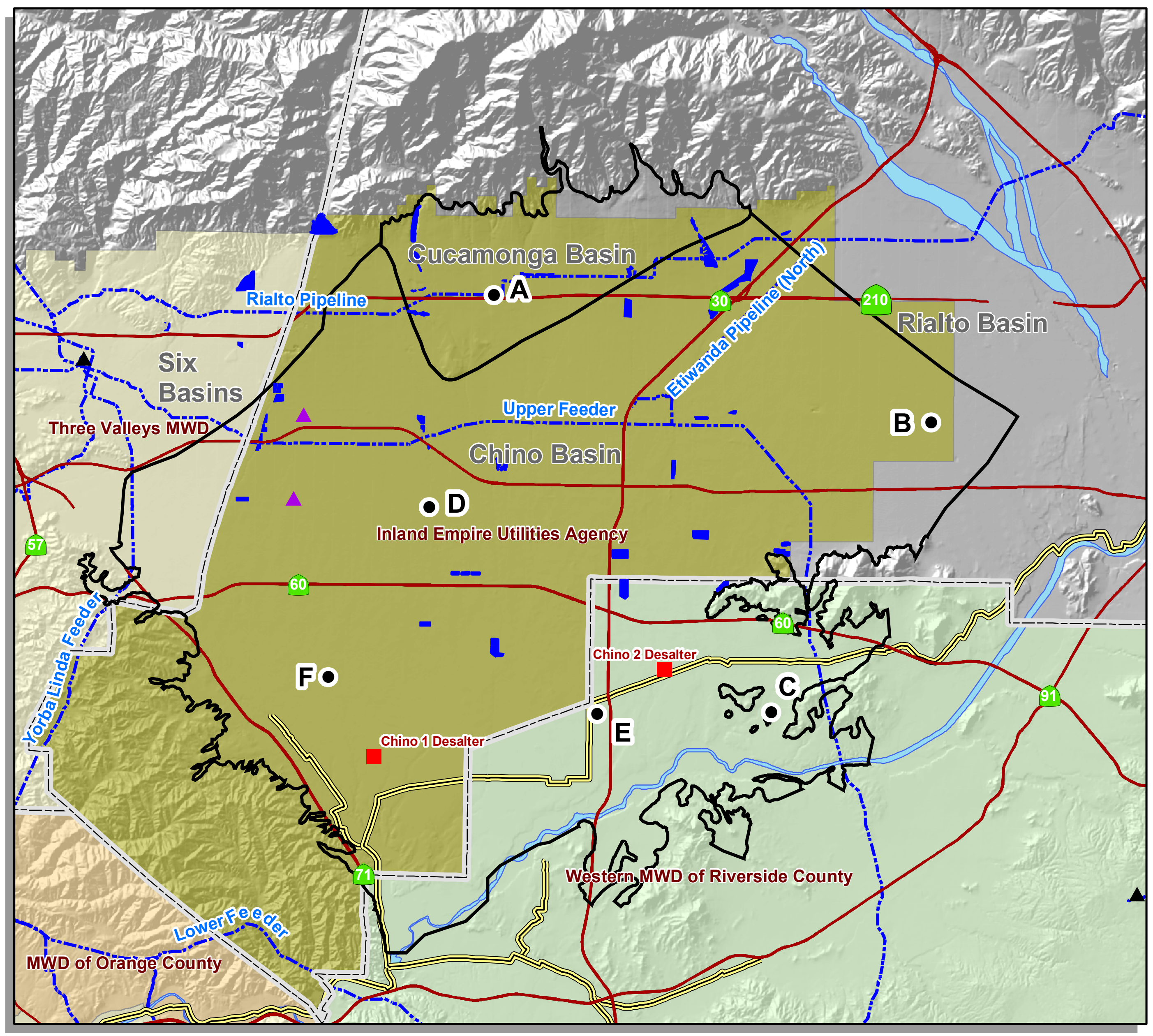

Chino and Cucamonga Basins

- A ● Key Well
- ASR Wells
- Desalter
- Recharge Basin
- County
- Freeways
- Water Body
- MWD Pipeline
- MWD Facility
- Santa Ana Regional Interceptor Line
- Basin
- MWD Member Agency Boundary (color varies)

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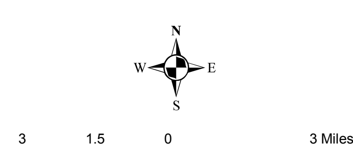
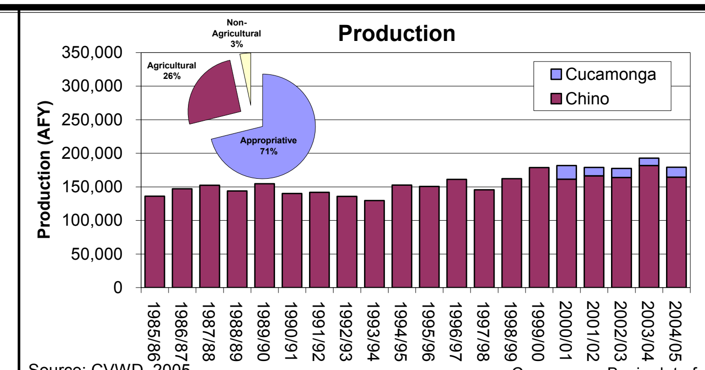
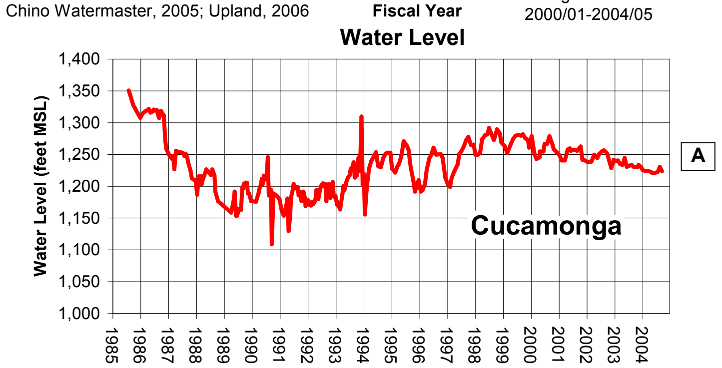


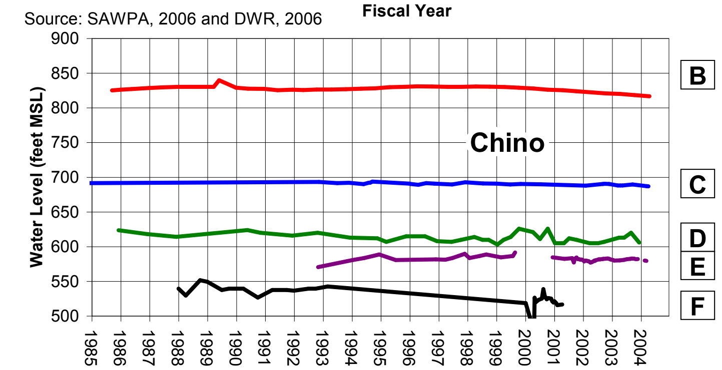


Source: CVWD, 2005
Chino Watermaster, 2005; Upland, 2006

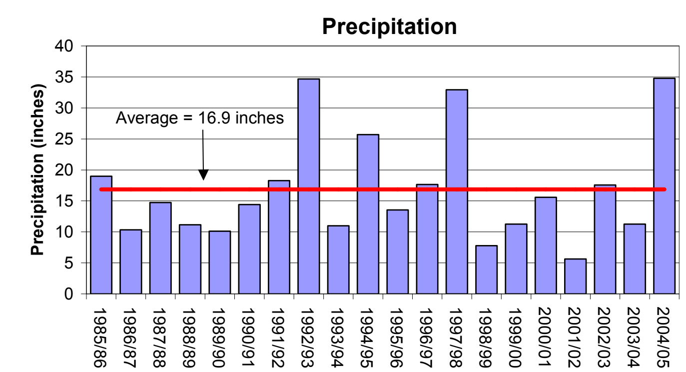
Cucamonga Basin data for 2000/01-2004/05



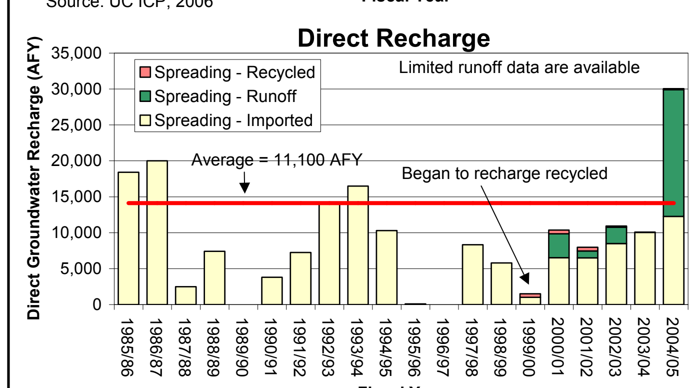
Source: SAWPA, 2006 and DWR, 2006



Source: SAWPA, 2006 and DWR, 2006



Source: UC ICP, 2006



BASIN FACTS

Chino and Cucamonga Basins

Description
Location: San Bernardino County
Watershed Surface Area: ~ 240 square miles
Management: Adjudicated
Chino Basin was adjudicated in 1978 and administered by Chino Basin Watermaster
Cucamonga Basin was adjudicated in 1958
MWD Member Agencies:
Inland Empire Utilities Agency
Western MWD
Three Valleys MWD

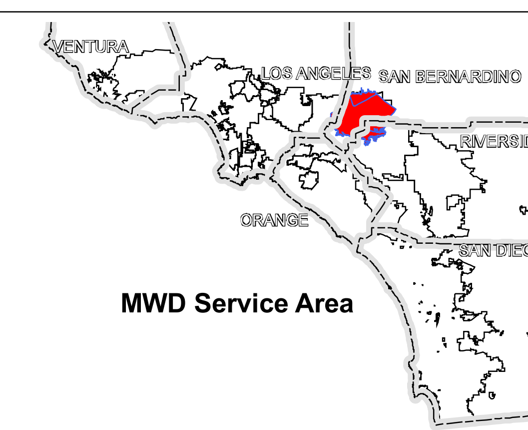
	Chino	Cucamonga
Natural Safe Yield	140,000 AFY	13,800 to 22,200 AFY
Adjudication Safe Yield	145,000 AFY	22,721 AFY
Total Storage	~6 million AF	Unknown
Unused Storage Space	~1 million AF	Unknown
Portion of Unused Storage Space Available for Storage	~500,000 AF	Unknown

Storage and Extraction Facilities

	Chino	Cucamonga
Production Wells		
Production Capacity	>336,000 AFY	Unknown
Average 1985-2004	~154,000 AFY	~15,000 AFY
Injection Wells		
Injection Capacity	4,500 AFY	None
Average 1985-2004	None	None
Spreading Basins		
Spreading Capacity	~60,000 AFY	~15,000 AFY
Average 1985-2004	~11,100 AFY	~6,100 AFY

Basin Management Considerations

- TDS and nitrate concentrations predominantly in southern portion of basin and several large VOC plumes are signficant issues for the basin.
- There are no court-ordered limits on pumping by groundwater users. However, pumping in excess of safe yield must be replenished.
- Desalters are used to cleanup basin, maintain hydraulic control and protect Santa Ana River water quality.
- Recent increased use of recycled water has increased management flexibility.



MWD Service Area

Plate 12-1
Overview of Chino and Cucamonga Basins

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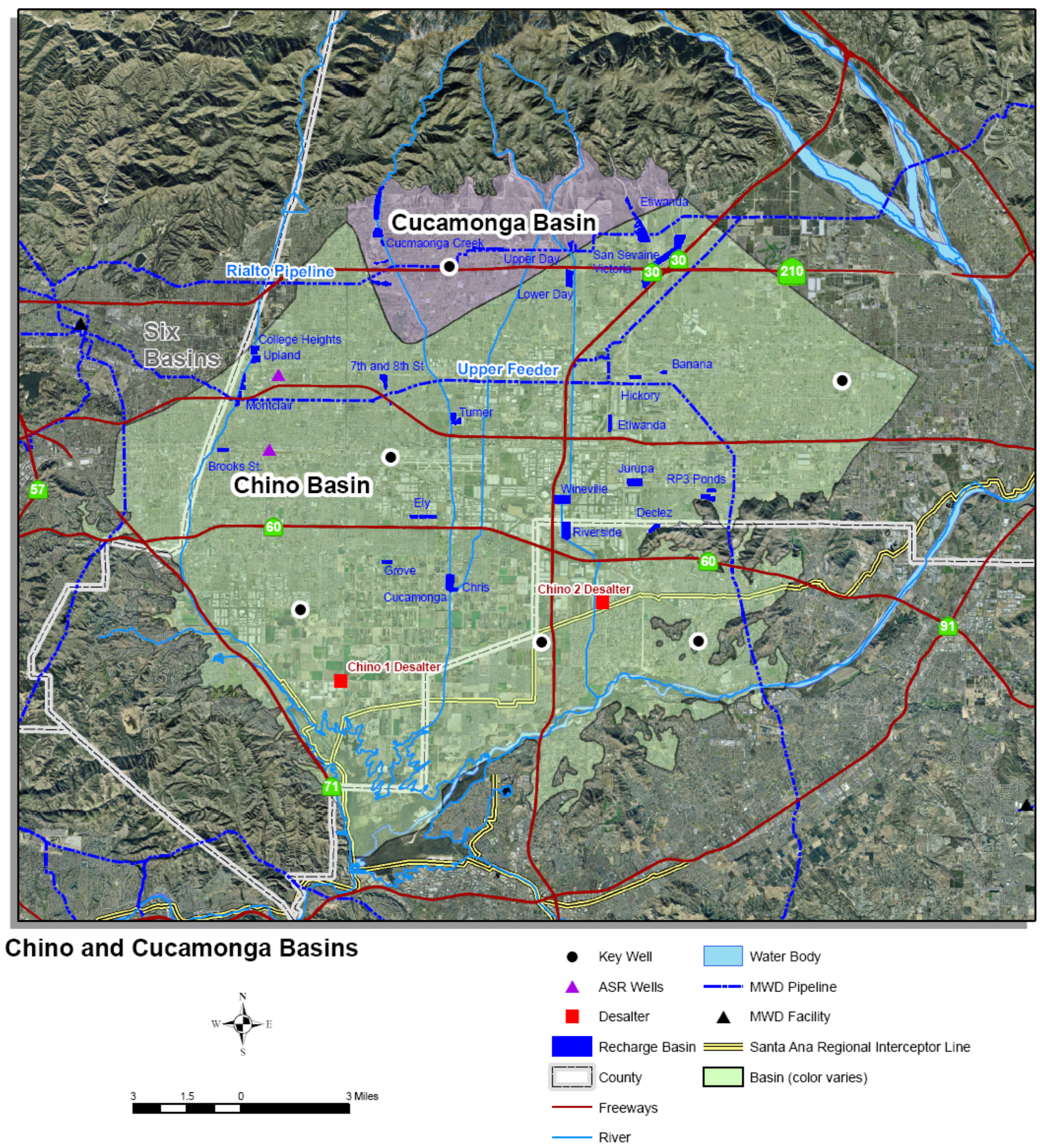
The Chino and Cucamonga Basins are located in the northwestern portion of the upper Santa Ana River Watershed in San Bernardino County and portions of western Riverside and northern Los Angeles Counties. The Chino and Cucamonga Basins underlie the service areas of Inland Empire Utilities Agency (IEUA), Western Municipal Water District (Western MWD) and Three Valleys Municipal Water District (Three Valleys). It includes the communities of Rancho Cucamonga, Pomona, Upland, Fontana, Chino, Chino Hills, Montclair, Jurupa Community Services District and Ontario. A map showing these basins is provided in **Figure 12-1**.

Figure 12-1
Map of the Chino and Cucamonga Basins



BASIN CHARACTERIZATION

The following section provides a physical description of the Chino and Cucamonga Basins, including geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

Table 12-1 provides a summary of hydrogeologic parameters of the Chino Basin and Cucamonga Basins. Each basin is discussed separately in the following section.

Table 12-1
Summary of Hydrogeologic Parameters of Chino and Cucamonga Basins

Parameter	Chino Basin	Cucamonga Basin
Structure		
Aquifer(s)	Upper aquifer (Layer 1) Unconfined alluvium Deep aquifer (Layers 2 and 3) Confined alluvium	Unconfined older and younger alluvium
Depth of groundwater basin	Up to 1,100 feet	> 1,600 feet
Thickness of water-bearing units	Upper aquifer (Layer 1) 200 to 300 feet Deep aquifer (Layer 2) 200 to 500 feet Deep aquifer (Layer 3) 100 to 500 feet	Upper aquifer Up to 150 feet Deep aquifer Up to 1,400 feet
Yield and Storage		
Natural Safe Yield	140,000 AFY	13,800 to 22,200 AFY
Adjudication Safe Yield	145,000 AFY	22,721 AFY
Total Storage	~ 6 million AF	Unknown
Unused Storage Space	~1 million AF	
Portion of Unused Storage Space Available for Storage	~500,000 AF	

Source: Wildermuth, 2005a, DWR, 2006, CDM, 1985 Tom Dodson &Associates, 2000 and CDM, 1999

Chino Basin

The Chino Basin is part of an alluvial-filled valley bounded by the Cucamonga Basin and the San Gabriel Mountains to the north, the Temescal Basin to the south, Chino Hills and Puente Hills to the southwest, the San Jose Hills and Six Basins on the northwest and the Rialto/Colton Basins on the east. The valley is relatively flat from east to west and slopes from the north to the south at a one to two percent grade. The Santa Ana River is the primary drainage for the valley, and flows from its origin in the San Bernardino Mountains to the Pacific Ocean (DWR, 2006).

The water-bearing sediments of the Chino Basin have been generally divided in to two aquifer systems: the Shallow aquifer system (referred to as Layer 1 or younger alluvium) and the Deep aquifer system (referred to as Layers 2 and 3 or older alluvium).

The Shallow aquifer system is generally characterized by unconfined to semi-confined groundwater conditions and high permeability within its sand and gravel units. Layer 1 consists of the upper 200 to 300 feet of sediments (Wildermuth, 2005a). The sediments that comprise the shallow aquifer system are saturated in the southern portion of Chino Basin, but are unsaturated in the northern portion. Where saturated, this zone is highly transmissive and yields high production rates.

The Deep aquifer system is generally characterized by confined groundwater conditions and lower permeability within sand and gravel units (Wildermuth, 2005a). The sediments that comprise the deep aquifer system are always at least partially saturated, and typically pinch out near bedrock outcrops and in the southern-most portion of Chino Basin. The upper portion of the Deep aquifer system (Layer 2) is approximately 200 to 500 feet thick. On the west side of Chino Basin, the sediments of Layer 2 are primarily silt and clay and become increasingly coarser in the northern and eastern portions of the basin. The lower portion of the Deep aquifer system (Layer 3) is approximately 100 to 500 feet thick. Layer 3 is only found in the central portion of the basin and pinches out near the boundaries. This zone is characterized by sand and gravel but are generally less productive than the shallower sediments in Layer 1 (Wildermuth, 2005a).

Total storage capacity of the Chino Basin is estimated to be approximately 6 million AF. There is currently about 5 million AF in storage leaving about 1 million AF unused (Wildermuth, 2005a). The Optimum Basin Management Program (OBMP) Program Environmental Impact Report (PEIR) identified 500,000 AF of the unused storage that could be utilized without significant impacts. The determination of the actual amount of the unused storage that could be used is subject to further review (Tom Dodson and Associates, 2000).

Cucamonga Basin

The Cucamonga Basin underlies the northern part of upper Santa Ana Valley, and is bounded on the north by the San Gabriel Mountains and the Cucamonga fault and on the west, south and east by the Red Hill fault. The Red Hill fault is a barrier to groundwater flow, with groundwater levels reported to be 225 to 375 feet higher on the north side than on the south of the fault. Groundwater flow is generally towards the south (DWR, 2004).

Groundwater occurrence in the Cucamonga Basin is generally unconfined within unconsolidated to loosely consolidated sand, gravel, and silt with a few beds of compacted clay. Like the Chino Basin, there are generally two aquifers within the Cucamonga Basin correlative with younger and older alluvium. The Upper aquifer (or younger alluvium) is characterized by unconsolidated silts, sands, gravels and boulders and can attain thickness of up to 150 feet in the vicinity of Cucamonga and Deer creeks. The Upper aquifer is generally unsaturated because groundwater is generally deeper than 150 feet. However, this aquifer allows for the infiltration of surface runoff in the groundwater. The Deep aquifer consists mostly of laterally discontinuous clays, silts, sands and gravels and reach a maximum thickness of 1,400 feet (CDM, 1999). Storage capacity within the Cucamonga Basin is unknown.

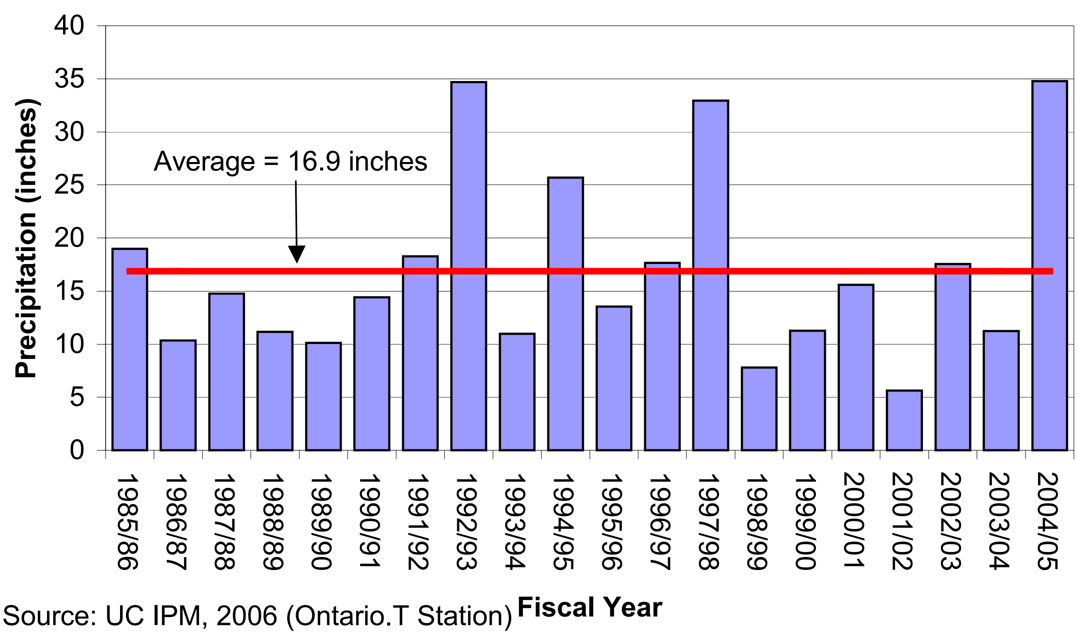
Safe Yield/Long-Term Balance of Recharge and Discharge

The natural sources of recharge and long-term balance for the Chino and Cucamonga Basins are discussed separately in the following section.

Chino Basin

Recharge to the groundwater is predominantly from percolation of direct precipitation and infiltration of stream flow from the surrounding mountains and hills, and from the Santa Ana River. **Figure 12-2** presents historical precipitation data during the period from fiscal years 1985/86 to 2004/05.

Figure 12-2
Historical Precipitation in the Chino Basin



Source: UC IPM, 2006 (Ontario.T Station)

During this period, an average of about 16.9 inches per year of rainfall occurred in the Chino Basin. Other sources of recharge include underflow from the saturated sediments and fractures within the bounding mountains and hills; recharge of storm water, imported water, and recycled water at spreading grounds; and underflow from seepage across faults (Wildermuth, 2005a).

Sources of discharge include groundwater production, rising water within Prado Basin, evapotranspiration where groundwater is near or at the ground surface, and underflow to adjacent basins (Wildermuth, 2005a). The Chino Basin's estimated natural safe yield is 140,000 AFY (Judgment, 1978). Artificial recharge of runoff, recycled and imported water allow the basin to sustain higher annual production than its safe yield.

Cucamonga Basin

Recharge to the Cucamonga Basin includes infiltration of stream flow, percolation of rainfall to the valley floor, underflow from the San Gabriel Mountains, and return irrigation flow. Spreading grounds along Cucamonga Creek and near Red Hill and Alta Loma also contribute to storm flow recharge to the basin (DWR, 2004). Average precipitation is higher in the Cucamonga Basin than the Chino Basin with historical average precipitation ranging from about 17.8 inches at the lower elevations to about 21.3 inches at the higher elevations (CDM, 1999).

Estimates of the safe yield of the geologically defined Cucamonga Basin range from 13,800 AFY (Howard, 1992) to 22,200 AFY (CDM, 1985). These estimates are less than the safe yield defined in the Cucamonga Basin Judgment of 22,271 AFY. It is important to note that the geologically defined area of the Cucamonga Basin is larger than the area subject to the Judgment (as described below). Therefore, the yield of the Judgment area would be expected to be less than the estimates above. For example, CDM (1985) estimated to sustainable yield of the geologically defined Cucamonga Basin to be 22,200 AFY and the sustainable yield of the adjudicated portion of the basin has been estimated to be approximately 19,100 AFY. The geologically-defined estimates are used throughout this document.

GROUNDWATER MANAGEMENT

The following section describes how the Chino and Cucamonga Basins are currently managed. This includes a discussion of the management structure and relationship with adjoining basins.

Basin Governance

The following section describes the management structure and adjudication of the Chino and Cucamonga Basins. A summary of the management agencies for the Chino and Cucamonga Basins is provided in **Tables 12-2 and 12-3**.

Chino Basin

The Chino Basin is an adjudicated basin. The groundwater rights and storage capacity within the Chino Basin were established by San Bernardino Superior Court Case No. 164327 in

Chino Basin Municipal Water District v.City of Chino, et al. in 1978, now designated No. RCV 51010 (referred to herein as the Chino Basin Judgment). In the Chino Basin Judgment, the Chino Basin Watermaster was appointed to administer and enforce the provisions of the Judgment and any subsequent instructions or orders of the Court.

Table 12-2
Summary of Management Agencies in the Chino Basin

Agency	Role
Chino Basin Watermaster	Court-appointed Watermaster for Chino Basin.
Chino Basin Desalter Authority	Joint Powers Authority established to operate and manage the Chino I and Chino II Desalters.
Chino Basin Water Conservation District (CBWCD)	Operation of some recharge facilities in Chino Basin. The CBWCD also promotes water conservation through an active public education program.
San Bernardino County Flood Control District (SBCFCD)	Operation of some recharge and flood control facilities in Chino Basin.
City of Upland	Operation of one recharge facility in Chino Basin.
Monte Vista Water District	Owns and operates ASR wells in Chino Basin.
Santa Ana Watershed Project Authority (SAWPA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the Santa Ana River Watershed.
San Bernardino County Department of Environmental Health	Regulation of new well permits within vicinity of recharge basins and throughout basin.
Inland Empire Utilities Agency (IEUA)	Implementation of recharge and management strategies. Operation and maintenance of some recharge basins and associated facilities in Chino Basin.
Santa Ana River Watermaster	Watermaster for 1969 Stipulated Judgment that defined water allocations in the Santa Ana River between lower Santa Ana River and upper Santa Ana River producers.
California Department of Health Services	Regulation of water quality in recharge facilities and production wells.
Regional Water Quality Control Board – Santa Ana Region (Regional Board)	Regulation of recharge of recycled water and desalter facilities.

As described above, the Chino Basin Judgment defines the natural safe yield as 140,000 AFY (Judgment, 1978). The safe yield is allocated among three pools as follows:

(1) Overlying Agricultural Pool (dairy farmers and the State of California): 82,800 AFY;
(2) Overlying Non-Agricultural Pool (industrial users): 7,366 AFY; and
(3) Appropriative Pool (water for municipalities and other government agencies): 49,834 AFY (Judgment, 1978).

An additional 5,000 AFY (200,000 AF of controlled overdraft, averaged over 40 years) is allocated to the Appropriative Pool, which defines the safe yield per the Chino Basin Judgment as 145,000 AFY. Parties are allowed to pump in excess of the safe yield as needed, provided replenishment water is later purchased and restored to the basin. Groundwater not pumped by the agricultural users (Overlying Agricultural Pool) is re-allocated to the Appropriative Pool for municipal use (Chino Basin Judgment, 1978).

The Superior Court mandated that the Chino Basin Watermaster develop an Optimum Basin Management Plan (OBMP). The OBMP, developed in 1998, established primary management goals to address issues, needs and interests of the water producers in Chino Basin, including four primary goals: (1) enhance basin water supplies, (2) protect and enhance water quality, (3) enhance management of the basin, and (4) equitably finance the OBMP (Wildermuth, 1999). In July 2000, the Watermaster's planning process culminated with the adoption of the Peace Agreement that ended over 15 years of litigation within the Chino Basin. The Peace Agreement outlines the schedule and actions for implementing the OBMP.

In 2004, the Regional Board adopted amendments to the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) incorporating a "maximum benefit" proposal recommended by IEUA and the Chino Basin Watermaster for the Chino Basin. The Maximum Benefit Basin Plan establishes new, scientifically-based Total Dissolved Solids (TDS) and Total Inorganic Nitrogen (TIN) groundwater quality objectives and wasteload allocations that allow the use of recycled water for groundwater recharge while providing reasonable protection of the groundwater quality in the region. As part of the Maximum Benefit Basin Plan, IEUA and the Chino Basin Watermaster have committed to a specific set of projects and requirements in order to demonstrate that the water quality of the groundwater basin is protected and that the plan provides the maximum benefit to the users of the groundwater basin. These commitments include implementation of the following projects (IEUA, 2006a):

- Surface water and groundwater monitoring programs;
- Chino desalters (consistent with OBMP requirements of 40 mgd by 2020);
- Recharge facilities/conjunctive use program;
- Recycled water quality management and
- Hydraulic control to protect the Santa Ana River quality (consistent with the Orange County Water District and IEUA Memorandum of Understanding).

Each of these elements has been implemented or is underway.

Cucamonga Basin

The Cucamonga Basin is also adjudicated, as defined in the 1958 Judgment of the Superior Court (Decree No. 92645), herein referred to as the Cucamonga Basin Judgment. It is important to note that the basin's legal boundary established by the Cucamonga Basin Judgment is different from the geologic boundary depicted on **Figure 12-1.** The eastern boundary of the Cucamonga Basin defined in the Cucamonga Judgment is not based upon geologic features and, as a result, a portion of the geologically defined Cucamonga Basin is actually within the legal boundary of the Chino Basin.

Table 12-3
Summary of Management Agencies in the Cucamonga Basin

Agency	Role
Chino Basin Watermaster	Court-appointed Watermaster for Chino Basin.
Cucamonga Valley Water District	Primary producer in basin.
San Antonio Water Company	Producer in basin and recharge of runoff in San Antonio Canyon Spreading Basins.
City of Upland	Not party to Judgment. However, pumps groundwater from basin using SAWC and West End Consolidated Water Company's rights.
San Bernardino County Flood Control District (SBCFCD)	Operation of some recharge and flood control facilities in Cucamonga Basin
Santa Ana Watershed Project Authority (SAWPA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the Santa Ana River Watershed.
San Bernardino County Department of Environmental Health	Regulation of new well permits within vicinity of recharge basins and throughout basin.
California Department of Health Services	Regulation of water quality in recharge facilities and production wells.
Regional Water Quality Control Board – Santa Ana Region (Regional Board)	Regulation of recharge of recycled water and desalter facilities.

The Cucamonga Basin Judgment stipulates water rights for Cucamonga Basin groundwater users. The Cucamonga Basin Judgment provides that 22,721 AFY may be pumped from the basin and approximately 3,620 AFY may be diverted from Cucamonga Creek. Santa Ana Water Company (SAWC), Cucamonga Valley Water District (CVWD) and the City of Upland (through agreements with SAWC and West End Consolidated Water Company) are the primary producers in the Cucamonga Basin. Under the Cucamonga Basin Judgment, SAWC is allowed to export 100 percent of their 6,500 AFY allocation while CVWD is allowed to export 8,177 AFY (43 percent of their total allocation of 19,071). The SAWC is required to recharge a minimum of

2,000 AFY imported water (mostly runoff) into the basin over a 10-year period. Over these ten years, 95 percent of any additional water spread may be added to SAWC's adjudicated right. The West End Consolidated Water Company rights of 750 AFY are currently pumped by the City of Upland (City of Upland, 2005).

Interactions with Adjoining Basins

The Chino Basin is geographically adjacent to the Cucamonga, Six, Rialto-Colton and Temescal Basins. Except for the Temescal Basin, the aforementioned basins are adjudicated, and no formal agreements between the basins exist. Generally, the status quo of underflow is maintained.

The Chino Basin is upstream of the Orange County Basin. On April 17, 1969, the Orange County Superior Court entered a Stipulated Judgment in Case No. 117628 involving the Orange County Water District vs. City of City of Chino et al. The Judgment, which became effective October 1, 1970, contained a declaration of rights of the entities in the lower Santa Ana River area (i.e. OCWD) versus those in the upper Santa Ana River area (i.e. San Bernardino Valley Municipal Water District, or SBVMWD, Chino Basin MWD, now called IEUA, and Western MWD). The Judgment is administered by the Santa Ana River Watermaster, a committee of five members (one each from SBVMWD, IEUA and Western MWD and two from OCWD). Under this Judgment, purveyors upstream of Prado Dam, have the right to use all surface and groundwater supplies originating above Prado Dam without interference from water purveyors downstream of Prado Dam, provided that the average adjusted base flow at Prado Dam is at least 42,000 AFY. Baseflows have ranged from approximately 38,000 AFY in 1970 to approximately 170,000 AFY in 2002. (Santa Ana River Watermaster, 2003). SBVMWD has an obligation to ensure an average annual adjusted base flow of 15,250 AFY at Riverside Narrows. IEUA and Western MWD have a joint obligation to ensure average annual adjusted base flow of 42,000 AFY at Prado Dam. In addition, SBVMWD, IEUA and Western MWD are prohibited from exporting water from the lower area to the upper area while OCWD is prohibited from exporting water or causing water to flow from the upper area to the lower area (Santa Ana River Watermaster, 2003).

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Chino and Cucamonga Basins. Facilities include nearly 800 groundwater production wells (including 2 ASR wells), about 350 acres of spreading basins and 2 desalters.

Municipal Production Wells

The following section provides a summary of the municipal production in the Chino and Cucamonga Basins. **Table 12-4** summarizes the production well information for each basin.

Table 12-4
Summary of Production Wells in the Chino and Cucamonga Basins

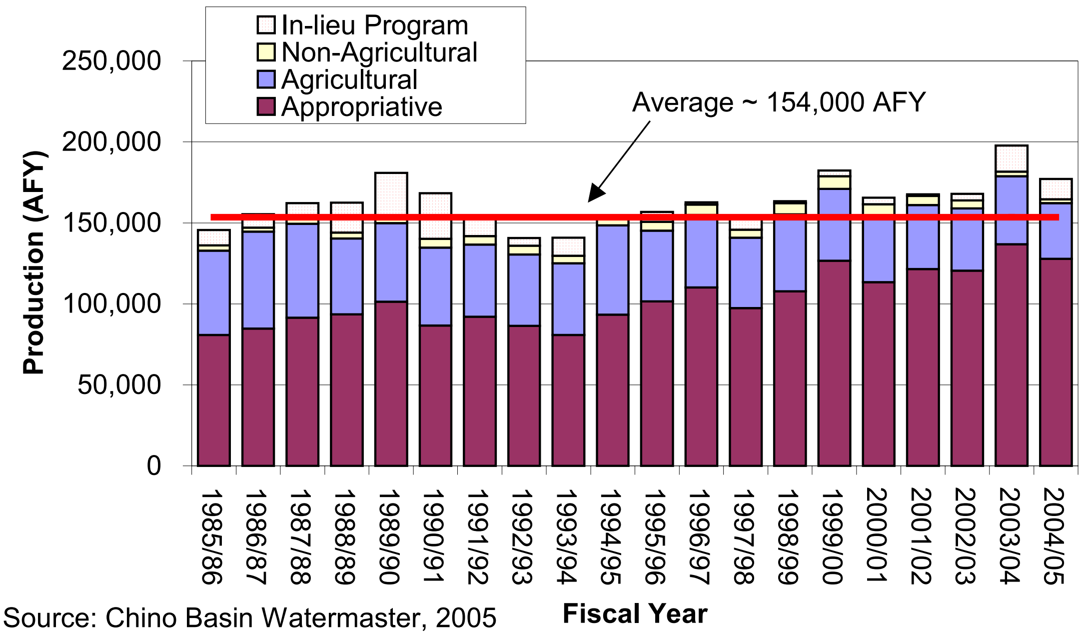
Category	Number of Wells	Estimated Production Capacity (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Chino Basin				Data not available
Appropriative Pool	193 Production 14 Monitoring	286,000	102,749	
Agricultural	530	>42,000	45,961	
Non-Agricultural	25 Production 22 Monitoring	>8,000	4,870	
Total Chino Basin	748 Production 22 Monitoring	>336,000	**153,581**	
Cucamonga Basin	~25	Data not available	14,452 [1]	

Source: CBWM, 2006; B&V, 2003
Note: Data for Cucamonga Basin from 2000 to 2004 only.

Chino Basin

Figure 12-3 presents the average basin production for the 20-year period from fiscal year 1985/86 to 2004/2005. During this time period, total groundwater production has ranged from a about 130,000 to 182,000 AFY, with an average of about 154,000 AF. Generally, over time, Agricultural Pool production in the southern portion of the basin has decreased, while Appropriative Pool production, mainly in the northern portion of the basin, has increased. For example, Appropriative Pool production increased from about 60 percent of total production in 1985/86 to 80 percent in 2004/05.

Figure 12-3
Historical Groundwater Production in the Chino Basin



Source: Chino Basin Watermaster, 2005

Water purveyors in the Chino Basin also participate in a variety of in-lieu groundwater storage programs whereby they receive imported water from Metropolitan in-lieu of pumping groundwater. These programs result in decreased pumping when water is delivered and increased pumping later. Historically, these have included Metropolitan's cyclic, replenishment water and conjunctive use programs. The long-term in-lieu storage (cyclic, replenishment or conjunctive use) is included in the data provided in **Figure 12-3**. Between fiscal years 1985/86 and 2004/05, about 9,300 AFY was stored in the Chino Basin via in-lieu. These and other storage programs are discussed in more detail below.

Cucamonga Basin

As discussed above, there are three groundwater producers in the Cucamonga Basin. In the period between 2000 and 2004, the average production in the Cucamonga Basin was approximately 14,500 AFY, which is similar to the long-term average production in the basin. Note that production in these five years is significantly lower than the peak period between 1985 and 1989 (when production was more than 25,000 AFY) as a result of declining water levels due to dry conditions and water quality issues.

Other Production

The following provides a brief summary of other, non-municipal production from the Chino and Cucamonga Basins.

Chino Basin

For Chino Basin, non-municipal production includes agricultural wells, industrial wells, and domestic wells. As of June 1, 2005, Watermaster counted about 530 active agricultural wells, 45 of which were anticipated to become inactive within 18 to 24 months due to urban development in the southern portion of Chino Basin (Wildermuth, 2005a). Production from these wells is included in **Figure 12-3**.

Cucamonga Basin

CVWD obtains a significant portion of its water supply from surface flows from the adjacent canyons. In the past 10 years, surface diversions have ranged from 1,892 AFY in 2004 to 9,580 AF in 1998 (CVWD, 2005). These diversions are treated in accordance with DHS guidelines and served for municipal demand. These surface water flows are not recharged.

ASR Wells

The following section describes the ASR wells in the Chino and Cucamonga Basins.

Chino Basin

The Monte Vista Water District (MVWD) has recently implemented the Aquifer Storage and Recovery (ASR) Program by converting existing wells whose water quality has been impacted by high nitrates to ASR. MVWD has constructed two new ASR wells and modified several existing facilities. The ASR wells with wellhead treatment have the ability to provide up to 4,500 AFY of additional recharge capacity within the western part of the Chino Basin (IEUA, 2005). An additional 2 ASR wells are being considered. No injection occurred from these new wells during the period from 1985 to 2004.

Cucamonga Basin

There are no ASR wells in the Cucamonga Basin.

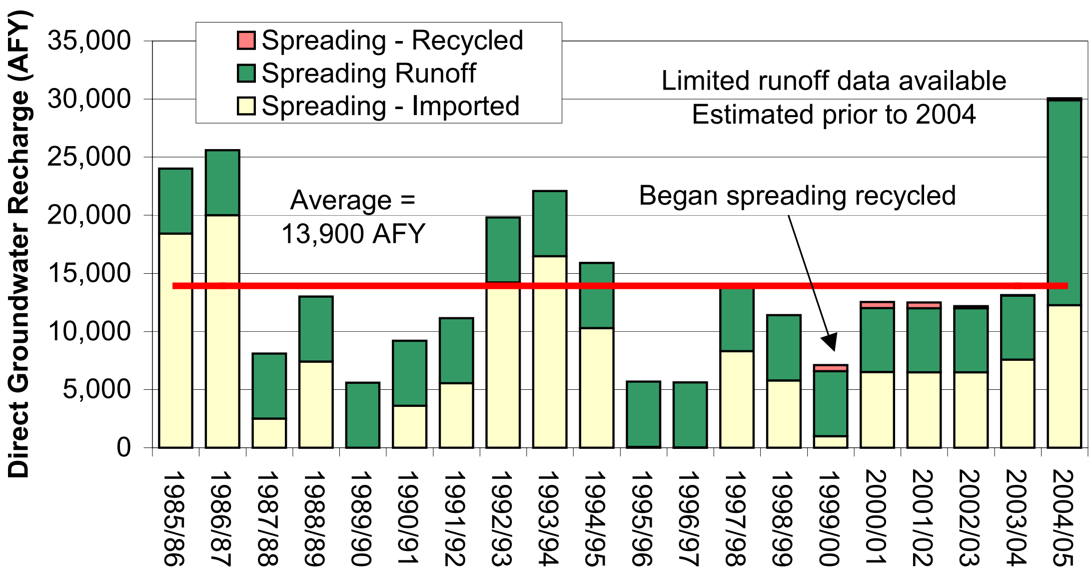
Spreading Basins

About 350 acres of spreading basins are located in the Chino and Cucamonga Basins. These are described below.

Chino Basin

Spreading basins are a key component of groundwater management in the Chino Basin. Data related to the recharge basins in the Chino Basin are summarized in **Table 12-5**. Imported water, recycled water and stormwater are currently spread in the Chino Basin. **Figure 12-4** shows historical groundwater recharge by spreading. An average of about 13,900 AFY has been spread between fiscal years 1985/86 and 2004/05 (CBWM, 2007c). About 7,700 AFY has been recharged with imported water from Metropolitan between fiscal years 1985/86 and 2004/05. Runoff recharge was not measured prior to 2004. However, the Chino Basin Watermaster estimates that the historical runoff spread was approximately 5,600 AFY (CBWM, 2007c). In fiscal year 1999/00, recycled water began to be recharged in the Ely Basins and since then, an average of about 300 AFY of recycled water has been recharged in the Chino Basin. IEUA is planning to increase the amount of recycled water recharge in the future. According to the Chino Basin Watermaster, there is currently about 60,000 AFY of available capacity for supplemental recharge, including about 50,000 AFY of imported and recycled water capacity and 10,000 AFY of stormwater capacity (Chino Basin Watermaster, 2006). Additional improvements currently identified under the OBMP could increase the capacity to 134,000 AFY (IEUA, 2005).

Figure 12-4
Historical Groundwater Recharge in the Chino Basin



Source: CBWM, 2007c

Cucamonga Basin

Spreading in the Cucamonga Basin is at the Cucamonga Creek and the Upper Day Creek Spreading Basins. Data related to these facilities is summarized in **Table 12-6**. SAWC imports water from San Antonio Creek for recharge in the Cucamonga Creek Spreading Basins. Imported water from Metropolitan has been recharged at the Upper Day Creek Spreading Basins since 1978. Because the Upper Day Creek Spreading Basins are located immediately adjacent to the boundary with the Chino Basin, it is unknown how much of this infiltration actually provides recharge to the Cucamonga Basin. The total estimated recharge capacity of both recharge areas is approximately 14,900 AFY based upon historical data since 1958. The average spreading in the Cucamonga Creek Spreading Basins from 1985 to 1997 was approximately 3,750 AFY. Between 1978 and 1991, Chino Basin Watermaster spread an average of about 2,390 AFY in the Day Creek Spreading Basins (CDM, 1999).

Table 12-5
Summary of Spreading Basins in the Chino Basin

Spreading Basin	Wetted Area (acres)	Recharge Capacity (cfs)	Recharge Capacity (AFY)	Source Water	Owner
College Heights	22	6	3,870	Imported	CBWCD
Brooks Street	7.7	5	3,000	Runoff Imported	CBWCD
Montclair	28.2	10	7,770	Runoff Imported	CBWCD
7th & 8th Street	14.5	5	1,350	Runoff	SBCFCD
Upland	10.1	4	2,730	Runoff Imported	City of Upland
Ely	35.7	3	2,880	Runoff Recycled	SBCFCD/CBWCD
Etiwanda Debris Basin	20	5	5,250	Runoff	SBCFCD
Hickory	8	6	2,280	Runoff Imported Recycled	SBCFCD
Lower Day Creek	14.4	6	3,150	Runoff Imported	SBCFCD
San Sevaine (1,2,3)	33.6	10	7,740	Runoff Imported	SBCFCD
San Sevaine (4, 5)	56.5	10	7,740	Runoff Imported	SCBCFCD
Turner Nos. 1,2	12	3	3,980	Runoff Imported Recycled	SBCFCD
Turner Nos. 3,4	12	3		Runoff Imported Recycled	SBCFCD
Victoria	11.8	2	1,260	Runoff	SBCFCD
Banana	6.2	4	2,010	Runoff Imported Recycled	SBCFCD
Declez	6.0	2	1,590	Runoff	SBCFCD
RP3 Ponds	18	3	3,000	Runoff Imported Recycled	IEUA
TOTAL	**319.7**	**87**	**59,600**	**--**	**--**

Source: Chino Basin Watermaster, 2007b and Wildermuth, 2005a

Table 12-6
Summary of Spreading Basins in the Cucamonga Basin

Spreading Basin	Recharge Capacity [1] (AFY)	Source Water
Cucamonga Creek	10,100	Runoff
Upper Day Creek	4,800	Imported
Total	**14,900**	--

Notes: [1]Based upon maximum historical recharge

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Chino and Cucamonga Basins.

Desalters

There are two groundwater desalters in the Chino Basin designed to treat high-nitrate and TDS water from the southern part of the Chino Basin (Chino I and Chino II). In addition to reducing the TDS and nitrates in the groundwater, the desalters also provide hydraulic control for the southern portion of the basin. The maximum benefit concept approved by the Regional Board provides that hydraulic control and water quality improvement projects could be implemented to prevent degradation of adjacent water supplies such as the Santa Ana River. The southern portion of the Chino Basin was identified with the intent to control and managed the outflow of groundwater with high-TDS and nitrates into the Santa Ana River. The Chino Desalter Authority was established in 2001 to reclaim the groundwater in the southern Chino Basin. It is estimated that as much as 50,000 AFY of groundwater will need to be extracted from the southern portion of the basin to maintain hydrologic control and prevent groundwater from the Chino Basin from entering the Santa Ana River (Chino Desalter Authority, 2005).

The Chino I Desalter, which initially came online in August 2000 and upgraded in July 2005, produces up to 15,900 AFY of potable water. Facilities consist of 14 groundwater wells, a reverse osmosis (RO) water treatment plant (WTP), and pipelines to deliver water to and from the WTP to the water retailers, and a stripping tower to remove volatile organic compounds (VOCs). Brine concentrate from the RO process is discharged to the Santa Ana Regional Interceptor (SARI), which is treated at the Orange County Sanitation District facility in Orange County (Chino Desalter Authority, 2005). Through fiscal year 2004/05, about 7,900 AFY has been treated by the Chino I desalter (IEUA, 2006b).

The Chino II Desalter, which came online in June 2006, produces up to 10,200 AFY. Similar to the Chino I Desalter, facilities include 8 groundwater wells, RO facilities and associated pipelines. No water was produced from the desalter during the time period from fiscal years 1985/86 to 2004/05 (IEUA, 2006b).

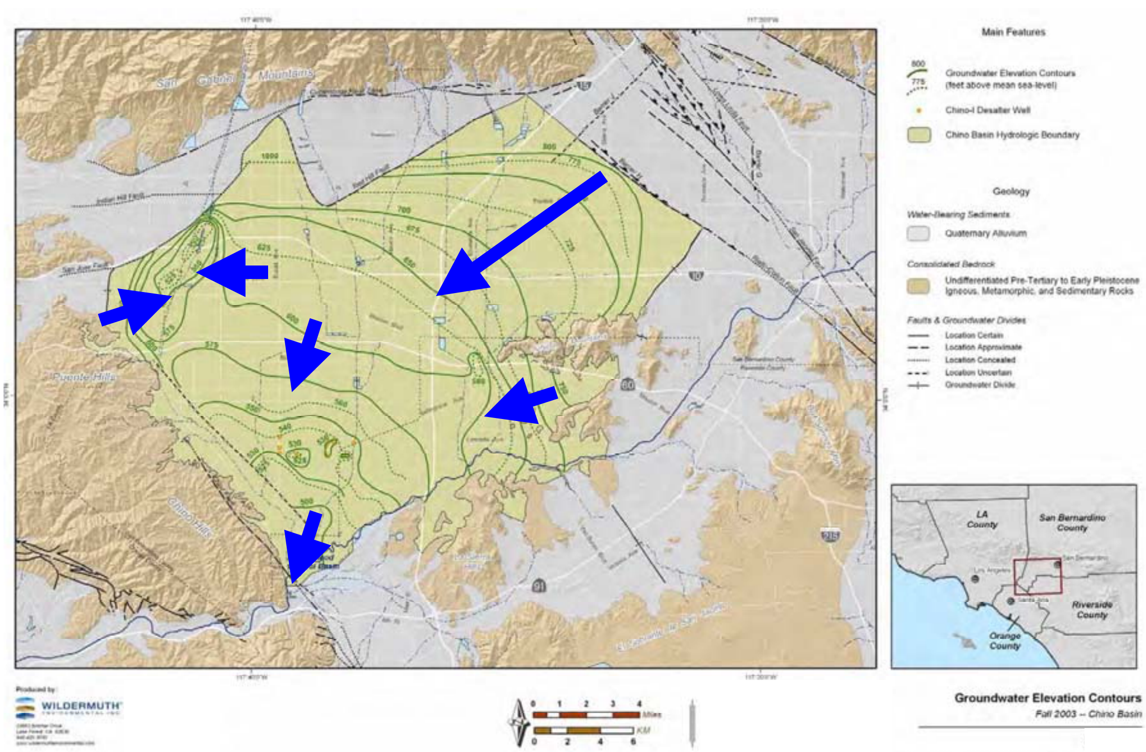
GROUNDWATER LEVELS

The following section provides a description of groundwater levels in the Chino and Cucamonga Basins.

Chino Basin

In the Chino Basin, surface drainage patterns generally flow from the areas in the north and east flanking the San Gabriel and Jurupa Mountains towards areas of discharge near the Santa Ana River within the Prado Flood Control Basin. Groundwater flow generally follows the same pattern. As shown on **Figure 12-5**, groundwater elevations within the Chino Basin range from less than 500 feet, above MSL to over 1,000 feet MSL. Notable groundwater depressions can be seen in the Pomona-Montclair area of the western portion of the basin and near the Chino I Desalter.

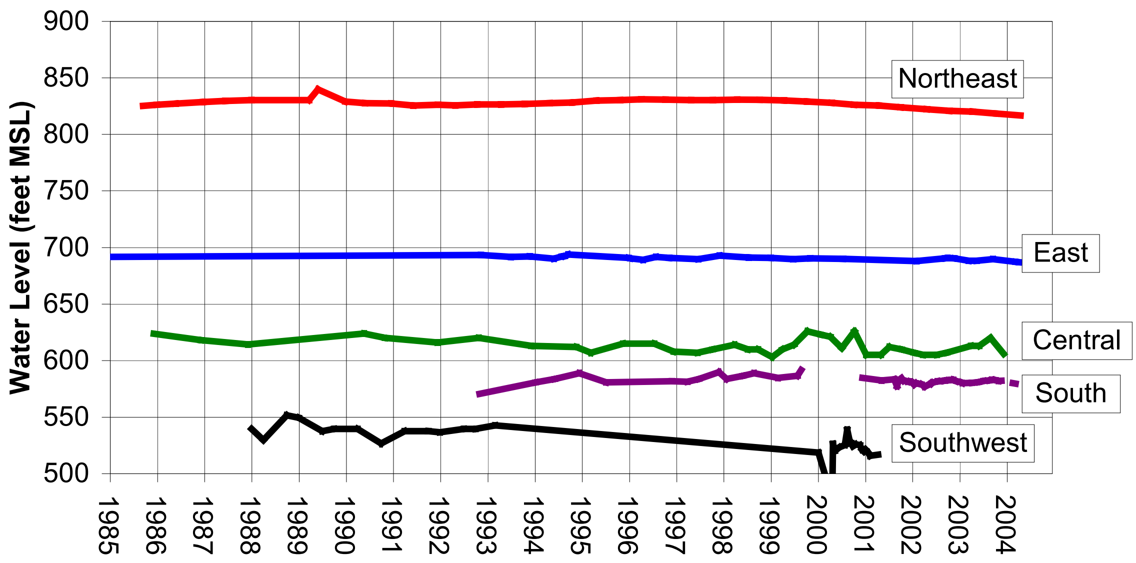
Figure 12-5
Groundwater Contour Map in the Chino Basin – Fall 2003



Source: Wildermuth, 2005a

Groundwater levels over time in various areas within the Chino Basin are shown on **Figure 12-6**. Groundwater levels appear to have stabilized since the Chino Basin Judgment was implemented and groundwater production has been managed within the Basin's safe yield. Water levels in some areas, particularly in the western portion of the basin near the boundary with Six Basins, continued to decline in the period between 1985 and 2004.

Figure 12-6
Historical Water Levels in the Chino Basin



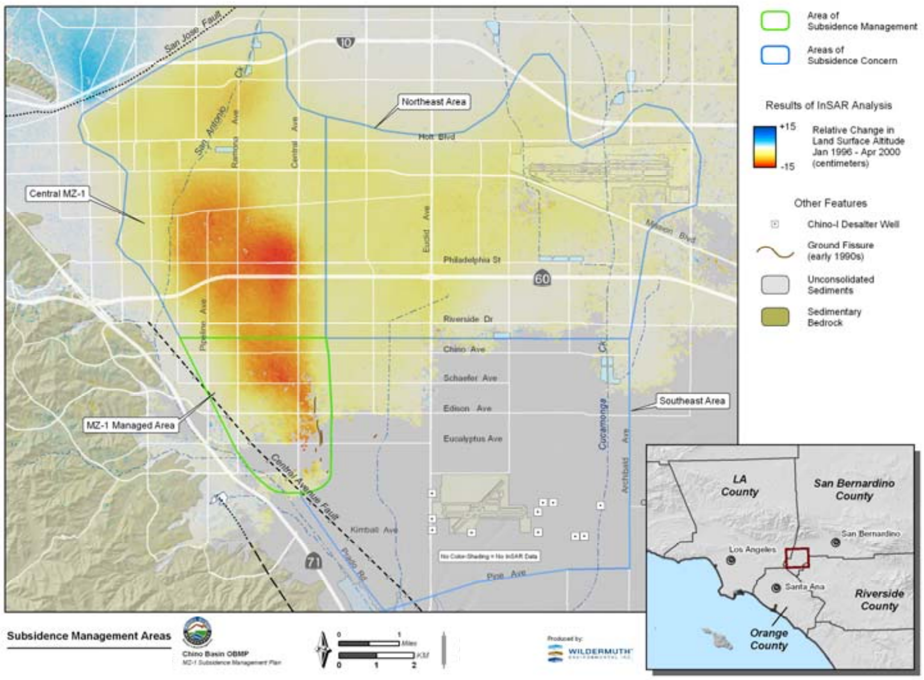
Source: SAWPA, 2006 and DWR, 2006

Land subsidence and ground fissuring have been observed in the area underlying the City of Chino and the California Institution for Men in the southern portion of the basin, which has been attributed to groundwater extraction as shown in **Figure 12-7**. As shown in this figure, land surface elevations dropped as much as 15 cm, or about 6 inches, in the five-year period between 1996 and 2000. In order to minimize further subsidence, a monitoring plan has been formulated and implemented. The new ASR wells and expansion of the recharge basin capacities discussed above are intended to increase the recharge to this area. Management is ongoing.

Cucamonga Basin

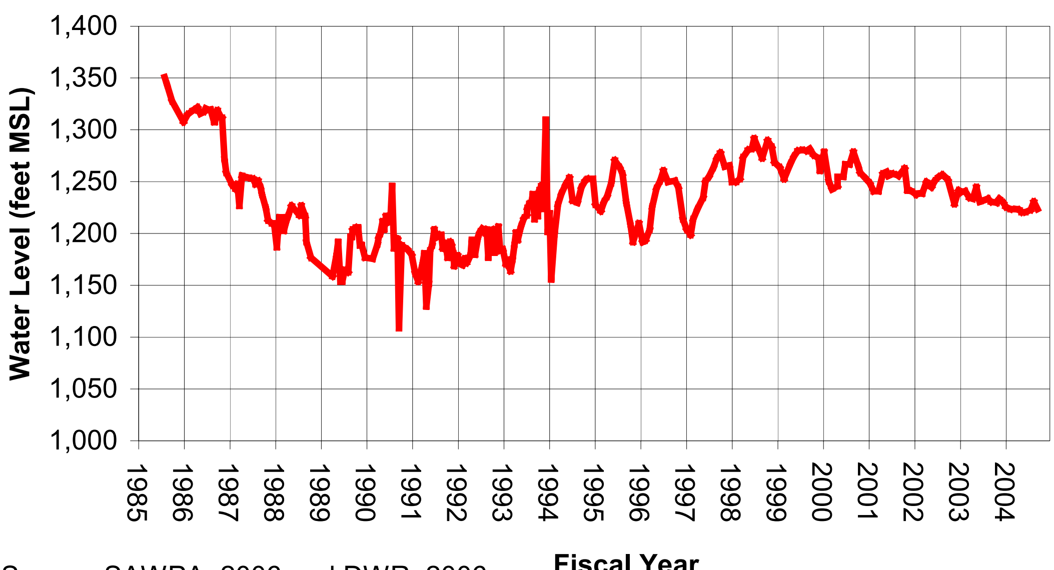
Historical groundwater levels are shown in **Figure 12-8**. As shown in this figure, water levels have dropped more than 150 feet between fiscal year 1985/86 and 2004/05. However, the Cucamonga Basin is small and reacts quickly to precipitation and long seasonal pumping (Michael, 1981), water levels are largely dependent upon precipitation. As such, the dry period between 2000 and 2004 is reflected in the water levels.

Figure 12-7
Areas of Subsidence in the Chino Basin (1996 to 2000)



Source: Wildermuth, 2006

Figure 12-8
Historical Water Levels in the Cucamonga Basin



Source: SAWPA, 2006 and DWR, 2006

GROUNDWATER QUALITY

The following provides a brief description of the groundwater quality issues for the Chino and Cucamonga Basins.

Groundwater Quality Monitoring

Historically, groundwater quality data in the Chino Basin were collected by various entities. In 1990, Watermaster initiated a regular monitoring program for Chino Basin. Subsequent to the initial monitoring program, Watermaster developed the OBMP in 1999, and the Peace Agreement that implemented the OBMP in 2000.

The OBMP established goals for the Chino Basin Watermaster, beginning with the Comprehensive Water Quality Monitoring Program (CMP), which included water quality sampling and analysis from all known active production and monitoring wells in the Chino Basin (from 1999 to 2001). Subsequently, the Groundwater Monitoring Program has continued to provide an evaluation of water levels and water quality for the Chino Basin (Wildermuth, 2005a).

The Chino Basin Watermaster and IEUA have an agreement to share in the monitoring efforts in the basin with the intent of minimizing the cost of data acquisition, laboratory services, and data management. The types of data being collected in the cooperative program include surface water quality at recharge basins, surface water quality in the Santa Ana River, soil water samples from lysimeters at recharge basins, groundwater quality, groundwater level, and surface water discharge measurements in the Santa Ana River. Chino Basin Watermaster will complete most of the fieldwork and IEUA will do most of the analytical work at their laboratory (Wildermuth, 2005a).

Programs to monitor groundwater levels and water quality have been reorganized to better support new initiatives. These include such projects as subsidence management in the western portion of the Chino Basin, hydraulic control monitoring, nitrogen loss, and desalter expansion. Automatic measuring and recording devices are increasingly being used to replace manual sampling. These automatic data loggers lower costs, improve accuracy and provide better data. These include three active groundwater-monitoring programs:

1. Semiannual Basin-Wide Monitoring Program in which Watermaster manually measures water levels in about 480 agricultural wells twice each year to determine the effects of production on groundwater levels.

2. Intensive Key Well Program associated with the desalter activities and the Hydraulic Control Monitoring Program. Launched in 2003-04, the Key Well Program involves about 107 wells.

3. MZ-1 Monitoring Program transitions to Long-Term Planning. Using a series of standard monitoring wells as well as sophisticated piezometric monitors and infrared satellite imagery, Watermaster has been monitoring the western portion of the Basin.

The focus is on looking ahead to a long-range plan to understand and prevent any ground subsidence due to changes in groundwater levels. Related to this are cooperative aquifer stress tests that measure water production versus groundwater levels, conducted in cooperation with the cities of Chino and Chino Hills.

Chino Basin Watermaster, IEUA, Orange County Water District and the Regional Board developed a hydraulic control-monitoring program in 2005 to characterize the relationship of the Santa Ana River and the Chino Basin. Hydraulic control monitoring wells have been constructed and the monitoring program initiated. Information from this program will be use to adaptively manage the Chino Basin storage and recovery programs (IEUA, 2005). In 2004-05, nine new monitoring wells were installed as part of the piezometric monitoring element of the Hydraulic Control Monitoring Program. The new monitoring wells were needed because existing well locations and well construction are not sufficient to measure the extent of hydraulic control near the desalter well fields. They also were needed because of the loss of agricultural well monitoring caused by the conversion of agriculture to urban land uses (Chino Basin Watermaster, 2005).

Chino Basin Watermaster and IEUA are also designating a number of monitoring wells at recharge basins to monitor the influence of recharge on groundwater levels, as well as the changes in water quality resulting from the recharge of storm, imported and recycled water. At least one monitoring well will be installed downgradient of each recharge facility that receives recycled water.

The Santa Ana Watershed Basin Monitoring Task Force is a collaborative effort of public and private sector agencies and interests. As part of this effort, SAWPA compiles water quality data in the Santa Ana River Watershed, including total dissolved solids (TDS) and nitrate (as N) data. SAWPA also prepares a triennial update of the ambient groundwater quality throughout all the groundwater basins in the Santa Ana River Watershed.

Groundwater Contaminants

Table 12-7 provides a summary of the groundwater constituents of concern for the Chino and Cucamonga basins. Each basin's quality is discussed separately. **Figures 12-9 through 12-11** show the distribution of nitrate, total dissolved solids (TDS), and VOCs measured in wells in the Chino Basin (Wildermuth, 2005a).

Chino Basin

The following section describes the groundwater quality issues in the Chino Basin. Constituents of concern for the Chino Basin include: TDS, nitrate, VOCs and perchlorate. Each of these constituents is described in more detail below.

TDS concentrations range from less than 250 mg/L to more than 2,000 mg/L in the Chino Basin. TDS concentrations in the northern portion (*i.e.*, north of the 60 Freeway) of the Chino Basin are generally less than 250 mg/L. TDS concentrations in municipal wells south of the 60 Freeway were typically in the range of 250 to 500 mg/L with areas of greater than 2,000 mg/L.

More than 72 percent of private wells had TDS concentrations that exceeded recommended secondary standard of 500 mg/L (Wildermuth, 2005a).

Table 12-7
Summary of Constituents of Concern in the Chino and Cucamonga Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	**Chino Basin** <125 to > 2,000 **Cucamonga Basin** 163 to 446	TDS concentrations in the northern portion of the Chino Basin are generally less than 250 mg/L. TDS concentrations south of the 60 Freeway were typically in the range of 250 to 500 mg/L with some areas greater than 2,000 mg/L. More than 72 percent of private wells exceed 500 mg/L. Current average ambient in Cucamonga Basin is approximately 250 mg/L.
Nitrate (as N) Primary MCL = 10	mg/L	**Chino Basin** Less than 5 to >40 **Cucamonga Basin** Up to 25	Nitrate concentrations generally increase from north to south with levels in wells south of the 60 Freeway commonly exceeding 40 mg/L. 83 percent of private wells exceed the nitrate MCL. Current average ambient nitrate in Cucamonga Basin is approximately 4.3 mg/L.
VOCs **(TCE and PCE)** Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	**Chino Basin** ND to > 20 for TCE ND to >20 for PCE **Cucamonga Basin** ND	In general, PCE and TCE are below detection limits for wells in the Chino Basin. Isolated pockets of TCE and PCE are noted. PCE and TCE are not detected in the Cucamonga Basin.
Perchlorate Notification level = 6	µg/L	**Chino Basin** ND to > 34 **Cucamonga Basin** ND to 6	Perchlorate has been detected above notification level in 128 wells in the Chino Basin. Concentrations below action levels have been detected in the Cucamonga Basin.
DBCP Primary MCL = 0.2	µg/L	**Cucamonga Basin** ND to 1	Wells are currently blended in Cucamonga Basin. Concentrations since 1990 have ranged from ND to 1 µg/L.

Source: Wildermuth, 2005a,b

Figure 12-9
Total Dissolved Solids in Groundwater - Chino Basin (1999-2004)

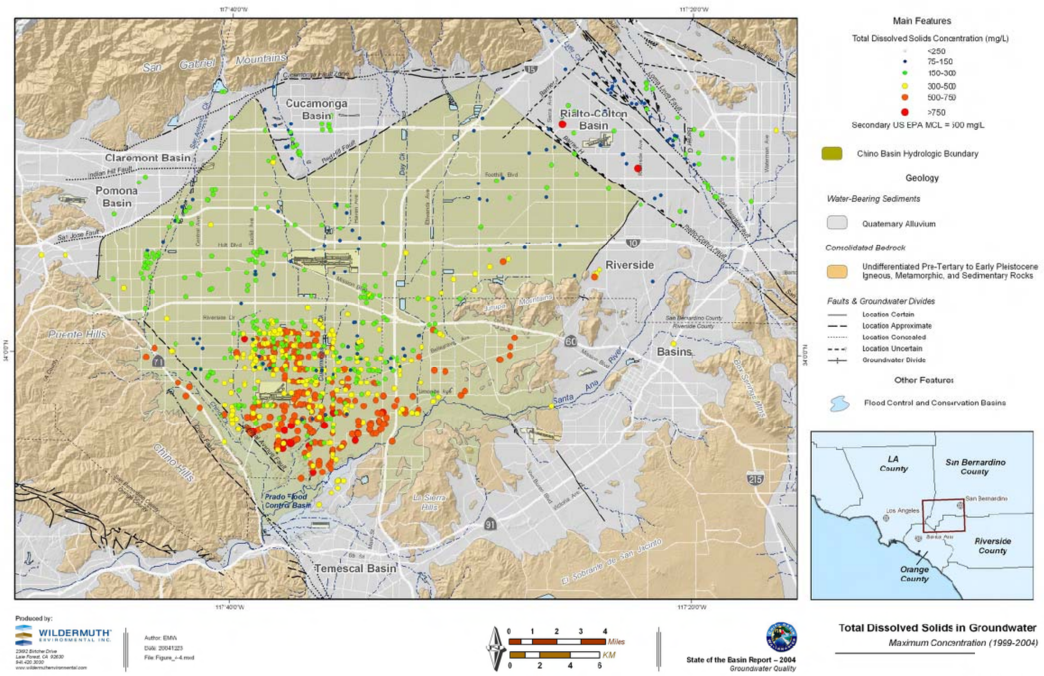


Figure 12-10
Nitrate (as N) in Groundwater - Chino Basin (1999-2004)

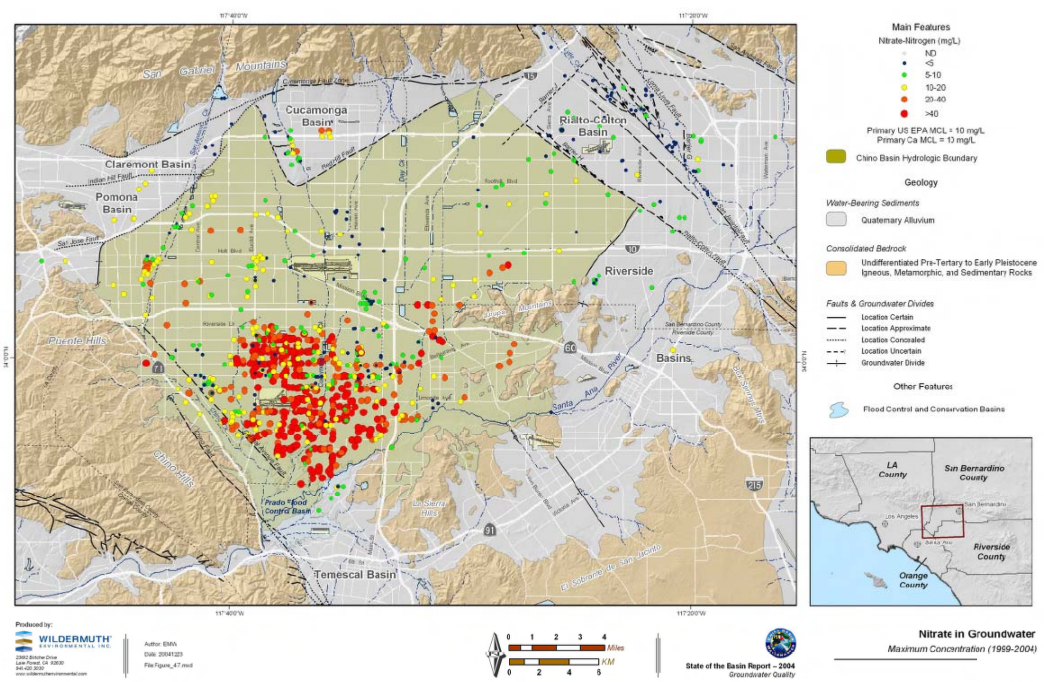
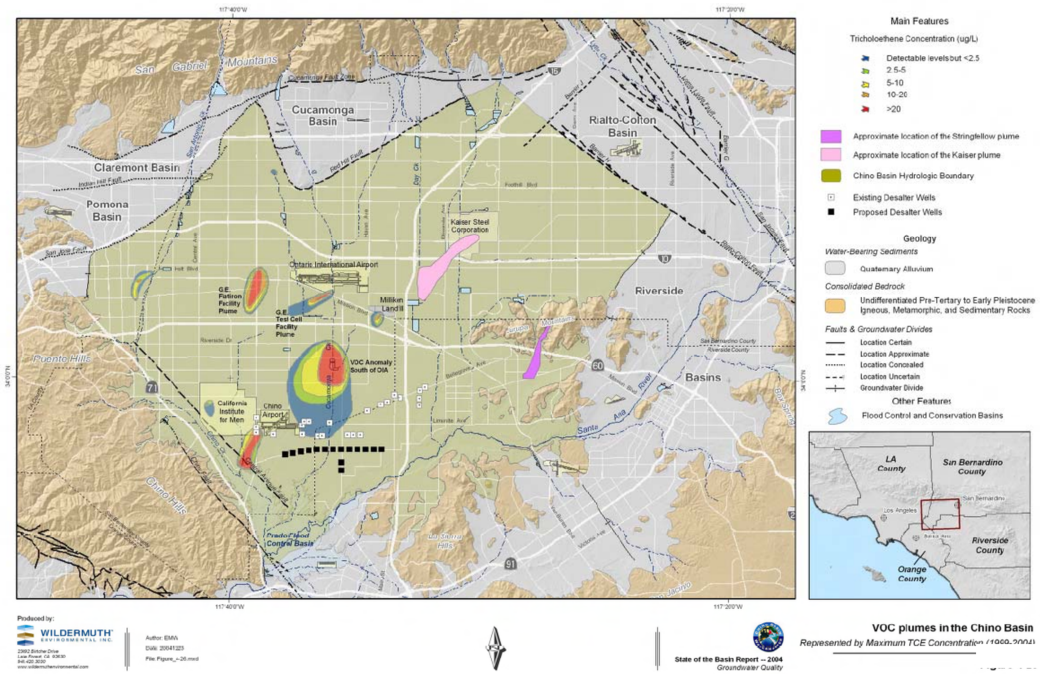


Figure 12-11
Location of VOC Plumes in the Chino Basin (1999-2004)



There are various locations where nitrate exceeds the maximum contaminant level (MCL) of 10 mg/L for nitrate (as N). Nitrate concentrations in the Chino Basin generally increase from north to south within the basin. North of the 10 Freeway, nitrate levels are generally less than 10 mg/L. Wells measured in the area south of the 10 Freeway and north of the 60 Freeway contain concentrations of nitrate that range from non-detect to 40 mg/L. South of the 60 Freeway nitrate concentrations are predominantly greater than the maximum contaminant level (MCL) of 10 mg/L with many wells exceeding 40 mg/L (Wildermuth, 2005b). The results from a 2002 and 2003 study indicate that about eighty-three percent of the private wells had nitrate concentrations greater than the MCL and 60 percent are more than 2.5 times greater than the MCL (Wildermuth, 2005a)

In general, PCE and TCE concentrations are below detection limits for wells in the Chino Basin. The wells with detectable levels tend to occur in clusters such as those seen around Milliken Landfill, south and west of the Ontario Airport and along the margins of the Chino Hills (Wildermuth, 2005a). The areas are discussed in more detail with respect to treatment below.

Perchlorate has been detected above the notification level of 6 µg/L in 128 wells in the Chino Basin (IEUA, 2005) in the period between 1999 and 2004. Historical values of perchlorate exceeding the State Notification Level have occurred in the Fontana area, downgradient of the Stringfellow Superfund Site (concentrations have exceeded 600,000 µg/L in on-site observation wells), City of Pomona, City of Ontario south of the Ontario Airport, and in scattered wells throughout Chino Basin.

Cucamonga Basin

For the Cucamonga Basin, water sampled from 23 public supply wells have TDS concentrations that range from 163 mg/L to 446 mg/L with an average of 261 mg/L (DWR, 2004). Average ambient TDS calculated by Wildermuth (2005b) was slightly lower at 250 mg/L.

Six of CVWD's seventeen active wells contain high concentrations of nitrate and dibromochloropropane (DBCP). Concentrations of DBCP in CVWD wells since 1990 range from ND to 1 μg/L, which is above the MCL of 0.2 μg/L. Current average ambient nitrate (as N) in Cucamonga Basin is approximately 4.3 mg/L (Wildermuth, 2005b). Low levels of perchlorate have also been found in some wells (CVWD, 2005).

Blending Needs

Chino Basin

No data related to blending in Chino Basin are available at this time.

Cucamonga Basin

In Cucamonga Basin, other wells are used to blend down concentrations of key constituents. Wells that contain concentrations of nitrate and DBCP greater than the MCLs are blended to reduce the concentrations to levels that meet standards. Water in some wells containing perchlorate is also blended with other groundwater (CVWD, 2005). CVWD has developed operational blending plans so that wells within the Cucamonga Basin can continue to provide potable water. The well blending plans were approved by the DHS.

Groundwater Treatment

Chino Basin

To address the water quality issues described above, there are various groundwater treatment facilities online in the Chino Basin.

In the Chino Basin, various groundwater contaminant plumes are treated at on-site remediation facilities. As shown in **Figure 12-11**, identified plumes of contaminated groundwater from past industrial operations include: the GE Flatiron Facility, GE Test Cell Facility, Ontario Airport, Kaiser Steel Corporation, Milliken Landfill, California Institute for Men, Upland Landfill, Stringfellow and Chino Airport plumes. Treatment details are summarized in **Table 12-8**. Desalter facilities, including Chino I and Chino II, as discussed above, treat TDS and nitrate-impacted groundwater in the southern portion of the basin. The details of the desalters are included in **Table 12-8** below.

Additional ion exchange wellhead treatment is also included as part of the Chino Basin conjunctive use program (discussed below) with Metropolitan. These facilities are currently under construction and are not yet operational. Actual capacities and amount treated are not known at this time.

Table 12-8
Summary of Groundwater Treatment in the Chino Basin

Treatment Facility	Constituent Treated	Treatment Type	Amount Treated	Comments
Upland Landfill	VOCs	None	None	No treatment due to low concentration.
GE Flatiron Facility	TCE	GAC	0.8 MGD (1996-2004)	One extraction well began operation in 1996. A second extraction well began operation in 2004.
	Hexavalent chromium chromate	Ion Exchange	1.2 MGD (2004-present)	
GE Test Cell Facility	TCE Other VOCs	None	None	Treatment expected to start by early 2008. Plume is stable and not moving.
Milliken Landfill	VOCs	Aeration Tower	4,000 gallons per day	Treatment started in 2003. Plume contained on landfill site.
California Institute for Men	PCE	Air Stripping	None	Air stripping was used to remove PCE from a water supply well from 1997 until 2004. PCE concentrations diminished, and there has been no treatment since 2004. Ongoing treatment consists of using groundwater for crop irrigation.
Kaiser Steel	TDS VOCs	None	None	No treatment due to low concentrations.
Chino Airport	TCE	None	None	Remedial investigation in progress. Treatment may begin in 2008/2009.
VOC Anomaly South of Ontario International Airport	TCE Perchlorate	None	None	Site assessment and remedial investigation beginning. Not known when treatment will start.
Stringfellow Superfund Site	VOCs	GAC	10,000 gallons per month	VOCs largely remediate.
	Metals	Precipitation	10 – 20 gpm	Metals captured at existing treatment plant.
	Perchlorate	Ion Exchange and/or Bio-remediation	None	California Department of Toxic Substances Control has characterized the contamination and is conducting the feasibility study. The Record of Decision is expected by December 2009. Plume appears to extend to the Santa Ana River.

Table 12-8 (continued)
Summary of Groundwater Treatment in the Chino Basin

Treatment Facility	Constituent Treated	Treatment Type	Amount Treated	Comments
Chino I Desalter	TDS Nitrate VOCs	Reverse Osmosis Ion Exchange Air Stripping	Up to 15,900 AFY	Online in 2000 Average of 7,900 AFY treated.
Chino I Desalter	TDS Nitrate	Reverse Osmosis Ion Exchange	Up to 10,200 AFY	Online in 2006.

Source: Regional Board, 2007; IEUA, 2006b; Chino Desalter Authority, 2005; Chino Basin Watermaster, 2007a; DTSC, 2006; DTSC, 2007.

Cucamonga Basin

The active wells in the Cucamonga Basin are operated in accordance with a DHS-approved blending plan. Concentrations of contaminants are not expected to increase from current levels, and well-head treatment systems have not been installed (CVWD, 2005).

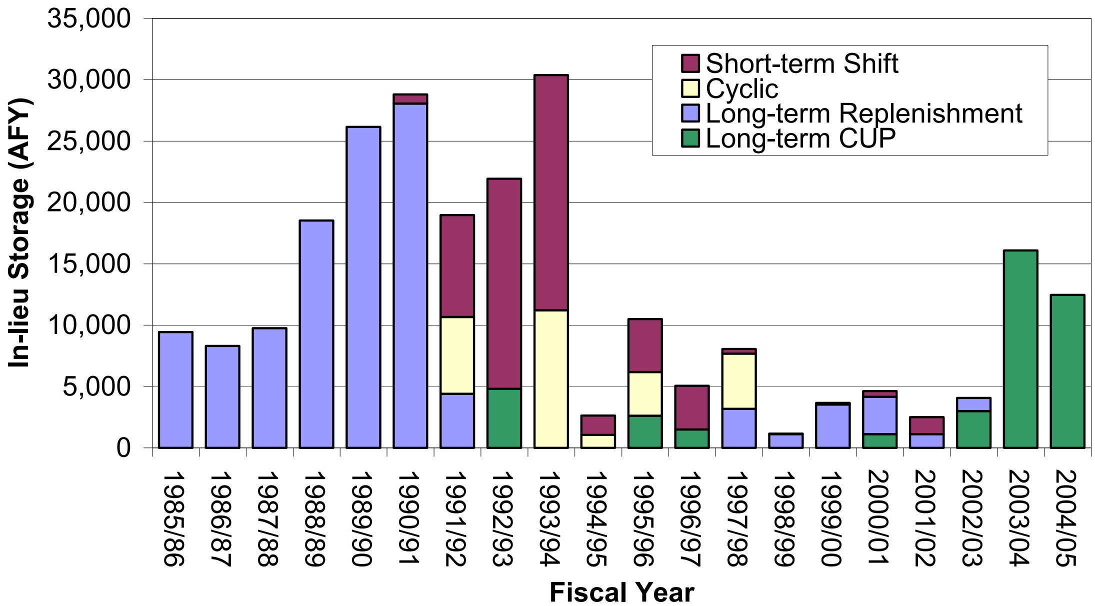
CURRENT GROUNDWATER STORAGE PROGRAMS

In 2003, the Chino Basin Watermaster, Three Valleys Municipal Water District, and IEUA executed a conjunctive use program (also referred to as the Dry Year Yield Program, DYY or CUP) with Metropolitan. The Chino CUP provides for a 100,000 AF storage account in the Chino Basin. Upon a call by Metropolitan, program participants will extract up to 33,000 AFY in lieu of receiving deliveries at a Metropolitan service connection. The program provides funding for development of facilities needed for extraction of stored water. As of June 30, 2005, the stored account balance in the CUP account was approximately 59,000 AF.

In addition, the Chino Basin producers have participated in a variety of other groundwater storage programs with Metropolitan since 1985. These include Metropolitan's cyclic and replenishment water programs for purchase of imported water for spreading and in-lieu. Direct recharge volumes are discussed above. In-lieu deliveries are summarized in **Figure 12-11**. In-lieu programs include: short-term shift, cyclic, long-term replenishment, and the long-term CUP storage account (programs such as cooperative storage and trust accounts have been rolled into the CUP storage account).

No groundwater storage programs currently exist within the Cucamonga Basin.

Figure 12-12
In-lieu Storage in Chino Basin



BASIN MANAGEMENT CONSIDERATIONS

The following describes general management considerations that affect the use of groundwater in the Chino and Cucamonga Basins.

Considerations in the Chino Basin include:

- TDS and nitrate concentrations predominantly in southern portion of basin and several large VOC plumes are significant issues for the basin.
- There are no court-ordered limits on pumping by groundwater users. However, pumping in excess of safe yield must be replenished.
- Desalters are used to maintain hydraulic control and protect Santa Ana River water quality.
- Recent increased use of recycled water has increased management flexibility.
- Subsidence and fissuring could limit production in the deep aquifer of southwestern portion of basin.

Considerations in the Cucamonga Basin include:

- Groundwater pumping from the Cucamonga Basin is limited by the 1958 Superior Court stipulated judgment to 22,721 AFY (CVWD, 2005).

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CHAPTER IV

GROUNDWATER BASIN REPORTS

EASTSIDE METROPOLITAN SERVICE AREA BASINS

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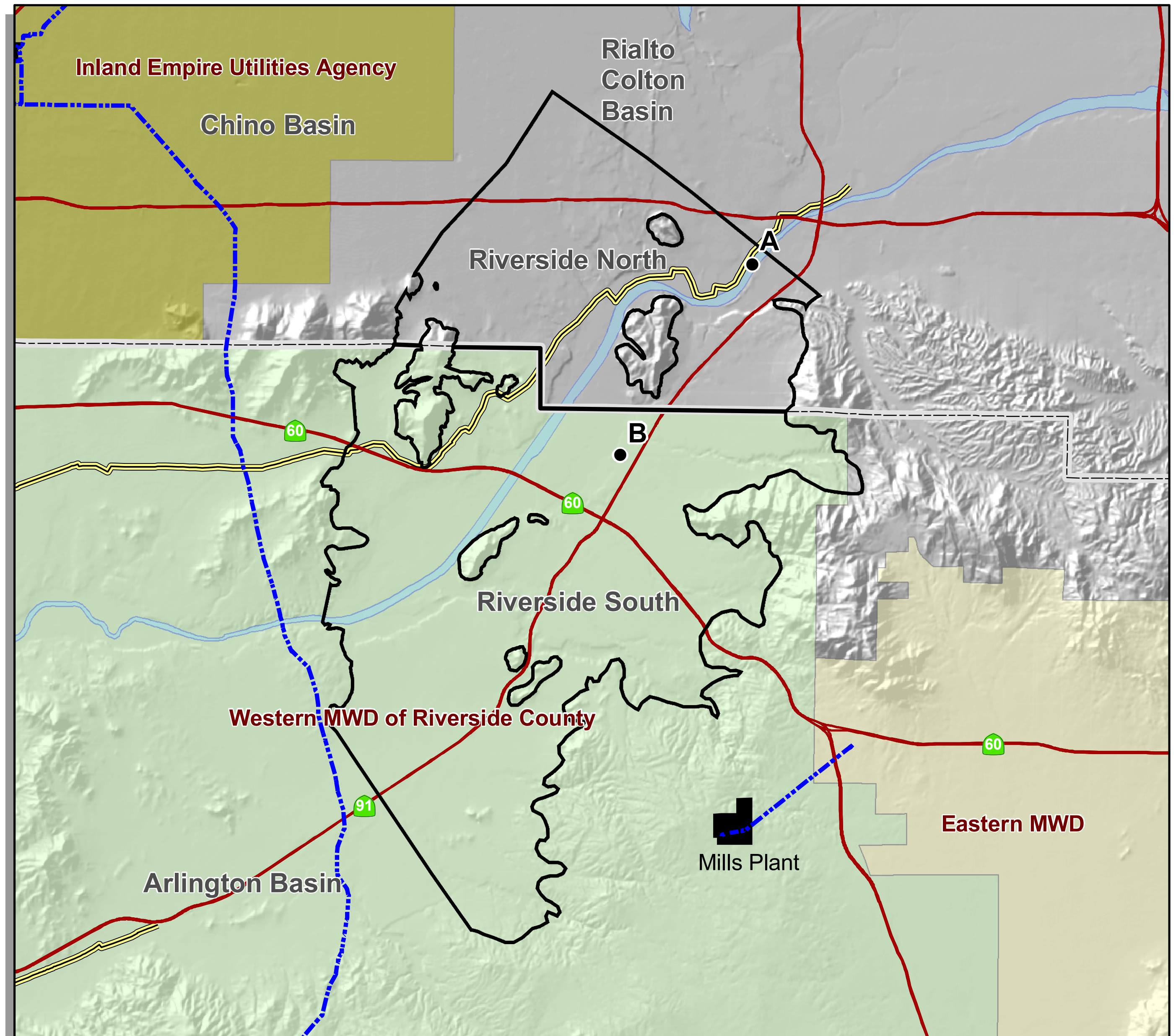

Riverside Basin

A ●	Key Well		MWD Facilities
	County		Santa Ana Regional Interceptor Line
	Freeways		Basin
	Water Body		MWD Member Agency Boundary (color varies)
	MWD Pipeline		

N W E S

3 1.5 0 3 Miles

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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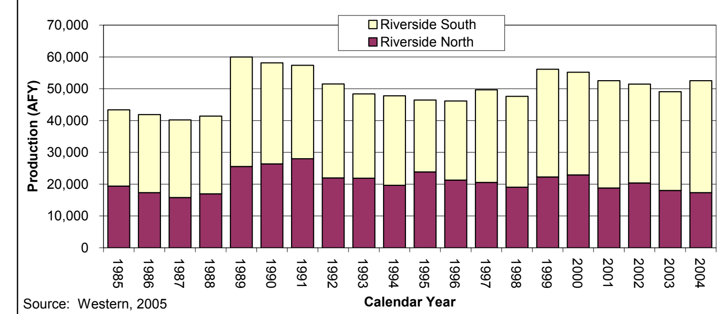
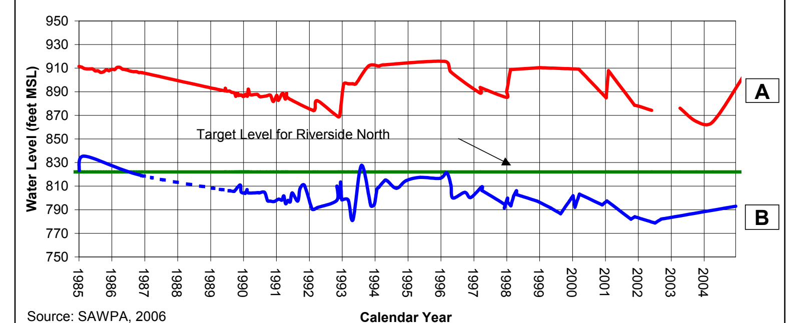
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).

Production



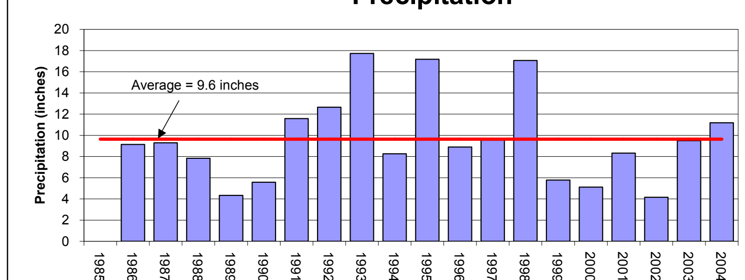
Source: Western, 2005

Water Level



Source: SAWPA, 2006

Precipitation



Source: CIMIS, 2006

Direct Groundwater Recharge

No direct groundwater recharge data available for this basin.

BASIN FACTS

Riverside Basin

Description
Location: Riverside County and San Bernardino County
Watershed Surface Area: 36 square miles
Subbasins:
Riverside North
Riverside South
Management: Adjudicated
Although production is not limited, maintaining of water levels in Riverside North is included in 1969 San Bernardino Judgment
MWD Member Agencies:
Western MWD

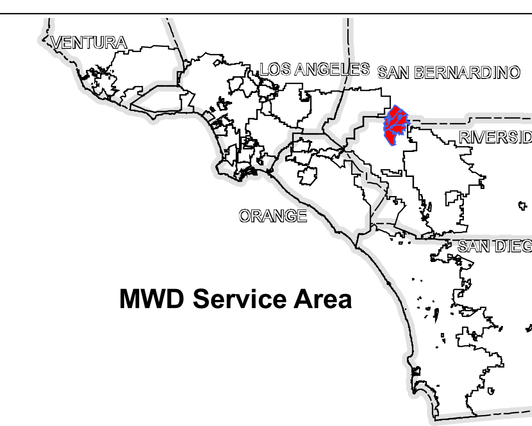
	Riverside North	Riverside South
Natural Safe Yield	33,729 AFY	29,633 AFY
Total Storage	1.15 million AF	
Unused Storage Space (Fall 2003)	427,000 AF	
Portion of Unused Storage Space Available for Storage	Unknown	

Storage and Extraction Facilities

	Riverside North	Riverside South
Production Wells		
Production Capacity	~30,000 AFY	~54,000 AFY
Average 1985-2004	20,690 AFY	28,971 AFY
Injection Wells		
Injection Capacity	None	None
Average 1985-2004	None	None
Spreading Basins		
Spreading Capacity	None	None
Average 1985-2004	None	None

Basin Management Considerations

- Water quality (TDS, nitrate, perchlorate, TCE, PCE and DBCP) could limit ability to store and extract water
- Maintaining water levels in Riverside North is required by SBVMWD



MWD Service Area

Plate 13-1
Overview of Riverside Basin

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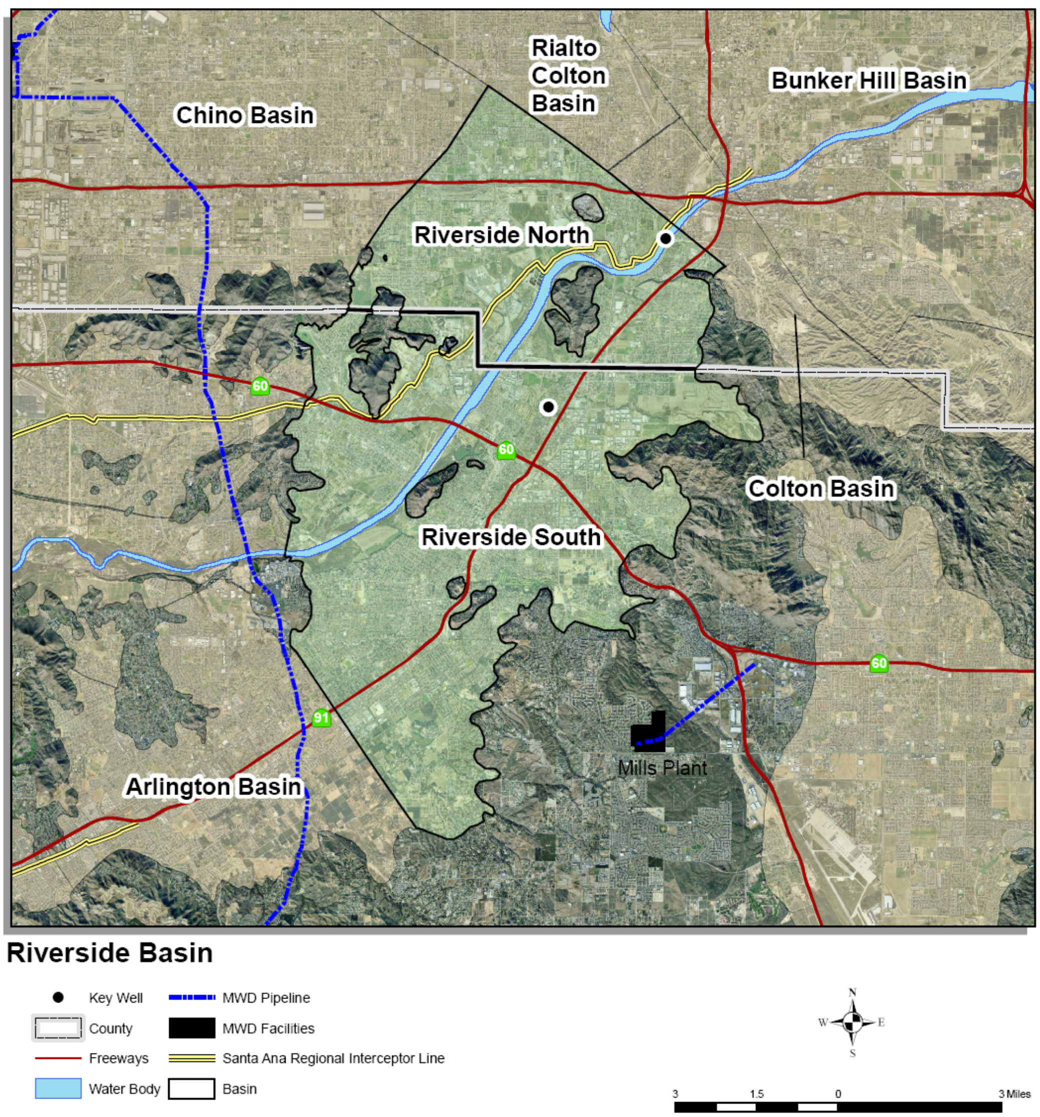
The Riverside Basin, located in northwestern Riverside County and southwestern San Bernardino County, includes the Riverside North and Riverside South subasins. The Riverside North Basin includes the portion of the Riverside Basin located in San Bernardino County, which is within the service area of the San Bernardino Valley Municipal Water District (SBVMWD), and the Riverside South Basin, which is located within the service area of Western Municipal Water District (Western MWD), includes the portion in Riverside County. This division is strictly administrative and does not reflect a physical barrier to groundwater flow between the subasins. The Riverside Basin includes the community of Riverside and unincorporated areas of Riverside County. The location and key facilities of the Riverside Basin are shown in **Figure 13-1**.

Figure 13-1
Map of the Riverside Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Riverside Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The Riverside Basin, which follows the course of the Santa Ana River, is a large alluvial fill basin that is bounded by major faults and topographic barriers. The northeast boundary is formed by the Rialto-Colton fault, and a portion of the northern boundary is a groundwater divide. The Santa Ana River flows over the northern portion of the basin (DWR, 2004). Alluvial deposits in the basin consist of sand, gravel, silt, and clay deposited by the Santa Ana River and its tributaries. Near the city of Riverside, the upper 50 feet of deposits are principally clay. At the northern end of the basin, coarser gravels with cobbles 4 to 6 inches in diameter are common (DWR, 2004). As discussed above, the Riverside Basin is divided into the Riverside North and Riverside South for administrative purposes; there are no groundwater barriers or physical divides between these subbasins within the Riverside Basin. The hydrogeologic parameters for the Riverside Basin are summarized in **Table 13-1**.

Groundwater occurrence is generally unconfined in the Riverside Basin. Maximum aquifer depth in the Riverside North Basin ranges from about 600 to 700 feet and more than 400 feet in the Riverside South Basin, with water bearing units comprised of sand and gravel deposits (Riverside, 2005a). The total estimated groundwater storage capacity in the Riverside Basin is approximately 1.15 million AF (Wildermuth, 2006). In the fall of 2003, it is estimated that approximately 427,000 AF was unused (Wildermuth, 2006). However, because the upper 50 to 100 feet of unsaturated thickness cannot generally be used because of issues such as increased liquefaction potential, not all of the storage space identified can be used for storage. The usable storage in the Riverside Basin is unknown.

Safe Yield/Long-Term Balance of Recharge and Discharge

Recharge to the basin occurs via infiltration of flow from the Santa Ana River and unlined channels, underflow from saturated alluvium and fractures within the surrounding bedrock hills, underflow as seepage across the Rialto-Colton fault and percolation of precipitation and returns from use. About 1/3 of the inflows to the basin (about 20,000 AFY) come from underflow across the Rialto-Colton fault (Riverside, 2005a). Safe yield of the combined Riverside Basin is approximately 63,362 AFY (Riverside, 2005a).

Precipitation recharge is a relatively small component of the water budget for the Riverside Basin. Average precipitation is 9.6 inches per year. **Figure 13-2** provides the historical precipitation data from the CIMIS Riverside #44 Station located near UC Riverside (CIMIS 2006). These data suggest below average precipitation between 1986 and 1990 and 1999 and 2003, above average precipitation between 1991 and 1998 and since 2004.

Table 13-1
Summary of Hydrogeologic Parameters of Riverside Basin

Parameter	Description
Structure	
Aquifer(s)	Unconfined alluvium
Depth of groundwater basin	0 to 700 feet
Thickness of water-bearing units	Riverside North: 600 to 700 feet Riverside South: at least 400 feet
Yield and storage	
Natural safe yield	Riverside North: 33,729 AFY [1] Riverside South: 29,633 AFY [1] Total: 63,362 AFY [1]
Total Storage	1,149,000 AF
Unused Storage Space (Fall 2003)	427,000 AF
Portion of Unused Storage Space Available for Storage	Unknown

Source: Riverside, 2005a ;DWR, 2004; and Wildermuth, 2006
[1]1959-63 base period average extraction as verified by the Watermaster

GROUNDWATER MANAGEMENT

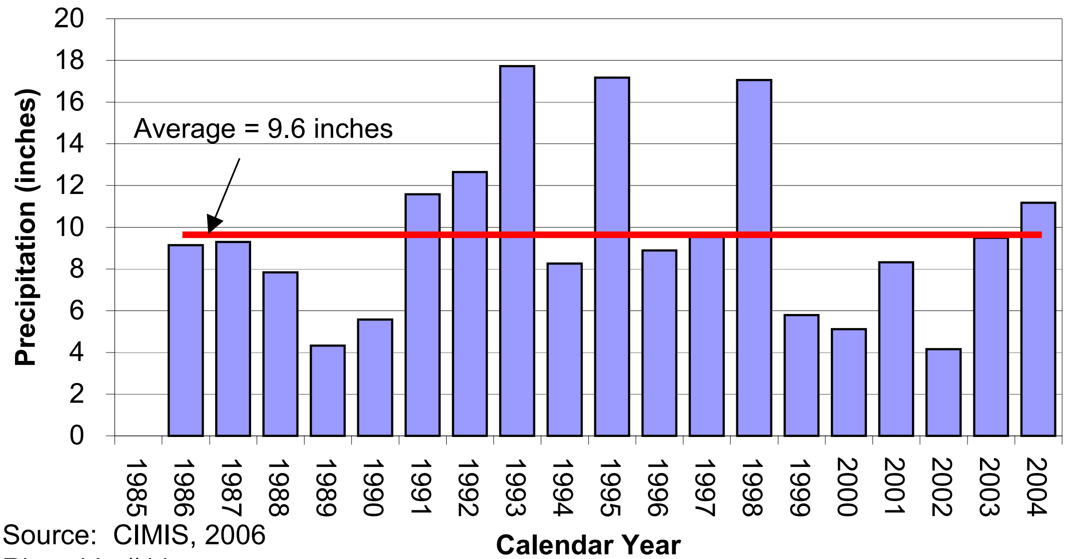
The following section describes how the Riverside Basin is currently managed. This description includes a description of the governing structure and agreements pertaining to adjoining basins.

Basin Governance

The Riverside Basin is adjudicated. The Riverside Basin is included in the 1969 Stipulated Judgment No. 78426, Western Municipal Water District of Riverside County et al. versus East

San Bernardino County Water District, et al, Superior Court of the State of California for Riverside County (1969 Judgment). The 1969 Judgment distinguishes the portions of Riverside

Figure 13-2
Historical Precipitation in the Riverside Basin



Source: CIMIS, 2006
Riverside #44

Basin in San Bernardino and Riverside counties sets out the average annual extraction for each portion of the Riverside Basin and establishes a watermaster to administer and enforce the judgment provisions. Extraction from the San Bernardino County portion for use *outside* San Bernardino Valley and from the Riverside County portion of the basin, without replenishment obligation, are limited within any 5 consecutive year period to 5 times the annual average extraction during the 1958-63 base period. Replenishment is required if the extraction in any year is 20 percent more than the annual average in a basin portion. Extractions from the Riverside Basin within San Bernardino County for use *within* San Bernardino Valley are not limited except that static water levels in the area shall not fall below a specified water elevation. The 1969 Judgment specifies that it does not limit rights to spread, store and recapture imported water.

Table 13-2 provides a list of managing agencies in the Riverside Basin.

Interactions with Adjoining Basins

As discussed above, the Rialto-Colton fault to the northeast separates the Riverside Basin from Rialto-Colton Basin. The fault is a barrier to groundwater flow along of its length, especially in its northern reaches (Wildermuth 2000). A groundwater divide in the alluvium separates the Riverside Basin from the Arlington Basin to the south (DWR, 2004). In addition, groundwater beneath the Santa Ana River in the western portion of the Riverside Basin rises to become surface water within the Santa Ana River upstream of Riverside Narrows and flows into the Chino Basin. There are no agreements that govern the flow into Chino Basin.

The Riverside Basin is tributary to the Santa Ana River upstream of Prado Dam. On April 17, 1969, the Orange County Superior Court entered a Stipulated Judgment in Case No. 117628 involving the Orange County Water District vs.City of City of Chino et al (Santa Ana River Judgment). The Santa Ana River Judgment, which became effective October 1, 1970, contained a declaration of rights of the entities in the lower Santa Ana River area (i.e. OCWD) versus those in the upper Santa Ana River area (i.e. San Bernardino Valley Municipal Water District, or SBVMWD, Chino Basin MWD, now called IEUA, and Western MWD).

Table 13-2
Summary of Management Agencies in the Riverside Basin

Agency	Role
San Bernardino Valley Municipal Water District	Co-Watermaster for 1969 Judgment Part of Watermaster Committee responsible for administration of 1969 Santa Ana River Judgment.
Western Municipal Water District (Western MWD)	Co-Watermaster for 1969 Judgment Part of Watermaster Committee responsible for administration of 1969 Santa Ana River Judgment.
San Ana River Watermaster	Watermaster for 1969 Stipulated Judgment that defined water allocations in the Santa Ana River among lower Santa Ana River and upper Santa Ana River producers.
Santa Ana Water Project Authority (SAWPA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the Santa Ana River Watershed.
California Regional Water Quality Control Board – Santa Ana Region (Regional Board)	Issuance of permits for discharges to Santa Ana River
Cities of Colton and San Bernardino	Operation of Rapid Infiltration and Extraction (RIX) facility

The Judgment is administered by the Santa Ana River Watermaster, a committee of five members (one each from SBVMWD, IEUA and Western MWD and two from OCWD). Under this Judgment, purveyors upstream of Prado Dam, have the right to use all surface and groundwater supplies originating above Prado Dam without interference from water purveyors downstream of Prado Dam, provided that the average adjusted base flow at Prado Dam is at least 42,000 AFY. Baseflows have ranged from approximately 38,000 AFY in 1970 to approximately 170,000 AFY in 2002. (Santa Ana River Watermaster, 2003). SBVMWD has an obligation to ensure an average annual adjusted base flow of 15,250 AFY at Riverside Narrows. IEUA and Western MWD have a joint obligation to ensure average annual adjusted base flow of

42,000 AFY at Prado Dam. In addition, SBVMWD, IEUA and Western MWD are prohibited from exporting water from the lower area to the upper area while OCWD is prohibited from exporting water or causing water to from the upper area to the lower area (Santa Ana River Watermaster, 2003).

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Riverside Basin. Facilities include about 100 active production wells and the RIX facility in Colton.

Active Production Wells

There are currently about 100 active production wells (both agricultural and municipal) in the Riverside Basin. A summary of the production from these wells is provided in **Table 13-3**. Average production between 1985 and 2004 was approximately 49,661 AFY and presented in **Figure 13-3**. Based upon the past 5 years of production, the estimated production capacity is about 84,000 AFY.

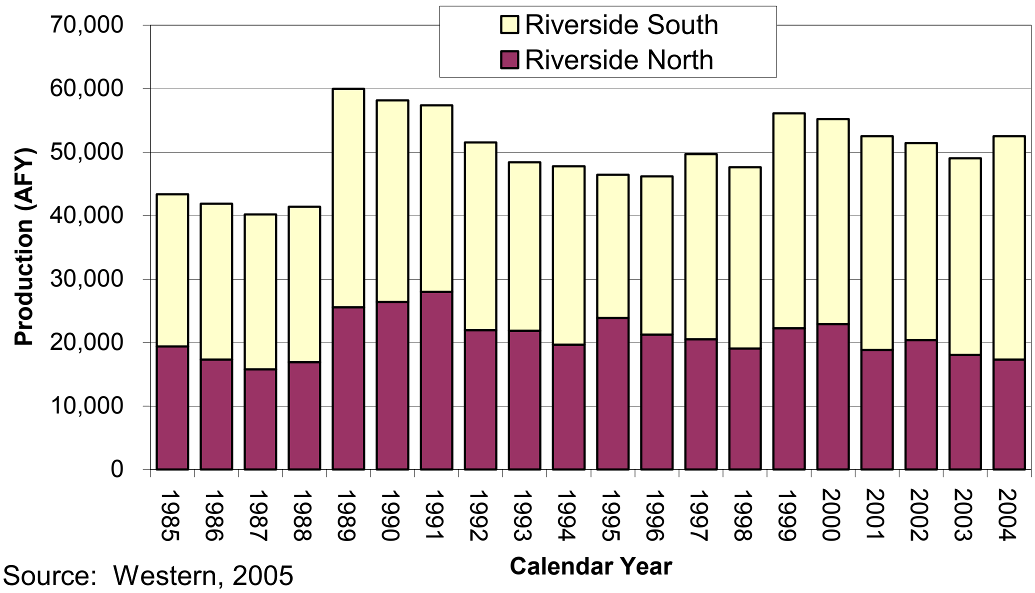
Table 13-3
Summary of Production Wells in the Riverside Basin

Category	Number of Active Wells [1]	Estimated Production Capacity [2] (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Riverside North	43	30,000	20,690	Not available
Riverside South	57	54,000	28,971	
Total	**100**	**84,000**	**49,661**	

Source: Western, 2005
1. Active wells have production within past 5 years
2. Estimated production capacity is based upon maximum annual production rate for each well in past 5 years.

Like many water systems in Southern California, Riverside's water system is aging. Many critical elements have exceeded their service life span and are in need of repair and/or replacement. A consultant hired by the City of Riverside recommended about $139 million (2004 dollars) of capital improvement facilities to address water system distribution needs over the next 20 years (MWH, 2005).

Figure 13-3
Historical Groundwater Production in the Riverside Basin



Source: Western, 2005

Other Production

In the 1990s, the cities of San Bernardino and Colton were required by the Regional Board to upgrade the quality of their wastewater discharges to the Santa Ana River to meet certain established discharge standards. In cooperation with SAWPA, and with the approval of the Regional Board, a wastewater treatment plan using the tertiary treatment process known as Rapid Infiltration and Extraction (RIX) was constructed in the city of Colton in the Riverside North Basin and placed into service in 1995. In this process, secondary treated wastewater from the two cities' treatment plants is applied to a series of percolation basins. As wastewater percolates through the soil, physical and biological treatment occurs removing many harmful pollutants from the wastewater. After the water infiltrates approximately 15 feet deep, the treated wastewater is extracted through shallow wells surrounding the basins, treated by ultraviolet radiation for disinfection purposes and discharged to the Santa Ana River. Currently, about 37,000 AFY of secondary effluent is percolated at RIX (Wildermuth, 2006). The current permit for RIX requires a certain amount of overextraction to contain percolated effluent. This overextraction is native groundwater from the Riverside Basin and currently (December 2006) equals about 20 percent of the volume of percolated effluent, or about 7,800 AFY. A portion of the treated water that is discharged from RIX percolates back into the Riverside Basin from the Santa Ana River. Between 1995 and 2004, an average of about 9,000 AFY of groundwater was over-extracted from the Riverside North Basin by the RIX project and discharged into the Santa Ana River (Western MWD, 2005).

ASR Wells

There are no ASR wells in the Riverside Basin.

Spreading Basins

There are no intentional spreading basins in the Riverside Basin to enhance groundwater recharge. Incidental recharge may occur at the RIX facility and stormwater detention basins throughout the basin

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Riverside Basin.

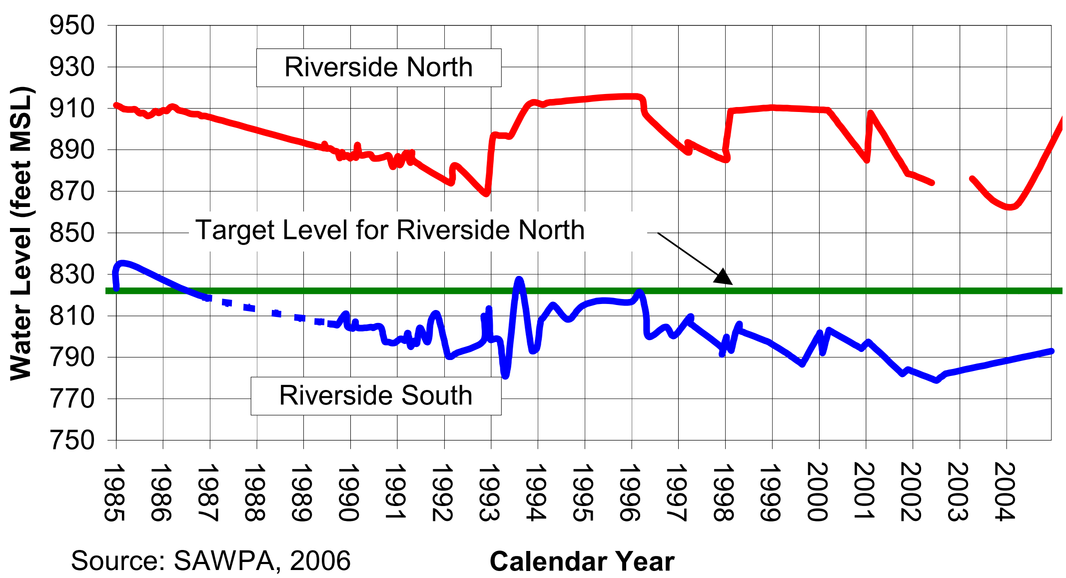
Desalters

There are no desalters in the Riverside Basin.

GROUNDWATER LEVELS

Groundwater levels in the Riverside North and Riverside South basins are summarized in **Figure 13-4**.

Figure 13-4
Historical Water Levels in the Riverside Basin



Source: SAWPA, 2006

As discussed above, per the 1969 Judgment, the target level based upon the water level in three specific wells (two in the Riverside North Basin and one in the Colton Basin) is 822.04 feet

MSL. Water levels below the target level trigger replenishment obligations. Between 1985 and 2004, water levels were above this level and remained relatively stable with fluctuations not exceeding 50 feet. Water levels in the Riverside South Basin decreased about 40 feet between 1985 and 2004.

GROUNDWATER QUALITY

The following provides a brief description of the current water quality of the Riverside Basin. It includes a discussion of current groundwater monitoring activities, contaminants of concern and treatment processes for the region.

Groundwater Quality Monitoring

Groundwater quality samples are collected from active production wells in accordance with California DHS requirements as specified in Title 22 of the California Code of Regulations.

The Santa Ana Watershed Basin Monitoring Task Force is a collaborative effort of public and private sector agencies and interests. As part of this effort, SAWPA compiles water quality data in the Santa Ana River Watershed, including total dissolved solids (TDS) and nitrate (as N) data. SAWPA also prepares a triennial update of the ambient groundwater quality throughout all the groundwater basins in the Santa Ana River Watershed.

In 2004, the Basin Plan for the Santa Ana Region was amended to incorporate an updated TDS and nitrogen management plan (Regional Board, 2004). For water quality purposes, the Regional Board divided the Riverside Basin into six management zones, defined as Riverside A through Riverside F. These management zone boundaries are shown in **Figure 13-5**.

Groundwater Contaminants

Constituents of concern for the Riverside Basin include: TDS, nitrate, volatile organic compounds (VOCs) namely trichloroethylene (TCE) and tetrachloroethylene (PCE), perchlorate and dibromochloropropane (DBCP). Descriptions of the range and extent of concentrations in the basin are summarized in **Table 13-4.**

As discussed above, inorganic constituents of concern for the Riverside Basin are TDS and nitrate. As shown in **Figure 13-5**, TDS is generally lower in the northern portion of the basin and increases toward the south. Current ambient TDS concentrations range from 310 mg/L in the Riverside B management zone in the Riverside North Basin to 750 mg/L in the Riverside C management zone of the Riverside South Basin.

Like TDS, as shown in **Figure 13-6**, nitrate (as N) concentrations generally increase from north to south. Average ambient nitrate concentrations range from about 4.6 mg/L in the Riverside A management zone to 15.4 mg/L in the Riverside E management zone. Nitrate (as N) concentrations currently exceed the current MCL of 10 mg/L in management zones C, D, E and F.

Figure 13-5
Ambient TDS Concentrations (1984 to 2003)

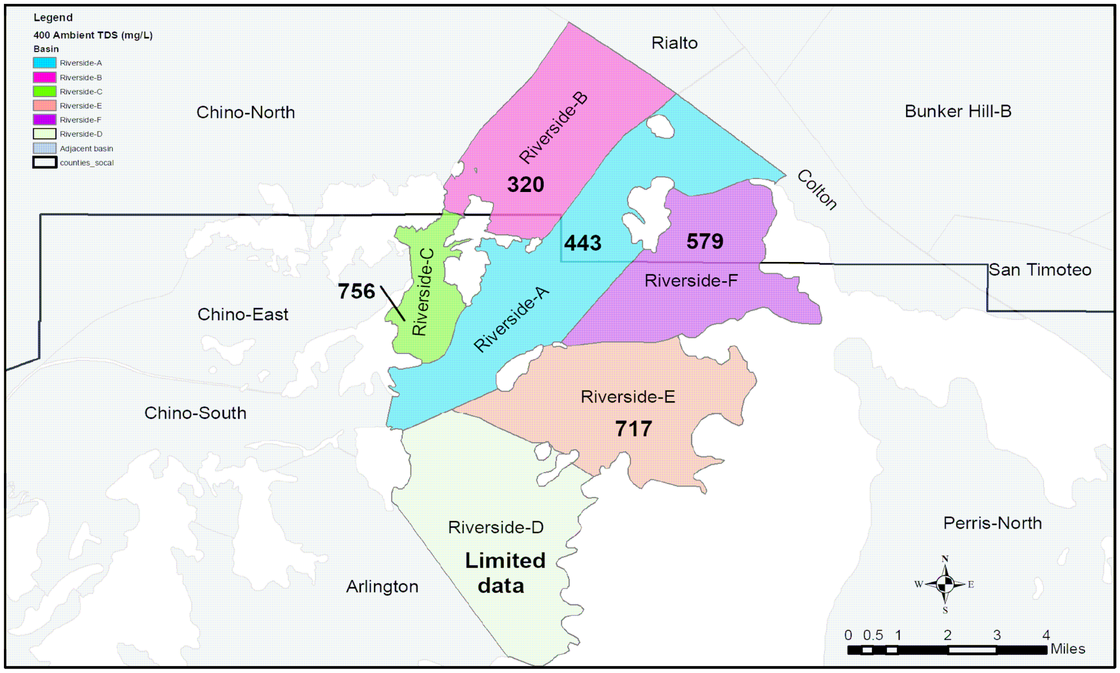
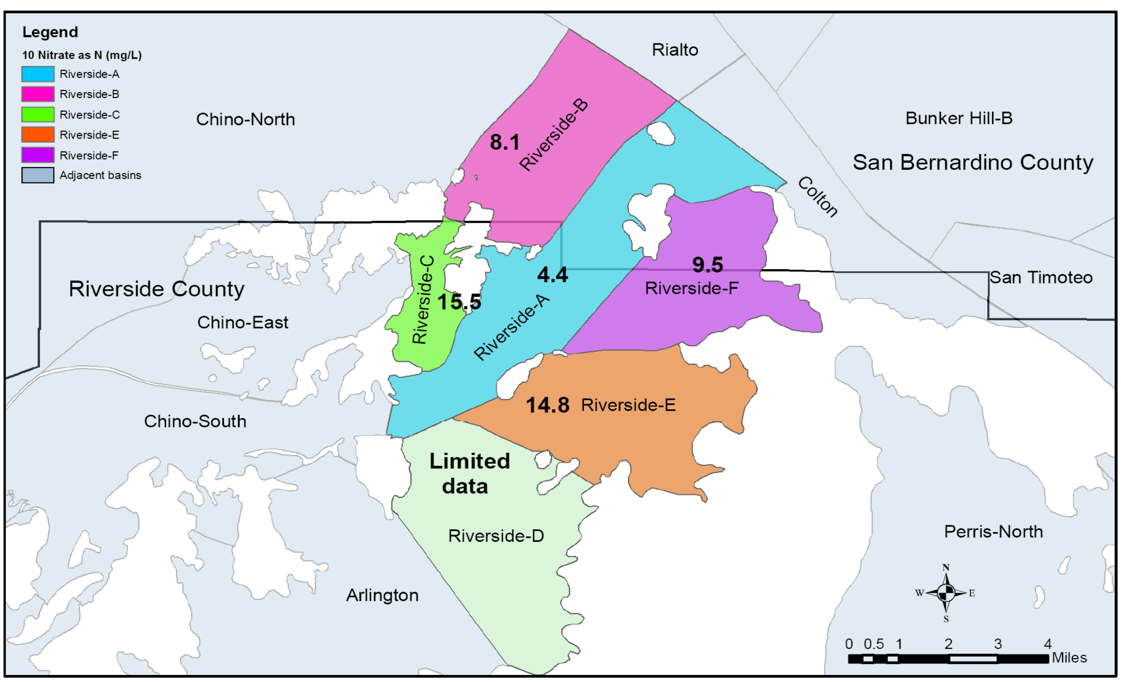


Figure 13-6
Ambient Nitrate Concentrations (1984 to 2003)



Source: Wildermuth, 2005

Table 13-4
Summary of Constituents of Concern in Riverside Basin

Constituent	Units	Range	Description
TDS Secondary MCL=500	mg/L	Average Ambient 310 to 750	TDS is generally lower in the northern portion of the basin and increases toward the south.
Nitrate (as N) Primary MCL =10	mg/L	Average Ambient 4.6 to 15.4	Like TDS, nitrate concentrations generally increase from north to south. Nitrate concentrations currently exceed the current MCL of 10 mg/L in management zones C, D, E and F.
VOCs (TCE and PCE) Primary MCL: TCE = 5 PCE =5	µg/L	ND to 52 for TCE ND to 7 for PCE	Seven wells have been impacted by TCE and 15 wells have been impacted by PCE
Perchlorate Notification level =6	µg/L	Riverside North ND to 5.2 Riverside South ND to 23	Sixteen wells within the Riverside Basin are known to have been impacted by perchlorate, 5 in the Riverside North Basin and 11 in the Riverside South Basin.
DBCP Primary MCL =0.2	µg/L	Not available	Nature and extent not available at this time

Source: Wildermuth, 2005, SAWPA, 2006 and Regional Board, 2006

In addition, perchlorate, DBCP, TCE and PCE have also been detected in produced groundwater from the Riverside Basin. Sixteen wells within the Riverside Basin are known to have been impacted by perchlorate, 5 in the Riverside North Basin and 11 in the Riverside South Basin. The perchlorate concentrations range from 4 to 5.2 µg/L in the Riverside North Basin and from 4 to 23 µg/L in the Riverside South basin (Regional Board, 2006).

Seven wells have been impacted by TCE with maximum concentrations of 52 µg/L (MCL of 5 µg/L) and 15 wells have been impacted by PCE with maximum concentrations of 7 µg/L (MCL of 5 µg/L).

Blending Needs

Groundwater produced from some wells within the Riverside Basin are treated at the wellhead. In addition, groundwater produced at some wells are blended within transmission mains before reaching the distribution system. Based upon wells within the City of Riverside's system, about 8 percent of the groundwater produced is blended.

Groundwater Treatment

The North Riverside Water Project, which includes two treatment plants and pipeline system, treats groundwater for TCE and DBCP. It was completed in June 2003 (Riverside, 2006). About 30 percent of the groundwater produced in Riverside Basin was treated in 2004/05 (Riverside, 2006; Western MWD, 2005).

CURRENT GROUNDWATER STORAGE PROGRAMS

There are no current groundwater storage programs in the Riverside Basin.

The City of Riverside currently produces about 18,000 AFY of water from the southern portion of the Riverside Basin and is planning to increase production up to a total of 45,000 AFY in the future. To address the issues associated with increasing groundwater production in the southern portion of the Riverside Basin, Western MWD and the City of Riverside are cooperatively conducting several hydrogeologic studies of the basin.

BASIN MANAGEMENT CONSIDERATIONS

As discussed above, primary management considerations in the Riverside Basin involve water quality concerns, specifically:

- TDS and nitrate could limit ability to store and extract water
- Perchlorate, TCE, PCE and DBCP contaminants could limit ability to store and extract water

In addition to water quality issues, water levels must be maintained by SBVMWD in the Riverside North Basin per the 1969 Judgment.

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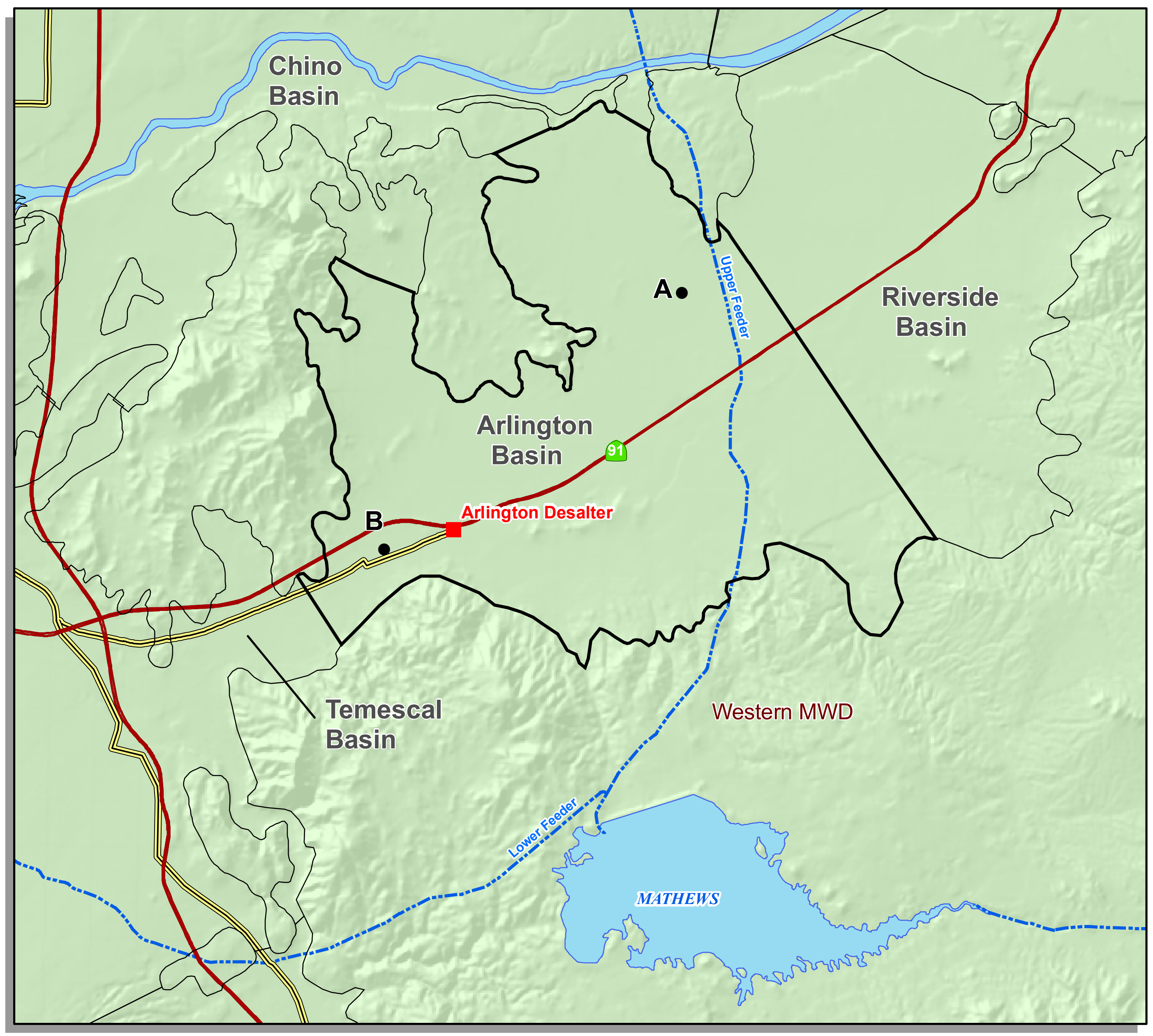
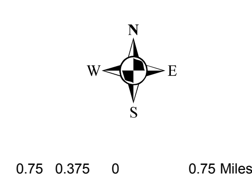


Arlington Basin

A ●	Key well	MWD Pipeline	
Desalter		Santa Ana Regional Interceptor Line	
Freeways		Adjacent Basin	
Water Bodies		Basin	
		MWD Member Agency Boundary (color varies)	



Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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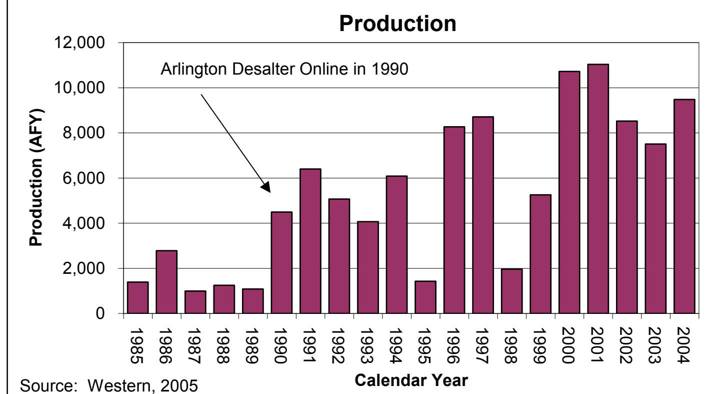
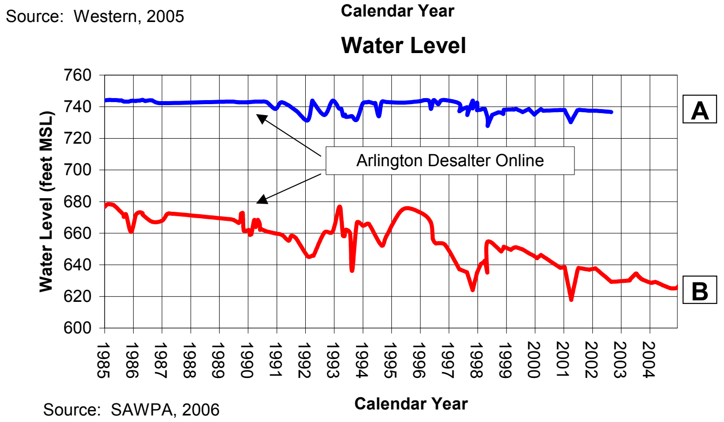
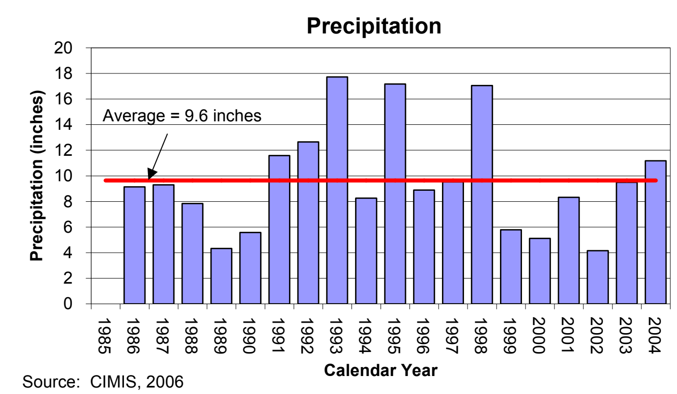
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).



Source: Western, 2005



Source: SAWPA, 2006



Source: CIMIS, 2006

Direct Groundwater Recharge

No direct groundwater recharge data available for this basin.

BASIN FACTS

Arlington Basin

Description
Location: Riverside County
Watershed Surface Area: 12.8 square miles
Management: Unadjudicated
MWD Member Agencies:
Western MWD

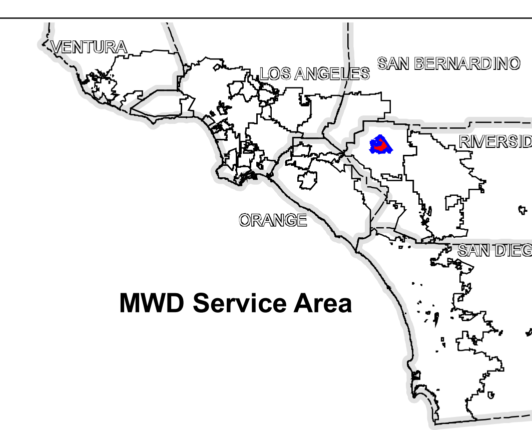
	Arlington
Natural Safe Yield	Unknown
Total Storage	101,000 AF
Unused Storage Capacity	32,000 AF
Portion of Unused Storage Capacity Available for Storage	Unknown

Storage and Extraction Facilities

	Arlington
Production Wells	
Production Capacity	~16,300 AFY
Average 1990-2004	~6,500 AFY
Injection Wells	
Injection Capacity	None
Average 1990-2004	None
Spreading Basins	
Spreading Capacity	None
Average 1990-2004	None

Basin Management Considerations

- Water quality (TDS and nitrate) could limit potential for storage and extraction
- Concentrations of TCE, PCE, perchlorate and DBCP may also limit potential for future use
- Arlington Desalter has increased utilization of basin. Current desalting capacity is 6,400 AFY



MWD Service Area

Plate 14-1
Overview of Arlington Basin

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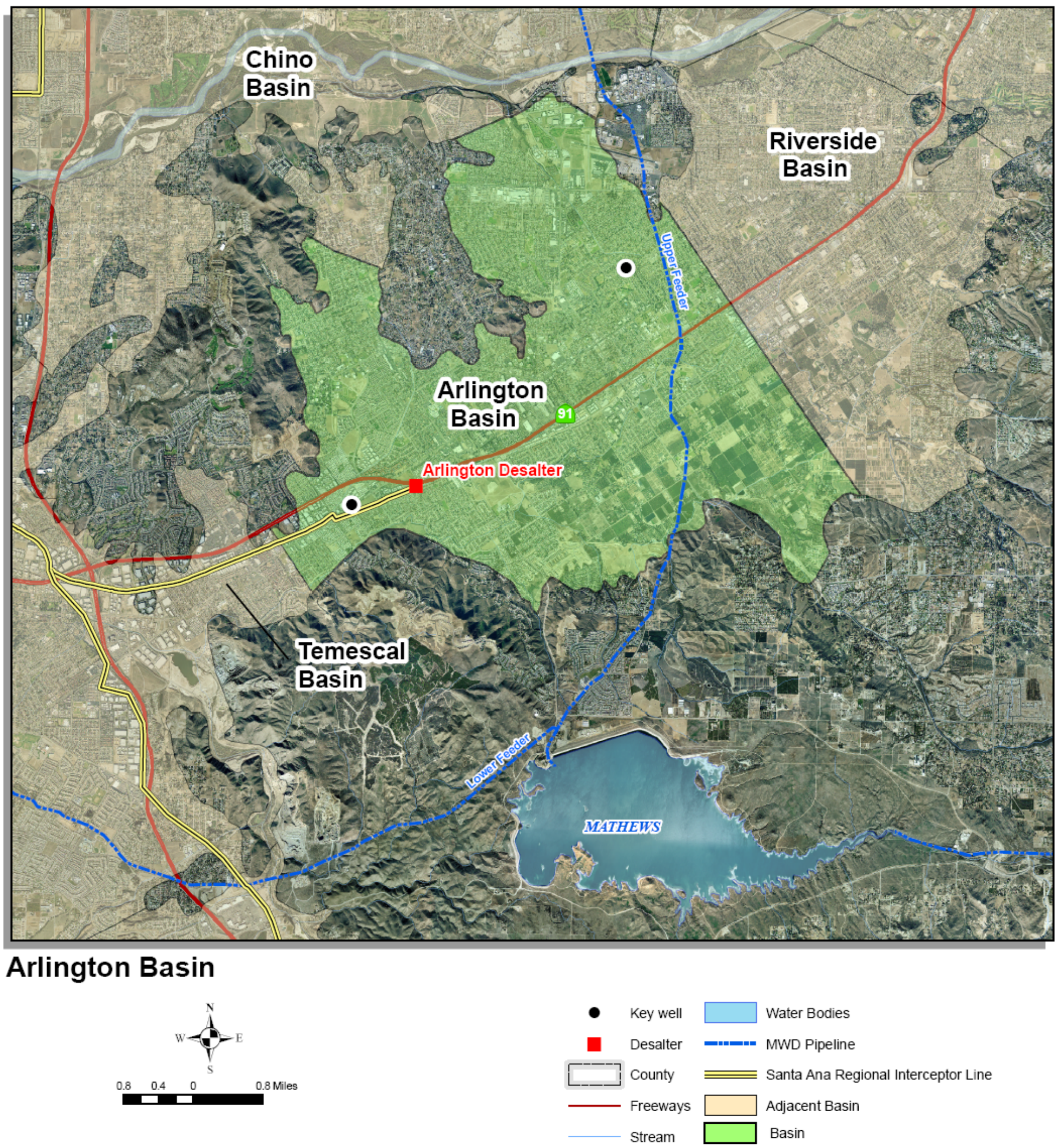
The Arlington Basin is an unadjudicated groundwater basin located south of the Santa Ana River in northwestern Riverside County. The Arlington Basin includes the communities of Riverside and portions of unincorporated Riverside County. The Arlington Basin underlies the service area of Western Municipal Water District of Riverside County (Western MWD). A map of the basin is provided in **Figure 14-1**.

Figure 14-1
Map of the Arlington Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Arlington Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

Groundwater occurrence in the Arlington Basin is generally unconfined. Groundwater producing zones in the Arlington Basin are characterized by considerable sand and little clay (DWR, 2004). Total storage in the basin is approximately 101,000 AF. Based upon Spring 2005 water levels there is about 69,000 AF in storage. Therefore, the unused storage space is approximately 32,000 AF. However, not all of the unsaturated portion can be used. The amount of unused storage space that could be used is unknown. Hydrogeologic data for the Arlington Basin are summarized in **Table 14-1**.

Table 14-1
Summary of Hydrogeologic Parameters of Arlington Basin

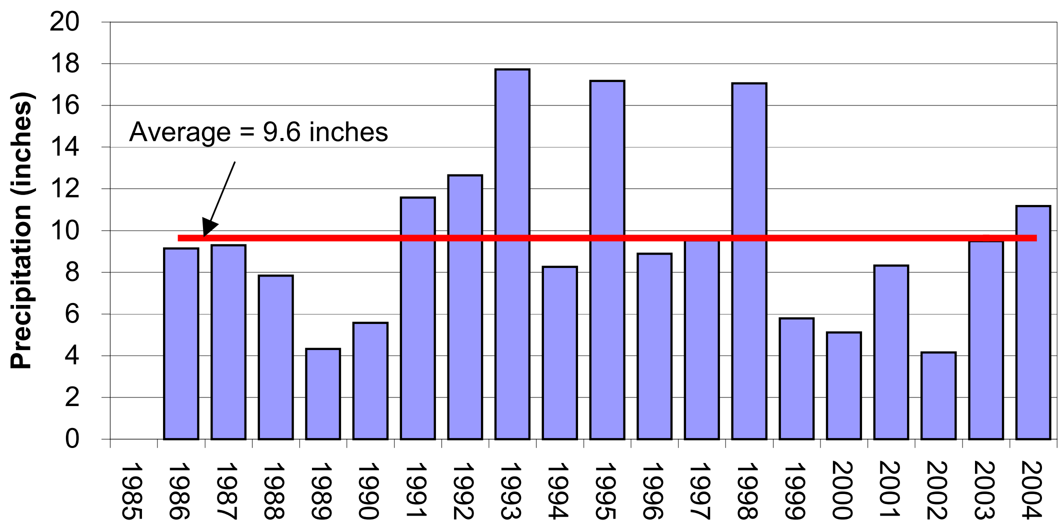
Parameter	Description
Structure	
Aquifer(s)	Unconfined alluvium
Depth of groundwater basin	0 to 300 feet
Yield and Storage	
Natural Safe Yield	8,300 AFY
Total Storage	101,000 AF
Unused Storage Space	32,000 AF
Portion of Unused Storage Space Available for Storage	Unknown

Safe Yield/Long-Term Balance of Recharge and Discharge

The Arlington Basin is replenished by infiltration from unlined stream channel overlying the basin, underflow from saturated alluvium and fractures within the bordering bedrock hills, return flows and percolation of precipitation (DWR, 2004; Wildermuth 2000, Wildermuth, 2006). Safe yield has not been determined for the Arlington Basin alone. Based upon a water budget analysis prepared by the City of Riverside (Riverside, 2005) for the combined Arlington-Riverside Basins, the long-term production from the Arlington Basin that yielded a balanced water budget was approximately 8,300 AFY.

The Arlington Basin is relatively dry with average precipitation of 9.6 inches per year. **Figure 14-2** provides the historical precipitation data from the CIMIS Riverside #44 Station located near UC Riverside (CIMIS 2006). These data suggest below average precipitation from 1986 to 1990 and from 1999 to 2003, above average precipitation between 1991 and 1998 and since 2004.

Figure 14-2
Historical Precipitation near the Arlington Basin



Source: CIMIS, 2006
Riverside #44

GROUNDWATER MANAGEMENT

The following section describes how the Arlington Basin is currently managed.

Basin Governance

The Arlington Basin is not adjudicated. Western MWD reports on the conditions of the Arlington Basin in addition to other groundwater basins in the Santa Ana River Watershed within its service area. Basin pumping activities are not formally regulated. The Arlington Basin is part of the Santa Ana River Watershed and falls under the jurisdiction of the Santa Ana Watershed Project Authority (SAWPA). **Table 14-2** provides a list of governing agencies in the Arlington Basin and their respective roles.

Interactions with Adjoining Basins

A groundwater divide in the alluvium separates the Arlington Basin from the Riverside Basin to the north (DWR, 2004). In the southwest, groundwater exits the Arlington Basin into the Temescal Basin as underflow through a bedrock gap. These boundaries are not barriers to flow. There are no agreements that govern these flows.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Arlington Basin.

Table 14-2
Summary of Management Agencies in the Arlington Basin

Agency	Role
Western Municipal Water District	Reports on water extraction for Arlington Basin and operates Arlington Desalter.
Santa Ana Water Project Authority (SAWPA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the Santa Ana River Watershed.
California Regional Water Quality Control Board – Santa Ana Region (Regional Board)	Issuance of permits for discharges within the Santa Ana River Watershed.

Active Production Wells

There are currently 12 active production wells in the Arlington Basin. **Table 14-3** summarizes data related to active production wells in the Arlington Basin since 1990 when the Arlington Desalter came online. Since 1990, nearly 95 percent of the production within the Arlington Basin feeds the Arlington Desalter discussed below. **Figure 14-3** summarizes the historical production data in the Arlington Basin. Basin production has increased from an average of about 1,500 AFY between 1985 and 1989 to nearly 9,500 AFY between 2000 and 2004. This increase is due to the operation of the Arlington Desalter.

Table 14-3
Summary of Production Wells in the Arlington Basin

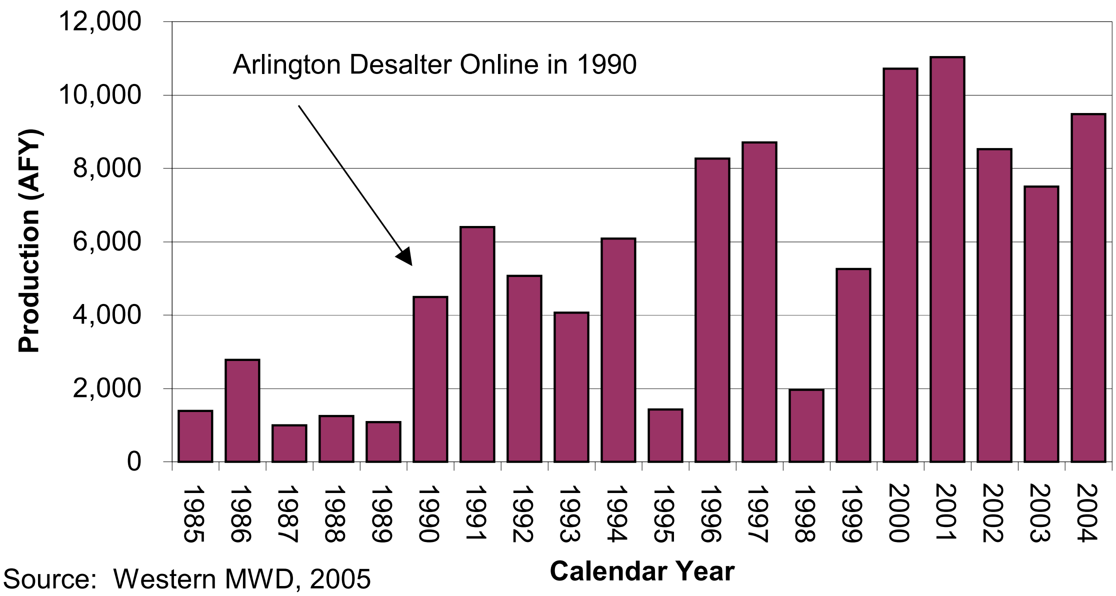
Category	Number of Active Wells [1]	Estimated Production Capacity [2] (AFY)	Average Production 1990-2004 (AFY)	Well Operation Cost ($/AF)
Desalter Wells	5	9,220	5,214	Not available
Other Wells	7	7,071	1,325	
Total	12	16,291	6,539	

Source: Western MWD, 2005 and Wildermuth, 2006
1. Active wells have production within past 5 years
2. Estimated production capacity is based upon maximum annual production in past 5 years. Estimated capacity from other wells determined by Wildermuth, 2006.

Other Production

Prior to 1997, surface diversions from the Harrison Wash by the City of Riverside were a source of additional production with an average of about 250 AFY. This source has been inactive since 1997.

Figure 14-3
Historical Groundwater Production in the Arlington Basin



Source: Western MWD, 2005

ASR Wells

There are no ASR wells in the Arlington Basin.

Spreading Basins

There are no spreading basins in the Arlington Basin.

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Arlington Basin.

Desalters

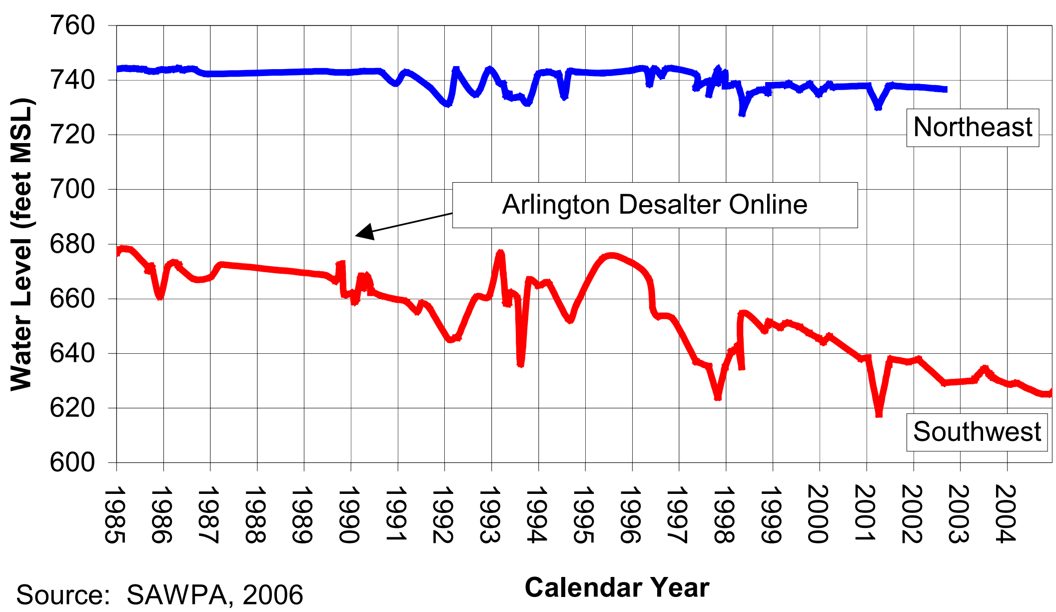
The existing Arlington Desalter facility, operating since 1990, extracts and treats impaired groundwater from the Arlington basin in the southwestern area of the City of Riverside. The desalter, using Reverse Osmosis (RO) technology, produces up to six (6) million gallons per day (MGD) of blended desalinized water, with another estimated one (1) MGD of concentrated brine (high salinity water) generated by the plant discharged to the Santa Ana Regional Interceptor

(SARI) line, which is treated by Orange County Sanitation District and used for recharge by Orange County Water District (SAWPA, 2006a). The desalter was managed and operated by SAWPA until 2005. At that time, the desalter assets and operations were transferred to Western MWD. Water from the Arlington Desalter is supplied to the City of Norco to meet municipal demand.

GROUNDWATER LEVELS

Groundwater flow is generally toward the north and west in the northern portion of the basin and southwest toward the Temescal Basin in the southern portion (DWR, 2004). In general, water levels in the Arlington Basin are relatively shallow with depths to water ranging from 10 to 60 feet below ground surface. Water level data from select inactive production wells in the basin are shown in **Figure 14-4**. In the northeastern part of the basin, water levels were relatively stable between 1985 and 2004. Water levels have declined about 50 feet in the southwest portion of the Arlington Basin during this same period. This decline is likely due to this well's proximity to the Arlington Desalter.

Figure 14-4
Historical Water Levels in the Arlington Basin



Source: SAWPA, 2006

GROUNDWATER QUALITY

The following provides a brief description of the current water quality of the Arlington Basin. It includes a discussion of current groundwater monitoring activities, contaminants of concern and treatment processes for the region.

Groundwater Quality Monitoring

Groundwater quality samples are collected from active production wells in accordance with California DHS requirements as specified in Title 22 of the California Code of Regulations.

The Santa Ana Watershed Basin Monitoring Task Force is a collaborative effort of public and private sector agencies and interests. As part of this effort, SAWPA compiles water quality data in the Santa Ana River Watershed, including total dissolved solids (TDS) and nitrate (as N) data. SAWPA also prepares a triennial update of the ambient groundwater quality throughout all the groundwater basins in the Santa Ana River Watershed.

Groundwater Contaminants

Contaminants of concern for the Arlington Basin from active production wells are summarized in **Table 14-4**. Inorganic constituents of concern for the Arlington Basin are TDS and nitrate. The native groundwater is currently non-potable with historical ambient levels of TDS and nitrate (as N) of 983 mg/L and 25.5 mg/L, respectively (Wildermuth, 2005). Average TDS concentrations of the active production wells from which data were available ranged from 964 to 1,400 mg/L with an average of 1,118 mg/L between 1994 and 2004. Average nitrate concentrations (as nitrogen) ranged from 13.6 to 22.7 mg/L with an average of 18.3 mg/L during the same period. (SAWPA, 2006b)

Trichloroethylene (TCE) and tetrachloroethylene (PCE) have been detected in various wells in the Arlington Basin. Concentrations of TCE have ranged from non-detect (ND) to 29 µg/L. Concentrations of PCE have ranged from ND to 0.7 µg/L, which is below the MCL of 5 µg/L for PCE. These wells are currently treated by the Arlington Desalter.

In addition, perchlorate and dibromochloropropane (DBCP) have also been detected in produced groundwater from five wells in the Arlington Basin. Concentrations of perchlorate ranged from 2 µg/L to 7.3 µg/L with an average of 5.6 µg/L between 1994 and 2004 (SAWPA, 2006b). Some of these concentrations are above the notification level of 6 µg/L. DBCP has also been detected in produced groundwater from the Arlington Basin. Concentrations have ranged from non-detect to 0.07 µg/L between 1994 and 2004 (SAWPA, 2006b). The MCL for DBCP is 0.2 µg/L. These wells are currently treated by the Arlington Desalter.

Blending Needs

Because the water quality of the Arlington Basin does not currently meet drinking water standards for TDS and nitrate, water is treated by the Arlington Desalter and/or blended to meet municipal demand.

Groundwater Treatment

As discussed above, the Arlington Desalter treats up to 6 MGD (6,400 AFY) of groundwater from the Arlington Basin.

Table 14-4
Summary of Constituents of Concern in the Arlington Basin

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	964 to 1,400 Average: 1,118	Historical ambient concentration of 983 mg/L. Wells are treated by Arlington Desalter.
Nitrate (as N) Primary MCL = 10	mg/L	13.6 to 22.7 Average 18.3	Historical ambient concentration of 25.5 mg/L. Wells are treated by Arlington Desalter.
VOCs **(TCE and PCE)** Primary MCL: TCE = 5 PCE = 5	µg/L	ND to 29 for TCE ND to 0.7 for PCE	One well has been impacted by TCE with maximum concentrations above MCL of 5 µg/L. Three wells have been impacted by PCE with concentrations below MCL.
Perchlorate Notification Level =6	µg/L	2 to 7.3 Average: 5.6	Five wells within the Arlington Basin are known to have been impacted by perchlorate. Four wells have had concentrations above the current action level of 6 µg/L.
DBCP Primary MCL = 0.2	µg/L	ND to 0.07	Five wells within the Arlington Basin are known to have been impacted by DBCP.

Source: Wildermuth, 2005, SAWPA, 2006 and Regional Board, 2006

CURRENT GROUNDWATER STORAGE PROGRAMS

There are no current groundwater storage programs in the Arlington Basin.

BASIN MANAGEMENT CONSIDERATIONS

The ambient water quality of the Arlington Basin is poor, particularly with respect to nitrate and TDS, which limit its potential for storage and extraction. However, the Arlington Desalter does increase the ability to use the basin in the future. The current treatment capacity of 6,400 AFY could limit the ability to participate in a large-scale conjunctive use program.

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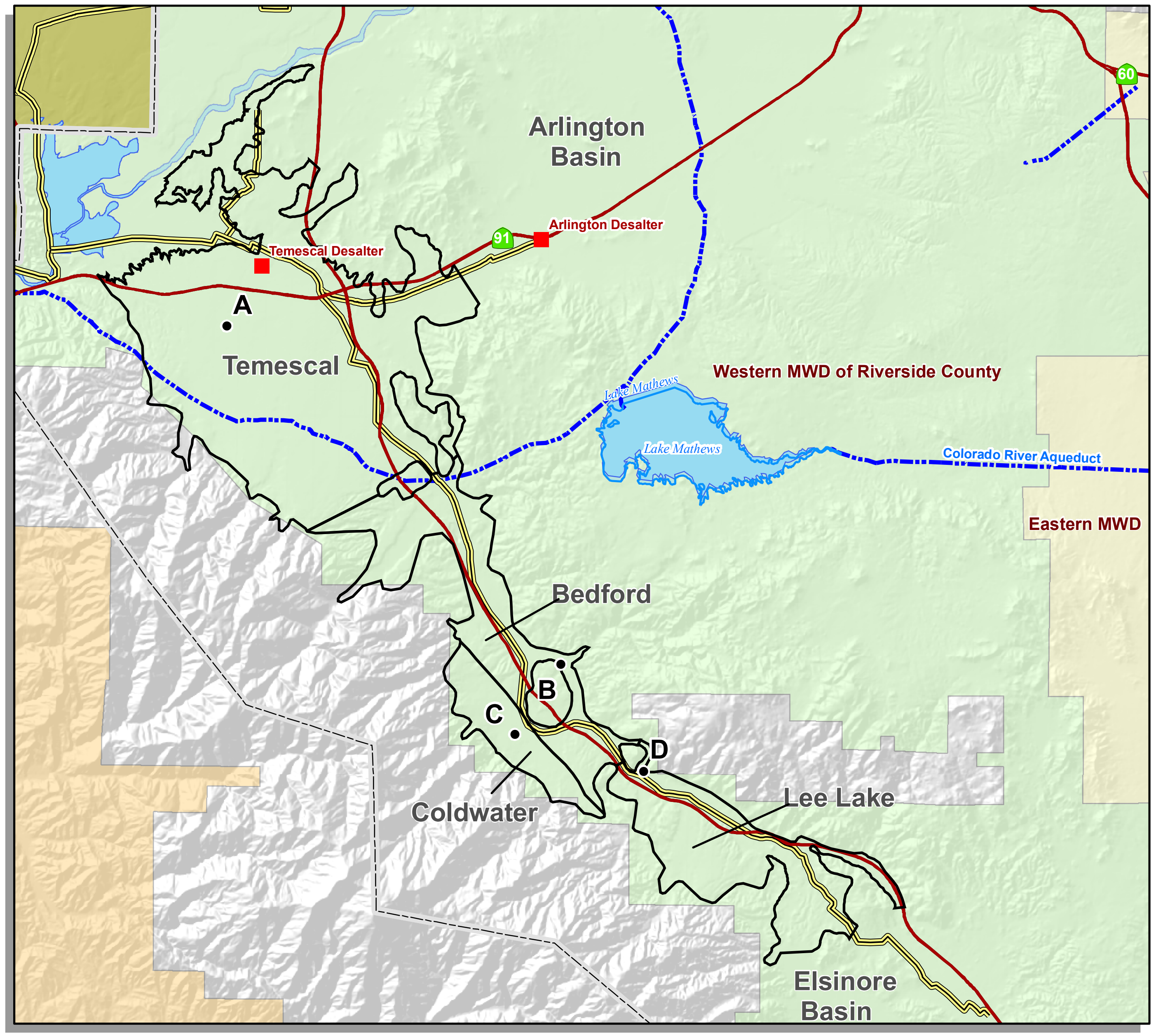
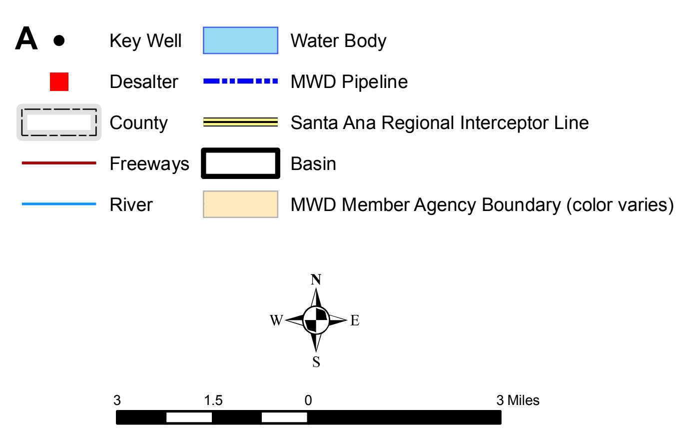


Temescal Valley Basins



Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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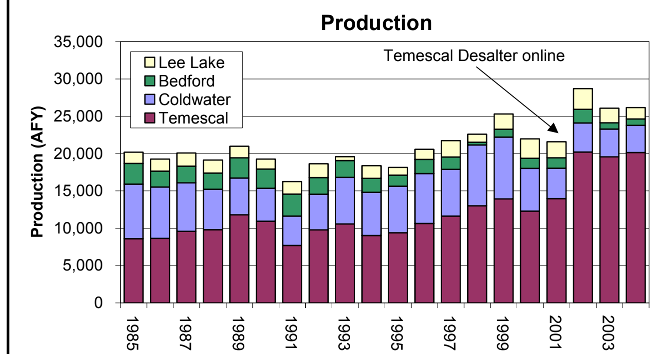
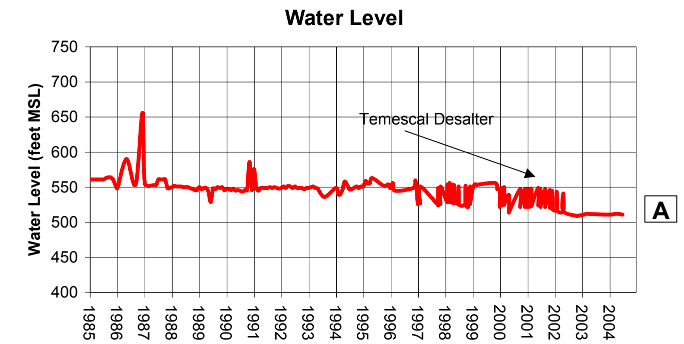
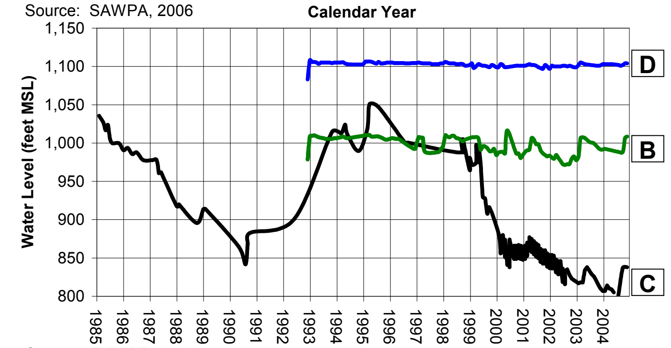
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).



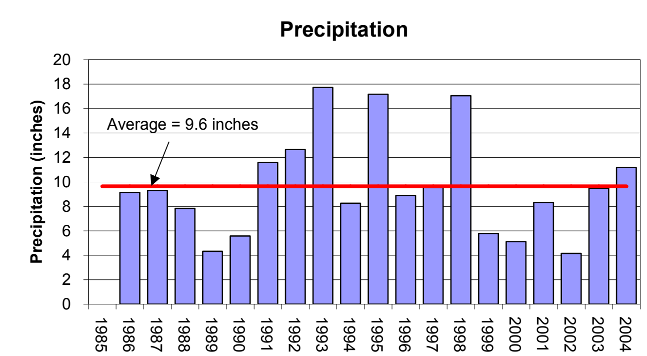
Source: Western MWD, 2005



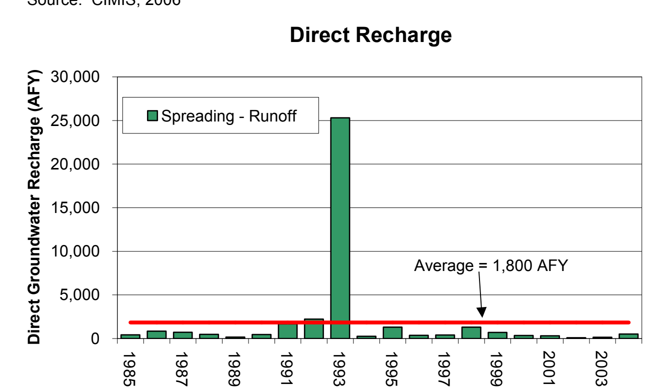
Source: SAWPA, 2006



Source: EVMWD, 2006; SAWPA, 2006



Source: CIMIS, 2006



BASIN FACTS

Temescal Valley Basins

Description
Location: Riverside County
Watershed Surface Area: 37 square miles
Subbasins:
Bedford
Coldwater
Lee Lake
Temescal
Management: Unadjudicated
The basins are not adjudicated. No formal groundwater management programs have been adopted for the Temescal Valley Basins.
MWD Member Agencies:
Western MWD

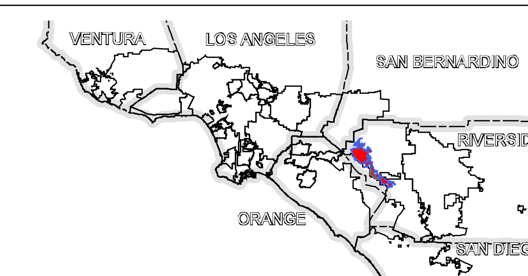
	Bedford	Coldwater	Lee Lake	Temescal
Natural Safe Yield	Unknown	Unknown	Unknown	Unknown
Total Storage	Unknown	100,000 AF	Unknown	Unknown
Usable Storage Space	Limited	Unknown	Limited	Unknown
Portion of Unused Storage Space Available for Storage	Limited	Unknown	Limited	Unknown

Storage and Extraction Facilities

	Bedford	Coldwater	Lee Lake	Temescal
Production Wells				
Production Capacity	2,000 AFY	11,000 AFY	3,000 AFY	42,000 AFY
Average 1985-2004	1,833 AFY	5,640 AFY	1,694 AFY	12,062 AFY
Injection Wells				
Injection Capacity	None	None	None	None
Average 1985-2004	None	None	None	None
Spreading Basins				
Spreading Capacity	None	12,000 AFY	None	None
Average 1985-2004	None	1,900 AFY	None	None

Basin Management Considerations

- Higher concentrations of nitrate, iron, manganese and TDS limit use of the Temescal, Bedford and Lee Lake Basins
- Perchlorate concentrations up to 12 µg/L occur in wells from Temescal Basin
- Reliability on natural recharge to maintain water levels in smaller basins limits potential for use.
- Regional Board Basin objectives may limit recharge potential



MWD Service Area

Plate 15-1
Overview of Temescal Valley Basins

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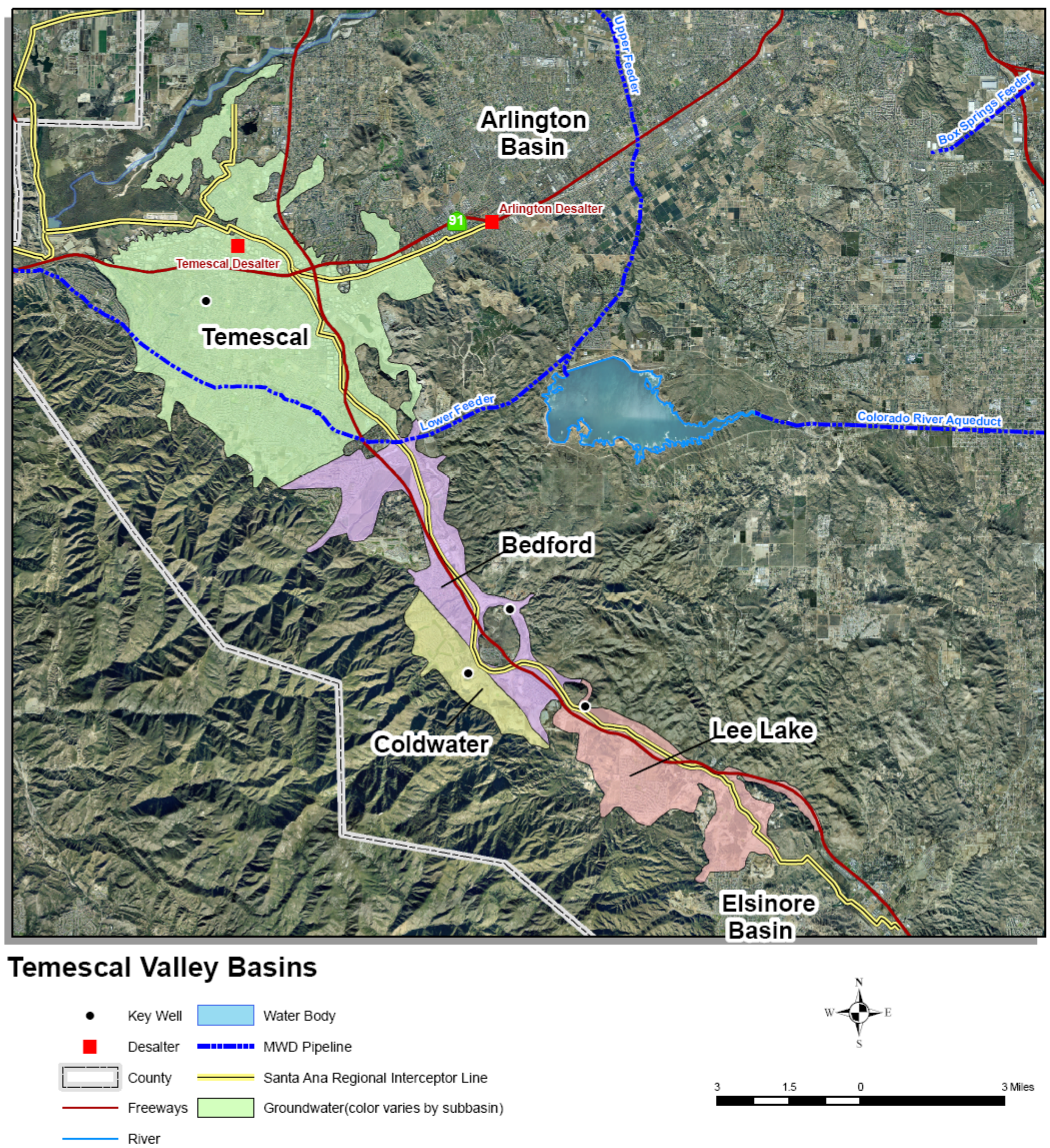
The Temescal Valley Basins include several small-unadjudicated groundwater basins in Riverside County between Prado Dam and Lake Elsinore along the Interstate 15 corridor. These include: the Bedford, Coldwater, Lee Lake, and Temescal basins. Because they are relatively small, these basins are discussed as a whole. The Temescal Valley Basins underlie the service area of Western Municipal Water District (Western MWD) and include the communities of Corona, Norco and unincorporated areas of Riverside County.

Figure 15-1
Map of the Temescal Valley Basins



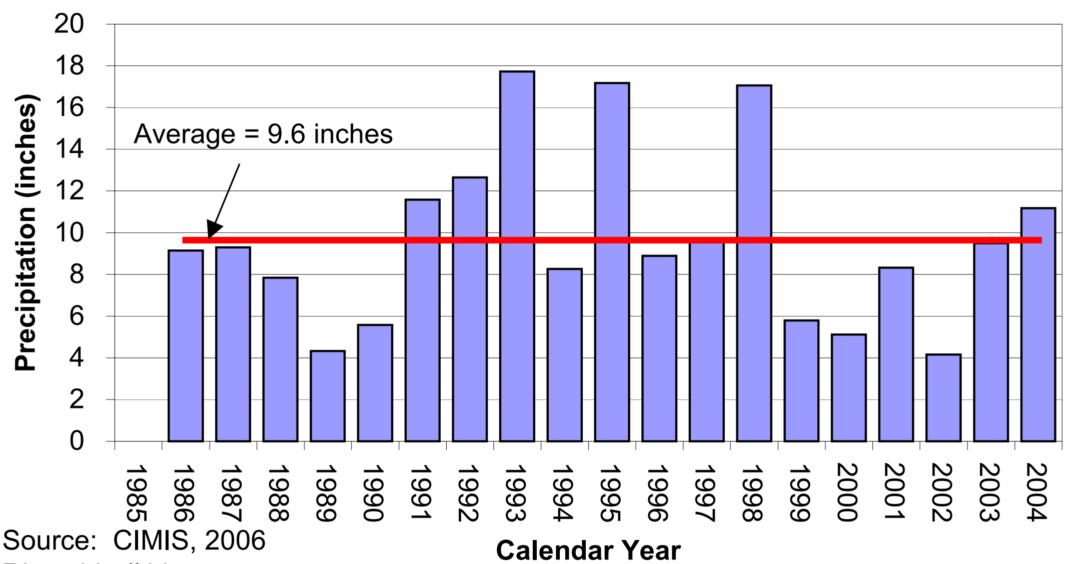
BASIN CHARACTERIZATION

The following section provides a physical description of the Temescal Valley Basins including their geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The following section describes the basin structure and storage capacity for each of the Temescal Valley Basins. Each basin is generally unconfined (one continuous aquifer) and therefore each responds rapidly to changes in hydrology and recharge. **Table 15-1** summarizes the hydrogeologic parameters for each basin. As shown in **Figure 15-2**, precipitation in the vicinity of the Temescal Valley Basins near Riverside averages approximately 9.6 inches per year.

Figure 15-2
Historical Precipitation in the Temescal Valley Basins



Source: CIMIS, 2006
Riverside #44

Bedford Basin

The Bedford Basin is located south of the Temescal Basin in Temescal Canyon between the Santa Ana Mountains and the El Sobrante Hills. The basin covers an area of approximately 10 square miles with an alluvial depth ranging from 30 to 200 feet. (AKM, 2005). Groundwater within the basin tends to flow northwest into the Temescal Basin. Total storage within the basin is unknown.

Coldwater Basin

The Coldwater Basin is located southwest of the Bedford Basin and the Temescal Wash. The Basin encompasses an area of approximately 2.6 square miles and lies within the structural block between the Santa Ana Mountains to the west and the El Sobrante Hills to the east. The Coldwater Basin is bound by the North Glen Ivy Fault to the northeast. The North Glen Ivy Fault behaves as an effective barrier to groundwater flow and prevents migration of groundwater from the Coldwater Basin into the Temescal Wash and the Bedford Basin at depth. Groundwater levels throughout the basin typically respond rapidly to precipitation and recharge because of the high permeability and limited groundwater storage within this basin. Maximum depth of the basin is approximately 600 feet. Total estimated storage in the Coldwater Basin is approximately 100,000 AF (MWH, 2004).

Table 15-1
Summary of Hydrogeologic Parameters of Temescal Valley Basins

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Structure</td><td></td></tr>
<tr><td>Aquifer(s)</td><td>Unconfined to semi-confined alluvium</td></tr>
<tr><td>Depth of groundwater basin</td><td rowspan="2">Bedford: 30 to 200 feet
Coldwater: Up to 600 feet
Lee Lake: Less than 200 feet
Temescal: 180 to 480 feet</td></tr>
<tr><td>Thickness of water-bearing units</td></tr>
<tr><td>Yield and Storage</td><td></td></tr>
<tr><td>Natural Safe Yield</td><td>Data not available</td></tr>
<tr><td>Total Storage</td><td>Approximately 100,000 AF in Coldwater Basin</td></tr>
<tr><td>Unused Storage Space</td><td>Unknown</td></tr>
<tr><td>Portion of Unused Storage Space Available for Storage</td><td>Unknown</td></tr>
</table>

Lee Lake Basin

The Lee Lake Basin covers an area of approximately 12 square miles and has alluvial depth of less than 200 feet. Groundwater within the basin flows toward the northwest along the course of the Temescal Wash. Primary sources of recharge include the adjacent canyon streams and seepage from Temescal Wash. Total storage within the basin is unknown.

Temescal Basin

The Temescal Basin encompasses an area of approximately 26 square miles bound by the Santa Ana River, La Sierra Hills, El Sobrante Hills and the Santa Ana Mountains. Typical depths for the City of Corona's wells in the Temescal Basin range from 180 to 480 feet (AKM, 2005). Groundwater flow is from the mountains to the center of the basin and northeast toward the Santa Ana River (DWR, 2006). Total storage within the basin is unknown.

Safe Yield/Long-Term Balance of Recharge and Discharge

Safe yield has not been determined for any of the Temescal Valley Basins.

GROUNDWATER MANAGEMENT

The following section describes how the Temescal Valley Basins are currently managed.

Basin Governance

The Temescal Valley Basins are not adjudicated. The management agencies for the Temescal Valley Basins are described in **Table 15-2**. The City of Corona is currently preparing a groundwater management plan for the Temescal Basin to be completed in 2007.

Table 15-2
Summary of Management Agencies in the Temescal Valley Basins

Agency	Role
City of Corona	Operation of Temescal Desalter Preparation of Groundwater Management Plan for Temescal Basin.
Western Municipal Water District (Western MWD)	Part of Watermaster Committee responsible for administration of 1969 Santa Ana River Judgment.
San Ana River Watermaster	Watermaster for 1969 Stipulated Judgment that defined water allocations in the Santa Ana River among lower Santa Ana River and upper Santa Ana River producers.
Santa Ana Water Project Authority (SAWPA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the Santa Ana River Watershed.

Interactions with Adjoining Basins

The Temescal Valley Basins are upstream of Prado Dam. On April 17, 1969, the Orange County Superior Court entered a Stipulated Judgment in Case No. 117628 involving the Orange County Water District vs. City of City of Chino et al.

The Judgment, which became effective October 1, 1970, contained a declaration of rights of the entities in the lower Santa Ana River area (i.e. OCWD) versus those in the upper Santa Ana River area (i.e. San Bernardino Valley Municipal Water District, or SBVMWD, Chino Basin MWD, now called IEUA, and Western MWD). The Judgment is administered by the Santa Ana River Watermaster, a committee of five members (one each from SBVMWD, IEUA and Western MWD and two from OCWD). Under this Judgment, purveyors upstream of Prado Dam, have the right to use all surface and groundwater supplies originating above Prado Dam without interference from water purveyors downstream of Prado Dam, provided that the average adjusted base flow at Prado Dam is at least 42,000 AFY. Baseflows have ranged from approximately 38,000 AFY in 1970 to approximately 170,000 AFY in 2002. (Santa Ana River Watermaster, 2003). SBVMWD has an obligation to ensure an average annual adjusted base flow of 15,250 AFY at Riverside Narrows. IEUA and Western MWD have a joint obligation to ensure average annual adjusted base flow of 42,000 AFY at Prado Dam. In addition, SBVMWD, IEUA and Western MWD are prohibited from exporting water from the lower area to the upper area while OCWD is prohibited from exporting water or causing water to from the upper area to the lower area (Santa Ana River Watermaster, 2003).

Fault or bedrock barriers prevent significant groundwater flow from the Temescal Valley Basins. Except for the 1969 Judgment described above, there are no agreements with other basins.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Temescal Valley Basins.

Active Production Wells

There are 53 active production wells within the Temescal Valley Basins. Historical production from 1985 to 2004 is summarized in **Figure 15-3**. A summary of the average production from these wells is provided in **Table 15-3**. Production by basin is discussed below.

Bedford Basin

There are 5 identified active wells in the Bedford Basin. The primary producer in the Bedford Basin is Elsinore Valley Municipal Water District (EVMWD). Groundwater production from the Bedford Basin has decreased in recent years from a high of approximately 2,900 AFY in 1991 to less than 900 AFY in 2004. The City of Corona has plans to drill news wells in this basin for future use (AKM, 2005).

Coldwater Basin

There are 9 identified wells in the Coldwater Basin. Primary producers in the Coldwater Basin include: the City of Corona and EVMWD. Historically, the Coldwater Basin production has been used for exportation outside the basin by both the City of Corona and EVMWD. EVMWD has stopped the exportation of Coldwater Basin water since 2004 because of low water levels in its wells. EVMWD has used three wells to serve municipal demand overlying the Coldwater

Basin. The primary source of domestic supply in the Coldwater Basin is groundwater from the EVMWD wells. Because of low water levels in 2004, this supply was supplemented by imported water from Lee Lake Water District.

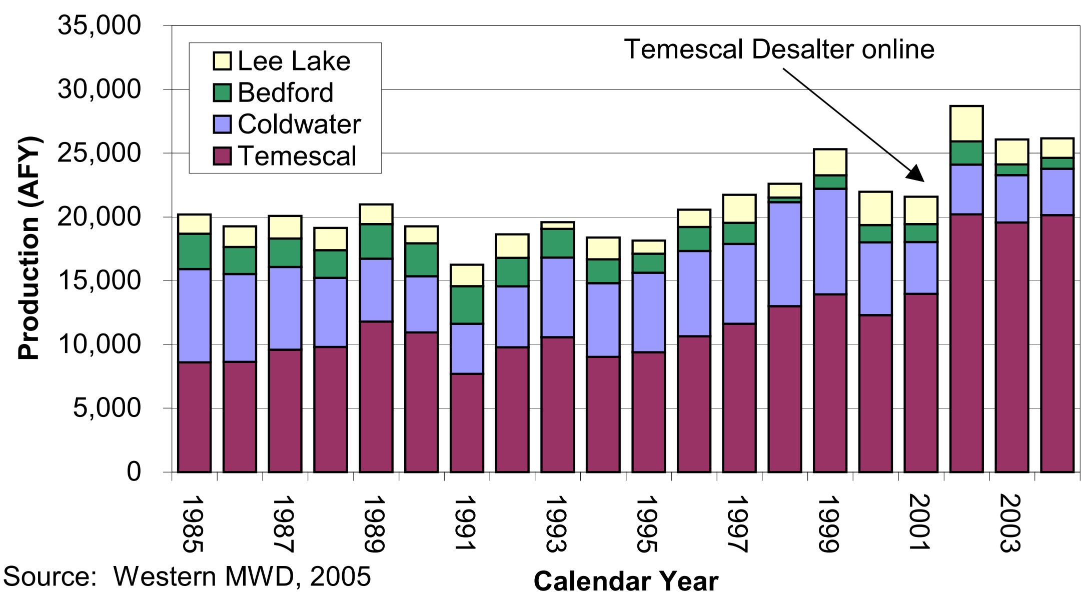
Lee Lake Basin

There are 10 identified active wells in the Lee Lake Basin. The primary producer of the Lee Lake Basin is EVMWD. This water is generally used for agricultural demand.

Temescal Basin

The City of Corona and the City of Norco are the primary pumpers from the Temescal Basin. Currently, 18 City of Corona wells with a combined annual capacity of approximately 39,000 AF extract groundwater from the Temescal Basin. In the past five years, Corona has drilled and equipped seven new wells to supply water to the Temescal Basin Desalter, which came online in 2001. The City of Corona plans to pump 29,765 AFY by year 2015 and will continue to pump that amount (AKM, 2005). The City of Norco has four wells in the Temescal Basin. The remaining wells are owned by private producers. In 1985, about 50 percent of the total production in the Temescal Basin was by the combined cities of Corona and Norco. Since the Temescal Desalter came online, more than 95 percent of the total production has come from these cities.

Figure 15-3
Historical Groundwater Production in the Temescal Valley Basins



Source: Western MWD, 2005

Table 15-3
Summary of Production Wells in the Temescal Basin

Basin	Number of Active Wells [1]	Estimated Production Capacity [2] (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Bedford	5	2,000	1,833	Not available
Coldwater	9	11,000	5,640	
Lee Lake	10	3,000	1,694	
Temescal	29	42,000	12,062	
Total	**53**	**58,000**	**21,229**	

Source: Western MWD, 2005
1. Active wells have production within past 5 years
2. Estimated production capacity is based upon maximum annual production in past 5 years or published data where available

Other Production

Major stream flows in the Coldwater and Lee Lake basins are diverted and either spread, used for irrigation or stored in Lee Lake. Between 1985 and 2004, total diversions for Coldwater and Lee Lake basins have averaged approximately 1,800 AFY and 1,500 AFY, respectively.

ASR Wells

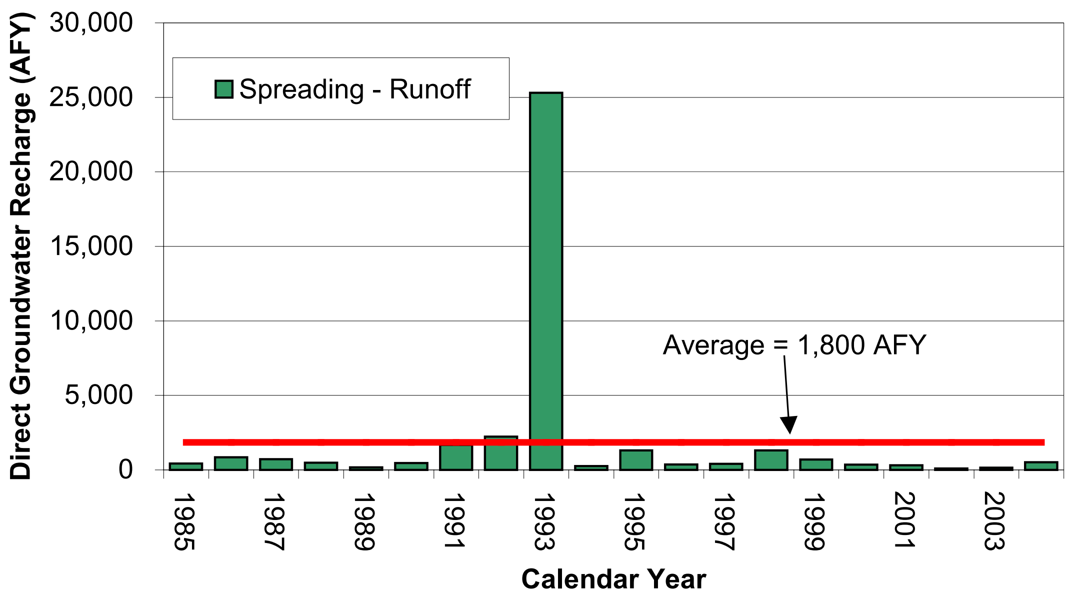
There are no ASR wells in the Temescal Valley Basins.

Spreading Basins

The only spreading basins in the Temescal Valley Basins are located in the Coldwater Basin. The City of Corona acquired the rights to the surface flows of Coldwater Canyon in 1964 when it purchased the assets of the Corona City Water Company. To meet California Department of Health Services requirements, the surface flow is spread in percolation ponds and extracted by the Corona's three Glen Ivy area wells in the Coldwater Basin. Historical groundwater recharge is shown in **Figure 15-4**.

There is a total spreading capacity of approximately 15 cfs. In addition, EVMWD has rights up to 1,000 AFY to divert flows from Mayhew Canyon and has spread the water in the adjacent gravel pits when not actively mined. Mining operations have limited the amount of water that can be spread in recent years. Recently, CEMEX, a gravel mining company, has constructed a concrete spillway at the north end of the basin to direct the Mayhew Canyon flow into the gravel pit immediately downstream for stormwater runoff control. More recharge is anticipated in the future as a result of this modification. (EVMWD, 2006).

Figure 15-4
Summary of Groundwater Recharge in Temescal Valley Basins



Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Temescal Valley Basins.

Desalters

The Temescal Desalter, located in the Temescal Basin, was completed in 2001. This facility utilizes approximately 6 miles of pipelines, 5 new wells, a blending station and 945 reverse osmosis membranes and has a capacity of approximately 10 million gallons per day (MGD), or about 11,000 AFY.

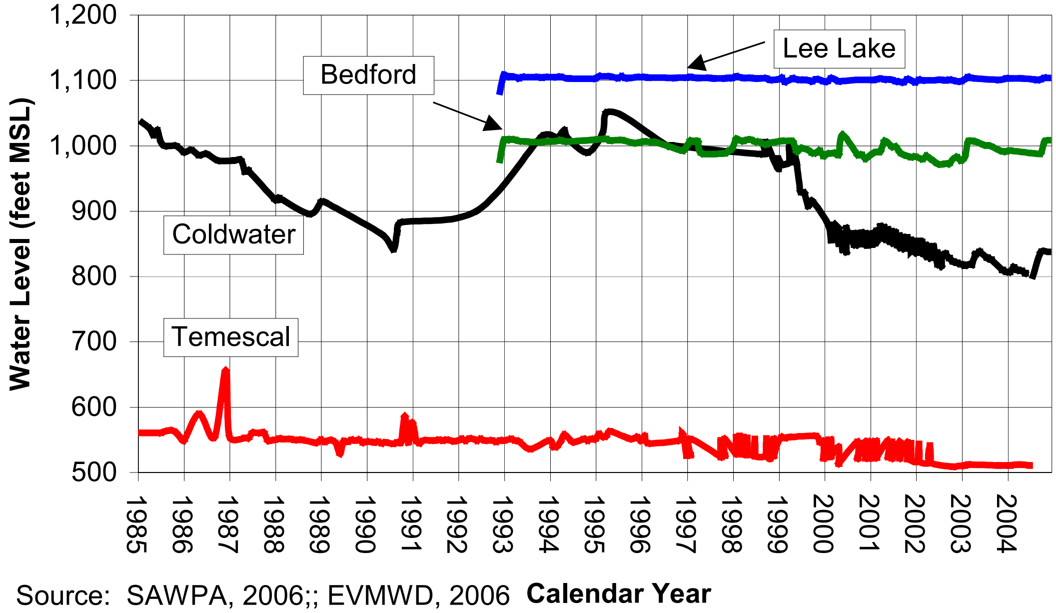
GROUNDWATER LEVELS

The following section provides a brief discussion of water level trends in the Temescal Valley. Historical groundwater levels are shown in **Figure 15-5**.

Bedford Basin

Limited water level data are available for the Bedford Basin. Depths to static groundwater are relatively shallow, ranging from less than 10 feet to about 30 feet. Therefore, there is limited storage space within this basin.

Figure 15-5
Historical Groundwater Levels in the Temescal Valley Basins



Source: SAWPA, 2006;; EVMWD, 2006

Coldwater Basin

In mid-2004, water levels in the Coldwater Basin were at a 20-year low due to lower than normal rainfall between 1999 and 2003 and decreased spreading of runoff. Groundwater levels in the Coldwater Basin track parallel with production (i.e. production is highest when water levels are highest and pumping costs are low). Production by the City of Corona wells in the Coldwater Basin has also decreased as production has increased in the Temescal Basin. Following the heavy rains of 2004/05, water levels in the Coldwater Basin had recovered nearly 40 feet by the end of 2004 and a total of 150 feet by June 2005.

Lee Lake Basin

Like the Bedford Basin, limited water level data are available. Depths to static groundwater are relatively shallow, ranging from less than 10 feet to about 30 feet. Therefore, there is limited storage space within this basin.

Temescal Basin

Groundwater levels in the Temescal Basin remained relatively stable between 1985 and 2000. Since the Temescal Desalter came online in 2001, groundwater levels have dropped as much as 40 feet. Depth to water is about 130 to 200 feet.

GROUNDWATER QUALITY

The following section describes the overall water quality considerations for the Temescal Valley Basins. The water quality of the Coldwater Basin is generally good with TDS concentrations less than about 400 mg/L while the Bedford, Lee Lake and Temescal Basins are generally poorer quality with TDS concentrations above 700 mg/L.

Groundwater Quality Monitoring

Groundwater quality samples are collected from active production wells in accordance with California DHS requirements as specified in Title 22 of the California Code of Regulations.

The Santa Ana Watershed Basin Monitoring Task Force is a collaborative effort of public and private sector agencies and interests. As part of this effort, SAWPA compiles water quality data in the Santa Ana River Watershed, including total dissolved solids (TDS) and nitrate (as N) data. SAWPA also prepares a triennial update of the ambient groundwater quality throughout all the groundwater basins in the Santa Ana River Watershed.

Groundwater Contaminants

Primary constituents of concern for the Temescal Valley Basins are total dissolved solids (TDS), nitrate, iron and manganese. In addition, the occurrence of key constituents of regional concern, volatile organic compounds (VOCs) and perchlorate, are described for reference. These constituents are summarized in **Table 15-4**.

The ambient 20-year (1984 to 2003) average TDS concentrations for the Temescal Valley Basins ranged from 400 mg/L in the Coldwater Basin to 740 mg/L in the Bedford Basin. These data are presented graphically in **Figure 15-6**. The ambient groundwater quality of the Bedford and Lee Lake Basins is generally poor and does not typically meet secondary drinking water standards for TDS. TDS concentrations within the Bedford Basin are generally greater than 600 mg/L and have historically been greater than 1,100 mg/L. The current ambient TDS concentration for the Bedford Basin is 740 mg/L (Wildermuth, 2005). As such, most of the wells are used for agricultural irrigation or are inactive. Ambient concentrations of TDS have increased about 20 mg/L in the Coldwater Basin and decreased by about 80 mg/L in the Temescal Basin compared to the 1978 to 1997 average. TDS concentrations from wells in the Lee Lake Basin have ranged from about 450 to 700 mg/L since 1985. Ambient TDS concentrations exceed secondary standards for TDS in the Bedford and Temescal Basins, which limit their potential use without treatment.

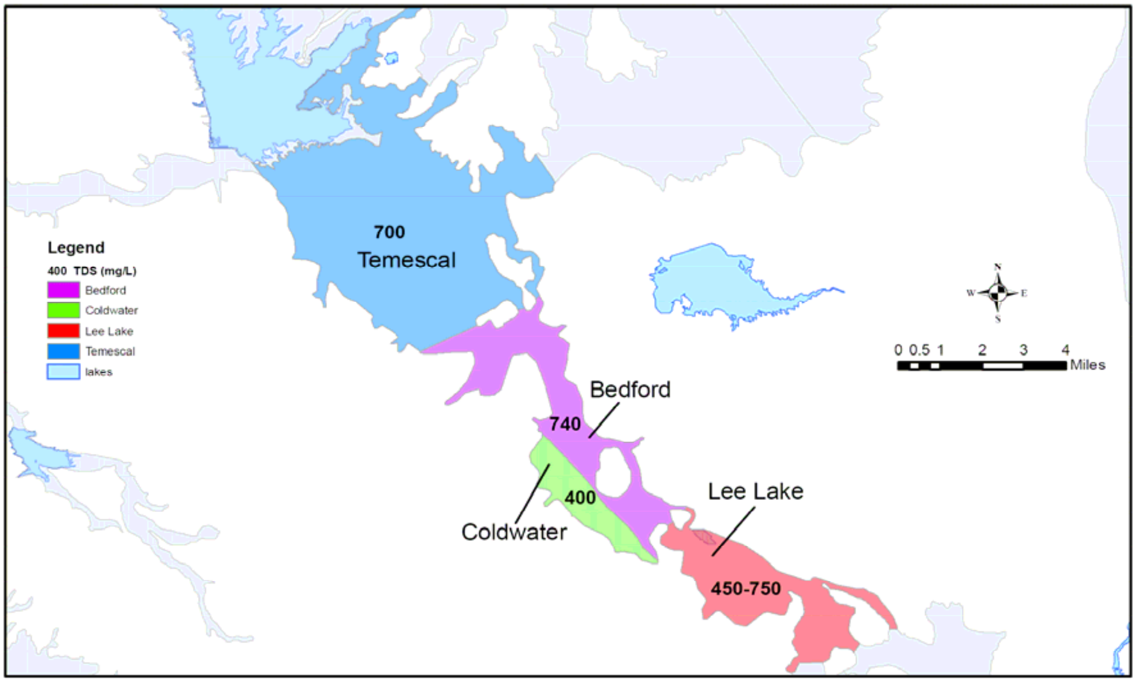
Ambient nitrate (as N) concentrations currently range from 2.4 mg/L in the Coldwater Basin to 12.8 mg/L in the Temescal Basin (Wildermuth, 2005). These data are presented graphically in **Figure 15-7**. Nitrate concentrations exceed the primary MCL of 10 mg/L in the Temescal Basin, potentially limiting its use without treatment. The ambient nitrate level in each basin dropped about 0.4 mg/L between 1997 and 2003. The current ambient nitrate concentrations in the Bedford Basin are about 2.8 mg/L as N (Wildermuth, 2005).

Table 15-4
Summary of Constituents of Concern in Temescal Valley Basins

Constituent	Units	Range	Description
TDS Secondary MCL =500	mg/L	Average: 400 to 740	Average TDS concentrations in Coldwater and Temescal Basins are about 400 mg/L and 700 mg/L, respectively. TDS concentrations within the Bedford Basin are generally greater than 600 mg/L and have historically been greater than 1,100 mg/L. TDS concentrations from wells in the Lee Lake Basin have ranged from about 450 to 700 mg/L since 1985.
Nitrate (as N) Primary MCL=10	mg/L	Average: 2.4 to 12.8	Lowest nitrate concentrations are found in the Coldwater Basin. Highest concentrations of nitrate are found in the Temescal Basin. Nitrate concentrations in the Bedford Basin have been as high as 5.8 mg/L since 1985. The current ambient nitrate concentrations are about 2.8 mg/L Nitrate concentrations in the Lee Lake Basin have been as high as 4.2 mg/L
VOCs **(TCE and PCE)** Primary MCL 5 for TCE 5 for PCE	µg/L	ND to 4.4 for TCE ND to 5 for PCE	Three known wells have had detections of TCE below the MCL in the Temescal Basin. One well has had detections of PCE in Temescal Basin. TCE and PCE were not detected in other basins.
Perchlorate Notification level = 6	µg/L	ND to 14	13 municipal production wells have had detection of perchlorate in the Temescal Basin. Perchlorate has not been detected in wells from the Bedford, Coldwater or Lee Lake Basins.
Iron and manganese Secondary MCL: 300 for iron 50 for manganese	µg/L	ND to 3,000 for iron ND to 3,000 for manganese	Four wells in Temescal Basin are currently treated for iron and manganese

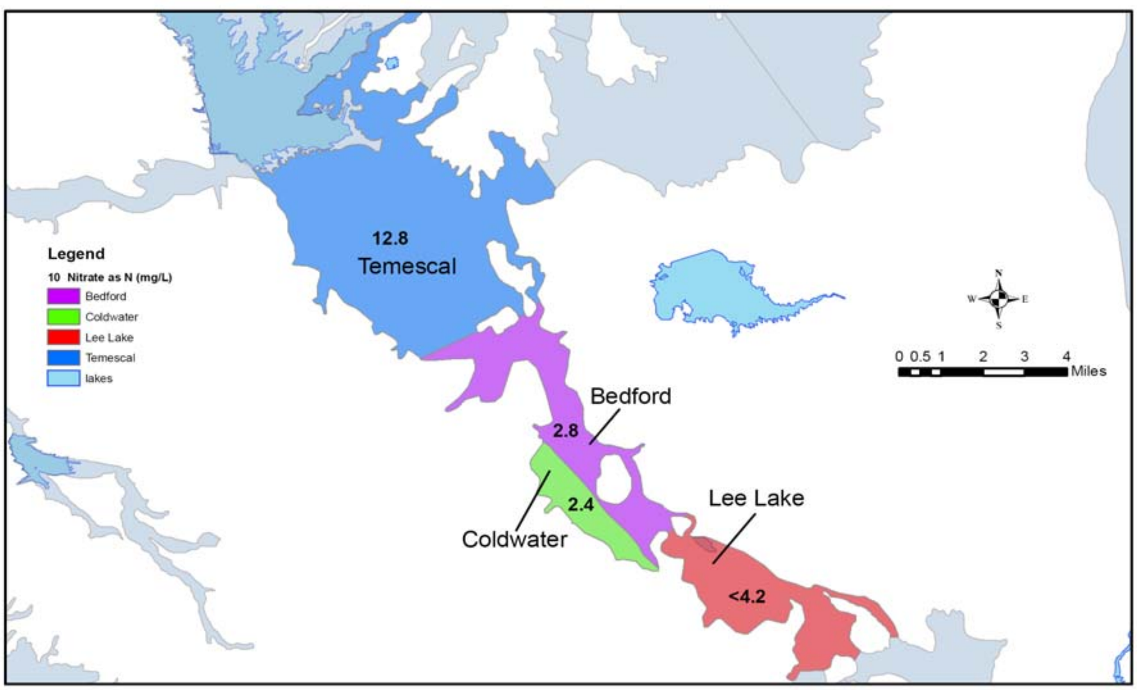
Source: Wildermuth, 2005, SAWPA, 2006 and Regional Board, 2006

Figure 15-6
Ambient TDS Concentrations (1984 to 2003)



Source: Wildermuth, 2005 and SAWPA, 2006

Figure 15-7
Ambient Nitrate Concentrations (1984 to 2003)



Source: Wildermuth, 2005 and SAWPA, 2006

Nitrate (as N) concentrations in the Bedford Basin have been as high as 5.8 mg/L since 1985 (SAWPA, 2006). Nitrate concentrations (as N) in the Lee Lake basin have been as high as 4.2 mg/L (SAWPA, 2006).

In addition to TDS and nitrate, elevated concentrations of perchlorate are encountered in the Temescal Basin. Thirteen municipal production wells in the Temescal Basin have known detections of perchlorate from 4 µg/L to 14 µg/L since 1998 (SAWPA, 2004; Regional Board, 2006). These wells are blended with other wells, imported water from Metropolitan or treated by the Temescal Desalter. Perchlorate has not been detected in wells from the Bedford, Coldwater or Lee Lake basins.

Three known wells have had detections of the VOC trichloroethylene (TCE) below the MCL in the Temescal Basin. One well has had detections of the VOC tetrachloroethylene (PCE) at or below the MCL in Temescal Basin. TCE and PCE were not detected in the other basins.

Iron and manganese are also detected above the applicable MCLs in the Temescal Basin. Concentrations range from non-detect to 3,000 µg/L.

Blending Needs

Nitrate concentrations in the Temescal Basin wells typically do not meet the EPA and DHS MCLs for nitrate (10 mg/L as N). The shallow basin groundwater typically has high levels of nitrate (0.9 to 24.4 mg/L as N) that has historically been blended to meet regulatory requirements. In 2001, the Temescal Desalter came online, eliminating the need for blending for nitrate.

In addition, perchlorate-impacted wells are blended with non-impacted sources to decrease the concentrations of perchlorate. Perchlorate-impacted water from three wells is treated by the Temescal Desalter (SAWPA, 2004).

Groundwater Treatment

The Temescal Desalter, completed in 2001, utilizes approximately 6 miles of pipelines, 5 new wells, a blending station and 945 reverse osmosis membranes. The cost to produce the water (pumping / filtering / delivering) for city residents is predicted to be $350 per AF. The capacity of the Temescal Desalter is approximately 16,803 AFY (AKM, 2005).

The City of Norco treats its wells for iron, manganese and hydrogen sulfide (City of Norco, 2005). Limited data are currently available related to this treatment.

CURRENT GROUNDWATER STORAGE PROGRAMS

There are no current groundwater storage programs in the Temescal Valley Basins. However, the City of Corona and EVMWD are evaluating a groundwater storage program in the Coldwater Basin.

BASIN MANAGEMENT CONSIDERATIONS

The following describes the basin considerations for each basin.

Bedford and Lee Lake Basins

Because the Bedford and Lee Lake Basins are shallow, there is limited storage and extraction potential in either basin. In addition, water quality concerns, specifically TDS and nitrate, limit the usability of the Bedford and Lee Lake Basins for significant storage and extraction.

Coldwater Basin

The usability of the Coldwater Basin is largely dependent upon natural recharge and gravel mining operations. When water levels are higher (less than about 200 feet below ground surface), fresher groundwater from the Coldwater Basin is lost to the open gravel pits and can spill into the Bedford Basin. Water levels are therefore maintained at a lower level. In addition, the TDS objective for the Coldwater Basin is 380 mg/L, which could potentially limit the ability to store water in this basin.

Temescal Basin

Historically, the use of the Temescal Basin has been limited because of elevated concentrations of TDS and nitrate. Upon completion of the Temescal Desalter in 2001, the potential for storage and utilization of this basin has improved. Several wells in the basin are treated for iron and manganese, which could limit its potential.

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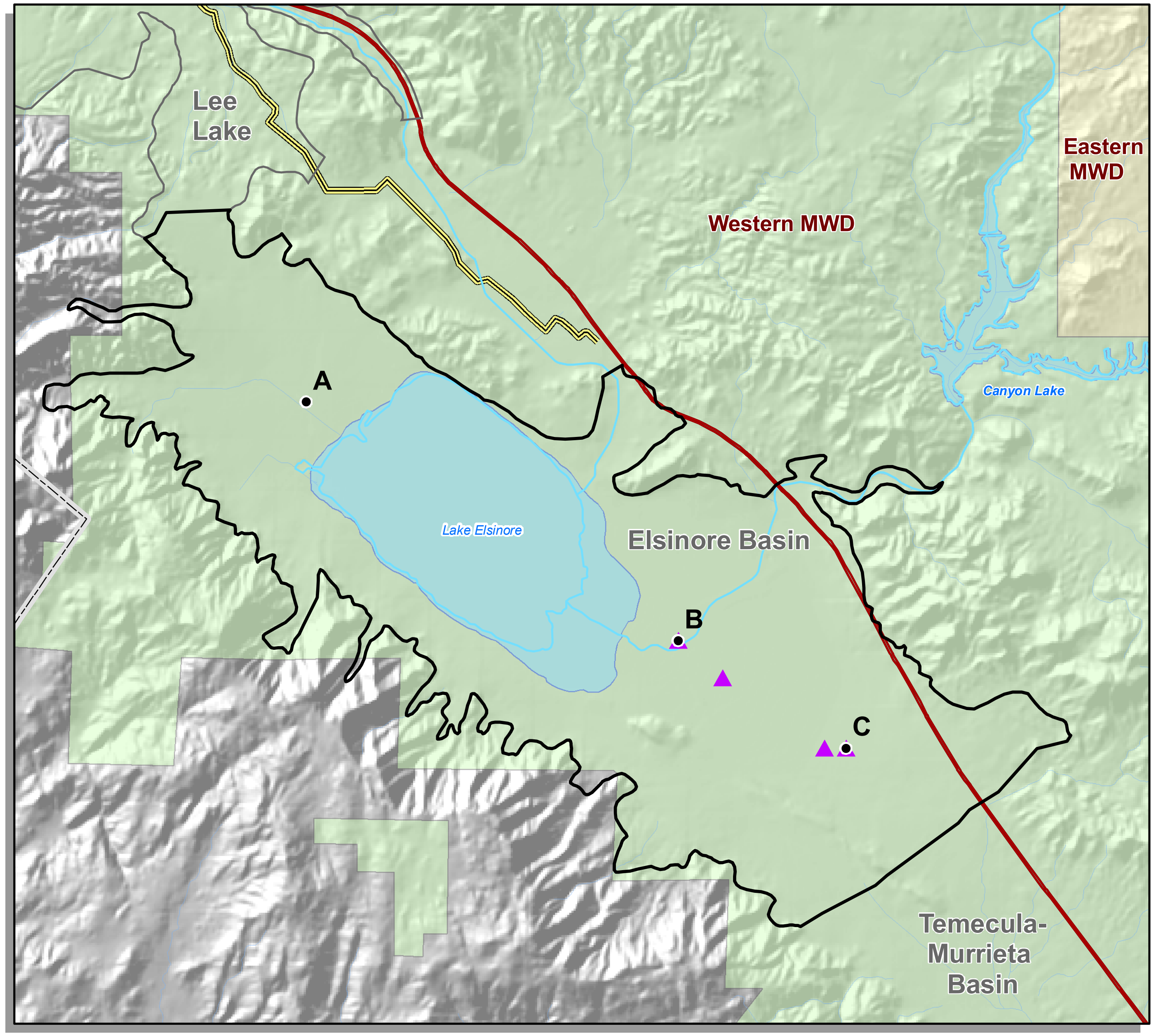

Elsinore Basin

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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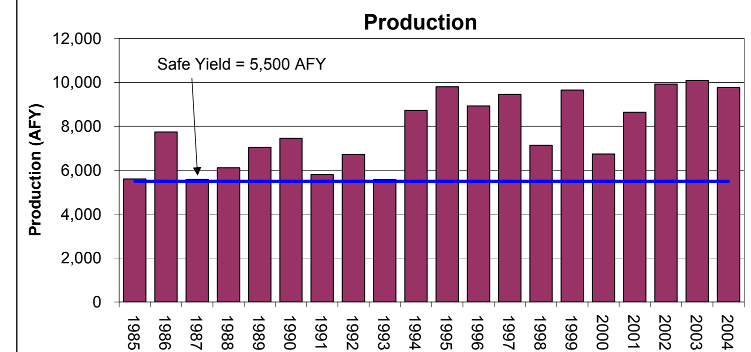
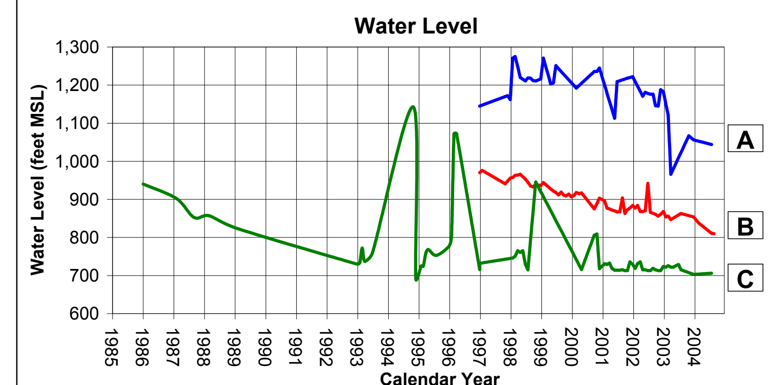
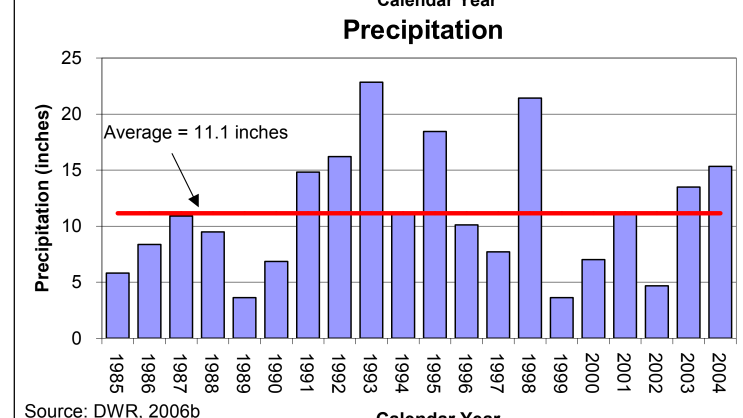
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).

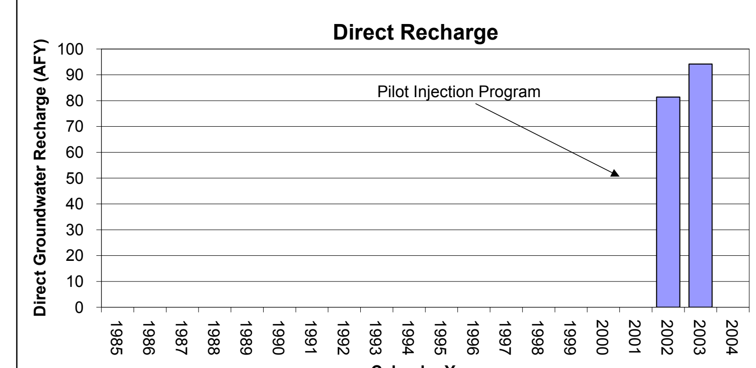


Source: Western , 2005





Source: DWR, 2006b
Elsinore Station



BASIN FACTS

Elsinore Basin

Description
Location: Riverside County
Watershed Surface Area: 40.2 square miles
Management: Managed
EVMWD adopted a Groundwater Management Plan in 2004
MWD Member Agencies:
Western MWD
Eastern MWD

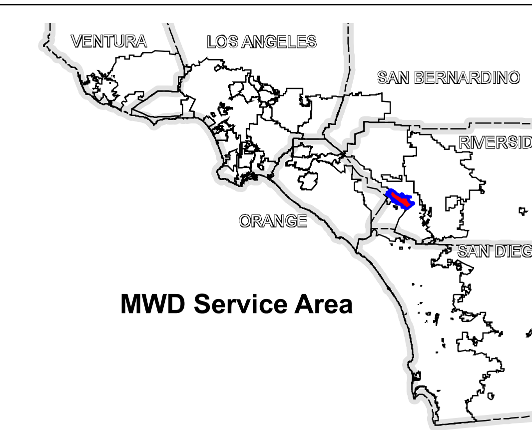
	Elsinore
Natural Safe Yield	5,500 AFY
Total Storage	1.4 million AF
Unused Storage Space (2001)	350,000 AF
Portion of Unused Storage Space Available for Storage	Unknown

Storage and Extraction Facilities

	Elsinore
Production Wells	
Production Capacity	~15,000 AFY
Average 1985-2004	~7,800 AFY
Injection Wells	
Injection Capacity	8,500 AFY
Average 2002-03	88 AFY
Spreading Basins	
Spreading Capacity	None
Average 1985-2004	None

Basin Management Considerations

- Lake augmentation obligation uses significant groundwater resources.
- Groundwater levels are declining and basin is in overdraft.
- Nitrate concentrations are increasing in some areas and affected areas could enlarge in some areas in the future.
- Potential for land subsidence.
- Water quality issues could limit storage potential.
- Water demands are projected to nearly double by 2020.



MWD Service Area

Plate 16-1
Overview of Elsinore Basin

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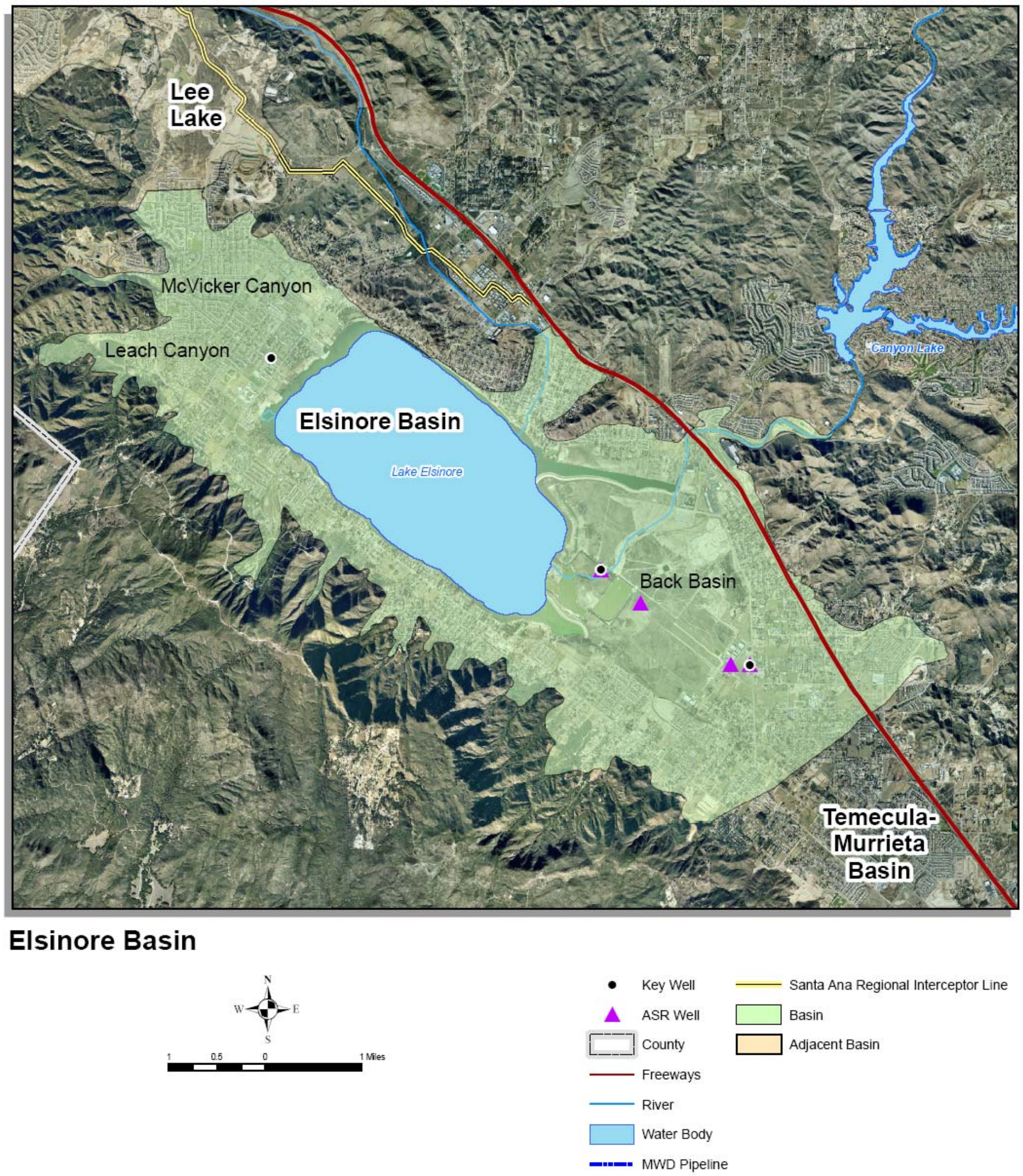
The Elsinore Basin underlies the Elsinore Valley in western Riverside County within the service area of Western Municipal Water District (Western MWD). The Elsinore Basin includes the communities of Lake Elsinore, Canyon Lake, Lakeland Village, Wildomar and portions of unincorporated Riverside County. A map of the basin is provided in **Figure 16-1**.

Figure 16-1
Map of the Elsinore Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Elsinore Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

The Elsinore Basin is bounded on the southwest by the Santa Ana and Elsinore Mountains along the Willard fault, a splay of the active Elsinore fault zone. The basin is bounded on the southeast by a shallow bedrock high coincident with a surface water divide that separates the Elsinore Basin from the Temecula-Murrieta Basin further to the southeast. The basin is bounded on the northwest by the Temescal Valley Basins at a constriction in the Temescal Wash, and on the northeast by non-water bearing rocks of the Peninsular Ranges along the Glen Ivy fault. Lake Elsinore lies in the closed basin formed between strands of the active Elsinore fault zone. (DWR, 2006A). The area referred to as the Back Basin includes the geographic area east of Lake Elsinore that represents the historical extent of the lake.

The Elsinore Basin is characterized by a series of down-dropped fault blocks between the Glen Ivy and Wildomar Fault Zones. As many as eight separate fault-bounded blocks are interpreted in the basin and there appears to be little groundwater movement between them (DWR 1981) thereby creating distinct pumping and storage zones within the basin.

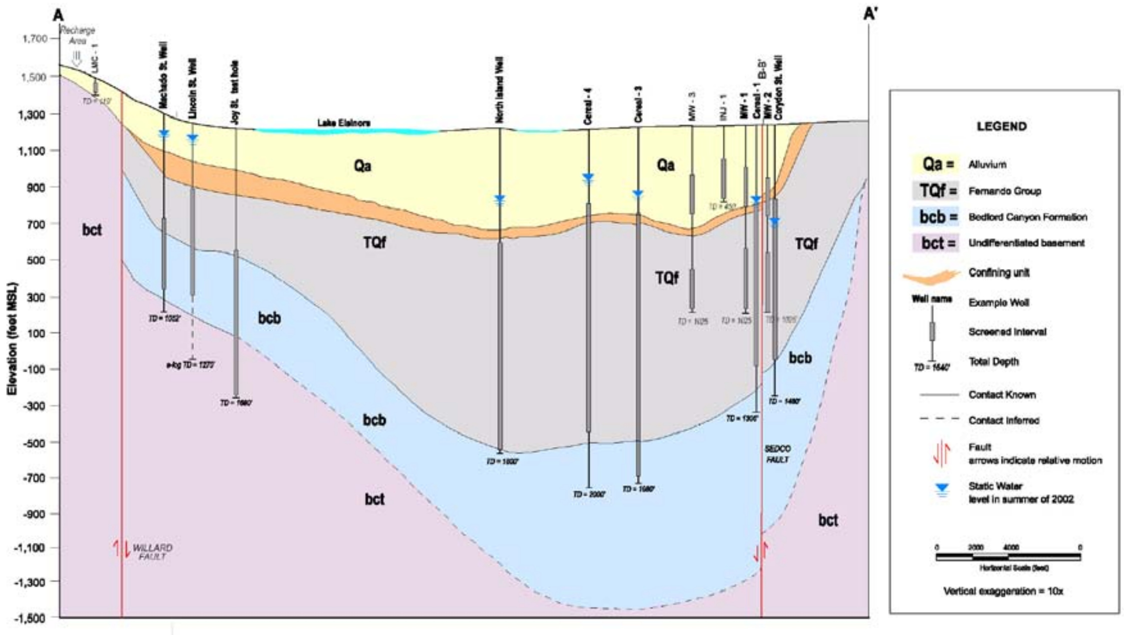
Groundwater occurs in two primary alluvial aquifers (the Upper aquifer, which is characterized by recent alluvium, and the Lower aquifer, which includes the Fernando Group and the Bedford Canyon Formation) separated by a semi-continuous confining clay. A conceptual cross section of the Elsinore Basin is provided in **Figure 16-2**. Perched groundwater as shallow as 25 feet below ground surface (bgs) can also be found in the Back Basin east of Lake Elsinore.

Table 16-1 summarizes the hydrogeologic parameters for the Elsinore Basin. Total storage capacity is estimated to be about 1.4 million AF (EVMWD 2001). Approximately 1.155 million AF was estimated to be in storage in 2001 (EVMWD 2001). Approximately 350,000 AF of storage space is currently unused. It is unknown how much of the unused storage space is available for storage.

Safe Yield/Long-Term Balance of Recharge and Discharge

The principal recharge of the basin is from infiltration of stream flow through alluvial fan deposits near the edges of the basin and through gravel deposits along the course of the San Jacinto River. Other contributing sources include infiltration from unlined channels overlying the basin, underflow from saturated alluvium and fractures within the surrounding bedrock mountains and hills (Wildermuth, 2000). Precipitation recharge is relatively minor. As shown in **Figure 16-3**, the average rainfall in the Elsinore Basin approximately 11.1 inches per year. Because of the predominance of clay beneath Lake Elsinore, it is assumed to be an insignificant source of recharge to the basin (MWH, 2003a).

Figure 16-2
Conceptual Hydrogeologic Cross Section of the Elsinore Basin

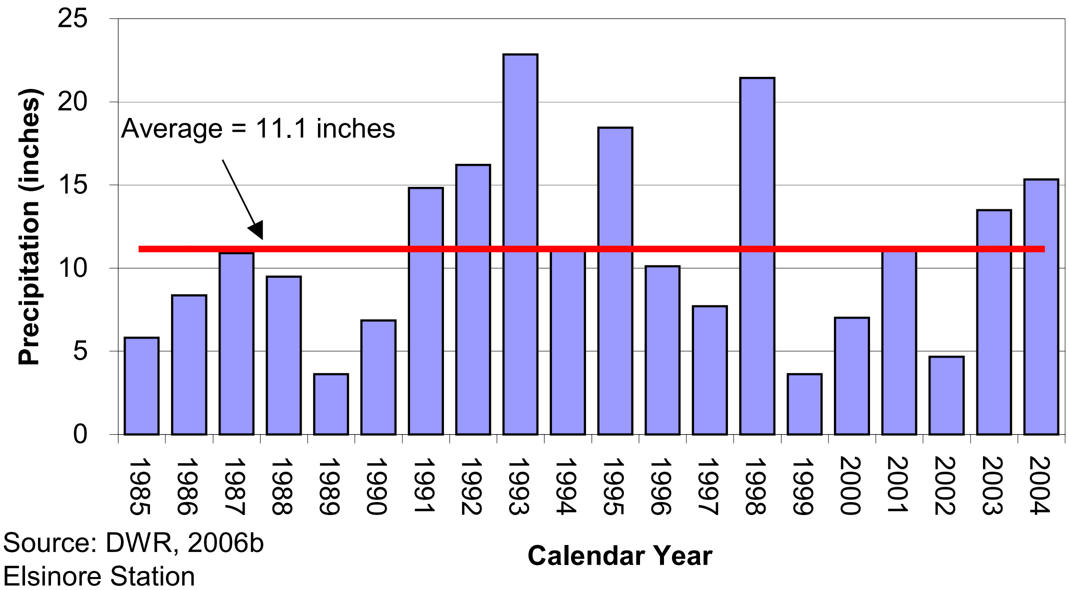


Source: MWH, 2004

Table 16-1
Summary of Hydrogeologic Parameters of Elsinore Basin

Parameter	Description
Structure	
Aquifer(s)	Upper aquifer Lower aquifer • Fernando Group • Bedford Canyon Formation
Depth of groundwater basin	120 to 2,300 feet
Thickness of water-bearing units	Upper aquifer: 120 to 450 feet Lower aquifer: ~800 to 2,000 feet
Yield and Storage	**Description**
Natural Safe Yield	5,500 AFY
Total Storage	1.4 million AF
Unused Storage Space	~ 350,000 AF
Portion of Unused Storage Space Available for Storage	Unknown

Figure 16-3
Historical Precipitation in the Elsinore Basin



Source: DWR, 2006b
Elsinore Station

The estimated natural safe yield of the Elsinore Basin is approximately 5,500 AFY (MWH, 2003a). Between 1990 and 2000, the annual groundwater deficit was approximately 1,800 AFY (MWH, 2003a).

GROUNDWATER MANAGEMENT

The following section describes how the Elsinore Basin is currently managed. **Table 16-2** lists the governing agencies in the Elsinore Basin.

Basin Governance

The Elsinore Basin is unadjudicated and is managed by the Elsinore Valley Municipal Water District (EVMWD), the primary producer from the basin. EVMWD adopted a groundwater management plan and groundwater monitoring plan in 2004 that conform to the requirements of Assembly Bill (AB) 3030 and Senate Bill (SB) 1938.

EVMWD is required by the City of Lake Elsinore to provide water to maintain water levels in Lake Elsinore. Currently, groundwater is used for lake augmentation. On average, about 3,200 AFY is needed to maintain lake levels in Lake Elsinore. As much as 12,500 AFY would be necessary during a dry year.

Interactions with Adjoining Basins

The Elsinore Basin is essentially a closed basin as the basin is surrounded by shallow bedrock. When groundwater levels are above 1,100 feet MSL in the southeastern portion of the basin, small amounts (less than 100 AFY) of groundwater could spill into the adjacent Temecula-Murrieta Basin (MWH, 2003a).

Table 16-2
Summary of Management Agencies in the Elsinore Basin

Agency	Role
Elsinore Valley Municipal Water District	Primary producer and basin manager.
Elsinore Water District	Participates in basin monitoring.
Santa Ana Water Project Authority (SAWPA)	Joint Powers Authority established to plan and build facilities to protect the water quality of the Santa Ana River Watershed.
California Regional Water Quality Control Board – Santa Ana Region (Regional Board)	Issuance of permits for discharges to Canyon Lake, Lake Elsinore, Temescal Wash and Back Basin Injection Project.
Western Municipal Water District	Provider of imported water from Metropolitan for municipal supply and injection.
Eastern Municipal Water District	Provider of recycled water for recharge to Lake Elsinore.

WATER SUPPLY FACILITIES AND OPERATIONS

The two primary water producers in the basin are EVMWD and Elsinore Water District (EWD). The following provides a summary of the facilities within the Elsinore Basin.

Active Production Wells

There are 10 active production wells in the Elsinore Basin with an estimated capacity of approximately 13 MGD or about 15,000 AFY (MWH, 2003b; MWH, 2006). Data for the wells are summarized in **Table 16-3**. Fourteen additional wells are planned to address peaking issues in the basin (MWH, 2003a). These wells are used primarily for municipal demand. **Figure 16-4** shows the production in the Elsinore Basin between 1985 and 2004. An average of approximately 7,800 AFY was produced from the basin between 1985 and 2004. Production has increased over the past few years – the average production for the past 3 years has been nearly 9,900 AFY. Groundwater production in the basin has exceeded the safe yield of the basin in nearly every year since 1985.

Operation costs for the wells in Elsinore Basin range from about $100 to $130 per AF (EVMWD, 2006).

Other Production

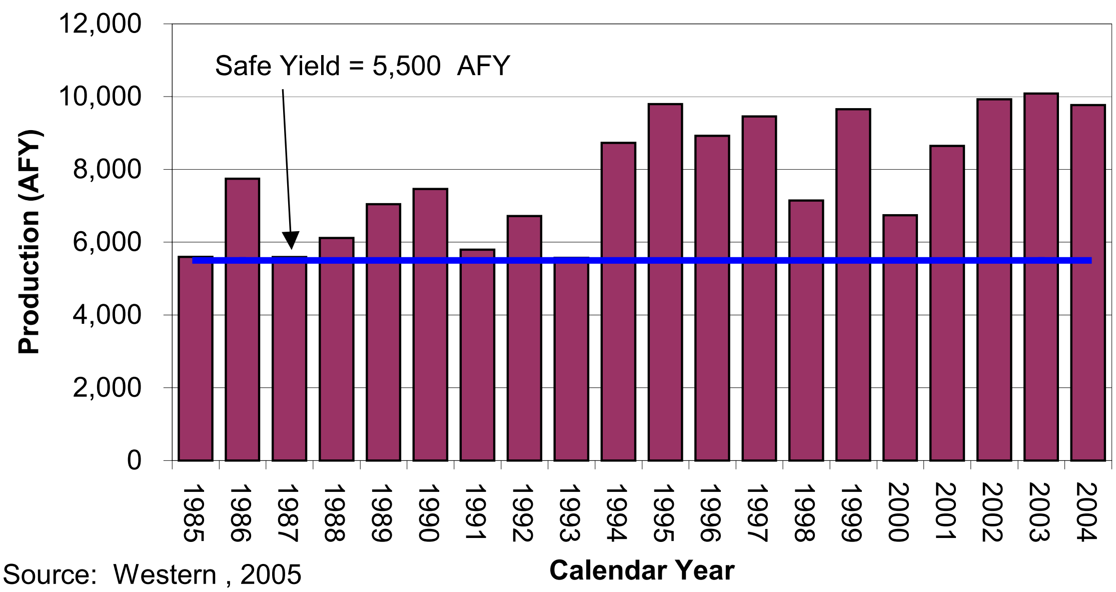
Private pumpers are estimated to pump a cumulative of approximately 100 AFY (MWH, 2003a).

Table 16-3
Summary of Production Wells in the Elsinore Basin

Category	Number of Active Wells [1]	Estimated Production Capacity [2] (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Municipal Wells	10	15,000	7,800	$100 to $130
Private Wells	Unknown	100	100	
Total	10	15,100	7,900	

Source: Western MWD (2005)
3. Active wells have production within past 5 years
4. Estimated production capacity is estimated by MWH, 2003a and 2006

Figure 16-4
Historical Groundwater Production in the Elsinore Basin



Source: Western , 2005

ASR Wells

EVMWD has recently retrofitted four of their existing wells to aquifer storage and recovery (ASR) and constructed one new injection well in the Back Basin. Estimated injection capacity is approximately 7.5 MGD, or about 8,500 AFY (MWH, 2006). EVMWD is currently considering constructing an additional two to three ASR wells in the Back Basin area with a combined injection capacity of 4 MGD.

EVMWD conducted a pilot injection test in the Back Basin in 2002 and 2003. Approximately 175 AF of treated imported water from Metropolitan was injected during this pilot test.

Table 16-4
Summary of ASR Wells in the Elsinore Basin

Category	Number of ASR Wells	Estimated Injection Capacity [1] (AFY)	Average Injection 1985-2004 (AFY)	Well Operation Cost ($/AF)
Existing	5	8,500	<10	Not available
Future	2 to 3	4,400	0	
Total	**7 to 8**	**12,900**	**<10**	

[1]Source: MWH, 2006

Spreading Basins

The Elsinore Basin does not currently contain any spreading basins. The Riverside County Flood Control and Conservation District maintains two debris basins in Leach and McVicker Canyons on the northwestern side of the basin for flood control. The amount of runoff infiltrated into groundwater from these basins is not calculated.

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Elsinore Basin.

Desalters

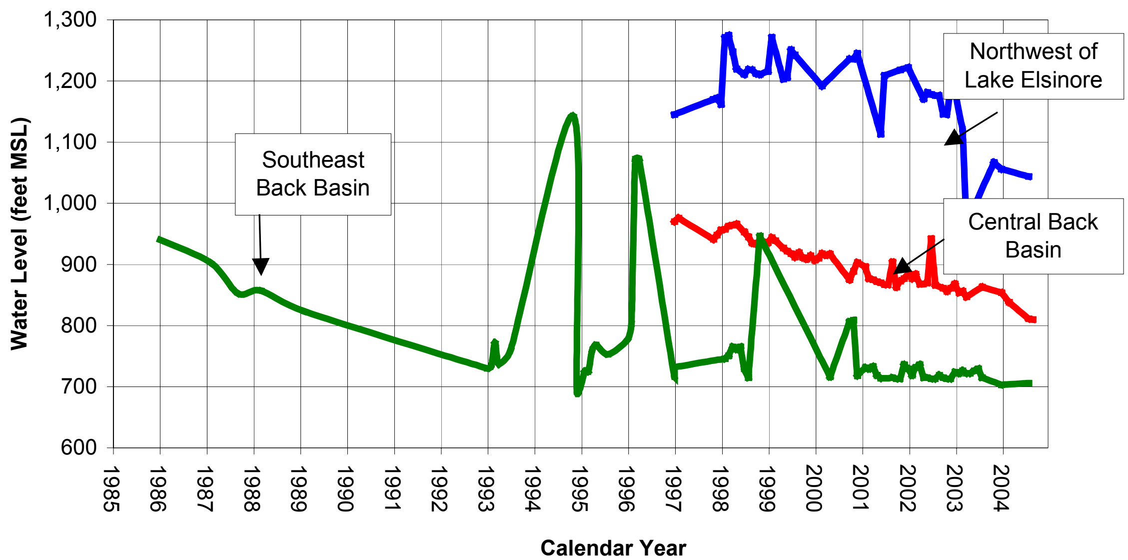
There are no desalters in the Elsinore Basin.

GROUNDWATER LEVELS

In concert with the water management plan, EVMWD adopted a groundwater-monitoring plan in 2004 to monitor groundwater levels in the basin. EVMWD and EWD currently measure water levels and water production on a monthly basis. There are currently four multi-level groundwater monitoring wells in the Back Basin and three monitoring wells in the areas downstream of Leach and McVicker Canyons.

Historical groundwater levels in the Elsinore Basin are plotted in **Figure 16-5**. Groundwater generally flows from the northwest to southeast beneath Lake Elsinore. The difference between groundwater levels on the northwest side and the southeast side is more than 300 feet. Depth to water currently ranges from about 250 feet in the northwest to more than 600 feet in the southeast.

Figure 16-5
Historical Water Levels in the Elsinore Basin



Groundwater levels are generally declining throughout the basin. Average declines have been about 15 feet per year throughout the basin over the past 20 years. This decline in water levels increases the risk for land subsidence particularly in the Back Basin area. EVMWD is currently in the process of implementing a subsidence-monitoring program.

GROUNDWATER QUALITY

The groundwater in the Elsinore Basin is generally of good to fair quality with total dissolved solids (TDS) concentrations ranging from 250 mg/L in the Back Basin area east of Lake Elsinore to about 600 mg/L in the northwest part of the basin (SAWPA, 2006).

Groundwater Quality Monitoring

Groundwater quality samples are collected from active production wells in accordance with California DHS requirements as specified in Title 22 of the California Code of Regulations. As discussed above, EVMWD adopted a groundwater-monitoring plan in 2004. Under this plan, EVMWD would collect samples from each of its production wells annually and its monitoring wells twice annually for Title 22 constituents. Other activities in the monitoring plan are depth-specific zone sampling, surface water sampling, spinner logging and subsidence monitoring.

The Santa Ana Watershed Basin Monitoring Task Force is a collaborative effort of public and private sector agencies and interests. As part of this effort, SAWPA compiles water quality data in the Santa Ana River Watershed, including total dissolved solids (TDS) and nitrate (as N) data. SAWPA also prepares a triennial update of the ambient groundwater quality throughout all the groundwater basins in the Santa Ana River Watershed.

Groundwater Contaminants

Primary constituents of concern for the Elsinore Basin are TDS, nitrate and arsenic. Each is discussed in more detail below. Data are summarized in **Table 16-5**.

The ambient 20-year (1984 to 2003) average TDS concentration for the Elsinore Basin is 460 mg/L. Ambient concentrations of TDS have decreased about 20 mg/L in the Elsinore Basin compared to the 1978 to 1997 average (Wildermuth, 2005). TDS concentrations have ranged from about 250 mg/L in the Back Basin area to above 600 mg/L northwest of Lake Elsinore (MWH, 2003a).

Nitrate concentrations range from non-detect in the Back Basin area to as much as 8 mg/L along the southern margin of the basin. Sources of nitrate in these areas are a result of historical agricultural practices and septic tanks in the shallower portions of the basin to the south. About 3,900 parcels are currently using septic systems, which create a high risk for nitrate contamination of groundwater. Nitrate concentrations in these areas are currently increasing. Two current production wells are located within the high-risk areas for future nitrate contamination (MWH, 2003a). The 20-year average ambient nitrate concentrations (1984 to 2003) are about 2.4 mg/L (Wildermuth, 2005).

Concentrations of arsenic range from non-detect in the northwestern portions of the Elsinore Basin to as much as 35 mg/L in the Back Basin area and exceed the primary MCL for arsenic. The highest concentrations of arsenic are found in the deeper zones of the basin. (MWH, 2003a).

Blending Needs

Blending of some wells in the Back Basin area is required to meet the arsenic MCL. These wells are currently blended with other wells in the EVMWD system and imported water from Metropolitan. EVMWD is currently in final design for a 5 MGD arsenic treatment plant to be online in 2007 (EVMWD, 2006a).

Table 16-5
Summary of Constituents of Concern in the Elsinore Basin

Constituent	Units	Range	Description
TDS Secondary MCL=500	mg/L	250 to >600 Ambient: 460	TDS concentrations range from about 250 mg/L in the Back Basin area to above 600 mg/L northwest of Lake Elsinore.
Nitrate (as N) Primary MCL =10	mg/L	ND to 8 Ambient:2.4	Nitrate concentrations range from non-detect in the Back Basin area to as much as 8 mg/L along the southern margin of the basin. Nitrate concentrations in areas where septic tanks exist are currently increasing.
VOCs **(TCE and PCE)** Primary MCL: TCE = 5 PCE =5	µg/L	ND	TCE and PCE have not been detected in the Elsinore Basin
Perchlorate Notification level =6	µg/L	ND	Perchlorate has not been detected in the Elsinore Basin.
Arsenic Primary MCL = 10	µg/L	ND to 35	Concentrations of arsenic range from non-detect in the northwestern portions of the basin to as much as 35 mg/L in the Back Basin area and exceed the primary MCL for arsenic. The highest concentrations of arsenic are found in the deeper zones of the basin

Groundwater Treatment

Wells in the Elsinore Basin are not currently treated for any constituent of concern discussed above. Since July 2005, the Elsinore Valley Municipal Water District has been upgrading its drinking water disinfection process. Chloramine disinfection will replace the current chlorine disinfection (EVMWD, 2006b).

EVMWD is currently in final design for a 5 MGD arsenic treatment plant to be online in 2007. Estimated cost of treatment is projected to be approximately $84 to $100 per AF (EVMWD, 2006).

CURRENT GROUNDWATER STORAGE PROGRAMS

In 2006, Western MWD and EVMWD executed a conjunctive use program (Elsinore CUP) with Metropolitan. The Elsinore CUP allows Metropolitan to store up to 12,000 AF in the Elsinore Basin to be produced upon Metropolitan's call in-lieu of imported supplies at the service connection during water shortage events (up to 4,000 AFY). At the end of 2005/06, the account balance in this program was 0 AF.

BASIN MANAGEMENT CONSIDERATIONS

Considerations related to basin management in the Elsinore Basin include:

- EVMWD is required by the City of Lake Elsinore to provide water to maintain water levels in Lake Elsinore. Currently, groundwater is used for lake augmentation. On average, about 3,200 AFY is needed to maintain lake levels in Lake Elsinore. As much as 12,500 AFY would be necessary during a dry year.
- Groundwater levels are declining, which could limit future extraction.
- Nitrate concentrations are increasing in some areas and affected areas could enlarge in the future.
- As water levels continue to decline, there is a potential for land subsidence, particularly in the Back Basin area.
- Water quality issues could limit storage potential. Arsenic concentrations exceed drinking water standards in some areas. Wells are currently blended to meet drinking water standards.
- Water demands are projected to nearly double by 2020 (MWH, 2003a). Only about 20 percent of the demand in the future could be met by groundwater.
- Geologic faulting within the basin may significantly limit storage and extraction operations.

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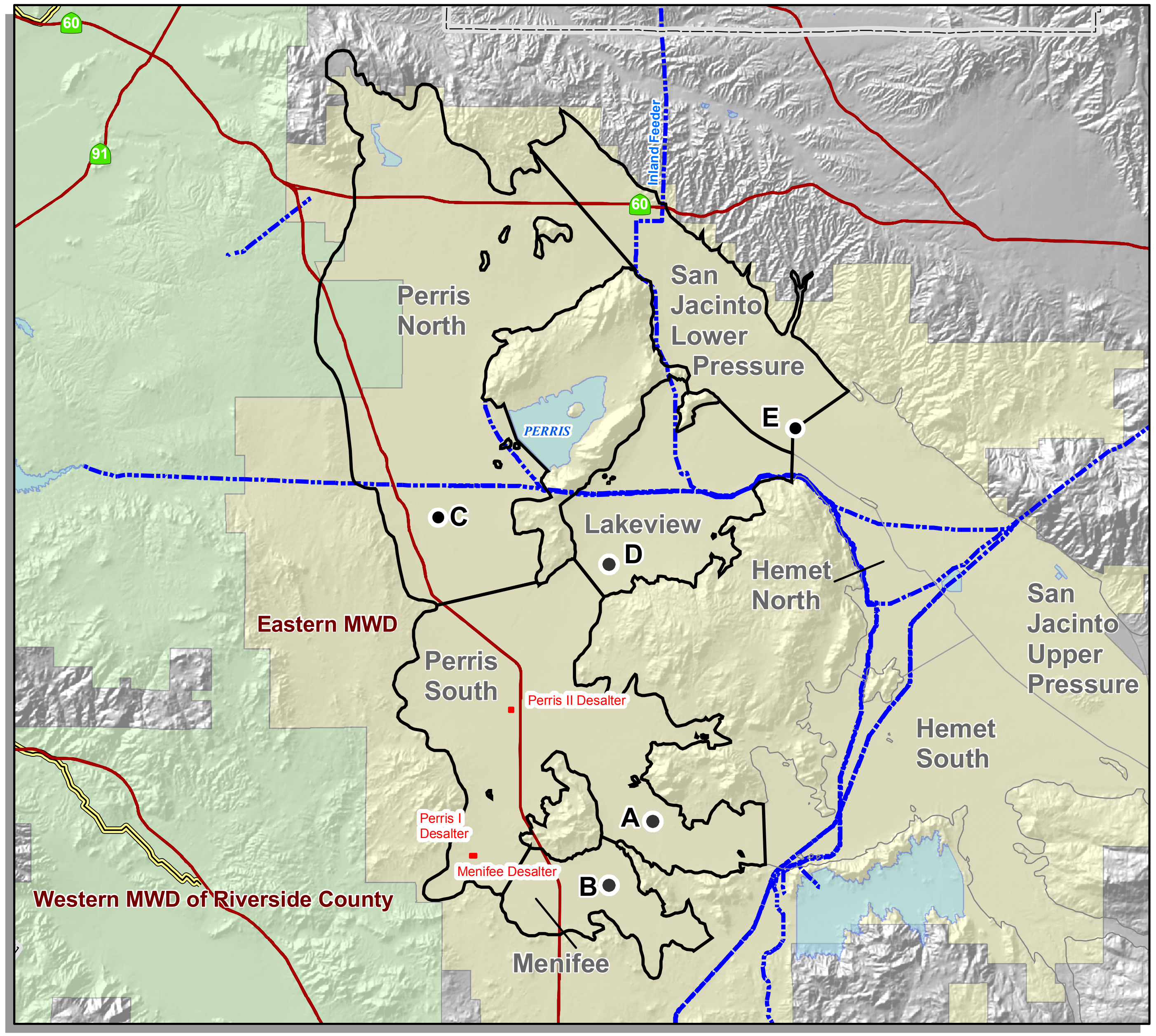

West San Jacinto Basins

A ●	Key well		Santa Ana Regional Interceptor Line
	Desalter		Adjacent Basin
	County		Basin
	Freeways		MWD Member Agency Boundary (color varies)
	Water Body		
	MWD Pipeline		

N W E S

2.5 1.25 0 2.5 Miles

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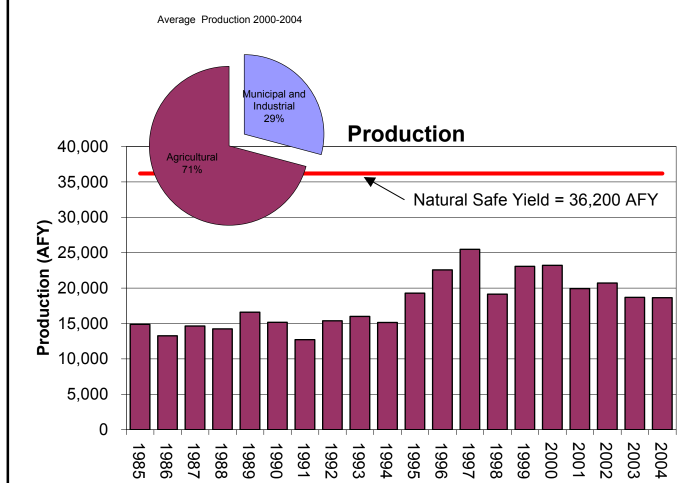
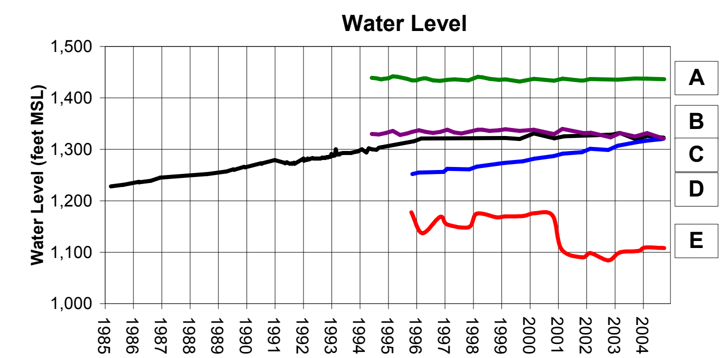
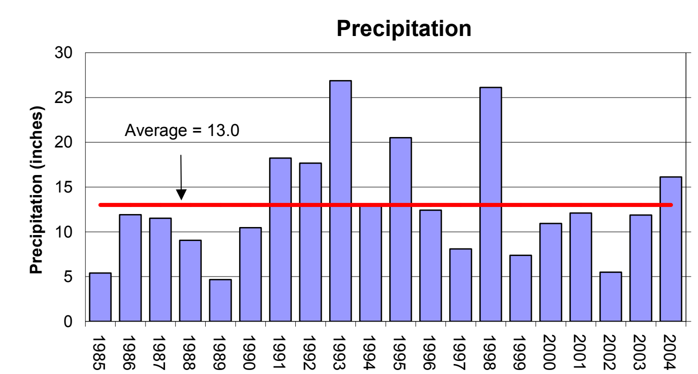


Source: Eastern, 1995 and 2006a



Source: Eastern, 2006



Source: UC ICP, 2006

Direct Recharge
Incidental recharge from recycled ponds only.

BASIN FACTS

West San Jacinto Basins

Description
Location: Riverside County
Watershed Surface Area: 148 square miles
Subbasins:
Perris North
Perris South
San Jacinto Lower Pressure
Lakeview
Menifee
Management: Managed
Basin is currently managed. Eastern MWD adopted a Groundwater Management Plan in 1995
MWD Member Agencies:
Eastern MWD
Western MWD

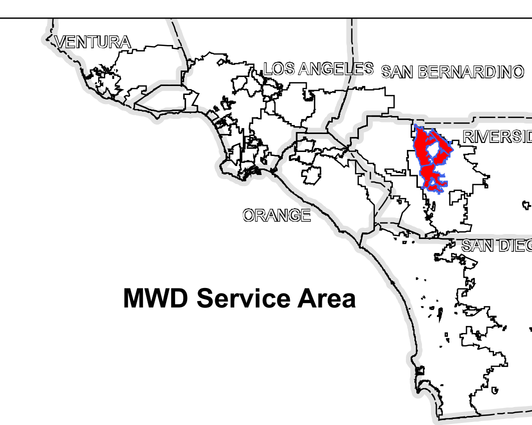
	West San Jacinto
Natural Safe Yield	36,200 AFY
Operational Safe Yield	48,100 AFY
Total Storage	1.8 million AF
Unused Storage Space (2000)	700,000 AF
Portion of Unused Storage Space Available for Storage	~200,000 AF

Storage and Extraction Facilities

	West San Jacinto
Production Wells	
Production Capacity	~26,000 AFY
Average 1985-2004	~18,000 AFY
Injection Wells	
Injection Capacity	None
Average 1985-2004	None
Spreading Basins	
Spreading Capacity	None
Average 1985-2004	None

Basin Management Considerations

- Poor water quality could limit storage and extraction potential



MWD Service Area

Plate 17-1
Overview of West San Jacinto Basins

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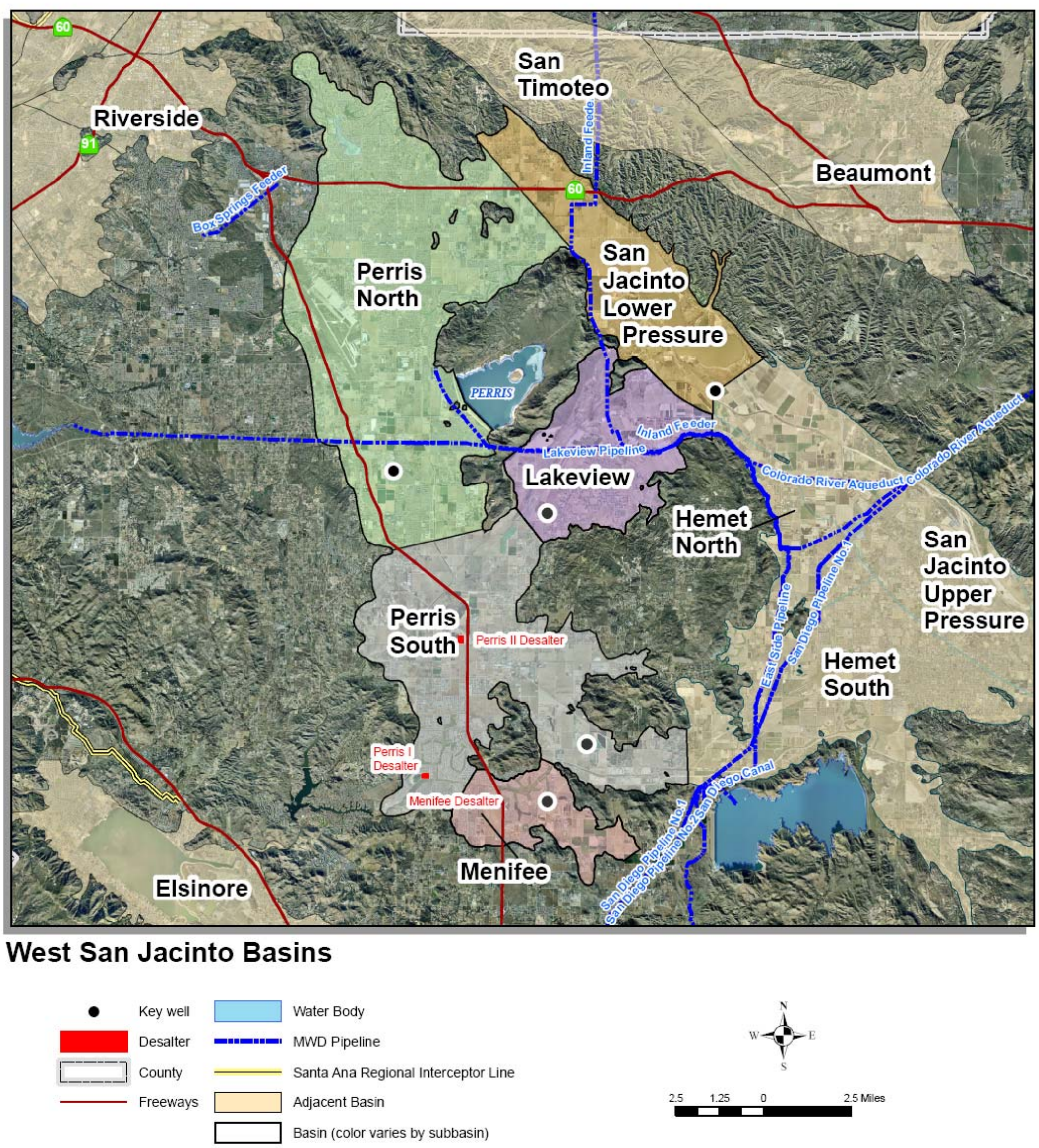
The West San Jacinto Basins are located within the western portion of the San Jacinto River watershed in Riverside County. The West San Jacinto Basins underlie the service area of Metropolitan member agencies Eastern Municipal Water District (Eastern MWD) and a minor portion of Western Municipal Water District (Western MWD), and are divided into five basins, or management zones (Perris North, Perris South, San Jacinto Lower Pressure, Lakeview, and Menifee). The West San Jacinto Basins are utilized for groundwater supply for the cities of Perris, Moreno Valley, and Sun City; unincorporated areas of Menifee, Juniper Flats, Sunnymead, Edgemont, Romoland, Homeland, Mead Valley, Quail Valley, and Winchester. A map of the West San Jacinto Basins is provided in **Figure 17-1**.

Figure 17-1
Map of the West San Jacinto Basins



BASIN CHARACTERIZATION

The following section provides a physical description of the West San Jacinto Basins, including geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

Groundwater occurrence in the West San Jacinto Basins is generally within unconfined alluvium. As described above, the West San Jacinto Basins are divided into five subbasins that are differentiated by physical constrictions such as bedrock highs, narrows and faults between the zones or water quality variations. Hydrogeologic parameters for each subbasin are summarized in **Table 17-1** and discussed below.

Table 17-1
Summary of Hydrogeologic Parameters of West San Jacinto Basins

Parameter Structure	Description
Aquifer(s)	Unconfined alluvium
Depth of groundwater basin	Perris North: Up to 850 feet Perris South: Up to 1,000 feet Lakeview: More than 1,000 feet Menifee: Up to 900 feet San Jacinto Lower Pressure: Up to 1,200 feet
Depth of producing zones or screen intervals	Perris North: 250 to 700 feet Perris South: 100 to 350 feet (desalter wells) 200 to 600 feet (southeast) Lakeview: 300 to 1,000 feet Menifee: 100 to 600 feet San Jacinto Lower Pressure: Data not available
Yield and Storage	
Natural Safe Yield	36,200 AFY
Operational Safe Yield	48,100 AFY
Total Storage	1.8 million AF
Unused Storage Space (2000)	700,000 AF
Portion of Unused Storage Space Available for Storage	~200,000 AF (Lakeview only)

Source: Eastern MWD, 1995, 2005b, and 2006

Total depth of the West San Jacinto Basins ranges from about 40 feet to 1,350 feet. The deepest basins are the Lakeview and San Jacinto Lower Pressure subbasins with total depths over 1,000 feet. The San Jacinto Lower Pressure subbasin has alluvium to about 1,200 feet in depth, although it is comprised mostly of clays and silts and produces little water. Maximum depths in the other basins range from 600 to 900 feet. Producing zones range in depth from 100 to 1,000 feet.

Total storage within the West San Jacinto Basins has been estimated to be approximately 1.8 million AF (Eastern MWD, 2005b). In 2000, there was an estimated 1.1 million AF in storage, or about 700,000 AF in unused storage space (Eastern MWD, 2005b). Within the West San Jacinto Basins, Lakeview is the only subbasin with available unused storage capacity. About 200,000 AF of the unused storage space is available for additional storage (Eastern MWD, 2006a). Storage in the subbasins other than Lakeview is not useable due to poor water quality.

Safe Yield/Long-Term Balance of Recharge and Discharge

The natural safe yield is estimated to be approximately 36,200 AFY (Eastern MWD, 2005b), which represents the yield of the basin without artificial recharge. If artificial recharge is included, the yield of the basin increases to about 48,100 AFY (Eastern MWD, 2005b).

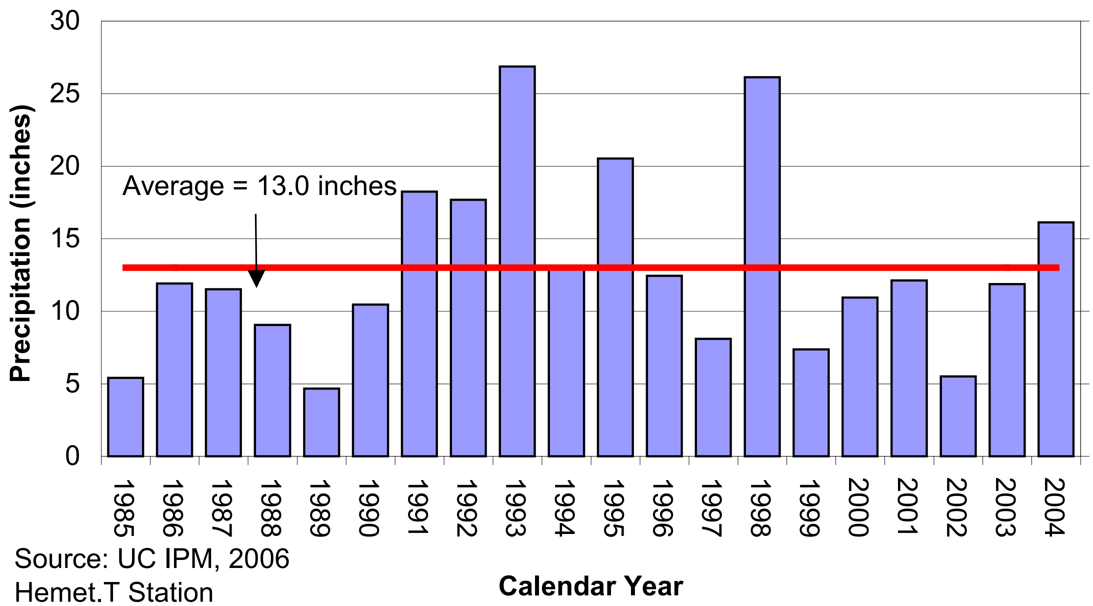
Sources of recharge in the West San Jacinto Basins consist of: percolation of stormwater runoff, precipitation, applied water, artificial recharge, and subsurface inflows from adjacent areas. Total natural inflows are estimated to be about 38,200 AFY (Eastern MWD, 2005b), more than 50 percent of which is a result of deep percolation of agricultural returns. Average recharge from stormflow percolation and runoff from the mountains is estimated to be about 11,500 AFY, or about 30 percent of the total inflows (Eastern MWD, 2005b). Deep percolation of precipitation also recharges the groundwater in the basin. Average historical precipitation in the area has been about 12 inches. However, over the 20-year period from 1985 to 2004 the average was slightly above with historical average at 13 inches as shown on **Figure 17-2** (CIMIS 2006). Annual evapotranspiration in the area is about 50 inches and, therefore, deep percolation of rainfall only occurs during wet years. The long-term recharge from precipitation in the West San Jacinto Basins is estimated to be about 6,400 AFY (Eastern MWD, 2005b).

Primary outflows include outflow to the Hemet-San Jacinto Basins to the east and groundwater production. About 2,000 AFY flows from the West San Jacinto Basins to the Hemet-San Jacinto Basins.

GROUNDWATER MANAGEMENT

The following section describes how the West San Jacinto Basins are currently managed. It includes a description of the governing structure within the basins and agreements with adjacent basins.

Figure 17-2
Historical Precipitation in the West San Jacinto Basins



Source: UC IPM, 2006
Hemet.T Station

Basin Governance

The West San Jacinto Basins are managed by Eastern MWD under the authority of the West San Jacinto Groundwater Basin Management Plan (Management Plan), which was cooperatively developed and adopted in 1995 under Assembly Bill 3030. Elements of the Management Plan include: artificial recharge, recovery of degraded groundwater to be blended with imported water, recovery of brackish water using demineralization treatment technologies, conjunctive use, and agricultural groundwater exchange. The managing agencies and their roles in groundwater management in the West San Jacinto Basins are summarized in **Table 17-2**.

The Management Plan also established an advisory committee that oversees management activities in the basin. Advisory committee members include the Nuevo Water Company, the cities of Moreno Valley and Perris, the McCanna Ranch Water Company, and two elected representatives from the private water producers.

Interactions with Adjoining Basins

Depending on groundwater levels, groundwater may flow between the Hemet-San Jacinto Basins to the east and southeast. This basin interaction primarily occurs between the San Jacinto Lower Pressure subbasin and the Lakeview subbasin of the West San Jacinto Basins and the San Jacinto Upper Pressure and Hemet North subbasins of the Hemet-San Jacinto Basins to the south. Flow can also occur between the Perris South and Menifee subbasins and the Hemet South subbasin of the Hemet-San Jacinto Basins to the east. These flows are not regulated and there are no formal agreements regarding these flows.

Table 17-2
Summary of Management Agencies in West San Jacinto Basins

Agency	Role
Eastern MWD	Basin Manager Implementation of water resources management projects (desalters, water treatment facilities, etc). Implementation of groundwater monitoring programs Member of Advisory Committee Retail and wholesale water sales Groundwater producer Operation of wastewater treatment and recycled water facilities
Nuevo Water Company	Member of Advisory Committee Groundwater producer
City of Moreno Valley	Member of Advisory Committee
City of Perris	Member of Advisory Committee Groundwater producer
McCanna Ranch Water Company	Member of Advisory Committee Groundwater producer

WATER SUPPLY FACILITIES AND OPERATIONS

The following section describes the water supply facilities within the West San Jacinto Basins. Facilities currently include 16 active municipal production well, 57 agricultural wells, about 340 acres of reclaimed water ponds and 3 desalters.

Municipal Production Wells

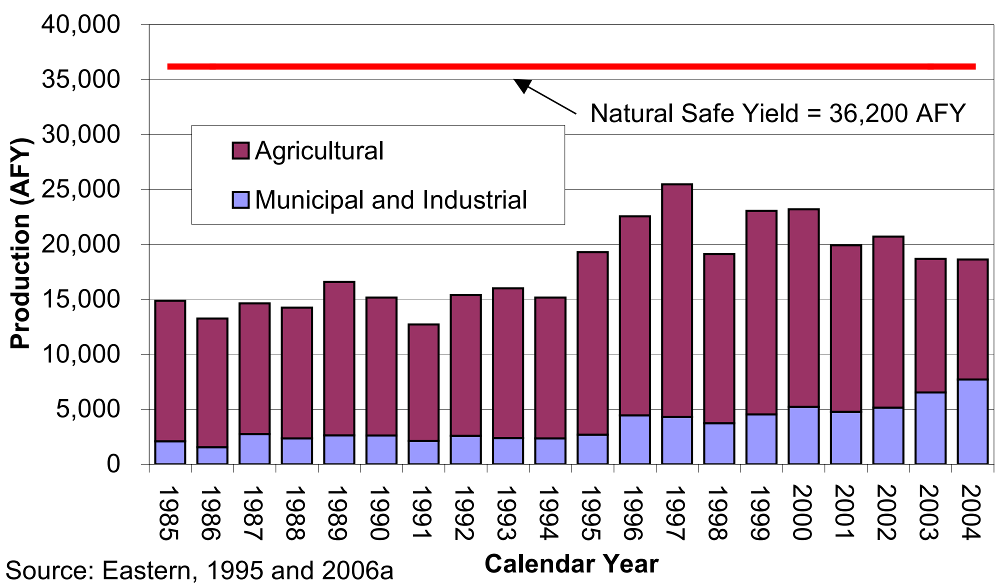
According to Eastern MWD, there are 16 active municipal production wells in the West San Jacinto Basins. Details of the production wells are provided in **Table 17-3**. **Figure 17-3** shows historical groundwater production between 1985 and 2004. Between 1985 and 1994, the percent of the total production attributed to municipal production was relatively small (averaging 15 to 16 percent). After 1995, with increasing shift from agricultural to urban land use and implementation of the Management Plan, the amount and relative percent of municipal production increased to an average of about 23 percent between 1995 and 2004.

Table 17-3
Summary of Production Wells in the West San Jacinto Basins

Category	Number of Active Wells	Estimated Production Capacity [1] (AFY)	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Municipal	16	7,710	3,626	Regular wells $56 Desalter wells $83
Agricultural	57	17,974	14,310	Data not available
Total	**73**	**25,684**	**17,936**	**-**

Note: 1 Production capacity is based upon maximum annual production in past 5 years

Figure 17-3
Historical Groundwater Production in the West San Jacinto Basins



Source: Eastern, 1995 and 2006a

As shown in **Figure 17-3**, groundwater production in the West San Jacinto Basins generally decreased from a high of more than 25,000 AFY in 1997 to about 18,600 AFY in 2004. Most of this reduction is due to decreasing production from the Perris North and Lakeview subbasins. Total production levels are relatively low when compared with the estimated safe yield. This limited utilization of the groundwater is primarily due to the generally poor quality of the groundwater in a large proportion of the West San Jacinto area, such as the Perris South and

Menifee subbasins and in portions of the Perris North and Lakeview subbasins as discussed in more detail below.

Other Production

Non-municipal production is entirely for agricultural purposes from 57 wells. As summarized in **Figure 17-3**, between 1985 and 1994, agricultural production ranged from 81 to 88 percent of the total production. After 1995, with increasing shift from agricultural to urban land use the agricultural production decreased to about 60 percent of the total groundwater production in 2004.

ASR Wells

There are no ASR wells in the West San Jacinto Basins.

Spreading Basins

There are no spreading basins located in the West San Jacinto Basins used specifically for groundwater recharge. Recycled water storage ponds, though, contribute incidental recharge. There are about 340 acres of ponds used for regional water reclamation facilities in the Perris South area.

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the West San Jacinto Basins.

Desalters

As part of the Management Plan, and with the help of funding through Metropolitan's Groundwater Recovery Program (GRP), Eastern MWD has implemented a Groundwater Salinity Management Program to reduce the total dissolved solids (TDS) concentrations in the Menifee and Perris South subbasins. This program consists of three desalination facilities. Specifically, the Menifee and the Perris I desalters are in operation, and the Perris II desalter is in design. The Menifee Desalter came online in 2001. The Perris I desalter came online in 2005. These facilities recover high-TDS water and treat it for potable use. The two online desalters produce 3 to 7 MGD of potable water. The desalters are a source of water, and help to decrease dependency on imported water. However, another role of the desalters is to call attention to and address the migration of brackish groundwater into areas of good quality groundwater (Eastern MWD, 2006). The locations of the desalters are shown in **Figure 17-1**.

GROUNDWATER LEVELS

Under the Management Plan Groundwater Monitoring Program, water levels in municipal and private agricultural wells are measured twice per year, in the spring and fall (Eastern MWD, 2006). There were 135 wells with groundwater level measurements in both 2003 and 2004. In spring 2005, groundwater level measurements were recorded for 158 wells. In addition, water levels for another 404 wells (mostly monitoring wells) were reported to Eastern MWD by March Air Reserve Base (Eastern MWD, 2006).

According to Eastern MWD, the depth to groundwater within the West San Jacinto Basins ranges between 10 to 346 feet below ground surface (Eastern MWD, 2006). **Figure 17-4** shows groundwater elevations within the West San Jacinto Basins subbasins during early 2005.

Groundwater elevations range from above 1,700 feet MSL in the San Jacinto Lower Pressure area to less than 1,200 feet MSL in the Lakeview area. In general, groundwater flow directions are highly variable and largely dependent upon local pumping depressions and hydrogeologic structure. For example, groundwater flow is generally from northwest to southeast in the San Jacinto Lower Pressure subbasin and northern portion of the Perris North subbasin Groundwater flow is toward the east in the southern portion of the Perris North subbasin and most the Perris South subbasin. Groundwater flow is generally toward the west in the Lakeview and Menifee subbasin. It important to note that groundwater flows from the northern portion of the Perris South subbasin into the Lakeview subbasin, allowing poorer quality water of the Perris South subbasin to enter the higher quality Lakeview subbasin. This issue is discussed in more detail below.

Historical water levels from representative wells in the West San Jacinto Basins are shown on **Figure 17-5**. Water levels have remained relatively stable in the Perris South and Menifee subbasins since 1995, while water levels have increased in the Perris North and Lakeview subbasins (largely due to decreased production) and decreased in the San Jacinto Lower Pressure subbasin. The cause of the decreased water levels in the San Jacinto Lower Pressure subbasin is unknown.

GROUNDWATER QUALITY

The following section describes the groundwater quality within the West San Jacinto Basins. In general, groundwater quality in the West San Jacinto Basins is fair to poor with total dissolved solids (TDS) concentrations exceeding 10,000 mg/L in some areas.

Groundwater Quality Monitoring

Water quality samples are collected once a year under the West San Jacinto Groundwater Management Plan's Groundwater Monitoring Program (Eastern MWD 2005b and 2006). These samples are usually collected in the summer from all available municipal and private (agricultural) wells. In 2005, 102 water quality samples (general mineral and nitrogen) were collected (Eastern MWD, 2006).

Figure 17-4
Groundwater Contour Map for the West San Jacinto Basins – Spring 2005

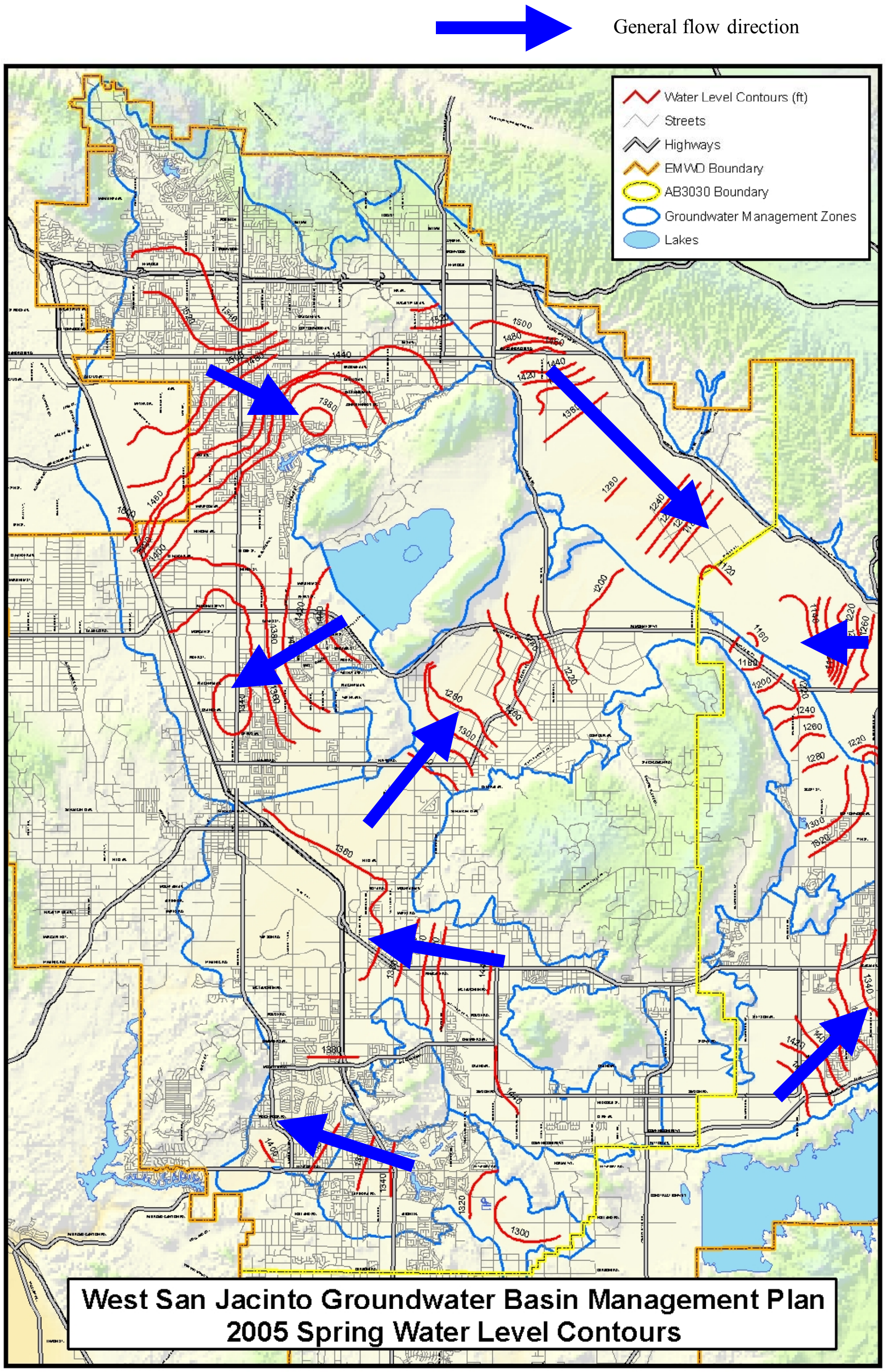
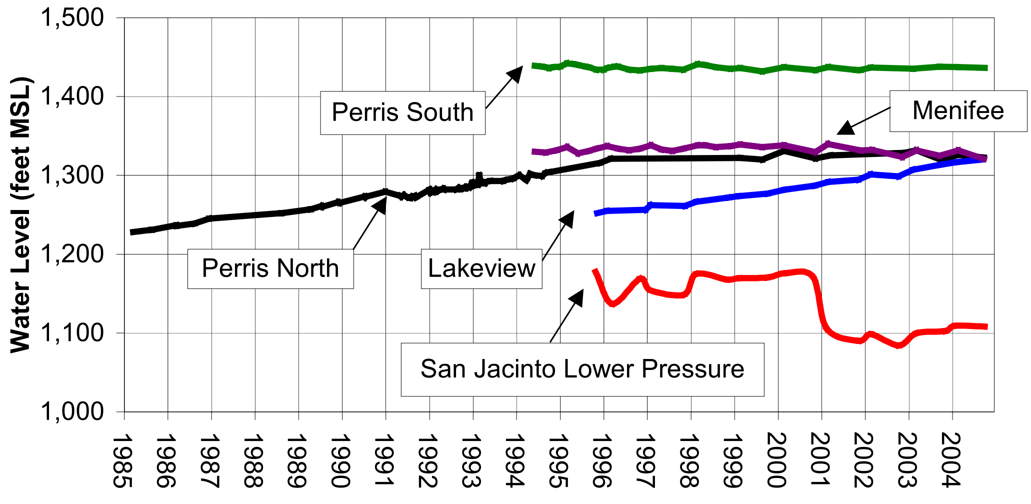


Figure 17-5
Historical Water Levels in the West San Jacinto Basins



Source: Eastern MWD, 2006

Groundwater Contaminants

Table 17-4 summarizes the constituents of concern in the West San Jacinto Basins. These include TDS, nitrate, volatile organic compounds (VOCs), perchlorate, iron and manganese. Water quality in the West San Jacinto Basins is generally poor, particularly in the Perris South, Menifee and San Jacinto Lower Pressure subbasins. The water with the highest TDS level (10,100 mg/L) was found in the southwest portion of the Perris South subbasin. The lowest TDS concentration of 220 mg/L was found in the northwest portion of the Perris North subbasin. **Figures 17-6 and 17-7** show 2005 concentrations of TDS and nitrate (as N), respectively.

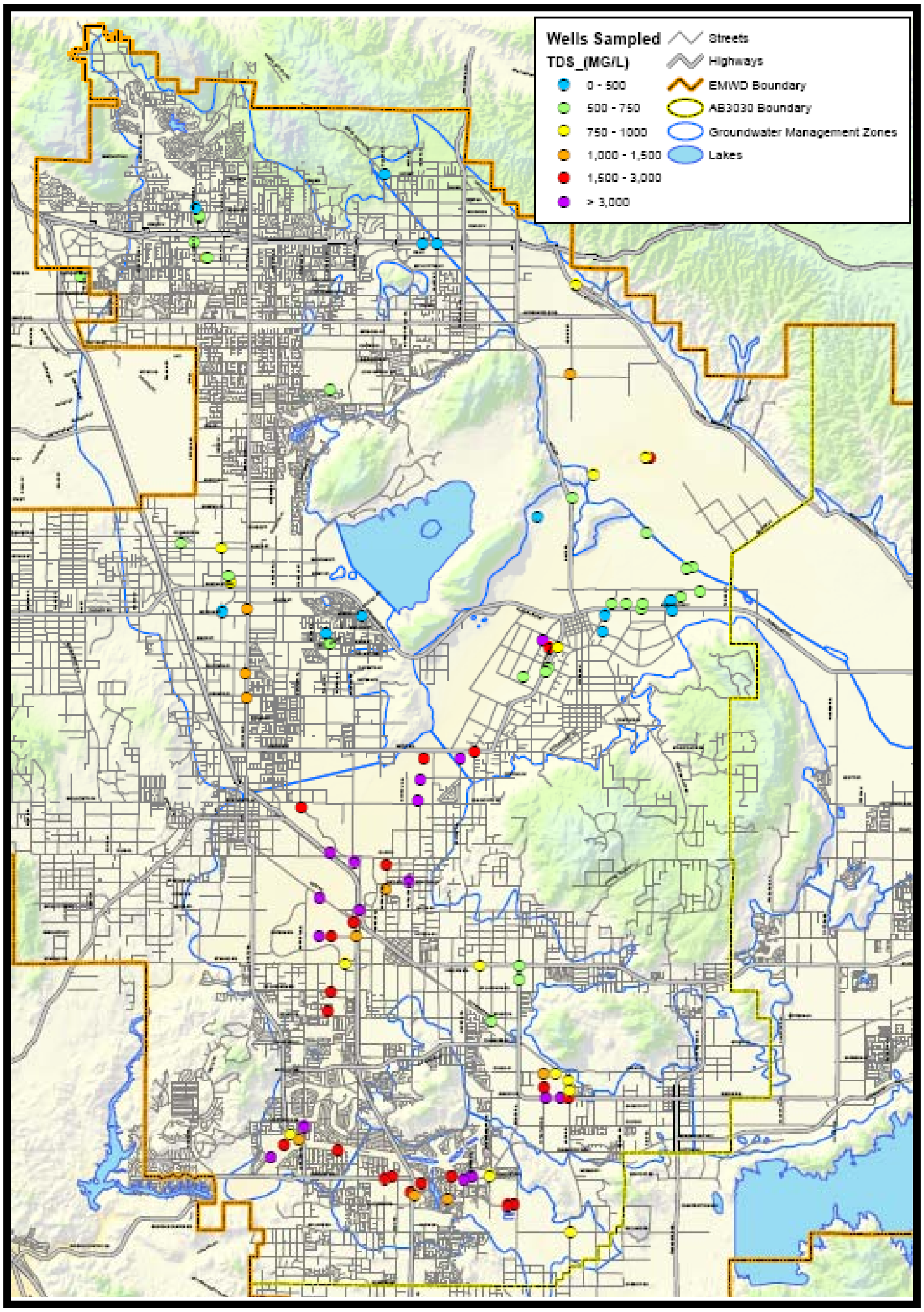
The groundwater resources of the Lakeview subbasin have been relied upon for irrigation and domestic water supply uses since the early part of the twentieth century. Although as seen in **Figure 17-5**, groundwater levels since 1995 have been rising in the Lakeview subbasin, historically significant groundwater level declines and water quality degradation have occurred. In the early 1960s, basin flow patterns changed as a result of excessive pumping in the Lakeview subbasin and groundwater flowed from the Perris South subbasin to the Lakeview subbasin. This change resulted in the intrusion of poor quality groundwater (high TDS) from the Perris South subbasin into areas previously containing good quality water. The poor quality water plume now extends more than two miles into the Lakeview subbasin. This reversal in the hydraulic gradient and the intrusion of poorer quality water into the Lakeview subbasin has resulted in the loss of use of production wells, depletion of groundwater reserves, and higher pumping costs. As discussed above, one of the purposes of the Perris Desalter Program is to reverse the migration trend of the poorer quality groundwater into the Lakeview subbasin. (Eastern MWD, 2006a)

Table 17-4
Summary of Constituents of Concern in the West San Jacinto Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	**Lakeview** 360 to 4,360 **Perris North** 220 to 1,310 **Perris South** 580 to 10,100 **San Jacinto L. Pressure**: 260 to 1,870 **Menifee** 910 to 3,680	Values reported are summarized from the 2005 Water Quality Monitoring Program for 102 wells
Nitrate (as N) Primary MCL = 10	mg/L	**Lakeview** ND to 21 **Perris North** ND to 23 **Perris South** ND to 18 **San Jacinto L. Pressure** ND to 8 **Menifee** ND to 10	Values reported are summarized from the 2005 Water Quality Monitoring Program for 102 wells
VOCs **(TCE and PCE)** Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	PCE: 1.5 to 7.9 TCE: 1.5 to 1.7	PCE detected in Eastern MWD's Moreno Valley Wells 44 and 49; TCE detected in Eastern MWD's Perris Valley Well 56. VOC plumes occur at March Air Reserve Base
Perchlorate Notification level = 6	µg/L	5 to 11	Detected in Eastern MWD's Moreno Valley Wells 44 and 49
Iron and manganese Secondary MCL Iron = 300 Manganese = 50	µg/L	**Iron** ND to 260 (240 for desalter wells) **Manganese** ND to 92 (310 for desalter wells)	Iron and manganese are reported for East Valley Wells and for Desalter Wells 75 and 76

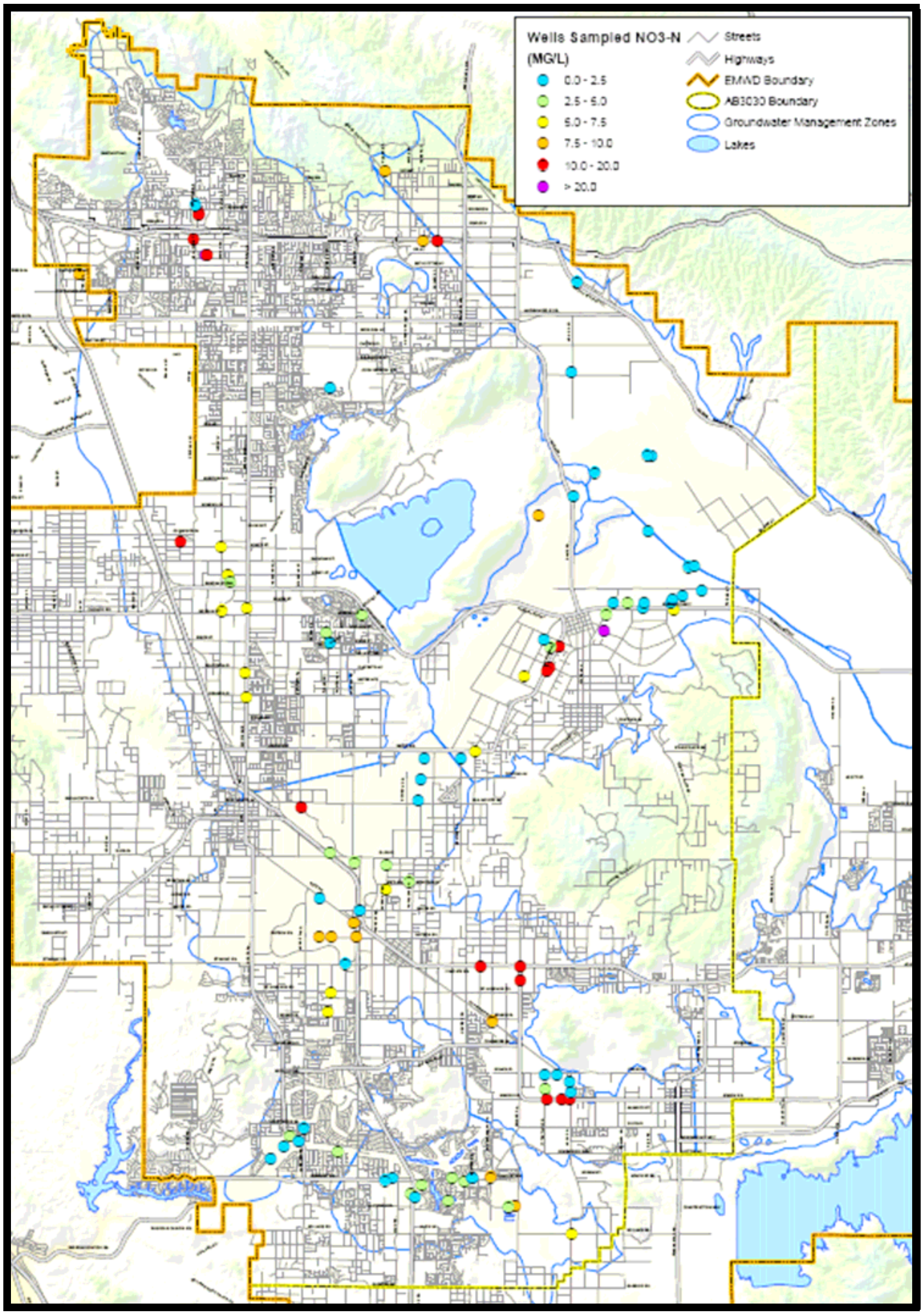
Source: Eastern MWD, 2004, 2005, 2006b

Figure 17-6
Summary of TDS Concentrations (2005)



Eastern MWD, 2006a

Figure 17-7
Summary of Nitrate Concentrations (2005)



Eastern MWD, 2006a

Since the opening of March Air Force Base in 1918, in the Perris North subbasin, various aircraft operations used cleaning solvents, petroleum products, and other hazardous substances. For more than eight decades, these contaminants were spilled, disposed of onto the ground, or stored in underground tanks that subsequently leaked. As a result, soil and groundwater have been contaminated by a variety of chemicals. The cleanup activity or remedial action is in accordance with an agreement signed by the Air Force and the three regulatory agencies overseeing environmental cleanup at March (U.S. Environmental Protection Agency, California E.P.A. Department of Toxic Substances Control, and California Regional Water Quality Control Board). As part of the cleanup effort, March Air Reserve Base operates monitoring, extraction, and injection wells. (Eastern MWD, 2006a)

Historical agricultural use and naturally occurring conditions in the Menifee and Perris South subbasins have contributed to high TDS groundwater in these areas.

Groundwater production has decreased in some areas due to conversion of agricultural lands to residential uses and high TDS in groundwater. The reduced production has resulted in rising groundwater levels. Rising groundwater can leach salts from the soil into the groundwater, and create areas of higher TDS levels or brackish groundwater. (Eastern MWD, 2006a)

Blending Needs

Groundwater production from a few wells is blended with imported water to meet drinking water quality regulations. Blending provided by Eastern MWD (2006a) is summarized in **Table 17-5**.

Groundwater Treatment

As discussed above, the Menifee and Perris Desalters treat up to 3,400 AFY of groundwater from the Menifee and Perris South subbasins and March Air Reserve Base operates treatment systems for the cleanup of VOCs, petroleum hydrocarbons and other hazardous substances. Approximately 1,441 AF was treated by the Menifee Desalter in 2004. The Perris I and Perris II desalters were not yet online during the period of record for this report.

Table 17-6 summarizes the cost to treat the high TDS water recovered from the 8 currently operating wells (Eastern MWD, 2006a).

Table 17-5
Blending Needs in the West San Jacinto Basins

Constituent Blended	Average Annual Blended (AFY)
Nitrate	900
TDS	1,400

Table 17-6
Summary of Groundwater Treatment in the West San Jacinto Basins

Treatment Type	Number of Wells	Constituents(s) of Concern	Treatment Target	Treatment Cost ($/AF)	Amount Treated (AFY)
Reverse Osmosis	8	TDS	500 mg/L	$503.50	3,400

CURRENT GROUNDWATER STORAGE PROGRAMS

No formal groundwater storage programs have been reported in the West San Jacinto Basins.

BASIN MANAGEMENT CONSIDERATIONS

Considerations for the West San Jacinto Basins include:

- There are no legal constraints, limitations, or ongoing/potential legal disputes within the West San Jacinto Management Area.
- The primary constraint on groundwater extraction is poor water quality, which limits use of groundwater as a potable water resource. Another related limiting factor involves controlling the migration of poor quality water into areas of pumped good quality groundwater.

References:

California Department of Water Resources (DWR), 2006. California's Groundwater Bulletin 118 – San Jacinto Groundwater Basin. Updated 1/20/06. Website: http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/8-5.pdf Accessed 7/10/07.

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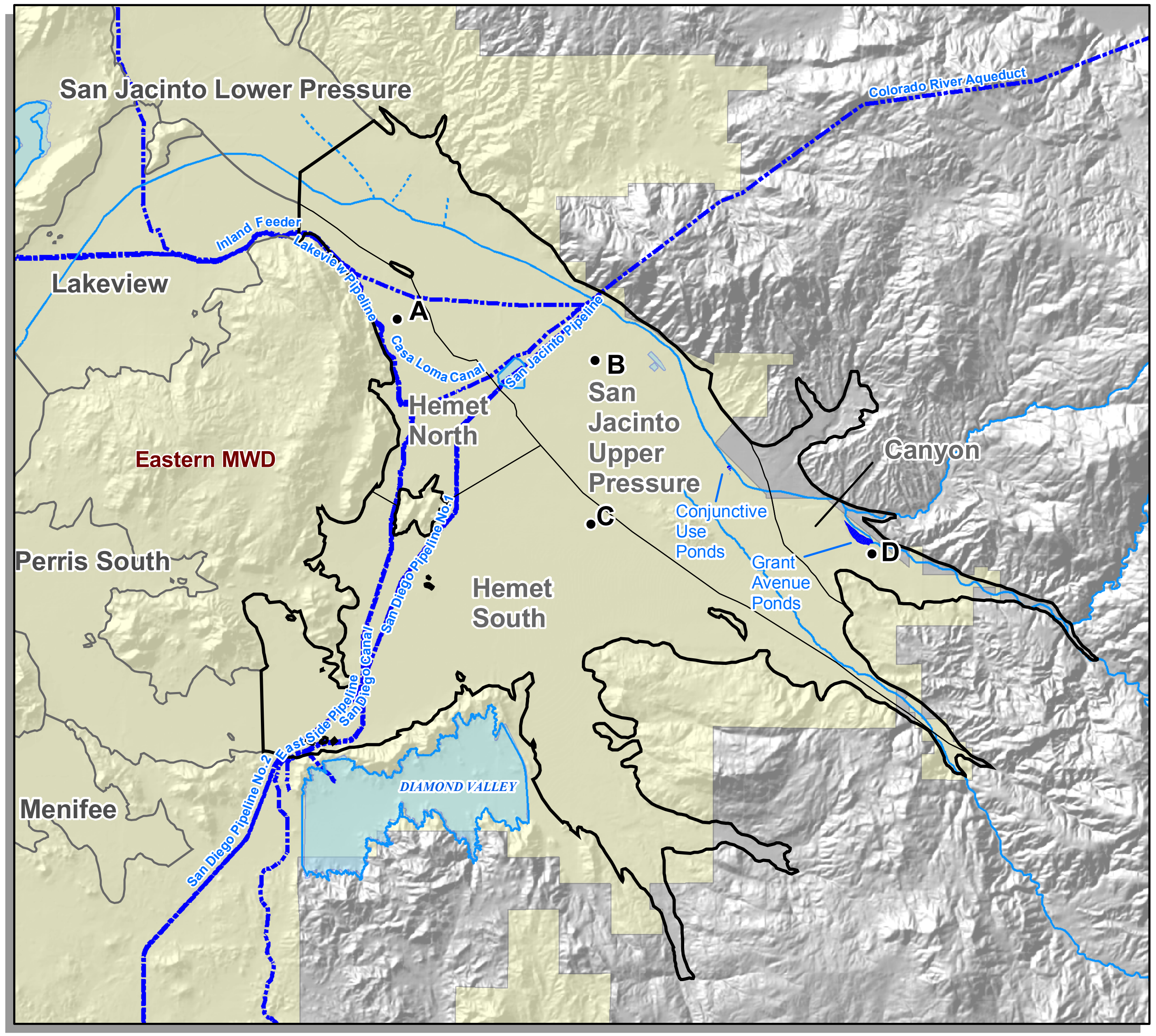

Hemet/San Jacinto Basins

A • Key Well	MWD Pipeline
Recharge Basins	Adjacent Basin
Freeways (TBM)	Basin
River	MWD Member Agency Boundary (color varies)
Water Body	
Santa Ana Regional Interceptor Line	

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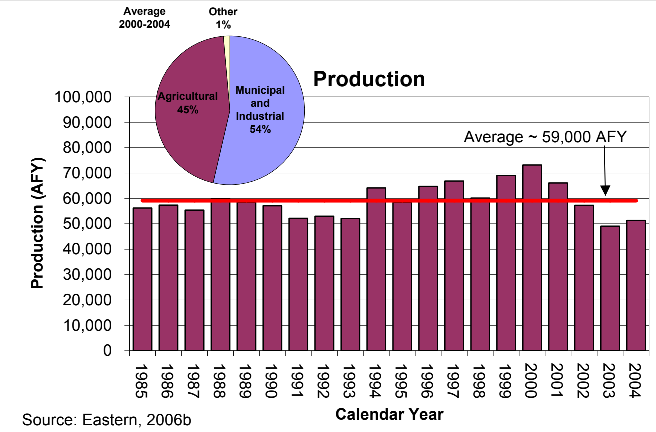
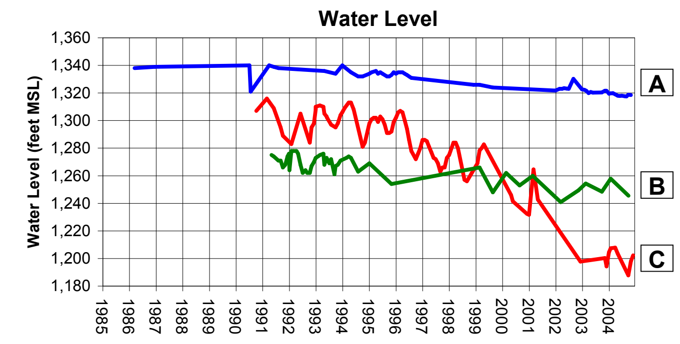
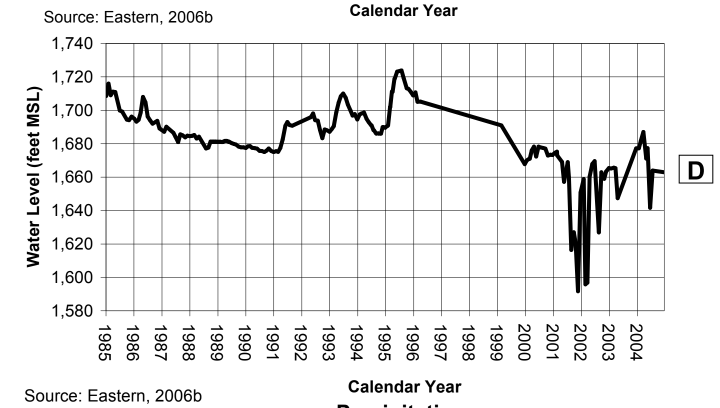


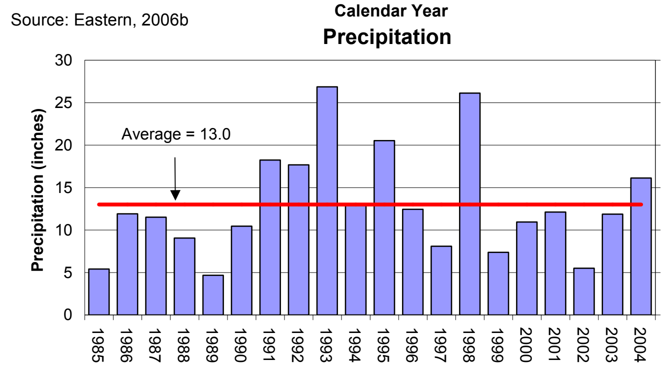
Source: Eastern, 2006b



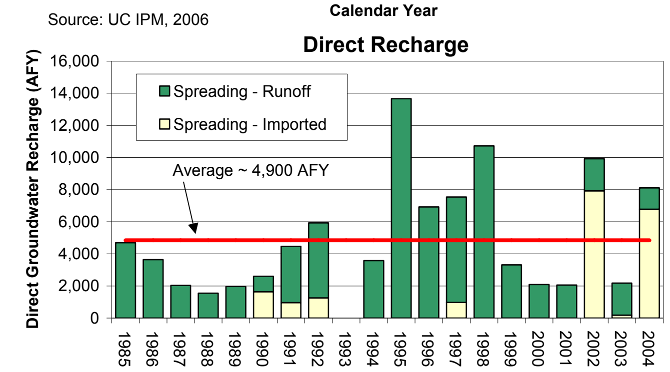
Source: Eastern, 2006b



Source: Eastern, 2006b



Source: UC IPM, 2006



Source: Eastern MWD, 2006b

BASIN FACTS

Hemet-San Jacinto Basins

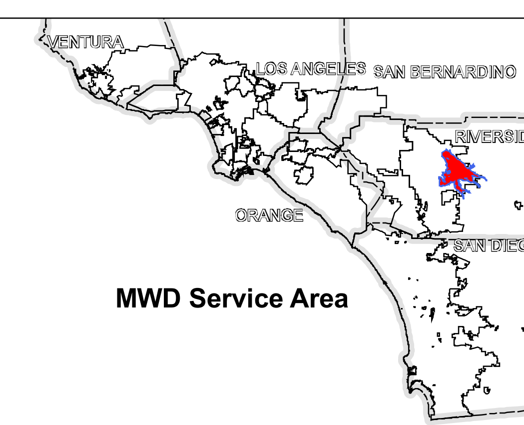
Description
Location: Riverside County
Watershed Surface Area: 88 square miles
Subbasins:
San Jacinto Upper Pressure
Canyon
Hemet North
Hemet South
Management: Adjudicated. Amended adjudication in process Canyon subbasin adjudicated by 1954 Fruitvale Judgment. Basin is currently managed by Eastern MWD. Formal Groundwater Management Plan in process.
MWD Member Agencies:
Eastern MWD

	Hemet-San Jacinto
Natural Safe Yield	Unknown
Operational Safe Yield	40,000 to 50,000 AFY
Total Storage	~1.3 million AF
Unused Storage Space	950,000 AF
Portion of Unused Storage Space Available for Storage	400,000 AF

Storage and Extraction Facilities

	Hemet-San Jacinto
Production Wells	
Production Capacity	121,500 AFY
Average 1985-2004	59,000 AFY
Injection Wells	
Injection Capacity	None
Average 1985-2004	None
Spreading Basins	
Spreading Capacity	~19,400 AFY
Average 1985-2004	4,900 AFY

Basin Management Considerations
- Tribal Settlement with Soboba Tribe limits extractions
- Declining water levels and overdraft could limit future extraction potential
- Water quality, particularly TDS and nitrate, could limit future storage and extraction potential



MWD Service Area

Plate 18-1
Overview of Hemet-San Jacinto Basins

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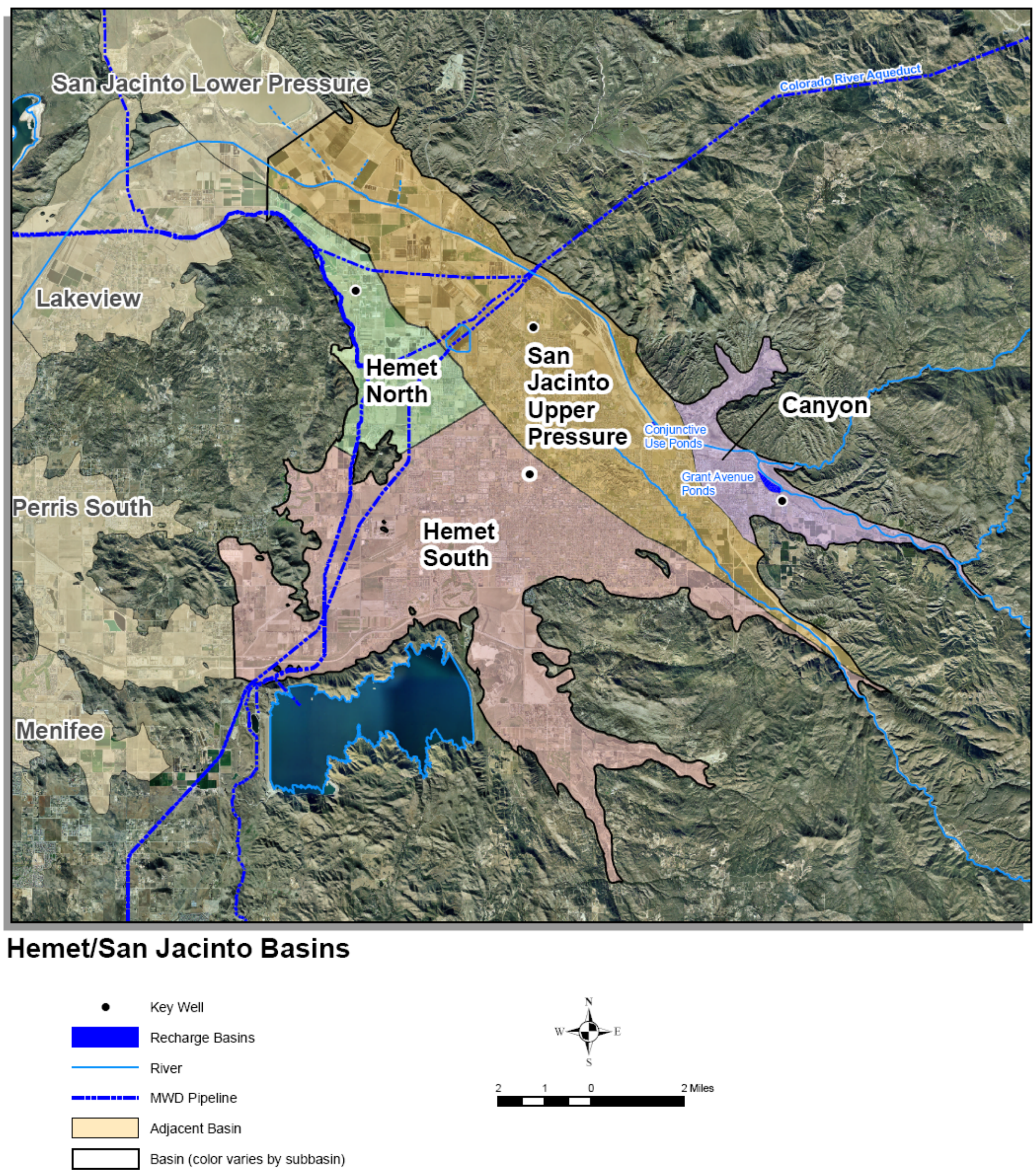
The Hemet-San Jacinto Basins are located within the San Jacinto River Watershed in Western Riverside County. The Hemet-San Jacinto Basins consist of the Hemet South, Hemet North, Canyon, and San Jacinto Upper Pressure subbasins or management zones. These subbasins underlie Eastern Municipal Water District's (Eastern MWD) service area and are utilized for groundwater supply for the cities of San Jacinto and Hemet, as well as unincorporated areas of Riverside County. The location and key facilities of the Hemet-San Jacinto Basins are shown in **Figure 18-1**.

Figure 18-1
Map of the Hemet-San Jacinto Basins



BASIN CHARACTERIZATION

The following section provides a physical description of the Hemet-San Jacinto Basins including geographic setting and hydrogeologic characteristics. A summary of the hydrogeologic properties of the Hemet-San Jacinto Basins is provided in **Table 18-1**.

Basin Producing Zones and Storage Capacity

The Hemet-San Jacinto Basins comprise alluvial-filled valleys that are surrounded and underlain, for the most part, by impermeable granitic and metamorphic bedrock or are contained by barrier fault zones. In some locations, groundwater flow between these basins is also constrained by groundwater divides and internal flow systems.

The depth of the groundwater basins ranges from 40 feet to 8,000 feet below the ground surface (Eastern MWD, 2006b). The deepest subbasin is the San Jacinto Upper Pressure, which was formed by tectonic offsets along the active San Jacinto fault (Claremont branch) and the Casa Loma fault causing a down-dropped graben between the two faults. The total depth of fresh water within the San Jacinto Upper Pressure subbasin has not been precisely determined (WRIME, 2003).

In the southeastern portion of the San Jacinto Upper Pressure subbasin and in the Canyon subbasin, sands and gravels dominate; which allows for rapid recharge and generally unconfined groundwater conditions. To the northwest, the basin becomes finer-grained and the unnamed deeper aquifers are confined (WRIME, 2003).

The specific yields and water levels within the basins are used to estimate the Hemet-San Jacinto Basins' storage capacity. Total storage in the basin is estimated to be approximately 1.3 million AF. While the basins are estimated to have an additional combined storage capacity available of about 950,000 AF, only about 400,000 AF are estimated as useable (Eastern MWD, 2006b).

Safe Yield/Long-Term Balance of Recharge and Discharge

The primary sources of natural groundwater recharge are from precipitation infiltration and percolation of flows on the San Jacinto River and its tributaries as they cross the area during periods of heavy rainfall. Because heavy rainfalls are infrequent, natural recharge is limited (Eastern MWD, 2000). **Figure 18-2** provides historical precipitation data from the Hemet Station for the Hemet-San Jacinto Basins (UC IPM, 2006). The 20-year average precipitation for this area between 1985 and 2004 was approximately 13 inches.

The operational yield, which is the long-term withdrawal from the groundwater system not exceeding natural and artificial recharge, has been estimated to be between 40,000 AFY and 50,000 AFY for a recent normal year range (EVMWD, 2006e). Currently, the average operational yield is estimated at 45,000 AFY, which includes in the estimate up to 8,000 AFY of imported recharge water (Eastern MWD, 2005b; Eastern MWD, 2006b).

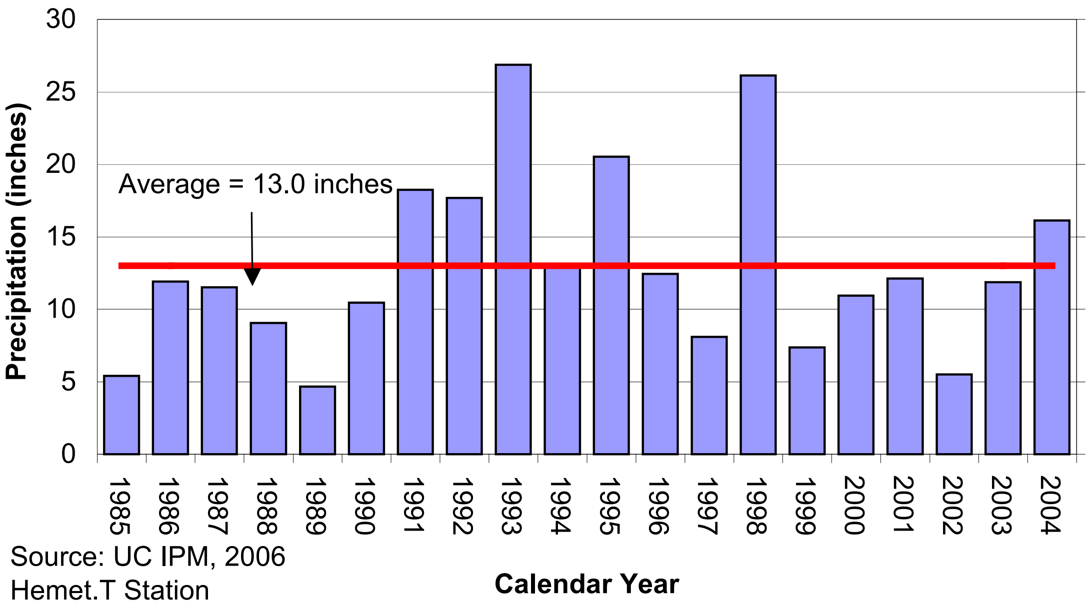
Table 18-1
Summary of Hydrogeologic Parameters of the Hemet-San Jacinto Basins

Parameter	Description
Structure	
Aquifer(s)	Forebay areas (unconfined) • Canyon • Southeast portion Upper Pressure • South Hemet Pressure areas (semi-confined to confined) • Northwest portion Upper Pressure • North Hemet
Depth of groundwater basin	40 to 8,000 feet
Depth of producing zones or screen intervals	Canyon: 150 to 1,000 feet Upper Pressure: 400 to 1,000 feet Hemet North and South: 150 to 400 feet
Yield and Storage	
Natural Safe Yield	Unknown
Operational Safe Yield	40,000 to 50,000 AFY Average: 45,000 AFY
Total Storage	~1.3 million AF
Unused Storage Space	950,000 AF
Portion of Unused Storage Space Available for Storage	400,000 AF

Source: WRIME, 2003; Eastern MWD, 2006a; Eastern MWD, 2006b; Eastern MWD, 2006e; DWR, 2006

Groundwater production in the Hemet-San Jacinto Basins has exceeded the operational yield for several years, and the basins are currently in a state of overdraft. Estimated overdraft is approximately 600 AFY in the Canyon subbasin, 10,000 AFY in the Upper Pressure subbasin and 3,000 AFY in the Hemet South subbasin. Production in the Hemet North subbasin has generally been in balance with this subbasin's long-term operational safe yield. On average, groundwater storage in all the Hemet-San Jacinto Basins has been reduced about 14,000 AFY due to overdraft for the period from 1958 to 2001 (WRIME, 2003). Current estimates of overdraft are approximately 10,000 AFY (Eastern MWD, 2005a; Eastern MWD, 2006e). Projections of water supply show the need for an additional 15,000 AFY to accommodate future growth (Eastern MWD, 2006b). Confined aquifers in the Hemet-San Jacinto Basins, particularly in the northern portion of the San Jacinto Upper Pressure subbasin are susceptible to subsidence.

Figure 18-2
Historical Precipitation in the Hemet-San Jacinto Basin



GROUNDWATER MANAGEMENT

The following section describes how the Hemet-San Jacinto Basins are managed. The summary includes a discussion of the governing structure and legal agreements with adjoining basins.

Basin Governance

The Hemet-San Jacinto Basins are currently managed by Eastern MWD and the Canyon subbasin is adjudicated. In addition, as discussed below, an adjudication for all basins is currently in process. The governing agencies in the Hemet-San Jacinto Basins are listed in **Table 18-2**.

Eastern MWD's groundwater production in the Canyon and San Jacinto Upper Pressure subbasins has been historically limited by the 1954 Fruitvale Judgment and Decree (Judgment). The Judgment limits Eastern MWD's groundwater extraction from the Canyon subbasin to 4,500 AFY when the depth to water in a specified Fruitvale well is greater than 25 feet and restricts exporting pumped water outside the Upper and Canyon subbasins to 12,000 AFY. Other groundwater producers in the two subbasins are not restricted.

To further protect the groundwater resources within the Hemet-San Jacinto Basins, Eastern MWD, in cooperation with Lake Hemet Municipal Water District, the cities of Hemet and

San Jacinto and private groundwater producers, agreed upon the Principles of Groundwater Management in 2004 following mutual agreement on Interim Principles in 2003 (Eastern 2005b). This plan is currently in the process of being incorporated as part of the Stipulated Judgment by the courts and will supersede the Fruitvale Judgment and Decree. Key elements of the plan call for (1) reducing public agency groundwater production, (2) implementing the San Jacinto River Recharge and Recovery Project, (3) groundwater replenishment, (4) in-lieu water use, (5) additional water conservation measures, and 6) water monitoring. Prior to implementing these elements, though, a supplemental environmental impact report (EIR) must be completed and approved. The process for this EIR is currently being pursued by Eastern MWD (Eastern MWD, 2006c).

Table 18-2
Summary of Management Agencies in the Hemet-San Jacinto Basins

<table>
<tr><th>Agency</th><th>Role</th></tr>
<tr><td>Eastern MWD</td><td>Member of Watermaster Board.
Retail and wholesale water sales.
Groundwater producer.
Operation of wastewater treatment, recycled water and spreading facilities.
Financial participant in purchase of replenishment water.</td></tr>
<tr><td>Lake Hemet Municipal Water District (Lake Hemet MWD)</td><td rowspan="3">Members of Watermaster Board.
Retail water sales.
Groundwater producers.
Financial participants in purchase of replenishment water.</td></tr>
<tr><td>City of Hemet</td></tr>
<tr><td>City of San Jacinto</td></tr>
</table>

The final Hemet-San Jacinto Water Management Plan will resolve a number of issues that have involved groundwater within the Hemet-San Jacinto Basins including settlement of the suit by the Soboba Band of Luiseno Indians regarding groundwater flow into Metropolitan's San Jacinto Tunnel along the Colorado River Aqueduct. The plan also addresses the pumping overdraft and declining water levels, ensures water supply reliability, provides for urban growth, protects and enhances water quality, provides for water supply and water quality monitoring, and would develop a cost-effective water supply.

Under the Hemet-San Jacinto Water Management Plan, groundwater resources would be managed by a five-member Watermaster Board with a representative from each of the four agencies listed above and a representative from the private groundwater producers.

Under this new management structure, each public agency would be required to achieve a 10 percent reduction from each of their base production rights in the first year after entry into the Stipulated Judgment, and periodic adjustments as necessary to achieve the operational safe yield (Eastern MWD, 2006b).

Interactions with Adjoining Basins

Flows from the Upper Pressure subbasin into the Lakeview subbasin, between Hemet and Lakeview subbasins, and the Hemet and the Perris South areas are dependant on groundwater gradients and points of connection are restricted both laterally and vertically. Therefore, large exchanges of groundwater flow between subbasins are not likely. Formal agreements have not been established regarding such underflow between these subbasins (WRIME, 2003, Eastern MWD, 2006b).

WATER SUPPLY FACILITIES AND OPERATIONS

The following section describes the water supply facilities within the Hemet-San Jacinto Basins. Facilities include approximately 147 production wells and over 50 acres of spreading basins.

Active Production Wells

Eastern MWD's extraction monitoring program began in 2004 consisting of metering or estimating production from wells included in the program. As shown in **Table 18-3**, extraction from the Hemet-San Jacinto Basins occurs from a total of 49 municipal wells and 98 or more private wells (182 total wells were monitored for the program in 2004 and 174 wells in 2005; Eastern MWD, 2006a). Over the 20-year period from 1985 to 2004, average production has been about 59,000 AFY with approximately 54 percent of this production for municipal purposes. For the fiscal year 2003/04 period, approximately 64 percent of the production was from municipal wells, while the remaining 36 percent of production was for agricultural and other water uses indicating the increase in demand for municipal production as urban areas in the region continue to grow. Nearly 100 percent of the private wells are for agriculture. The few private domestic wells serve the Soboba Tribe. **Table 18-3** provides a breakdown of water supply by category.

Table 18-3 also provides a summary of the costs for production wells belonging to Eastern MWD, not including other agencies cost (such as Lake Hemet MWD or the Cities of Hemet and San Jacinto). Total production costs are approximately $100 per AF. **Figure 18-3** shows historical production in the Hemet-San Jacinto Basin.

Other Production

As summarized above, groundwater production in the Hemet-San Jacinto Basins is from private agriculture and municipal wells with only a few private domestic wells that serve the Soboba Tribe (Eastern MWD, 2006a).

ASR Wells

There are no ASR wells in the Hemet-San Jacinto Basins.

Table 18-3
Summary of Production Wells in the Hemet-San Jacinto Basin

Category	Number of Wells	Estimated Production Capacity (AFY) [1]	Average Production 1985-2004 (AFY)	Well Operation Cost ($/AF)
Municipal and Industrial	49	58,000	31,751	$99.58 includes power, disinfection and O&M
Agricultural	98+	61,000	26,493	Data not available
Other		2,500	866	
Total	**147+**	**121,500**	**59,110**	**--**

Source: Eastern MWD, 2006
1. Production capacity based upon maximum monthly production for past 5 years

Spreading Basins

Spreading basins are located in two areas of the Hemet-San Jacinto Basins: (1) three acres of Conjunctive Use Ponds in the San Jacinto Upper Pressure subbasin that receives imported State water, and (2) approximately 50 acres of Ponds along Grant Avenue in the Canyon subbasin that receives both imported State water and diverted San Jacinto River runoff. **Table 18-4** summarizes basin sizes, estimated capacities, source of the water used for recharge and the basin owner. These basins are shown on **Figure 18-1**.

Recharge of runoff water is not measured other than San Jacinto River Diversions (shown below in **Figure 18-4**), which are recharged in ponds in the Canyon subbasin. Eastern MWD is restricted by permit to diverting no more than 5,760 AFY from the San Jacinto River while Lake Hemet MWD's diversions from the river are unlimited. Lake Hemet MWD typically spreads a portion of their river diversions for groundwater recharge. It should be noted that recharge only occurs in years when there is sufficient flow in the San Jacinto River, which does not flow every year (Eastern MWD, 2006b). **Figure 18-4** shows the volume of water recharged in the Hemet-San Jacinto Basins as a result of spreading imported and diverted river runoff water sources. An average of about 4,900 AFY has been recharged in these spreading basins. Recycled water storage ponds also contribute incidental recharge to the basins although the amount is not estimated.

Figure 18-3
Historical Groundwater Production in the Hemet-San Jacinto Basin

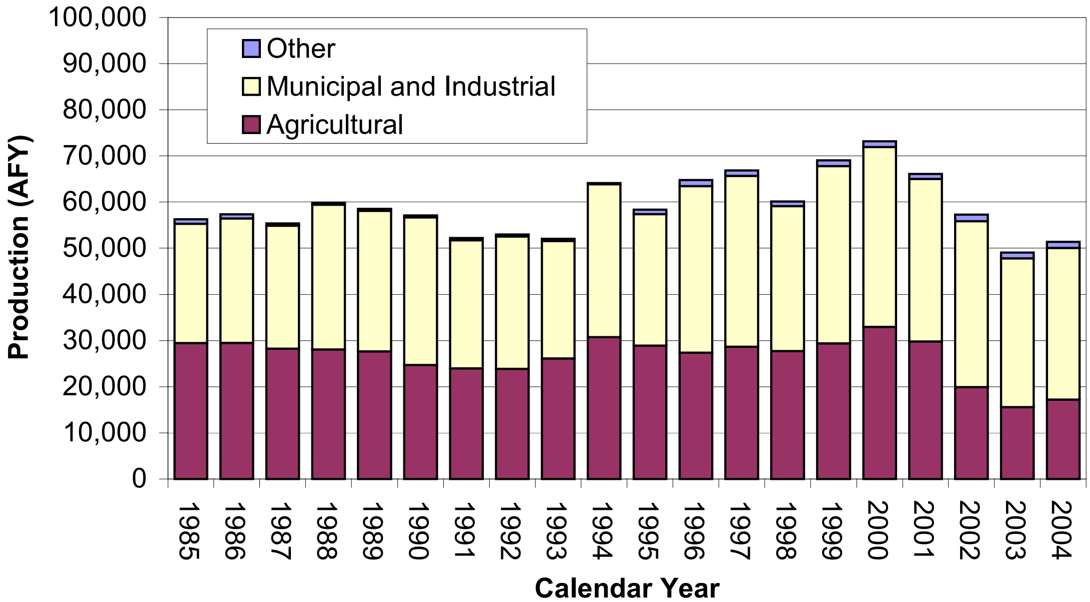


Table 18-4
Summary of Spreading Basins in the Hemet-San Jacinto Basins

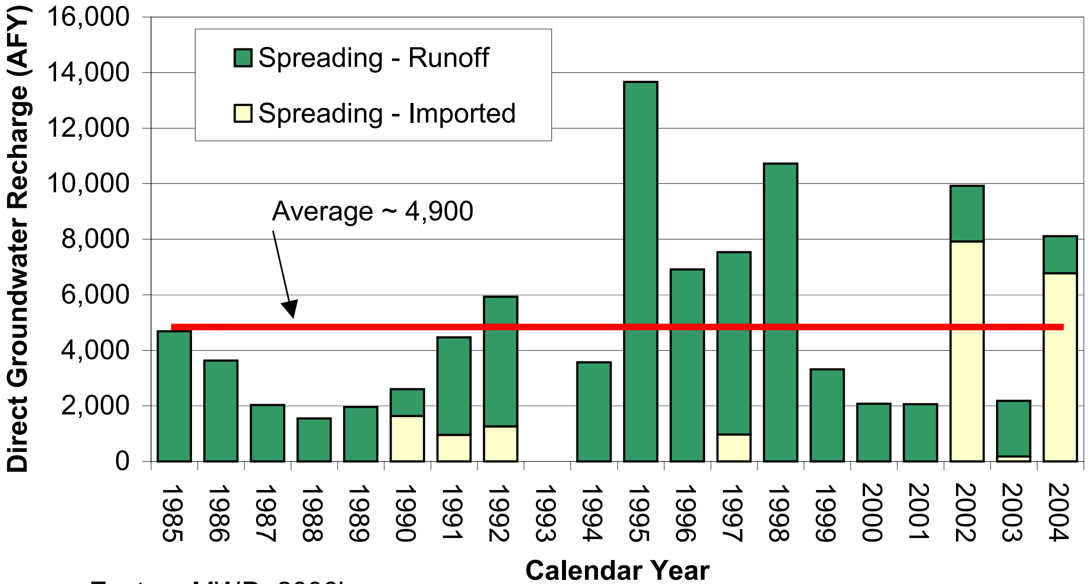
Basin	Area (acres)	Recharge Capacity (cfs)	Recharge Capacity (AFY)	Source Water	Owner
Conjunctive Use Ponds San Jacinto Upper Pressure Basin	3	10.2 [1]	7,380	Imported	Eastern MWD
Grant Avenue Ponds Canyon Basin	28	8.6 [1]	6,240	Imported and/or Runoff	Eastern MWD
Grant Avenue Ponds Canyon Basin	22	Data not available	5,760 [2]	Runoff	Eastern MWD
Total	53	--	19,380	--	--

Source: Eastern MWD, 2006b

1. Figures are based on January 2006 actual recharge. More water could be recharged, but pipe capacity limits current recharge ability.

2. Eastern's permit for diversion of streamflow is limited to 5,760 AF per year. Diversions can only occur when the river is flowing and, consequently, no diversion or less than maximum diversion frequently occurs. Lake Hemet MWD also diverts streamflow from the San Jacinto River for recharge and other beneficial uses.

Figure 18-4
Historical Groundwater Recharge in the Hemet-San Jacinto Basins



Source: Eastern MWD, 2006b

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the Hemet-San Jacinto Basins.

Desalters

There are no desalters in the Hemet-San Jacinto Basins.

GROUNDWATER LEVELS

As part of Eastern MWD's groundwater monitoring program, static water levels are measured twice a year, once in the spring following the winter rains and in the fall during the dry season. In 2005, water levels in 183 wells were measured in the spring and in 179 wells in the fall. A groundwater contour map for this time period is provided in **Figure 18-5**. Within the Hemet-San Jacinto Basins, groundwater flow is generally from the southeast to the northwest (WRIME, 2003). The depth to groundwater in the basins ranges between 21 to 634 feet. In some areas in the Canyon subbasin, cienegas are present as a result of the barrier created by faulting.

Figure 18-6 shows historical groundwater levels for several wells within the Hemet-San Jacinto Basins. The hydrographs show groundwater levels have been steadily declining in the Hemet-San Jacinto Basins. For example, water levels have declined as much as 100 feet in the Upper Pressure area since 1990. Water level declines in the Hemet North area are less dramatic with declines of only about 20 feet over the past 20 years. As discussed above, subsidence is an issue in the areas where groundwater is confined and declines continue.

Figure 18-5
Groundwater Contour Map for the Hemet-San Jacinto Basins– Spring 2005

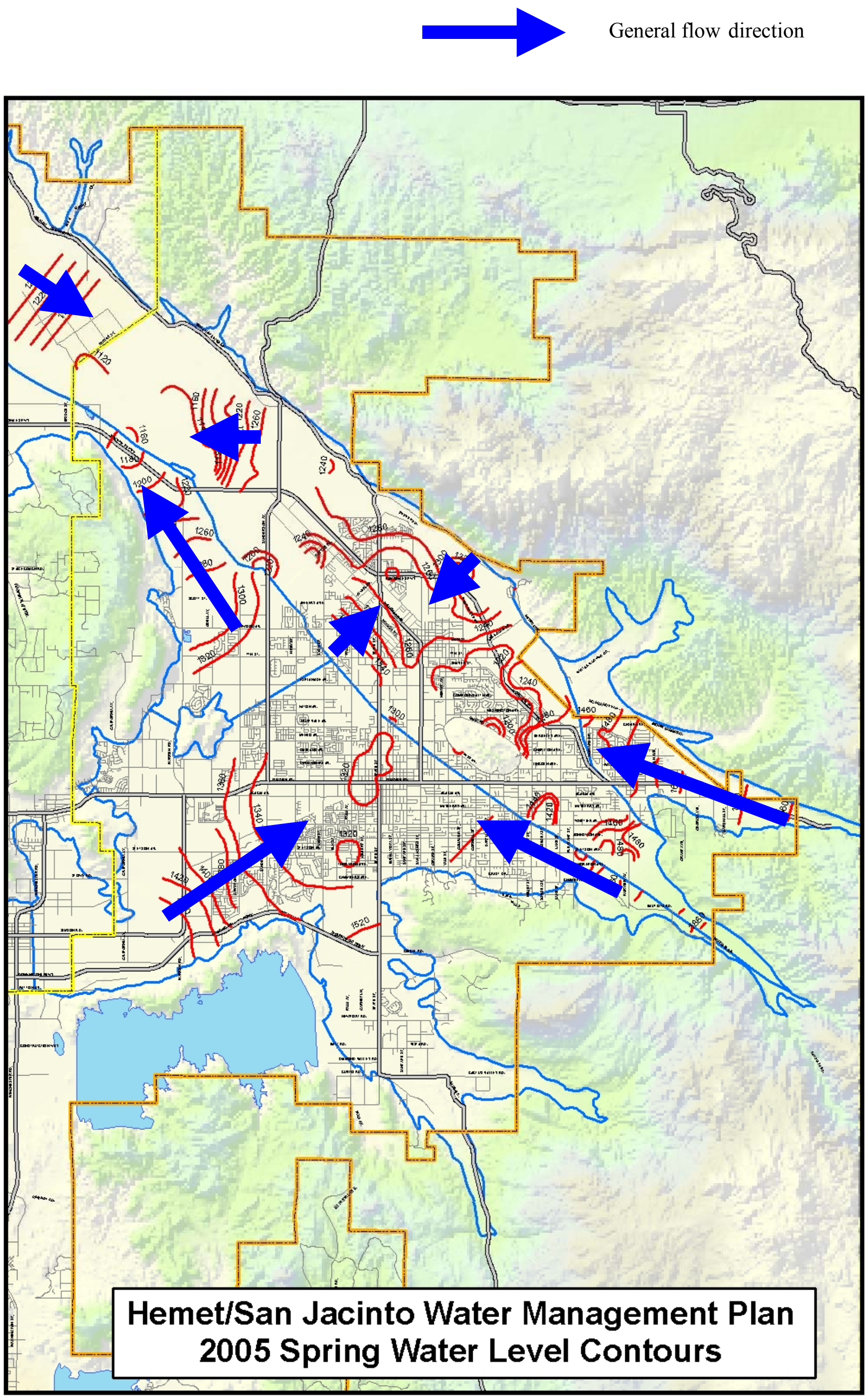
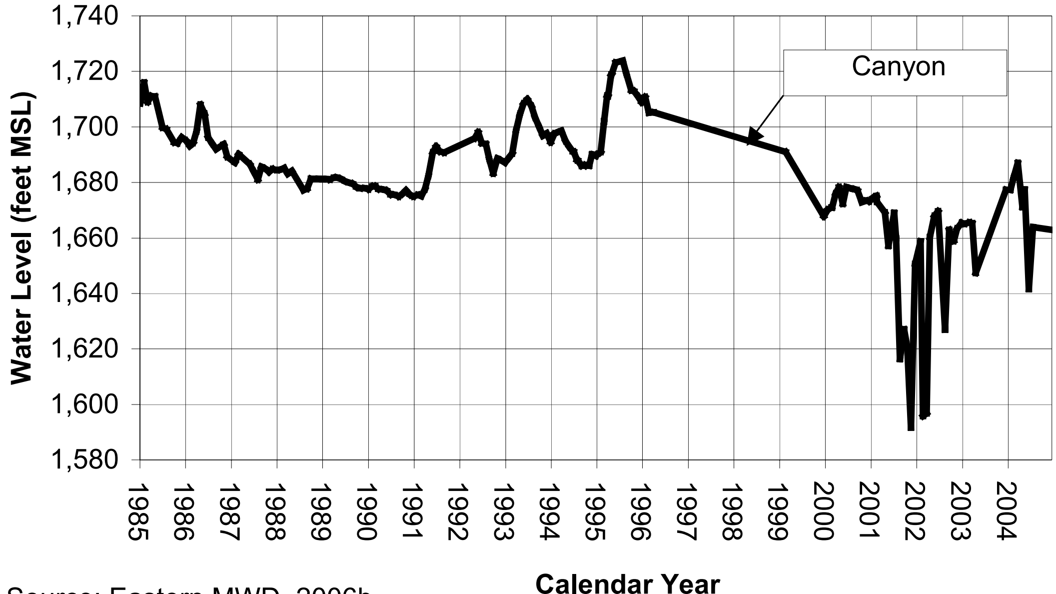
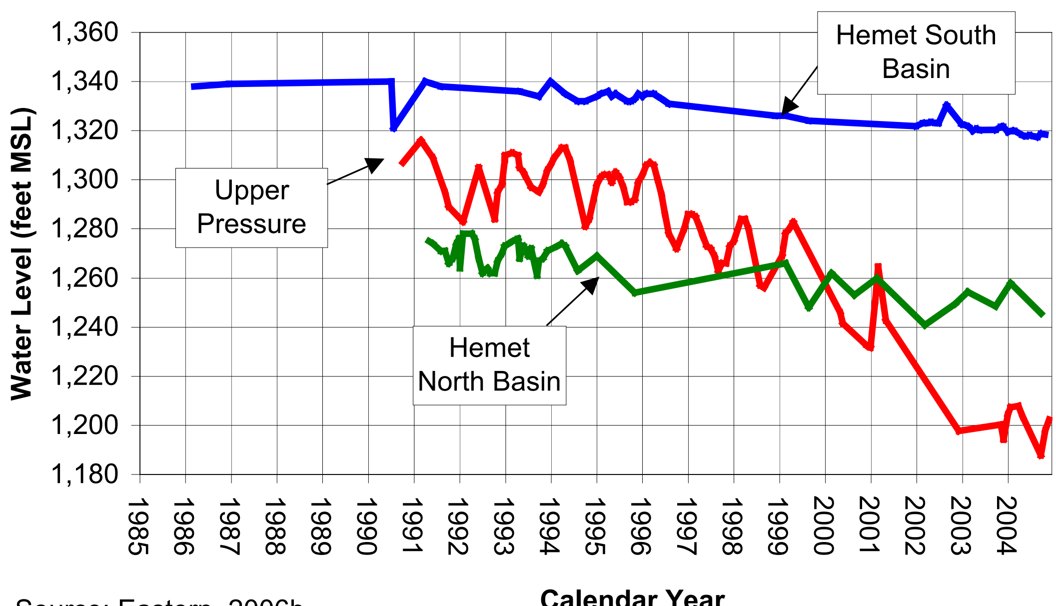


Figure 18-6
Historical Water Levels in the Hemet-San Jacinto Basins



Source: Eastern MWD, 2006b



Source: Eastern, 2006b

GROUNDWATER QUALITY

The following provides a brief description of the groundwater quality issues in the Hemet-San Jacinto Basins.

Groundwater Quality Monitoring

The Hemet-San Jacinto Groundwater Monitoring Program, a cooperative effort funded by Eastern MWD, Lake Hemet MWD, and the cities of Hemet and San Jacinto, was initiated in 2004 to collect, compile, and analyze water level data, water quality data, and extraction data. The program also documents other pertinent information regarding activities in the Hemet-San Jacinto Water Management Plan area such as issued well permits, capping and sealing of inactive wells, rainfall, surface water flows, conjunctive use/groundwater recharge, recycled water, and groundwater storage (Eastern MWD, 2006a).

The collected data are compiled and entered monthly into Eastern MWD's Regional Water Resources Database. Along with Eastern MWD, Lake Hemet MWD and the cities provide data on their wells, provide pro rata shares of the cost, and assist in communicating with the private well owners in their respective jurisdictions (Eastern MWD, 2006a).

Eastern MWD, Lake Hemet MWD and the cities of Hemet and San Jacinto collected 115 groundwater quality samples in 2005 for the annual water quality monitoring. Samples were collected from available private agricultural and domestic supply wells and municipal supply wells. Constituents tested included general minerals, metals, alkalinity, nitrogen compounds and miscellaneous water quality parameters such as pH, temperature, total dissolved solids (TDS) and total organic carbon (Eastern MWD, 2006a).

Groundwater Contaminants

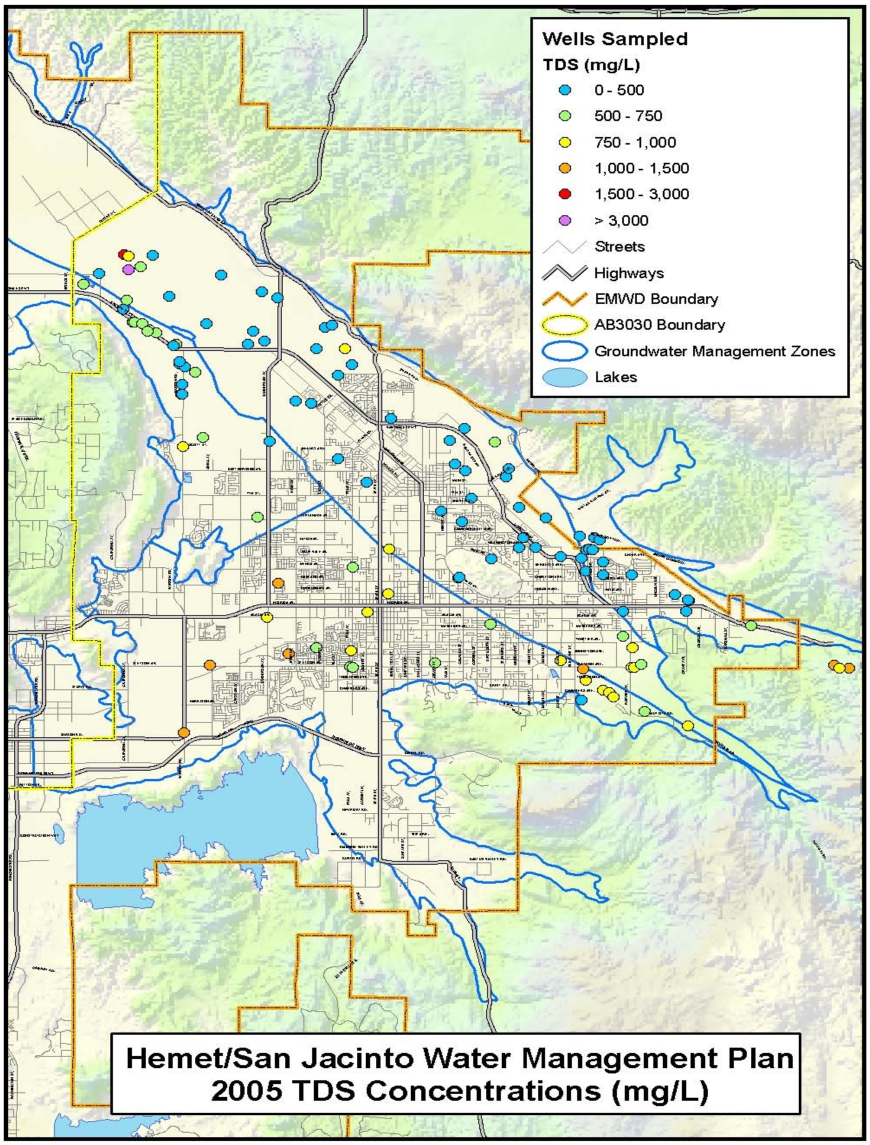
Constituents of concern for the Hemet-San Jacinto Basins include: TDS, nitrate, hydrogen sulfide, iron and manganese. A description of the range and extent for each constituent as well as constituents of regional concern (volatile organic compounds and perchlorate) are summarized in **Table 18-5**.

Results of the monitoring identified the best quality water in the canyons and along the San Jacinto River within the Canyon subbasin as indicated by the TDS concentrations for wells shown on **Figure 18-7**. Significant municipal production occurs in this area of the Canyon subbasin (Eastern MWD, 2006a).

As shown in **Figure 18-8**, nitrate concentrations in the basin show a similar trend to TDS with the best quality water occurring along the San Jacinto River of the Canyon subbasin. Nitrate concentrations in samples that exceed the MCL of 10 mg/L for nitrate as nitrogen are mostly from wells located in the southern and western portions of the Hemet-San Jacinto Basins. The range in TDS and nitrate concentrations reported from the annual water quality-monitoring program for 2005 for each subbasin are shown in **Table 18-5** (Eastern MWD, 2006a).

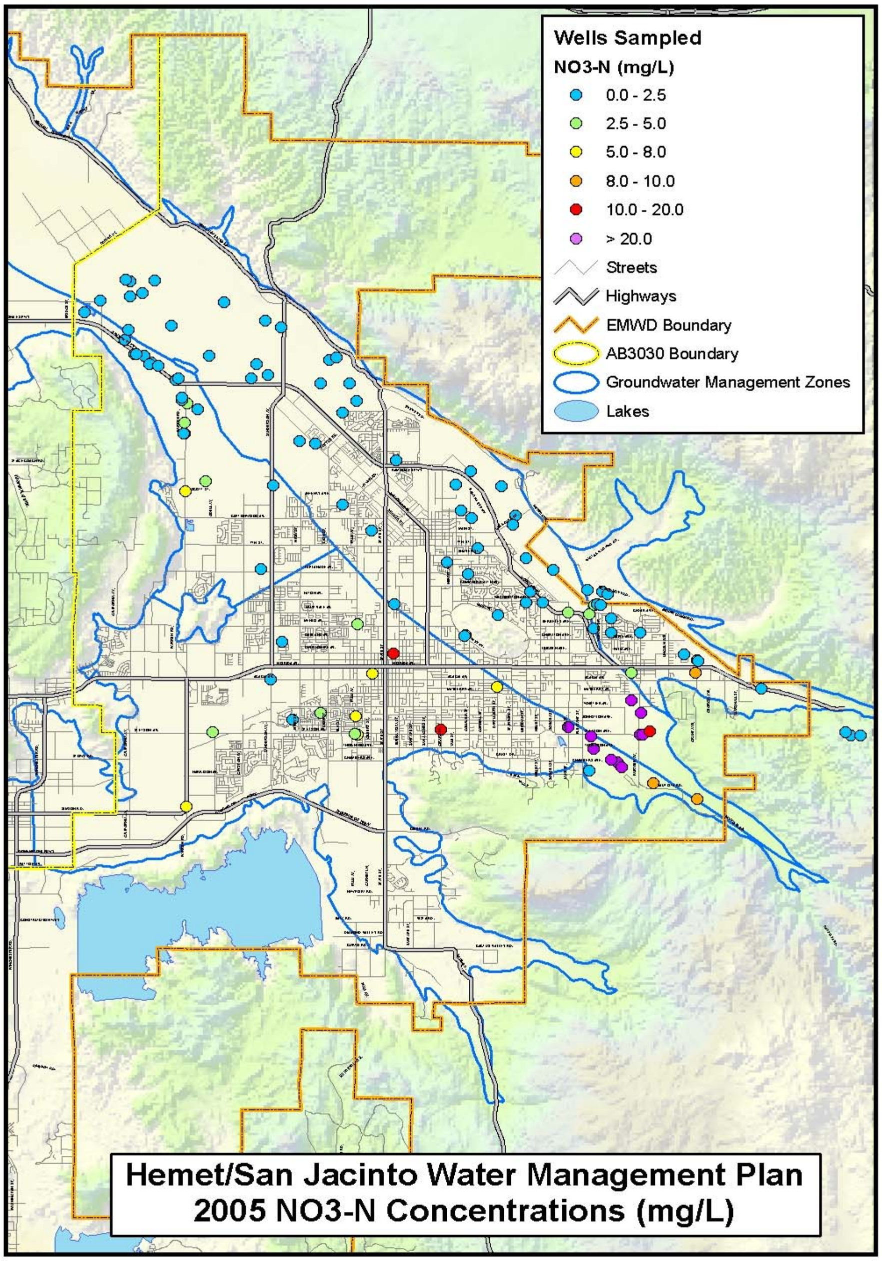
Iron and manganese data, also summarized in **Table 18-5**, were provided by Eastern (2006b) for the Upper Pressure subbasin.

Figure 18-7
Summary of TDS Concentrations (2005)



Eastern MWD, 2006b

Figure 18-8
Summary of Nitrate Concentrations (2005)



Eastern MWD, 2006b

Table 18-5
Summary of Constituents of Concern in the Hemet-San Jacinto Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	Canyon: 190 to 1,330 Upper Pressure: 180 to 3,050 Hemet North.: 360 to 1,000 Hemet South: 230 to 1,340	Values reported are summarized from the 2005 Water Quality Monitoring Program for 115 wells
Nitrate (as N) MCL = 10	mg/L	Canyon: <0.1 to 10 Upper Pressure: <0.1 to 32 Hemet North.: <0.1 to 6.1 Hemet South: 0.6 to 31	Values reported are summarized from the 2005 Water Quality Monitoring Program for 115 wells
VOCs **(TCE and PCE)** TCE MCL = 5 PCE MCL = 5	µg/L	ND	TCE and PCE are not known to be detected in the Hemet-San Jacinto basins.
Perchlorate Notification level =6	µg/L	ND to 6	Two wells have known detections of perchlorate. Concentrations are at or below the notification level.
Hydrogen sulfide No MCL	µg/L	Data not available	1 well has been impacted by hydrogen sulfide
Iron and manganese Iron Secondary MCL = 300 Manganese Secondary MCL = 50	µg/L	Iron: <4 to 140,000 Manganese: <1.0 to 4,600	Iron and manganese are only reported for the Upper Pressure subbasin. Of the 50 reported results for 2005, 19 exceeded the iron secondary MCL of 300 ug/L and 30 exceeded the manganese secondary MCL of 50 ug/L

Source: Eastern MWD, 2006b, Regional Board, 2006

Two wells have known detections of perchlorate (Regional Board, 2006). Concentrations are at or below the notification level. The VOCs trichloroethylene (TCE) and tetrachloroethylene (PCE) are not known to be detected in the Hemet-San Jacinto basins.

Blending Needs

Data related to blending needs are not available at this time.

Groundwater Treatment

One well in the Hemet-San Jacinto Basins owned by Eastern MWD has hydrogen sulfide gas and high iron and manganese and is treated with wellhead treatment as summarized in **Table 18-6** (Eastern MWD, 2006b).

Table 18-6
Summary of Groundwater Treatment in the Hemet-San Jacinto Basins

Treatment Type	Number of Wells	Constituents(s) of Concern	Treatment Target	Treatment Cost ($/AF)	Amount Treated (AFY)
Proprietary "Electra Media" with chlorine as an oxidizer	1	Hydrogen sulfide, iron and manganese	ND	Data not available	10,000

Source: Eastern MWD, 2006

Wellhead treatment, if any, by other agencies (such as Lake Hemet MWD or the Cities of Hemet and San Jacinto) is not currently known (Eastern MWD, 2006b).

CURRENT GROUNDWATER STORAGE PROGRAMS

As a Metropolitan member agency, Eastern MWD imports both State Project water and Colorado River Aqueduct water into the Hemet-San Jacinto Basins area. Imported untreated State water is currently received through Eastern's EM-14 service connection for groundwater recharge in the San Jacinto area.

Currently, Eastern MWD is pursuing efforts to work with other agencies and private groundwater producers to establish cooperative groundwater management programs including groundwater storage and conjunctive use programs (Eastern MWD, 2000). Preparation is underway to implement the Hemet-San Jacinto Recharge and Recovery Program. This project will involve 100 acres of ponds, eight recovery wells, and a 60-inch diameter pipeline from Eastern MWD's EM-14 connection to the ponds. The objectives of the project include: providing Tribal Settlement Water (long-term average of 7,500 AFY), elimination of groundwater overdraft (10,000 AFY) and additional long-term supply (15,000 AFY).

BASIN MANAGEMENT CONSIDERATIONS

The primary considerations in groundwater management of the Hemet-San Jacinto Basins are:

- The 1954 Fruitvale Judgment and Decree limits production from the Canyon subbasin to 12,000 AFY in normal precipitation years when the water level in a key well is not more than 25 feet below a specific elevation. If the groundwater levels in the key well are more than 25 feet below the specific elevation, then production limits from the Canyon subbasin drop to 4,500 AFY.

- The settlement of the suit by the Soboba Band of Luiseno Indians regarding groundwater flow into Metropolitan's San Jacinto Tunnel along the Colorado River Aqueduct requires supplying the Tribe with a long-term average of 7,500 AFY.
- Water quality issues (TDS, nitrate, hydrogen sulfide, iron and manganese) could limit ability to store and extract water.
- Recharge pipeline capacities and adjudication of the San Jacinto River limit the ability to recharge additional imported water or runoff, respectively.
- Confined aquifers in the Hemet-San Jacinto Basins, particularly in the northern portion of the San Jacinto Upper Pressure subbasin are susceptible to subsidence.

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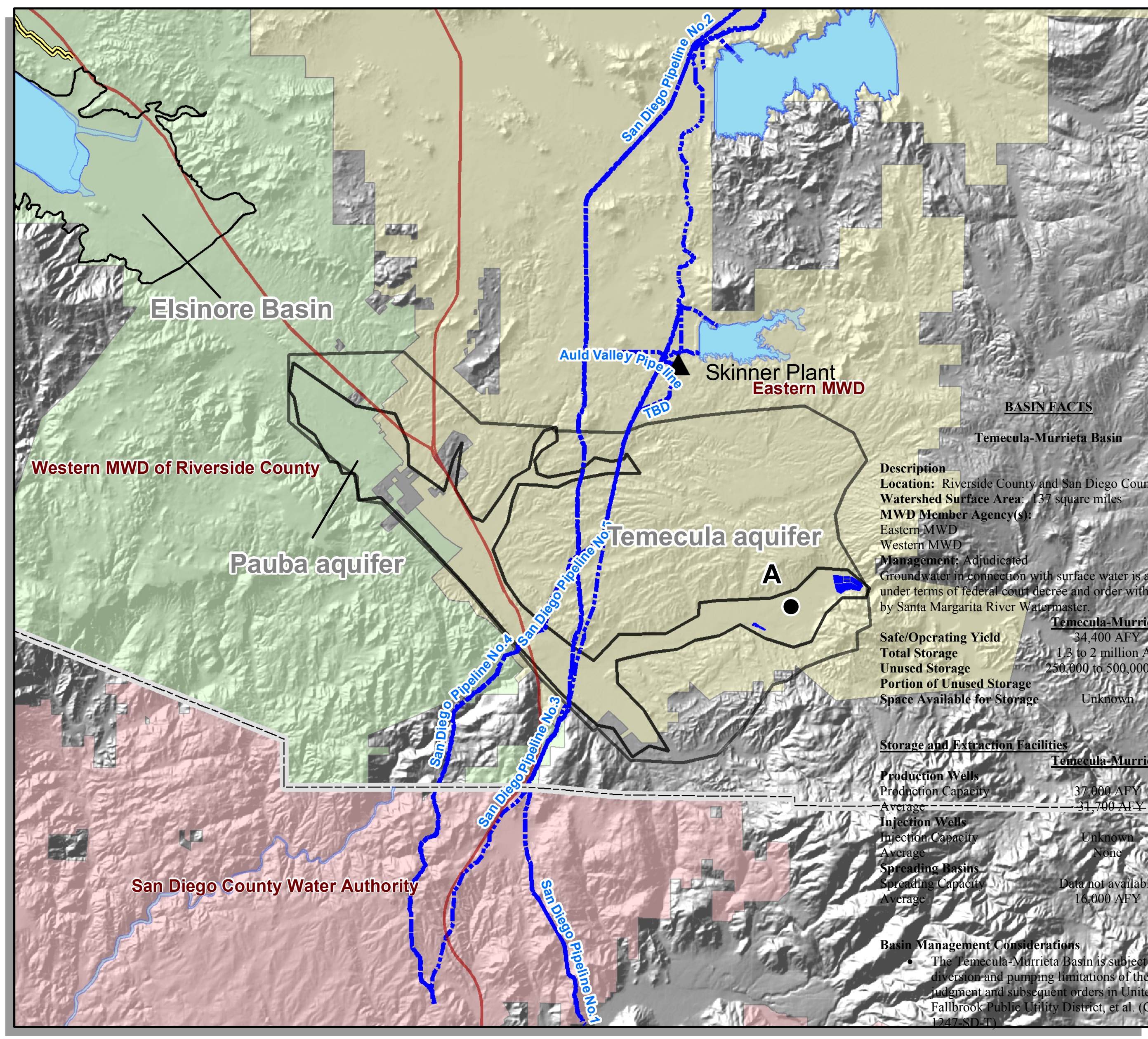

Temecula-Murrieta Basin

Key well	Water Body
Recharge Basins	MWD Pipeline
County	MWD Facility
Freeways	Santa Ana Regional Interceptor Line
River	Basin
	MWD Member Agency Boundary (color varies)

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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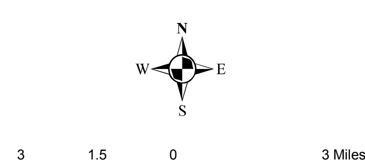
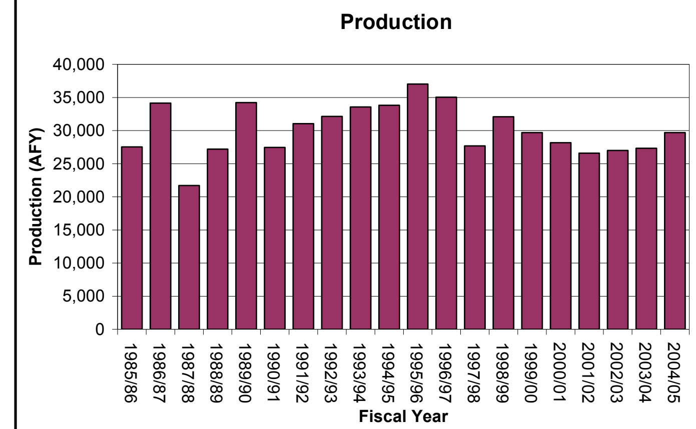
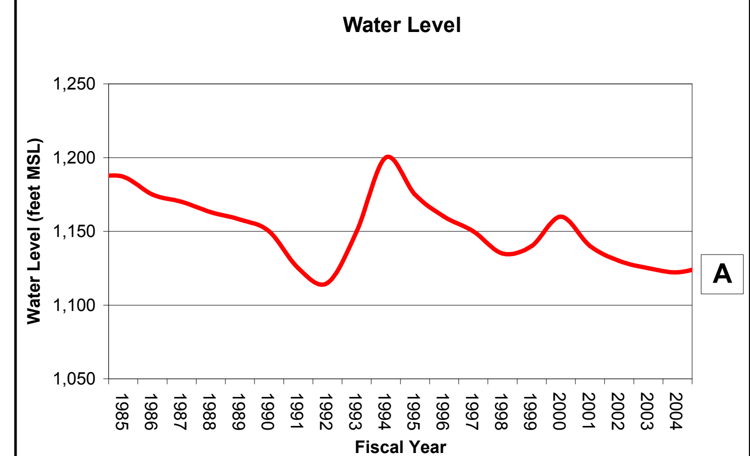
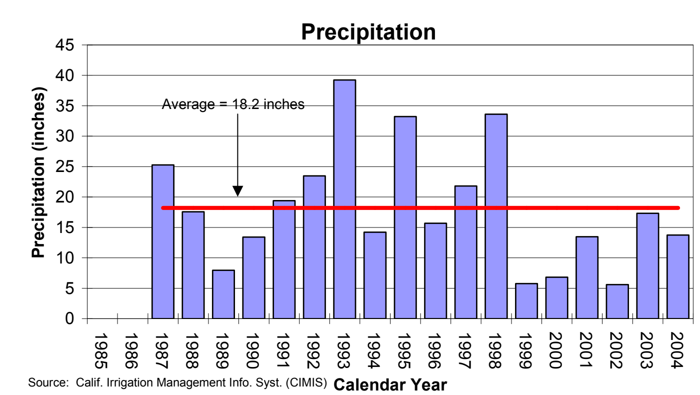
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).









Source: Calif. Irrigation Management Info. Syst. (CIMIS)

Direct Recharge
Historical annual recharge data not available for this basin.

BASIN FACTS

Temecula-Murrieta Basin

Description
Location: Riverside County and San Diego Counties
Watershed Surface Area: 137 square miles
MWD Member Agency(s):
Eastern MWD
Western MWD
Management: Adjudicated
Groundwater in connection with surface water is adjudicated under terms of federal court decree and order with oversight by Santa Margarita River Watermaster.

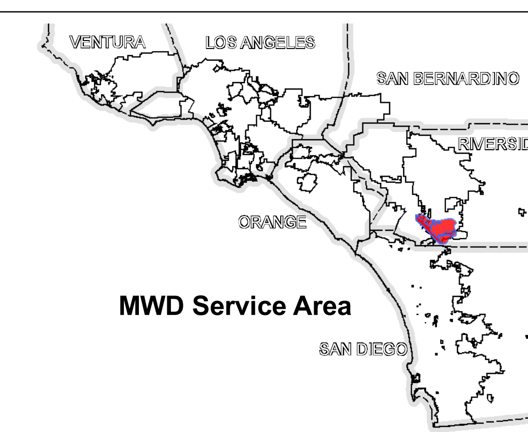
	Temecula-Murrieta
Safe/Operating Yield	34,400 AFY
Total Storage	1.3 to 2 million AF
Unused Storage	250,000 to 500,000 AF
Portion of Unused Storage	
Space Available for Storage	Unknown

Storage and Extraction Facilities

	Temecula-Murrieta
Production Wells	
Production Capacity	37,000 AFY
Average	~31,700 AFY
Injection Wells	
Injection Capacity	Unknown
Average	None
Spreading Basins	
Spreading Capacity	Data not available
Average	16,000 AFY

Basin Management Considerations

- The Temecula-Murrieta Basin is subject to the diversion and pumping limitations of the modified judgment and subsequent orders in United States v. Fallbrook Public Utility District, et al. (Civil No. 1247-SD-T)



MWD Service Area

Plate 19-1
Overview of Temecula-Murrieta Basin

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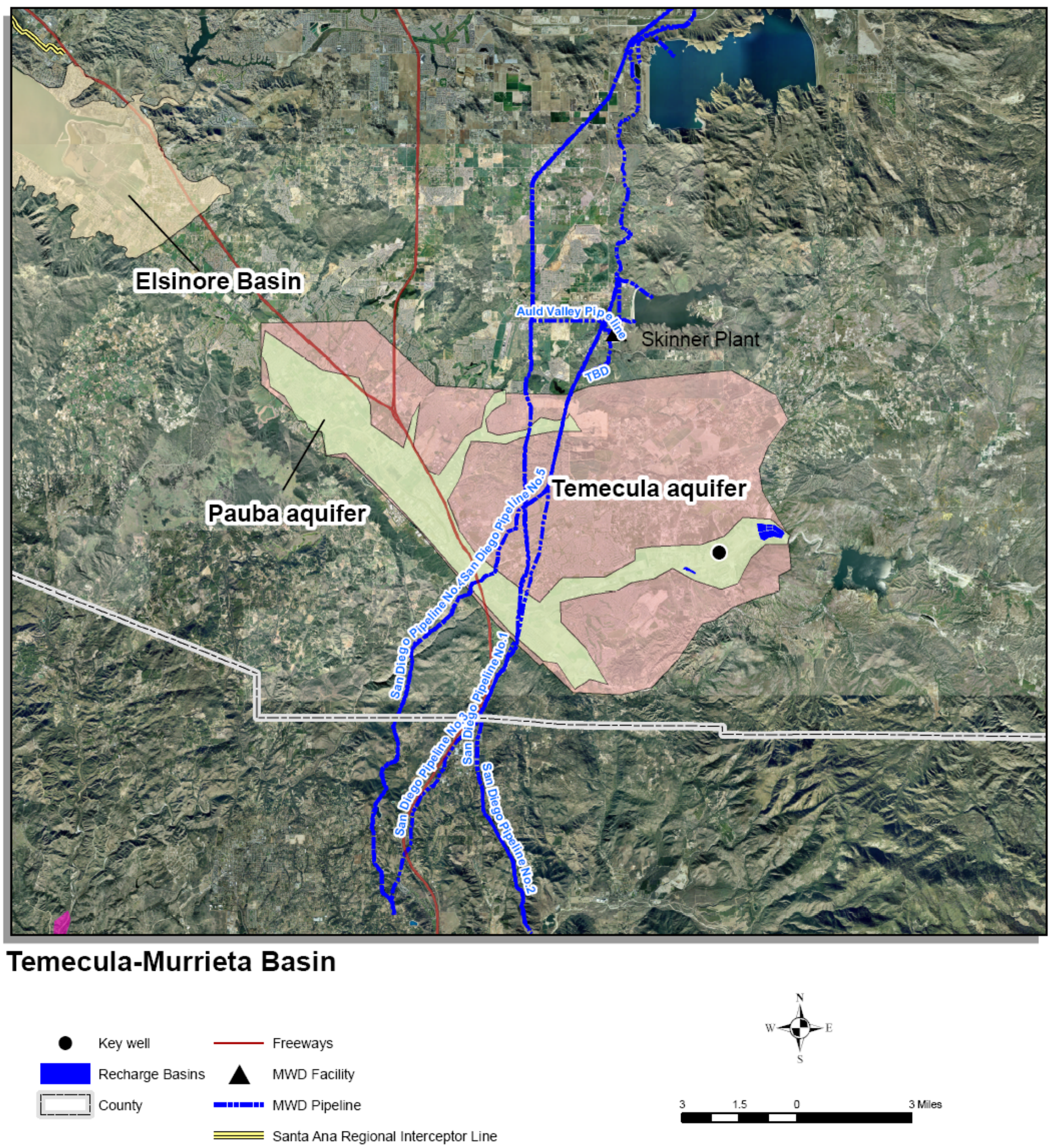
The Temecula-Murrieta Basin underlies several valleys in southwestern Riverside County and a portion of northern San Diego County. Alluvial sediments extend through the Pauba, Temecula-Murrieta, Santa Gertrudis, and Wolf valleys. These basins underlie the Metropolitan member agency service areas of Eastern Municipal Water District (Eastern MWD) and Western Municipal Water District (Western MWD). A map of the Temecula-Murrieta Basin is provided in **Figure 19-1**.

Figure 19-1
Map of the Temecula-Murrieta Basin



BASIN CHARACTERIZATION

The following section provides a physical description of the Temecula-Murrieta Basin, including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

There are two aquifers within the Temecula-Murrieta Basin: the Pauba aquifer and the Temecula aquifer. Within these two aquifers, Rancho California Water District (RCWD) has identified eight underlying groundwater basins, which are based upon surface water hydrology subbasins: Pauba Valley Basin, Lower Mesa Basin, Upper Mesa Basin, North Murrieta Basin, South Murrieta Basin, San Gertrudis Basin, Wolf Valley Basin, and Palomar Basin. For purposes of this report, the extent of the groundwater basins is defined by the extent of the principal aquifers rather than surface water designations. The Pauba aquifer consists of younger, unconfined alluvium deposited within the Temecula-Murrieta Basin. The deeper Temecula aquifer is semi-confined and confined, and underlies and extends beyond the boundaries of the Pauba aquifer. A description of each aquifer follows.

The Lancaster, Aguanga, and Agua Caliente faults and several strands of the Elsinore fault zone cross the basin and may affects groundwater movement. The Wildomar fault is a groundwater barrier that produces differences in water level and pressure in the northwestern part of the basin. Murrieta Hot Springs lie along an unnamed fault indicating that the fault affects subsurface flow (DWR, 2004). Significant differences in water levels can occur across this fault and RCWD reports that pumping wells on one side of this fault do not discernibly affects the piezometric levels on the other side of the fault.

Pauba aquifer

The Pauba aquifer covers approximately 18 square miles. Alluvial sediments extend through Pauba Valley, Temecula-Murrieta Valley, Santa Gertrudis Valley, and Wolf Valley. The Pauba Valley occurs along Temecula Creek and extends approximately seven miles westward from Vail Lake. Well yields in the unconfined alluvial aquifer of the Pauba Valley are excellent, and typically range from 500 gpm to 2,000 gpm. The Pauba aquifer is underlain by the confined Temecula aquifer. The storage capacity of the Pauba aquifer has been estimated at 200,000 AF.

Temecula aquifer

The Temecula aquifer extends over an area of approximately 100 square miles and is comprised of consolidated sediments that underlie and extend beyond the boundaries of the Pauba aquifer. Sediment depths within the Temecula aquifer are typically 1,000 feet or more. Except for upstream forebay areas, confining layers separate the Pauba and Temecula aquifers, and groundwater is confined or semi-confined throughout the Temecula aquifer. RCWD reports well yields ranging from several hundred gpm to approximately 2,000 gpm.

Estimates for the amount of groundwater stored within the Temecula aquifer vary widely. The Santa Margarita River Watermaster estimated total groundwater storage in the uppermost

500 feet at 1,340,556 AF as of September 30, 2001. RCWD reports total groundwater storage with the Temecula aquifer at approximately 2 million AF. DWR reports groundwater storage within the Pauba and Temecula aquifers at approximately 250,000 AF. Estimates of unused storage range from 250,000 to 500,000 AF. The amount of this storage that is available is unknown.

A summary of the hydrogeologic parameters of the Temecula-Murrieta Basin is presented in **Table 19-1**.

Table 19-1
Summary of Hydrogeologic Parameters of Temecula-Murrieta Basin

Parameter	Description
Structure	
Aquifer(s)	Temecula aquifer Pauba aquifer
Depth of groundwater basin	>2,500 feet
Thickness of water-bearing units	Temecula aquifer: 1,000 feet or more Pauba aquifer: 50 to 250 feet
Yield and storage	
Natural safe yield	34,400 AFY
Total Storage	1.34 to 2 million AF
Unused Storage	Temecula and Pauba aquifers: 250,000 to 500,000 AF
Portion of Unused Storage Available for Storage	Unknown

Source: DWR, 2004; RCWD, 2005; Anchor Environmental, 2004; and Santa Margarita River Watermaster, 2006

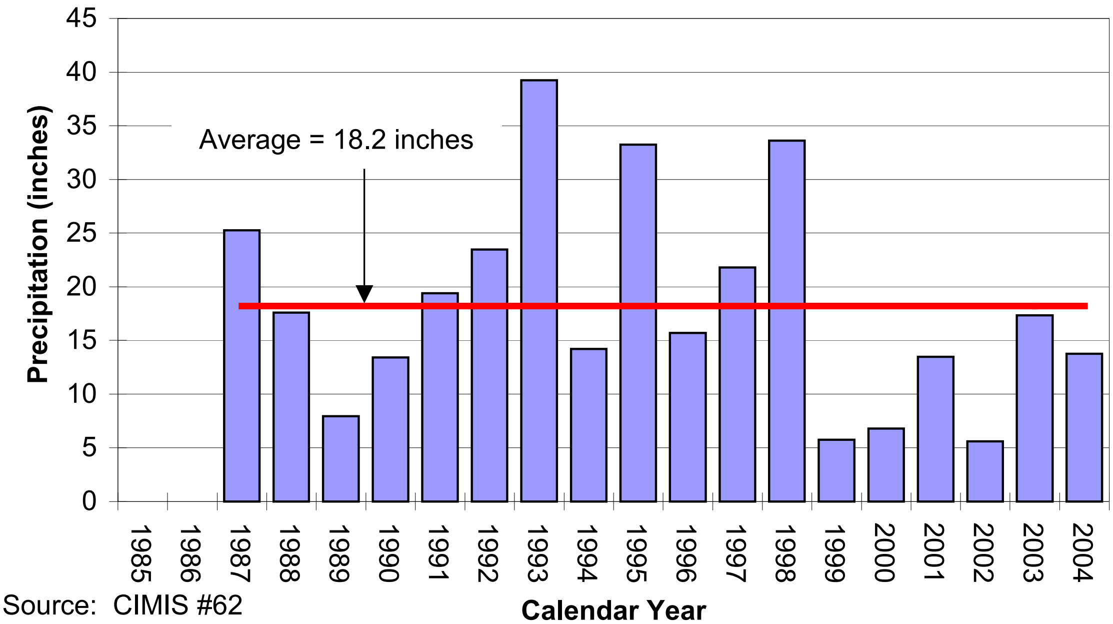
Safe Yield/Long-Term Balance of Recharge and Discharge

Average precipitation in the Temecula-Murrieta Basin is about 18.2 inches per year. **Figure 19-2** presents historical precipitation at the California Irrigation Management Information System (CIMIS) station Temecula #62. Extremely wet years occurred in 1993, 1995 and 1998. Very dry years occurred in 1989, 1999, 2000, 2001, and 2002.

According to RCWD's groundwater model, the average natural inflow (recharge, return flow, stream percolation and underflow) for all eight basins is 41,000 AFY when no artificial recharge is occurring (CDM, 2005). There are seven years in which the natural inflow has exceeded

70,000 AFY. The average natural basin outflow for all eight groundwater basins from 1935 to 1998 was 6,600 AFY. RCWD has estimated the natural yield of the eight basins equals the natural inflows less the natural losses, which would be 34,400 AFY (CDM, 2005). Parties in the watershed are continuing to evaluate the safe yield. Further descriptions on the recharge characteristics of the Pauba and Temecula aquifers follow.

Figure 19-2
Historical Precipitation in the Temecula-Murrieta Basin



Source: CIMIS #62

Pauba aquifer

As discussed above, the alluvial sediments of the Pauba aquifer extend through four valleys: Pauba Valley, Temecula-Murrieta Valley, Santa Gertrudis Valley, and Wolf Valley. The upstream portion of the Pauba Valley is a key forebay that recharges both the Pauba aquifer and the underlying Temecula aquifer. Pauba aquifer depths downstream from the forebay are typically in excess of 100 feet and extend to depths of more than 250 feet.

The Temecula-Murrieta Valley extends along Murrieta Creek northward from the Santa Margarita River confluence. The Murrieta forebay is located in the upstream portion of the valley, and the forebay recharges both the alluvial sediments of the Temecula-Murrieta Valley and the underlying Temecula aquifer. Downstream from the forebay, confining layers separate overlying alluvial sediments from the underlying Temecula aquifer. Sediment depths in the unconfined portion of the valley (Pauba aquifer) are typically in excess of 100 feet in depth, and extend to a maximum depth of approximately 200 feet.

The Santa Gertrudis Valley is a long and narrow valley that extends eastward from the Temecula-Murrieta Valley along Santa Gertrudis Creek. A forebay exists at the upstream end of the valley that recharges both the unconfined alluvial sediments of the valley (Pauba aquifer) and the underlying confined Temecula aquifer. The Pauba aquifer depths downstream from the forebay typically range from 50 to 100 feet.

Wolf Valley extends southward approximately three miles from the confluence of Pechanga Creek and Temecula Creek. A forebay exists at the upstream (south) end of Wolf Valley that recharges both the unconfined alluvial sediments of the Wolf Valley (Pauba aquifer) and the underlying Temecula aquifer. Pauba aquifer depths downstream from the Wolf Valley forebay range from 50 to 80 feet.

Temecula aquifer

The Temecula aquifer is a deeper, confined or semi-confined aquifer below the Pauba aquifer. Streamflow infiltration in unconfined alluvial forebays represents the primary source of recharge to the Temecula aquifer. Such streamflow infiltration recharge occurs in upstream forebays within Pauba Valley, Wolf Valley, Temecula-Murrieta Valley, and Santa Gertrudis Valley. In addition, portions of the Temecula aquifer are exposed in the upland mesa portion of eastern Temecula, allowing for recharge through streamflow infiltration, applied water infiltration, and precipitation infiltration.

GROUNDWATER MANAGEMENT

The following section describes how the basins are currently managed.

Basin Governance

As part of the Santa Margarita River system, surface water and groundwater supporting surface water (defined as being in the older and younger alluvium) with the Temecula-Murrieta Basin have been under some form of court jurisdiction since 1928. Groundwater basins not contributing the Santa Margarita River system are not adjudicated. A summary of the governing agencies and their roles is presented in **Table 19-2**.

Rights to utilize surface water and groundwater determined to be contributing to the Santa Margarita River are governed by the Modified Final Judgment and Decree entered on April 6, 1966 by the U.S. District Court in United States v. Fallbrook Public Utility District, et al. (Civil No. 1247-SD-T). The Modified Final Judgment incorporates the 1940 Stipulated Judgment and several subsequent orders have been entered that provide provisions for administering the water rights and managing surface water and groundwater resources in the watershed. The subsequent orders include the Cooperative Water Resource Management Agreement between RCWD and Camp Pendleton for management of groundwater and maintenance of surface water flows. Other governance documents include Permit 7032 issued by the State Water Resources Control Board for water rights in Vail Lake and a recently adopted agreement between RCWD and the Pechanga Band concerning groundwater management for the Wolf Valley subbasin.

In March 1989, the Court appointed a Watermaster to administer and enforce the provisions of the Modified Final Judgment and Decree and subsequent orders of the Court. The Court also appointed a Steering Committee that is currently comprised of representatives from the United States, Eastern Municipal Water District, Western Municipal Water District, Fallbrook Public Utility District, Metropolitan, the Pechanga Tribe, and RCWD. The purpose of the Steering Committee to assist the Court and the Watermaster in administering the water rights (Santa Margarita River Watershed Watermaster Report 2006).

Table 19-2
Summary of Management Agencies in the Temecula-Murrieta Basin

Agency	Role
Santa Margarita River Watershed Watermaster	Court-appointed Watermaster for oversight and administration of water rights
Santa Margarita River Watershed Steering Committee	Assist the Court and the Watermaster in administering the water rights
Rancho California Water District	Prepares Groundwater Audit and Recommended Groundwater Production Report for operation of District groundwater wells and recharge facilities

In addition, each year the RCWD prepares a Groundwater Audit and a Recommended Groundwater Production Report (RGPR). The amount of groundwater that can be produced varies due to such factors as rainfall, recharge area, and amount and location of well pumping capacity (RCWD, 1997).

Interactions with Adjoining Basins

The Temecula-Murrieta Basin is adjacent to the Elsinore Basin. When groundwater levels are above 1,100 feet MSL in the southeastern portion of the Elsinore Basin, small amounts (less than 100 AFY) of groundwater could spill into the adjacent Temecula-Murrieta Basin (MWH, 2003a). Current water levels are substantially below this level, and there are no agreements regarding this potential flow.

WATER SUPPLY FACILITIES AND OPERATIONS

The following section presents information on water supply facilities and operations. Facilities include more than 70 groundwater production wells, 4 groundwater recovery wells and spreading basins. Each of these facilities is discussed in more detail below.

Active Production Wells

A summary of production wells in the Temecula-Murrieta Basin is presented in **Table 19-3**.

The agencies that pump from the eight basins include RCWD, Eastern MWD, Western MWD (inclusive of Murrieta County Water District (MCWD), which was acquired by Western MWD in 2005), the Pechanga Indian Reservation, and other private pumpers (RCWD, 2005). Well yields generally range to 300 gpm in the northwestern part of the basin, but reach 1,750 gpm for wells in Pauba Valley (DWR, 2004). RCWD, the largest of these agencies, encompasses almost 100,000 acres and provides retail water supply for a variety of agricultural and residential uses. Typical agricultural uses include avocados, citrus, and grapes while residential demands are for the rapidly growing cities of Temecula and Murrieta (RCWD, 1997).

Table 19-3
Summary of Production Wells in the Temecula-Murrieta Basin

Category	Number of Wells	Estimated Production Capacity (AFY)	Average Production 1985/86 2004/05 (AFY)	Well Operation Cost ($/AF)
Municipal	49	Data not available	29,845	Data not available
Private "Substantial Users"	11		1,952 [1]	
Totals	**>60**		**31,797**	

Sources: Santa Margarita River Watermaster, 2006; Santa Margarita River Watershed Management Plan, Watershed Assessment Report Draft, 2004; RCWD, 2006
[1]Private party pumping is for 2004/05 only

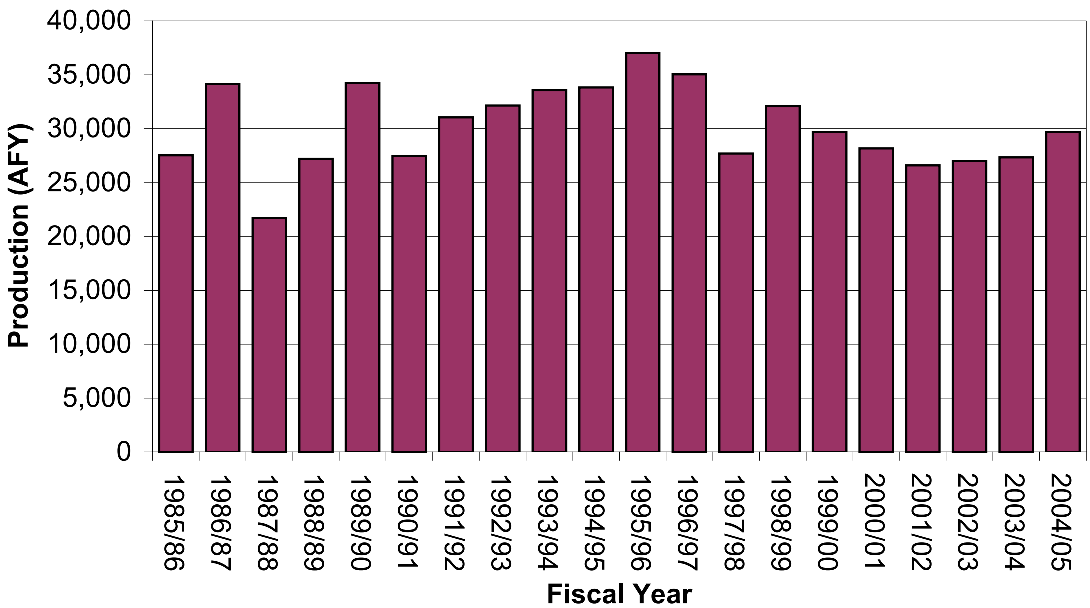
RCWD maintains more than 100 production and monitoring wells within the Temecula-Murrieta Basin. RCWD currently has 44 production wells in the eight basins with a total instantaneous capacity of 90 cfs, not including four groundwater recovery wells in the Valle de los Caballos project. Total RCWD groundwater pumping is dependent on water demands and hydrologic conditions, but RCWD typically derives 40 to 50 percent of its total water supply from local groundwaters of the Pauba and Temecula aquifers. From 1985/86 to 2004/05, RCWD groundwater production ranged from 21,400 AFY to 36,100 AFY, averaging 29,000 AFY (Santa Margarita River Watermaster, 2006).

Eastern MWD has historically derived a small percentage of its domestic water supply from wells within the Temecula-Murrieta Basin. From fiscal year 1985/86 to 2004/05, Eastern MWD groundwater production from the Temecula-Murrieta Basin ranged from 0 AFY to 685 AFY, averaging 301 AFY (Santa Margarita River Watermaster, 2006). In 2004, Eastern MWD destroyed its one remaining well in the Temecula-Murrieta Basin.

Groundwater served as the primary source of water supply for MCWD, which was acquired by Western MWD in 2005. Western MWD derives it supply from a combination of groundwater and imported surface water. Western MWD operates five water supply wells within the north end of the Temecula-Murrieta Basin. From 1985-86 to 2004-05, MCWD groundwater production from the Temecula-Murrieta Basin ranged from 286 AFY to 2,098 AFY, averaging 845 AFY, with production increasing significantly in recent years (Santa Margarita River Watermaster, 2006).

Historical municipal groundwater production for the Temecula-Murrieta Basin is presented in **Figure 19-3**. This figure does not include the production from substantial private users outside of these organized service areas.

Figure 19-3
Historical Groundwater Production in the Temecula-Murrieta Basin
(Within Organized Service Areas Only)



Source: Santa Margarita River Watermaster, 2006

Agricultural demands continue to be a significant part of the RCWD demands, as shown in **Figure 19-4**. However, increased residential and commercial development in the Temecula-Murrieta Basin will result in greater domestic/commercial demands over time.

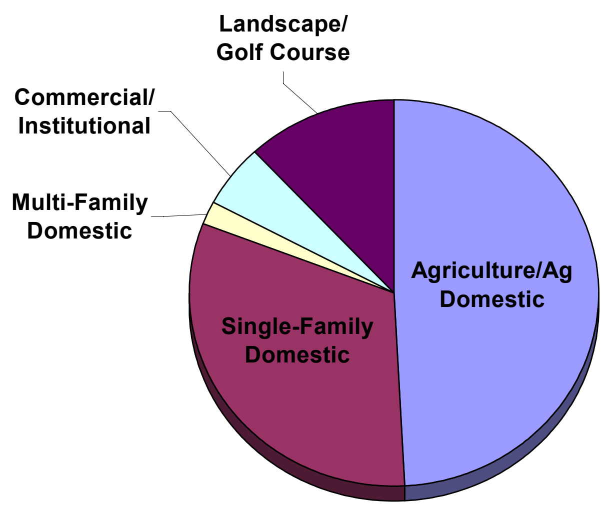
Other Production

It is important to note that as a condition to receiving RCWD water service, RCWD requires local water users to convey overlying groundwater rights to RCWD. As a result, virtually no private groundwater wells exist within the RCWD service area. Outside of the RCWD service area, however, dozens of private well owners pump groundwater within the Temecula-Murrieta

Basin. Most of the private wells are within the upstream portion of the Murrieta Valley, and are used for domestic or irrigation supply at private residences. In 2004-05, the Santa Margarita River Watermaster identified a total of eight private water users within the Temecula-Murrieta Basin as being "substantial users." During 2004-05, approximately 1,950 AF of groundwater was produced by these "substantial users" (Santa Margarita River Watermaster, 2006).

The Pechanga Indian Reservation is one of these "substantial users" and develops its potable and irrigation supplies from 11 onsite wells within the Temecula-Murrieta Basin. During 2004-05, the Pechanga Indian Reservation produced 608 AF of groundwater from the Temecula-Murrieta Basin (Santa Margarita River Watermaster, 2006).

Figure 19-4
Year 2000 Consumptive Water Demands in RCWD Service Area



Source: RCWD Urban Water Management Plan, 2005

RCWD's Vail Dam appropriative right provides that RCWD may store up to 40,000 AF in Vail Reservoir each year between November 1 and April 30, subject to limitations, and that the water so stored may be used for irrigation and domestic uses incidental to farming operations on 3,797 acres of land between May 1 and October 31. Such use may be by direct diversion from Vail Lake or by recovery with wells of water released from Vail and spread downstream in Pauba Valley. The amount of local runoff reaching the lake can vary widely depending on hydrological conditions. From 1962 to 2000, flows into Vail Lake ranged from 218 AFY to 29,570 AFY, with an average flow of 5,150 AFY. The storage capacity of the lake is approximately 40,000 AF, with a surface area of 1,000 acres. Currently, RCWD only uses Vail Lake to store local runoff. The historical available storage of the lake has varied widely as well, including two periods when the reservoir was full in March 1984 and February 1997. The average available storage is approximately 30,900 AF.

ASR Wells

RCWD operates four groundwater recovery wells – the Valle de los Caballos wells – at the Valle de los Caballos spreading basins discussed below.

Spreading Basins

In addition to the extraction of the natural yield of the basins, RCWD artificially recharges the Temecula-Murrieta Basin with untreated imported water for enhanced groundwater production. RCWD purchases imported water from Metropolitan and delivers it from the San Diego aqueduct turnout EM-19 to the Valle de los Caballos (VDC) recharge basins. In the past, the VDC recharge basins have provided up to 16,000 AFY of artificial groundwater recharge.

RCWD stores local runoff in Vail Lake, which was created in 1948 through construction of Vail Dam on Temecula Creek. RCWD has a surface water storage permit in Vail Lake for up to 40,000 AF from November 1 to April 30. During these months, RCWD releases available water from Vail Lake to the VDC spreading basins, about 1.5 miles downstream, for groundwater recharge. From May through October, existing State permits prohibit storage and require inflow to pass through Vail Lake to Temecula Creek (CDM, 2005).

Seawater Intrusion Barriers

There are no seawater barriers in the Temecula-Murrieta Basin.

Desalters

There are no desalters in the Temecula-Murrieta Basin

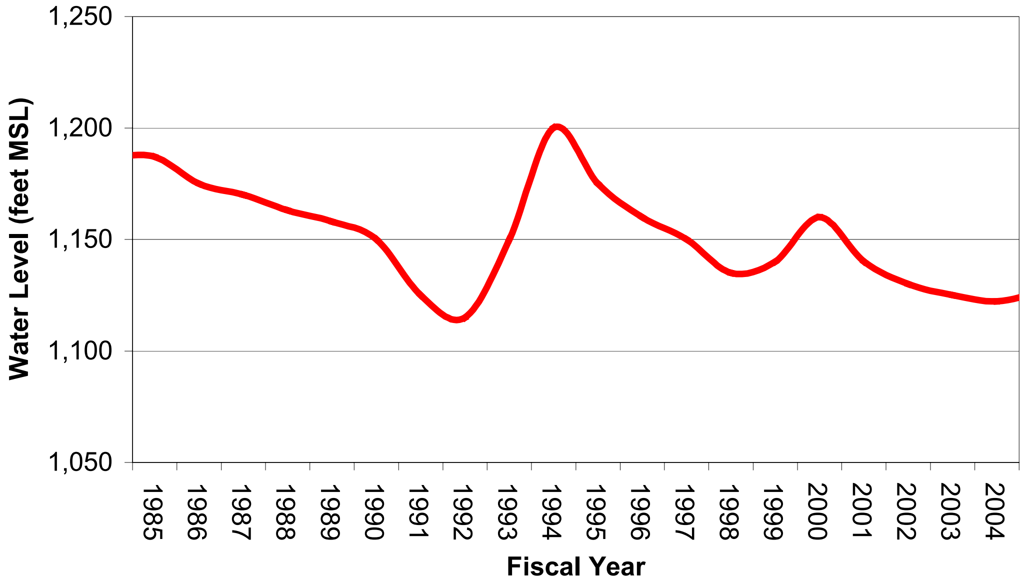
GROUNDWATER LEVELS

In general, groundwater flows southeastward under the Temecula-Murrieta Valley and southwestward beneath Pauba Valley to the southwestern part of the basin. A hydrograph of a monitoring well below Vail Lake within the Pauba aquifer is provided in **Figure 19-5**. This figure shows declines of about 70 feet and 60 feet between 1985 to1992 and 1995 to 1999, respectively, with recoveries following each period. Water levels in this portion of the basin have declined about 75 feet since 1994. Water levels in other portions of the basin show similar trends.

GROUNDWATER QUALITY

This following section presents information on the groundwater quality of the Temecula-Murrieta Basin.

Figure 19-5
Historical water Levels in the Temecula-Murrieta Basin



Source: Santa Margarita River Watermaster, 2006.

Groundwater Quality Monitoring

RCWD continually monitors the water quality of the eight groundwater basins and its 44 wells. Every year RCWD conducts over 2,000 tests for water quality on its wells and distribution system.

Groundwater Contaminants

Constituents of concern for the Temecula-Murrieta Basin are summarized in **Table 19-4**. These include: total dissolved solids (TDS), nitrate, volatile organic compounds (VOCs), perchlorate, fluoride and manganese. Groundwater in most of the Pauba aquifer and the Temecula aquifer is generally suitable for domestic and irrigation uses. TDS concentrations in the lower, confined and semi-confined Temecula aquifer tend to be lower than in the Pauba aquifer, though the percent sodium is higher in the Temecula aquifer. Nitrate (as N) levels are typically in compliance with the 10 mg/L MCL, although nitrate (as N) levels have been found to be higher in the wells in the Santa Gertrudis Valley. Sampling at RCWD's wells between 2002 and 2004 has indicated that the primary MCL standard of 2 mg/L for fluoride has been exceeded. However, well water is blended with other well water and imported MWD water and the distribution system average level of fluoride was well below the MCL. Well sampling has also indicated high levels for manganese, but blending reduces the manganese concentration to the non-detect level. Groundwater is rated inferior for domestic use locally near Murrieta Hot Springs because of high nitrate and fluoride content.

Table 19-4
Summary of Constituents of Concern in the Temecula-Murrieta Basin

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	200 to >1,000	In the unconfined Pauba aquifer, TDS ranges from 450 mg/L to greater than 1,000 mg/L. In the semi-confined and confined Temecula aquifer, TDS ranges from 200 mg/L to 600 mg/L. Percent sodium in the TDS for the Temecula aquifer can range from 55 to over 80 percent.
Nitrate (as N) Primary MCL = 10	mg/L	6.9 to 10	Based on sampling of 25 RCWD wells in 2003-04. High levels near Murrieta Hot Springs.
VOCs (TCE and PCE) Primary MCL TCE = 5 Primary MCL PCE = 5	µg/L	ND	No known detections of TCE or PCE.
Perchlorate Notification level = 6	µg/L	ND to 6.6	Detected in three RCWD wells since 2002. Only 1 well had a detection above notification level
Fluoride Primary MCL = 2	mg/L	0.2 to 7.6	A sampling of RCWD wells from 2002 to 2004. After blending with other well water and imported water, distribution system average was 0.4 mg/L. High levels near Murrieta Hot Springs.
Manganese Secondary MCL = 50	µg/L	50 to 250	RCWD wells. After blending with other well water and imported water, distribution system average was at non-detect level.

Sources: Santa Margarita River Watershed Annual Watermaster Report, 2005; RCWD Urban Water Management Plan, 2005; Santa Margarita River Watershed Management Plan, Watershed Assessment Report Draft, 2004

Blending Needs

RCWD blends groundwater with imported water from Metropolitan to reduce fluoride concentrations and manganese concentrations.

Groundwater Treatment

Agencies chlorinate the groundwater. Data related to other treatment is currently not available.

CURRENT GROUNDWATER STORAGE PROGRAMS

RCWD artificially recharges the Temecula-Murrieta Basin with untreated imported water for enhanced groundwater production. RCWD purchases imported water from Metropolitan and delivers it from the San Diego aqueduct turnout EM-19 to the Valle de los Caballos (VDC) recharge basins. In the past, the VDC recharge basins have provided up to 16,000 AFY of artificial groundwater recharge.

BASIN MANAGEMENT CONSIDERATIONS

The following describes the basin management considerations for the Temecula-Murrieta Basin. They include:

- The Temecula-Murrieta Basin is subject to the diversion and pumping limitations of the modified judgment and subsequent orders in United States v. Fallbrook Public Utility District, et al. (Civil No. 1247-SD-T), and to other local surface water diversion and groundwater pumping rights.

- Each year the RCWD prepares a Groundwater Audit and a Recommended Groundwater Production Report (RGPR). The amount of groundwater that can be produced varies due to such factors as rainfall, recharge area, and amount and location of well pumping capacity.

References:

Anchor Environmental, 2004. Santa Margarita River Watershed Management Plan, Watershed Assessment Report, Draft.

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CHAPTER IV

GROUNDWATER BASIN REPORTS

SAN DIEGO COUNTY BASINS

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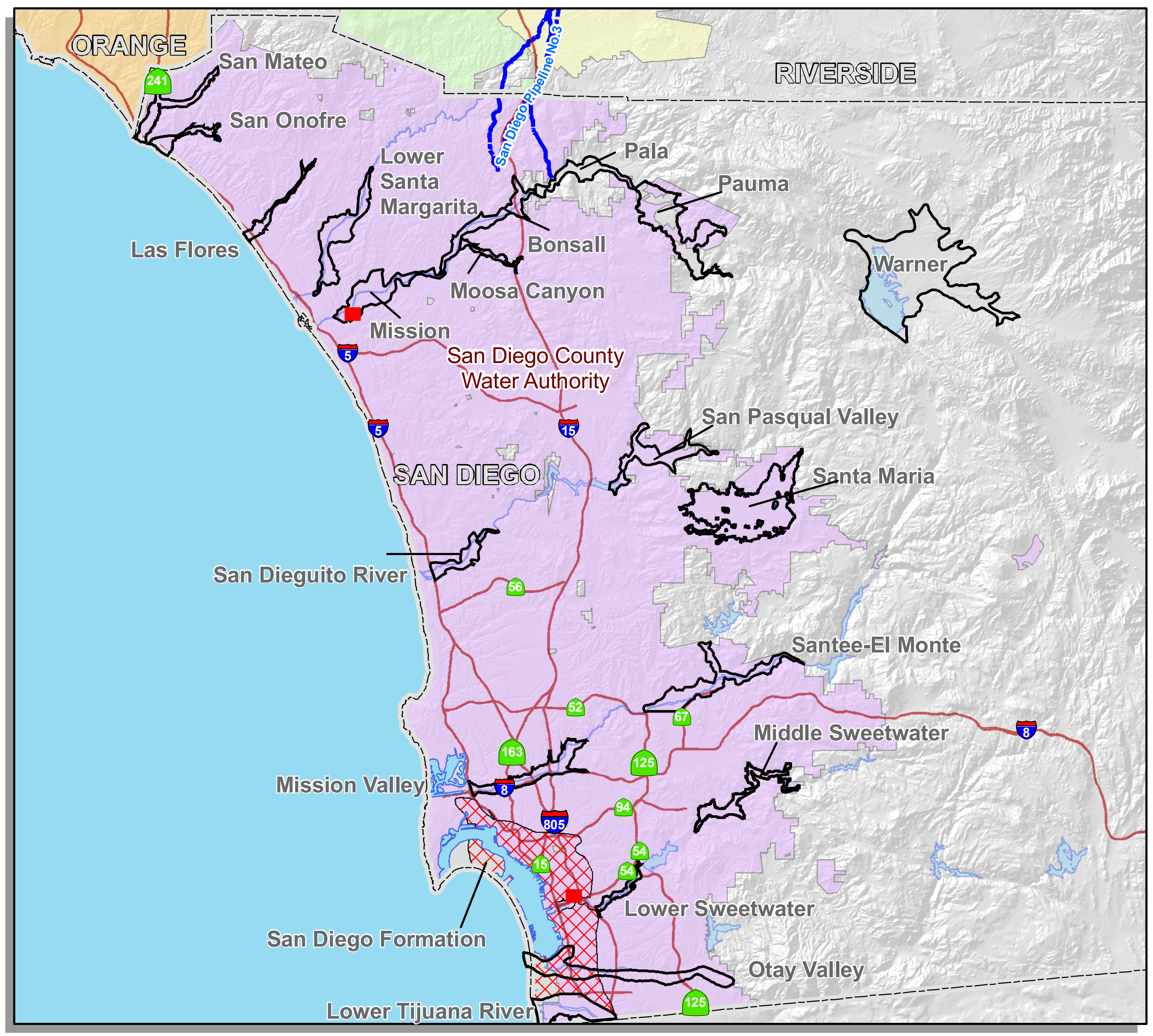

San Diego County Basins

Freeways
MWD Pipeline
County
Desalter
Water Body
MWD Member Agency Boundary (color varies)
Groundwater Basin
San Diego Formation

N
W E
S

9 4.5 0 9 Miles

Note: This map was prepared by the Metropolitan Water District of Southern California for its own use. No warranty is expressed or implied as to the correctness, timeliness, or content of the information shown herein.

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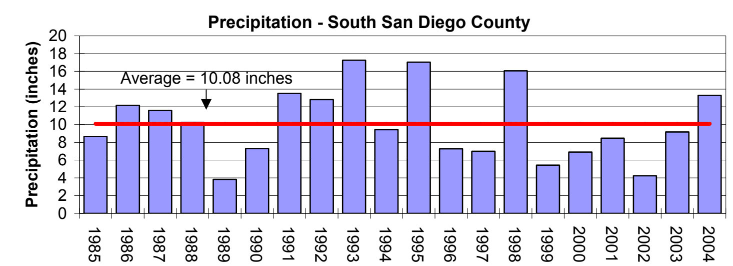
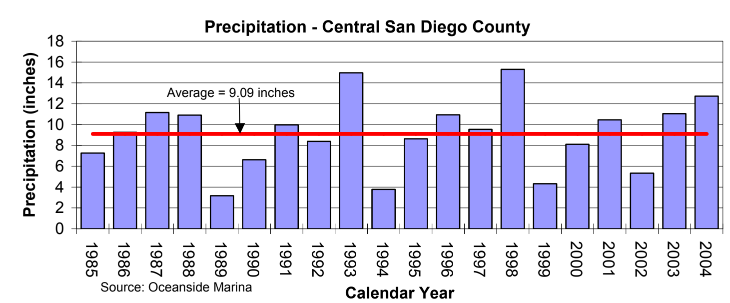
Additional Data Sourse(s): Santa Ana Watershed Project Authority (SAWPA); California Spatial Information Library (CaSIL).

Production

Basin	Average Production (AFY)	Safe Yield (AFY)
North San Diego County		
San Mateo	2,000	3,180
San Onofre	500	1,420
Las Flores	400	600
Subtotals (w/available data)	**2,900**	**5,200**
Central San Diego County		
Lower Santa Margarita River	5,800	5,400-16,700
San Luis Rey River		
• Mission	4,200	7,000-10,000
• Bonsall	2,500	5,400
• Pala/Pauma	7,700	8,000
• Moosa Canyon	Data not available	Data not available
• Warner Basin	7,000	12,000
San Dieguito River		
• San Dieguito Valley	2,500	<2,500
• San Pasqual Valley	4,000	5,800
• Santa Maria	250	>2,500
Subtotals (w/available data)	**33,950**	**48,600-62,900**
South San Diego County		
Sweetwater & San Diego Formation		
• Lower Sweetwater		2,400
• Middle Sweetwater	7,490	3,000
• San Diego Formation		3,000-5,000
Santee-El Monte	5,600	3,000-4,000
Other		
• Mission Valley	807	2,000-4,000
• Otay Valley	Data not available	Data not available
• Lower Tijuana River Valley	887	5,000-6,800
Subtotals (w/available data)	**14,784**	**18,400-25,200**
TOTALS (w/available data)	**51,634**	**72,200-93,300**



Source: San Diego Lindbergh Field



Source: Oceanside Marina

BASIN FACTS

San Diego County

<u>**Description**</u>

Location: San Diego County
Watershed Surface Area:
South County: 2,640 square miles
Central County: 1,416 square miles
North County: 150 square miles

Basins

Central County
Lower Santa Margarita River
- Upper Ysidora
- Chappo
- Lower Ysidora

San Luis Rey River
- Mission
- Bonsall
- Moosa Canyon
- Pala
- Pauma
- Warner

San Dieguito River
- San Dieguito Valley
- San Pasqual Valley
- Santa Maria

South County
Sweetwater & San Diego Formation
- Lower Sweetwater
- Middle Sweetwater
- San Diego Formation

Santee-El Monte
Other
- Mission Valley
- Otay Valley
- Lower Tijuana River Valley

North County
San Mateo
San Onofre
Las Flores

Management: Adjudicated, Managed, Unadjudicated
Court appointed Watermaster for Lower Santa Margarita River Basins in 1989. Adopted groundwater management plan for Lower Tijuana River Valley in 1995. Other basins are unadjudicated.

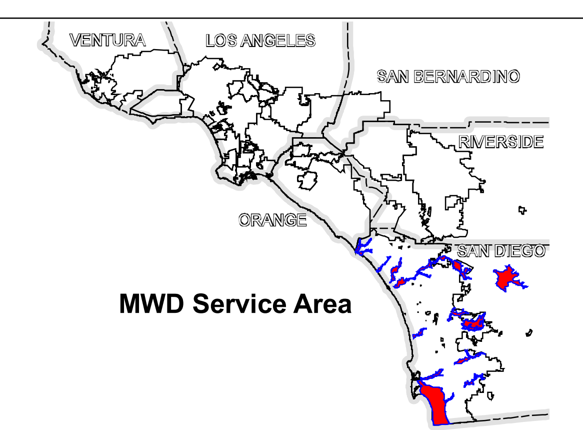
MWD Member Agencies:
San Diego County Water Authority

	North County	Central County	South County
Natural Safe Yield	5,200 AFY	48,600-62,900 AFY	18,400-25,200 AFY
Total Storage	21,400 AFY	913,100-974,200 AF	1.1-1.2 million AF
Unused Storage	Unknown	9,000 AF	60,000-110,000 AF
Portion of Unused Storage Available for Storage	Unknown	Unknown	At least 18,860 AF

Storage and Extraction Facilities

	North County	Central County	South County
Production Wells			
Production Capacity	Data not available	Data not available	Data not available
Average	2,900 AFY	33,950 AFY	14,784 AFY
Injection Wells			
Injection Capacity	Data not available	Data not available	None
Average	Data not available	Data not available	None
Spreading Basins			
Spreading Capacity	Data not available	4,000 AFY	None
Average	Data not available	Data not available	None

Basin Management Considerations
- Water quality (TDS, chloride, sulfate, magnesium, nitrate, fluoride, iron, manganese, and selenium) limit potential for storage and extraction.
- Potential for storage and extraction in certain basins could be limited due to size of basin and the ability to store and transmit water.



MWD Service Area

Plate 20-1
Overview of San Diego County Basins

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The groundwater basins of San Diego County have been grouped in three geographic sections that follow: North San Diego County Basins, Central San Diego County Basins, and South San Diego County Basins. The basins discussed are generally recognized by the San Diego County Water Authority (SDCWA.). These basins either fall within the SDCWA service area, or lie outside their service while providing water to their service area.

NORTH SAN DIEGO BASINS

The North San Diego County Basins include: San Mateo, San Onofre, and Las Flores Basins.

CENTRAL SAN DIEGO BASINS

The Central San Diego County Basins include: the Lower Santa Margarita River Basin (Upper Ysidora, Chappo, and Lower Ysidora Basins), the San Luis River Basins (Mission, Bonsall, Pala, Pauma, Moosa Canyon, and Warner Basins), and the San Dieguito River Basins (San Dieguito Valley, San Pasqual Valley, and Santa Maria Basins).

SOUTH SAN DIEGO BASINS

The South San Diego County Basins include: San Diego Formation and the Lower Sweetwater, Middle Sweetwater, Santee-El Monte, Mission Valley, Otay Valley, and Lower Tijuana River Valley Basins.

SUMMARY

Based upon available data, the natural safe yield of the San Diego Basins ranges from 72,200 to 93,300 AFY. The production of the San Diego Basins was estimated at 51,600 AFY, again based on available data. An overview of the San Diego County Basins is presented in **Table 20-1**. Detailed descriptions of each basin by geographic region follow.

Table 20-1
San Diego County Basins Overview

Basin	Natural Safe Yield	Basin Management	Facilities and Operations	Water Quality Concerns
North San Diego County Basins	**5,200 AFY (using available data)**		**Production for Camp Pendleton: 10 potable wells w/production of 2,900 AF**	
San Mateo Basin	3,180 AFY	**Unadjudicated** No formal management structure for these basins	• Production: :2,000 AFY	TDS: 400 – 700 mg/L
San Onofre Basin	1,420 AFY		• Potable production: 500 AFY	TDS: 300 – 800 mg/L
Las Flores Basin/Las Pulgas Basin	600 AFY		• Potable production: 400 AFY	TDS 600 – 900 mg/L
Central San Diego County Basins	**48,600 to 62,900 AFY**		**Total Central San Diego Production: 33,950 AFY (using available data)**	
Lower Santa Margarita River Basins	5,400 to 16,700 AFY	**Adjudicated** Adjudicated by the Court with decree entered on April 6, 1966 and administered by the Santa Margarita River Watermaster and the Watershed Steering Committee	• Potable- (80%) and agricultural (20%) supply for Camp Pendleton with total average production of 5,800 AFY • Recharge Basins: 65 acres managed by Camp Pendleton for spreading diverted river water	TDS: 325 – 1,260 mg/L Magnesium, sulfate, chloride and nitrate high for potable purposes.
San Luis Rey River Valley Basins	32,400 to 35,400 AFY	**Unadjudicated** Informal management via San Luis Rey Watershed Council	• Municipal production: 11,900 AFY • Other production: 9,500 AFY	TDS: 168- 3,400mg/L Warner, Pala and Pauma basins range from 168-900mg/L TDS. Other basins higher. Nitrates: Pala/Pauma basins high Manganese: Mission Basin high
San Dieguito River Basins	10,800 AFY	**Unadjudicated** San Dieguito Basin Task Force evaluating feasibility of groundwater management	• Total production: 6,750 AFY • No municipal production	TDS: Downstream reaches 1,000 – 27,000 mg/L Upstream areas: 320-1,680 mg/L Selenium: Santa Maria basin wells shutdown

Table 20-1 (continued)
San Diego County Basins Overview

Basin	Natural Safe Yield	Basin Governance	Facilities and Operations	Water Quality Concerns
South San Diego County Basins	**18,400 to 25,200 AFY (using available data)**		**Total South San Diego Production = 14,784 AFY (using available data)**	

Lower Sweetwater Basin	2,400 AFY	**Unadjudicated**
		Managed pursuant to Sweetwater Authority Interim Groundwater Management Plan
			• 13 municipal wells serving Chula Vista, National City and Bonita averaging 4,590 AFY
			  ○ Reynolds Groundwater Desalination Facility (RO) treats brackish groundwater averaging 2,850 AFY and blended with untreated groundwater
			  ○ National City wells averaged 1,740 AFY
			• Other production: 2,900 AFY
				TDS of municipal wells ranging from 600 – 3,320 mg/L
				Chloride 359 – 1,590 mg/L

Middle Sweetwater Basin	3,000 AFY			
San Diego Formation	3,000 to 5,000 AFY			
Santee-El Monte Basin	3,000 to 4,000 AFY	**Unadjudicated** Primary producer is Helix WD	• 9 active municipal wells with average production of 1,600 AFY • 19 other wells with average production of 4,000 AFY	Iron and manganese: exceed MCLs in central portion of basin TDS: 260 – 3,000 mg/L Nitrate (as N): exceed MCL in central portion of basin
Mission Valley	2,000 to 4,000 AFY	**Unadjudicated** Conceptual groundwater management plan	• Production: 807 AFY (average of 500 gpm)	Generally poor: TDS: 520 – 4,089mg/L Chloride: 80 – 1640 mg/L Sulfate: 68 – 607 mg/L Nitrate: 0 – 105 mg/L
Lower Tijuana	5,000 to 6,800 AFY	**Managed** Adopted groundwater management plan in 1995	• Production: 887 AFY (average of 550 gpm)	Problems with seawater intrusion TDS: 379 – 1749 mg/L (1982-83) Chloride: 83-650 mg/L (1982-83)
Otay Valley	Data not available	Data not available	Data not available	Data not available
TOTALS	**72,200 to 93,300 AFY (using available data)**		**Total San Diego Production 51,634 AFY (using available data)**	

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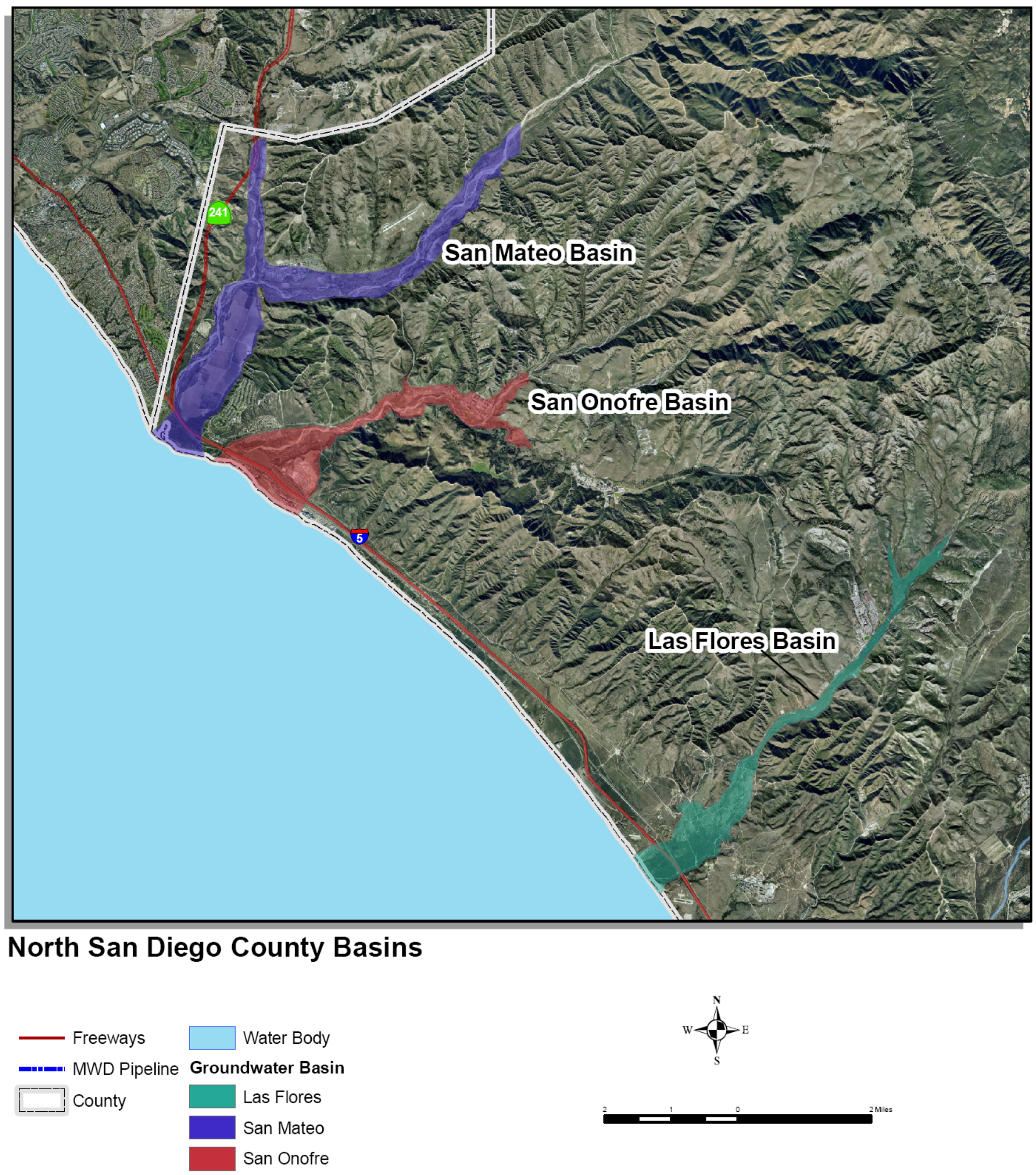
The groundwater basins in north San Diego County discussed in this section include: San Mateo Basin, San Onofre Basin, and Las Flores Basin. These basins consist of 496 square miles of drainage area in San Diego, Orange, and Riverside counties, with approximately 150 square miles located in northwest San Diego County. The North San Diego Basins underlie the service area of the San Diego County Water Authority (SDCWA). A map of the North San Diego County Basins is presented in **Figure 21-1**.

Figure 21-1
Map of North San Diego County Basins



Source: SDCWA, 1997

BASIN CHARACTERIZATION

The following section presents the physical descriptions of the North San Diego County Basins.

Basin Producing Zones and Storage Capacity

A summary of the aquifer characteristics of the North San Diego County Basins is presented in **Table 21-1**.

Table 21-1
Summary of Hydrogeologic Parameters for North San Diego County Basins

Parameter	San Mateo Basin	San Onofre Basin	Las Flores Basin
Aquifer(s)	Unconfined alluvium	Unconfined alluvium	Unconfined alluvium
Depth of groundwater basin	Up to 100 feet	Up to 55 feet	Up to 100 feet
Storage Capacity	6,500 AF	6,500 AF	8,400 AF

Source: San Diego County Water Authority, Groundwater Report, 1997

San Mateo Basin

The San Mateo Basin underlies the San Mateo Valley and Christianitos Canyon in northwestern San Diego County and southeastern Orange County. The basin is bounded by the Pacific Ocean on the west and elsewhere by semi-permeable Tertiary marine sedimentary rocks. The valleys are drained westward to the ocean by San Mateo and Christianitos Creeks.

San Onofre Basin

The San Onofre Basin underlies the San Onofre Valley in northwestern San Diego County. The basin is bounded by the Pacific Ocean on the west and elsewhere by semi-permeable Tertiary marine sedimentary rocks. The valley is drained westward to the ocean by San Mateo Creek.

Las Flores Basin

The Las Flores Basin (also known as the Las Pulgas Basin) underlies Las Flores Creek. The basin is bounded by the Pacific Ocean on the west and elsewhere by semi-permeable Tertiary marine sedimentary rocks. The valley is drained westward to the ocean by Las Flores Creek.

Safe Yield/Long-Term Balance of Recharge and Discharge

Camp Pendleton reports the estimated safe yield for the San Mateo Basin at 3,180 AFY, the San Onofre Basin at 1,420 AFY, and the Las Flores Basin at 600 AFY.

San Mateo Basin

Recharge is derived from percolation of runoff from rainfall through the natural reaches of San Mateo Creek. Effluent from Camp Pendleton Sewage Treatment Plant No. 12 is used for a seawater intrusion barrier.

San Onofre Basin

Recharge is derived from percolation of runoff from rainfall through the natural reaches of San Onofre Creek. Effluent from Camp Pendleton Sewage Treatment Plant No. 11 is used for a seawater intrusion barrier.

Las Flores Basin

Recharge is derived from percolation of runoff from rainfall through the natural reaches of Las Flores Creek. Effluent from Camp Pendleton Sewage Treatment Plant No. 9 is used for a seawater intrusion barrier.

GROUNDWATER MANAGEMENT

None of the basins are managed and interactions with adjoining basins are not fully understood.

WATER SUPPLY FACILITIES AND OPERATIONS

The following section provides a summary of facilities within the North San Diego County Basins.

Active Production Wells

Groundwater from the San Mateo and San Onofre Basins supplies the northern portion of Camp Pendleton. Groundwater from the Las Flores Basin (and the Santa Margarita River system) provides the source of supply to the southern portion of Camp Pendleton. Camp Pendleton has four potable water supply wells in the San Mateo Basin, three potable water supply wells in the San Onofre Basin and three potable water supply wells in the Las Flores Basin. Reported average groundwater production (1985 through 2004) from these basins, as provided by Camp Pendleton, is shown in **Table 21-2**.

Other Production

There are no data related to other production.

ASR Wells

There are no ASR wells in the North San Diego County Basins.

Spreading Basins

There are spreading basins in the San Mateo Basin and the San Onofre Basin, but these spreading basins are used only for spreading treated wastewater effluent for seawater intrusion barriers for each of these groundwater basins. This is discussed below.

Table 21-2
Summary of Production in the North San Diego County Basins

Basin	Number of Wells (Potable)	Average Production (AFY)	Well Operation Cost ($/AF)
San Mateo	4	2,000	Data not available
San Onofre	3	500	
Las Flores	3	400	
Total	**10**	**2,900**	

Source: Camp Pendleton, 2006

Seawater Intrusion Barriers

There are seawater intrusion barriers in San Mateo Basin, San Onofre Basin and Las Flores Basin. These are described as follows.

San Mateo Basin

In the San Mateo Basin, wastewater is treated to Title 22 standards at Camp Pendleton Sewage Treatment Plant No. 12 and the effluent is delivered to percolation ponds near Interstate 5 to maintain a seawater intrusion barrier for the basin. This operation takes place down gradient from all potable water production wells.

San Onofre Basin

In the San Onofre Basin, wastewater is treated to Title 22 standards at Camp Pendleton Sewage Treatment Plant No. 10 and the effluent is delivered to percolation ponds near the coast to maintain a seawater intrusion barrier for the basin. This operation takes place down gradient from all potable water productions wells.

Las Flores Basin

In the Las Flores Basin, wastewater is treated to Title 22 standards at Camp Pendleton Sewage Treatment Plan No. 9 and the effluent is delivered to six injection wells at the coast along Red Beach to maintain a seawater intrusion barrier for the basin. This operation takes place down gradient from all potable water production wells.

Desalters

There are no desalters in the North San Diego County Basins.

GROUNDWATER LEVELS

San Mateo Basin

According to DWR, groundwater level information is available until about 1988 with hydrographs showing that water levels vary with wet and dry weather cycles, generally recovering during wet periods. A hydrograph for a well in Christianitos Canyon ranges from 2 to 40 feet below ground surface during about 1965 through 1988. A hydrograph for one well at the confluence of Christianitos and San Mateo Creeks ranges from about 5 to 40 feet below ground surface during 1955 through 1988. Hydrographs for wells in the western part of the basin show small fluctuations about a stable level during 1946 through 1988.

San Onofre Basin

According to DWR (2004), groundwater level information is available until about 1988 with hydrographs showing that water levels vary with wet and dry weather cycles, generally recovering during wet periods. In the upper part of the San Onofre Valley, a hydrograph for one well shows declines of 25 to 35 feet per dry cycle, but overall long-term stable behavior. In the lower San Onofre Valley, hydrographs show water levels generally rising from 4 to 12 feet during the 1950s through 1980s.

Las Flores Basin

Water level data are not available for the Las Flores Basin.

GROUNDWATER QUALITY

The following section describes the groundwater quality issues in the North San Diego County Basins. It includes a discussion of the monitoring programs and constituents of concern.

Groundwater Quality Monitoring

The basin water quality assessments use Title 22 reporting for production wells.

Groundwater Contaminants

The main constituent of concern in North San Diego County Basins is TDS, as shown in **Table 21-3**.

Blending Needs

Data regarding blending needs are not available.

Groundwater Treatment

Data regarding groundwater treatment are not available.

Table 21-3
Summary of Constituents of Concern in the North San Diego County Basins

Basin	Constituent	Units	Range	Description
San Mateo Basin	**TDS** Secondary MCL = 500	mg/L	400 to 700	Suitable for domestic and irrigation uses.
San Onofre Basin	**TDS** Secondary MCL = 500	mg/L	300 to 800	Generally suitable for both domestic and irrigation uses, though groundwater in alluvium may be rated marginal for irrigation locally.
Las Flores Basin	**TDS** Secondary MCL = 500	mg/L	600 to 900	Generally suitable for both domestic and irrigation uses

Sources: SDCWA, 1997; DWR, 2003 and 2004, Camp Pendleton, 2006

CURRENT GROUNDWATER STORAGE PROGRAMS

There are no groundwater storage agreements in the basins.

In 1997, Camp Pendleton and the former Tri-Cities Water District in southern Orange County were evaluating the potential for additional groundwater development within the San Mateo Basin. The former Tri-Cities Water District is now identified as the "Joint Regional Water Supply System" or JWRSS under a Joint Powers Authority (JPA), with South Coast Water District accepting the responsibility for operations and maintenance of the JWRSS. One project under study would have involved connecting the Camp Pendleton and former Tri-Cities water systems, and constructing wells as a source of emergency supply. A second proposal under study was a conjunctive use program to develop up to 2,000 AF of additional potable supply.

Stetson Engineers completed a study of potential groundwater management scenarios in the San Mateo and San Onofre Basins. Scenarios included sustained basin yield pumping and development of conjunctive use elements consistent with use of water from the Santa Margarita River Basin. The study included examination of a water exchange with Orange County, with construction of a pipeline from the wells in the San Mateo Basin to a South Coast Water District pipeline in Orange County, with water provided to Orange County in exchange for a similar amount of water provided to the city of Fallbrook through the San Diego Aqueduct.

BASIN MANAGEMENT CONSIDERATIONS

- High TDS levels, in particular in the San Onofre Basin, influence the suitability of groundwater for potable water use.

- Camp Pendleton and the former Tri-Cities Water District studied a potential conjunctive use program. If a similar program were pursued by the JWRSS (the former Tri-Cities Water District system operated by the South Coast Water District), an institutional agreement would need to be developed by the two agencies.

References:

California Department of Water Resources (DWR), 2003. California's Groundwater Bulletin 118 – San Mateo Valley Groundwater Basin. Updated 10/1/03. Website: http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/9-2.pdf Accessed 7/10/07.

California Department of Water Resources (DWR), 2004. California's Groundwater Bulletin 118 – San Onofre Valley Groundwater Basin. Updated 2/27/04. Website: http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/9-3.pdf Accessed 7/10/07.

Project Clean Water, 2006. Accessed at: http://www.projectcleanwater.org/html/ws_san_juan.html

San Diego County Water Authority (SDCWA), 1997. Groundwater Report.

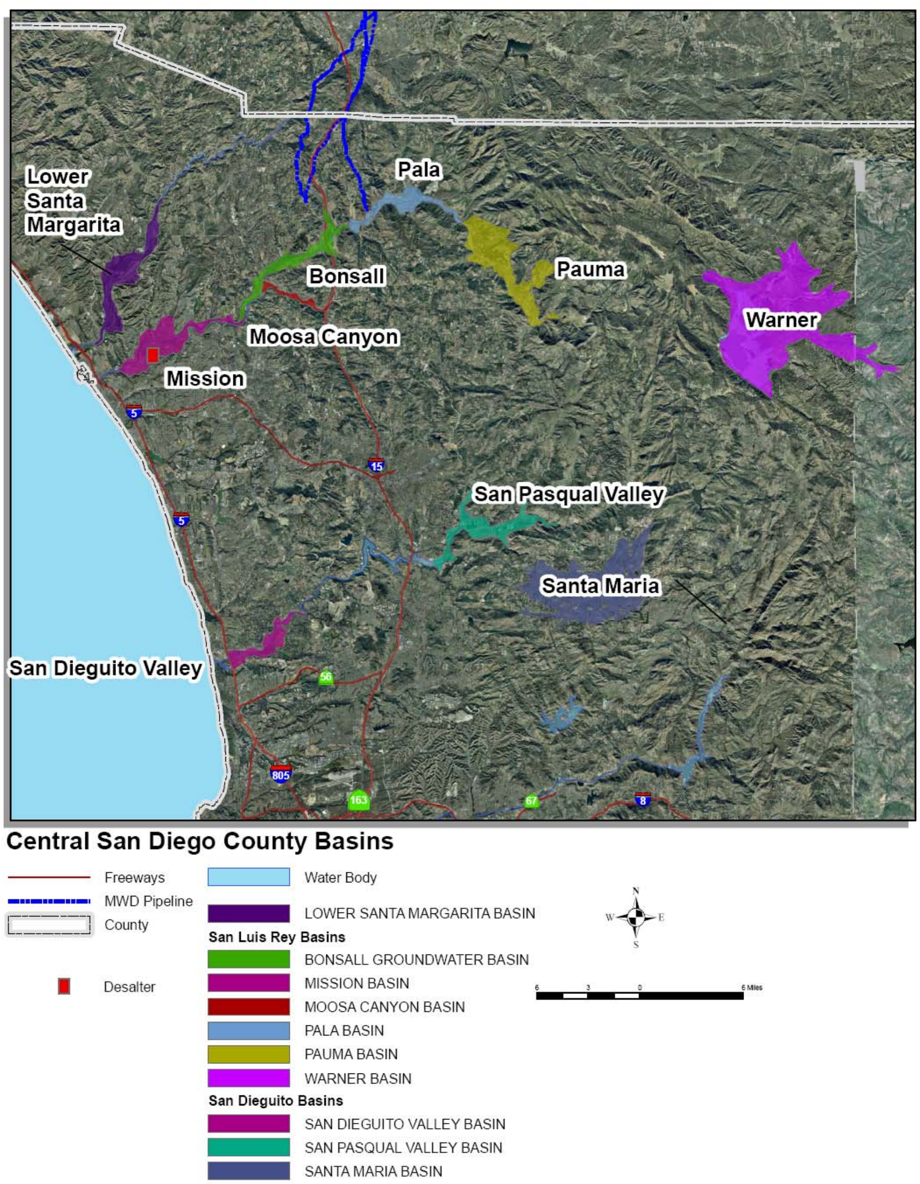
South Coast Water District (accepted responsibility for operations and maintenance of the former Tri-Cities Municipal Water District). Accessed at: http://www.scwd.org/about/about.htm#contract

United States Bureau of Reclamation and Stetson Engineers, Inc. 2005. Santa Margarita River Conjunctive Use Project, Pre-Feasibility Plan Formulation Study, San Diego County, California.

United States Marine Corps Base at Camp Pendleton. 2006. Comments on initial draft.

The groundwater basins in central San Diego County discussed in this section include: Lower Santa Margarita River Basin (Upper Ysidora Basin, Chappo Basin, and Lower Ysidora Basin), San Luis Rey River Valley Basins (Mission Basin, Bonsall Basin, Moosa Canyon Basin, Pala Basin, Pauma Basin, and Warner Basin), and the San Dieguito River Basins (San Dieguito Valley Basin, San Pasqual Valley Basin and Santa Maria Basin). The Central San Diego County Basins underlie the service area of the San Diego County Water Authority (SDCWA). A map of the Central San Diego County Basins is presented in **Figure 22-1**.

Figure 22-1
Map of the Central San Diego County Basins



Source: SDCWA

BASIN CHARACTERIZATION

The following section provides a physical description of the Lower Santa Margarita River Basins, the San Luis Rey River Valley Basins, and the San Dieguito River Basins, including their geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

Table 22-1 provides a summary of hydrogeologic parameters of the South San Diego Basins. Each basin is discussed separately in the following section. **Table 22-2** provides a summary of the storage and yield parameters for each of the basins in the Central San Diego County area.

Table 22-1
Summary of Hydrogeologic Parameters for Central San Diego County Basins

Parameter	Lower Santa Margarita River Basins	San Luis Rey River Valley Basins	San Dieguito River Basins
Aquifer(s)	Unconfined to semi-confined alluvium	Unconfined to semi-confined alluvium	Unconfined to semi-confined alluvium
Depth of groundwater basin	30 to 200 feet	Mission Basin Up to 220 feet Bonsall Basin Up to 130 feet Pala/Pauma Basin Up to 240 feet Moosa Canyon Basin Up to 150 feet Warner Basin > 900 feet	San Dieguito Valley Basin Up to 150 feet San Pasqual Valley Basin Up to 200 feet Santa Maria Basin Up to 225 feet
Thickness of water-bearing units	30 to 200 feet	Data not available	Data not available

Source: Camp Pendleton, 2006; City of San Diego, 2006; SDCWA, 1997

Lower Santa Margarita River Basins

The Santa Margarita River basin consists of 744 square miles of drainage area in both San Diego and Riverside Counties. The Santa Margarita River basin may be separated into the “Upper Basin” and the “Lower Basin.” The Upper Basin is located in Riverside County and is controlled by the drainage of Temecula and Murrieta Creeks. The Lower Basin is controlled by the 27-mile long Santa Margarita River and contains major tributaries such as De Luz, Sandia, and Fallbrook Creeks. The entire Lower Basin has a drainage area of approximately 154 square miles.

Groundwater is found in the alluvial basin located downstream from the confluence of the Santa Margarita River and De Luz Creek and, to a lesser extent, in the shallow alluvium upstream of that confluence. The water-bearing unit within the basin is Quaternary age alluvial deposits, which consist of unconsolidated gravel, sand, silt and clay, which are 150 to 200 feet thick. Well yields in the basin range from 200 to 1,980 gpm. Groundwater is unconfined in the eastern portion and semi-confined in the western portion of the basin. Groundwater is also extracted from residuum and fractured bedrock beneath the basin.

Table 22-2
Summary of Storage and Yield for the Central San Diego County Basins

Parameter	Lower Santa Margarita River Basins	San Luis Rey River Valley Basins	San Dieguito River Basins
Natural Safe Yield	5,400 to 16,700 AFY	Mission Basin 7,000 to 10,000 AFY Bonsall Basin 5,400 AFY Pala/Pauma Basin 8,000 AFY Moosa Canyon Basin Data not available Warner Basin 12,000 AFY	San Dieguito Valley Basin <2,500 AFY San Pasqual Valley Basin 5,800 AFY Santa Maria Basin >2,500 AFY
Total Storage	48,100 to 69,200 AF	Mission Basin: 92,000 AF Bonsall Basin 25,000 to 40,000 AF Pala/Pauma Basin 50,000 to 75,000 AF Moosa Canyon Basin 4,000 AF Warner Basin 550,000 AF	San Dieguito Valley Basin 50,000 AF San Pasqual Valley Basin 58,000 AF Santa Maria Basin 36,000 AF
Unused Storage Space	Negligible	Mission Basin 9,000 AF Other Basins Unknown	Unknown
Portion of Unused Storage Available for Storage	Negligible	Unknown	

Sources: Camp Pendleton, 2006; SDCWA, 1997; Vista Irrigation District, 2006; Santa Margarita River Watermaster, 2006; City of San Diego, 2006

SDCWA reports that the total storage capacity for the basin is 69,200 AF. The Santa Margarita River Watermaster reports that the total combined storage for the Lower Santa Margarita Groundwater Basin (including the Upper Ysidora, Chappo, and Lower Ysidora Basins) between the depths of 5 and 100 feet is 48,100 AF. However, much of the storage is below sea level. In 2004/05, useable groundwater in storage was computed for all three sub-basins to be 28,634 AF out of a total usable space of 28,700 AF (Santa Margarita River Watermaster, 2006), which suggests that the basin was nearly full. Because of shallow water levels (often less than 10 feet below ground surface) in this area, there is limited available storage space.

San Luis Rey River Valley Basins

The San Luis Rey River watershed is located east of the City of Oceanside. The watershed includes Mission Basin, Bonsall Basin, Moosa Canyon Basin, Pala Basin, Pauma Basin and Warner Basin. The 558 square mile drainage is the largest hydrologic unit in the San Diego region. The watershed drains to the Pacific Ocean to the west and is bounded by the Moserate Mountains to the north, the Cleveland National Forest and Camp Pendleton to the northwest, and Escondido, San Diego, and other cities to the south. The basin is roughly 50 miles long by 16 miles wide, and is divided into two hydrologic units by Henshaw Dam. The areas above and below the dam encompass 206 and 354 square miles, respectively.

San Luis Rey River Valley Groundwater Basins underlie an east-west-trending alluvium-filled valley located along the western coast of San Diego County. The major hydrologic feature is the San Luis Rey River, which drains the valley overlying the basin. The basin is bounded on the east, northeast and southeast by the contact of alluvium with impermeable Mesozoic granitic and Pre-Cretaceous metamorphic rocks. In the northwest and southwest of the lower portion of the basin, alluvium is in contact with the semi-permeable Eocene marine deposits and Tertiary non-marine deposits. The basin is bounded on the west by the Pacific Ocean. The watershed includes Mission Basin, Bonsall Basin, Moosa Canyon Basin, Pala Basin, Pauma Basin and Warner Basin.

Mission Basin

The Mission Basin lies almost entirely within the limits of the City of Oceanside and extends upstream from the Pacific Ocean to just past Oceanside's eastern boundary and west of the Bonsall Bridge near the intersection of State Route (SR) 76 and SR 13. The basin is alluvial and unconfined in the central and eastern areas; while there is unconfined alluvium overlying semi-confined alluvium in the western areas. The volume of groundwater currently in storage within the alluvial aquifers (shallow and deep) in the Mission Basin is estimated to be 54,000 AF. The volume of unused storage within the alluvium (occurring between the water table-and the ground surface) was estimated to be 9,000 AF. The amount of this storage that is unusable has not been determined.

Bonsall Basin

The Bonsall Groundwater Basin is located east and upstream of the Mission Basin. It is generally located within unincorporated areas of San Diego County. The Bonsall Groundwater

Basin extends eastward from the Bonsall Bridge to a point approximately one mile west of the intersection of Rice Canyon Road and SR 76. The basin is alluvial and unconfined.

Moosa Canyon Basin

This basin is south and tributary to Bonsall Basin.

Pala/Pauma Basins

These are unconfined alluvial basins to the east of the Bonsall Basin.

Warner Basin

This groundwater basin underlies the Warner Valley and Valle de San Jose, the upper drainage of the San Luis Rey River in northeastern San Diego County. The basin is bounded on the west by Lake Henshaw and the Elsinore fault and on all other sides by impermeable crystalline rocks of the Peninsular Ranges.

The principal water bearing deposits within the San Luis Rey River Basins are Quaternary and younger alluvium. The most productive materials are the sands and gravels. Well yields can exceed 2,000 gpm and average 500 gpm. Thickness of these deposits varies in the basin with an average thickness of 200 feet.

San Dieguito River Basins

The San Dieguito River watershed is a drainage area of approximately 346 square miles that includes portions of the cities of Del Mar, Escondido, Poway, San Diego, and Solana Beach, and unincorporated San Diego County. The watershed includes the San Dieguito Valley Basin, the San Pasqual Valley Basin, and the Santa Maria Basin.

San Dieguito Valley Basin

The San Dieguito Valley Basin is an alluvial groundwater basin that occupies the Lower San Dieguito River Valley west of Lake Hodges, and extends inland approximately six miles from the Pacific Ocean. The basin underlies the cities of Del Mar, Solana Beach and San Diego, and the County of San Diego. In the past, the basin provided a local source of water for both agricultural and domestic activities. However, the construction of Lake Hodges Dam significantly reduced natural recharge to the groundwater basin. Lake Hodges is a 33,550 AF reservoir owned and operated by the city of San Diego. This, coupled with periodic drought and increased local pumping has, in the past, resulted in an extreme lowering of the groundwater table, seawater intrusion, and increased salinity levels in the groundwater. The San Dieguito Valley basin is estimated to have a storage capacity of 50,000. It is unclear how much groundwater is currently in storage.

San Pasqual Valley Basin

The San Pasqual Basin is located in the northern portion of the City of San Diego, along the San Dieguito River upstream of Lake Hodges, between the City of Escondido to the north and the Community of Rancho Bernardo and the City of Poway to the south. The City of San Diego reports that the San Pasqual Basin is unconfined and that the basin surface area is approximately 5,064 acres. According to DWR, the groundwater basin underlies the San Pasqual Valley and the Cloverdale, Rockwood and Bandy Canyons. The basin is bounded by Lake Hodges on the west and otherwise nonwater-bearing rocks of the Peninsular Ranges. Metcalf & Eddy notes that the most common estimate for total groundwater storage capacity is 58,000 AF.

The majority of the San Pasqual Basin is owned and managed by the City of San Diego Water Department. Additionally, the City of San Diego owns the rights to the underlying groundwater basin. As a designated agricultural preserve, the San Pasqual Valley is sparsely populated. The San Diego Wild Animal Park operates in the valley through a lease agreement with the city.

Santa Maria Basin

The Santa Maria Basin underlies the Santa Maria Valley in central San Diego County. The basin is bounded by impermeable crystalline rocks. The valley is drained by Santa Maria Creek, a tributary to San Dieguito River. Total storage capacity of the basin is estimated to be 77,000 AF. Storage capacity for the alluvium is estimated at about 3,360 AF and for the residuum (bedrock that has weathered in place) is about 32,400 AF for a total storage capacity of 36,000 AF.

Safe Yield/Long-Term Balance of Recharge and Discharge

Central San Diego County is relatively dry with average precipitation of 9.09 inches per year. **Figure 22-2** presents the historical precipitation from the Oceanside Marina. Extremely dry years occurred in 1989, 1994, 1999, and 2002. Fairly wet years occurred in 1993 and 1998. Primary sources of recharge in these basins are from surface water infiltration in the river bottoms.

Lower Santa Margarita River Basins

As shown in **Table 22-2**, the safe yield of the Lower Santa Margarita River Basins is estimated at 5,400 to 16,700 AFY (Camp Pendleton, 2006).

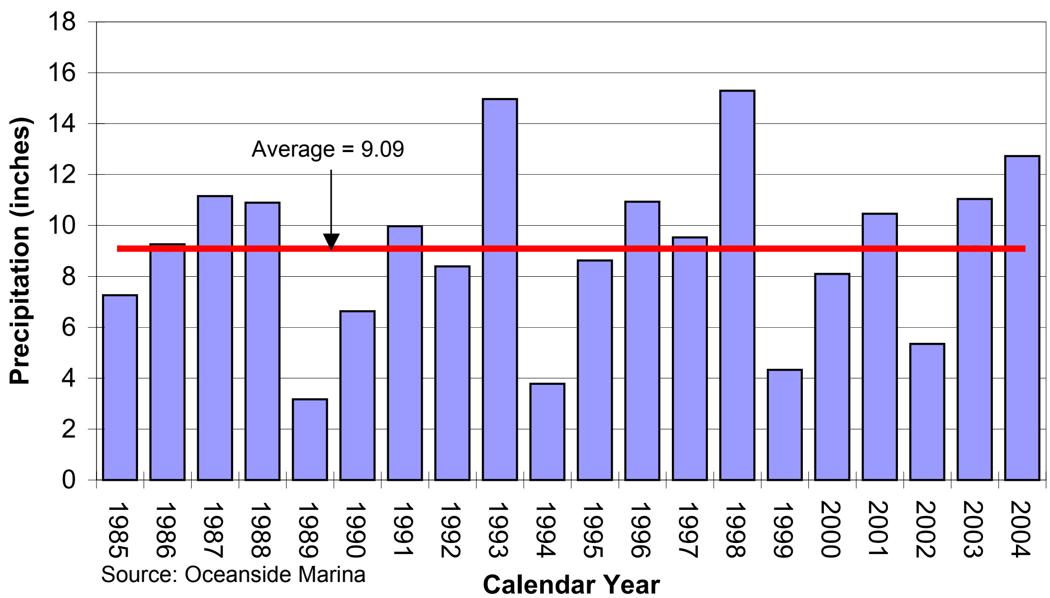
San Luis Rey River Valley Basins

The San Luis Rey Valley groundwater basins are recharged by imported irrigation water applied on upland areas and by storm-flow in the San Luis Rey River and its tributaries. Movement of groundwater in the alluvial aquifer is westward towards the Pacific Ocean. The estimated sustainable yield of the San Luis Rey River Basins without groundwater management totals is estimated to be approximately 25,400 AFY to 38,400 AFY.

San Dieguito River Basins

The estimated sustainable yield of the San Dieguito River Basins without groundwater management is presented in **Table 22-2**. Estimates of safe yield range from 14,230 to 17,310 AFY for the San Dieguito River Basins.

Figure 22-2
Historical Precipitation in the Central San Diego County



GROUNDWATER MANAGEMENT

The following section describes how the Lower Santa Margarita River Basin, the San Luis Rey River Basins, and the San Dieguito River Basins are currently managed.

Basin Governance

The following describes the management structure within the Lower Santa Margarita River Basins, the San Luis Rey River Basins, and the San Dieguito River Basins. A summary of the management agencies in the Central San Diego County Basins is shown in **Table 22-3**.

Lower Santa Margarita River Basins

The Lower Santa Margarita River Basins are adjudicated. The basin constraints and limitations are related to various state permits, rights, and licenses. There are various federal and state court judgments and decisions, as well as pre-1914 water rights. Also, there are pending lawsuits in state and federal courts concerning water rights and stream flows in the Santa Margarita River watershed.

Table 22-3
Summary of Management Agencies in the Central San Diego County Basins

Agency	**Role**
Lower Santa Margarita River Basins	
Santa Margarita River Watershed Watermaster	Court-appointed Watermaster for oversight and administration of water rights
Santa Margarita River Watershed Watermaster Steering Committee	Assist the Court and Watermaster in administering the water rights
Camp Pendleton	Operation of recharge facilities and Red Beach seawater barrier.
San Luis Rey River Basins	
San Luis Rey Watershed Council	Develop and implement a comprehensive resource management plan for the San Luis Rey River and its tributaries
San Dieguito River Basins	
San Dieguito Basin Task Force	Evaluating the feasibility of groundwater management and a 4,000 to 8,000 AFY conjunctive use project in the lower San Dieguito basin.
City of San Diego	AB3030 Groundwater Management Plan in San Pasqual Basin will be considered for adoption in September 2007. Evaluating the feasibility of 10,000 AFY of conjunctive use in San Pasqual Basin. Evaluating the feasibility of 5,000 AFY of brackish desalination facility in San Pasqual Basin.

In March 1989, the Court appointed a Watermaster to administer and enforce the provisions of the Modified Final Judgment and Decree entered on April 6, 1966 by the U.S. District Court in the United States v. Fallbrook Utility District, et al. (Civil No. 1247-SD-T) and subsequent orders of the Court. Also in 1989, the Court also appointed a Steering Committee that is currently comprised of representatives from the United States, Eastern Municipal Water District (EMWD), Fallbrook Public Utility District, Metropolitan, the Pechanga Band of Luiseño

Indians, and Rancho California Water District (RCWD). The purposes of the Steering Committee are to assist the Court and the Watermaster in administering the water rights.

The United States Bureau of Reclamation (USBR) is currently conducting a study on a conjunctive use project that is to provide a "physical solution" to the Federal lawsuit between Camp Pendleton and Fallbrook Public Utilities District. The project will also provide an emergency delivery system for imported water to Camp Pendleton, while allowing Camp Pendleton to meet its domestic, agricultural, and military water needs.

San Luis Rey River Valley Basins

The San Luis Rey River Valley Basins are unadjudicated. There is no established governance structure regulating the groundwater basins within the San Luis Rey River watershed. There is the San Luis Rey Watershed Council – a partnership of local landowners, agricultural growers, Native American bands, community and environmental organizations, government agencies and special districts – whose primary goal is to develop and implement a comprehensive resource management plan for the San Luis Rey River and its tributaries. The Council developed the "San Luis Rey Watershed Management Guidelines" document in 2000, to serve as the foundation for current and future San Luis Rey River management efforts. Council members identified and prioritized important issues for the river and outlined recommended actions for improving the health of the watershed. These guidelines will be revised and updated periodically to reflect the needs of the watershed.

San Dieguito River Basins

The San Dieguito River Basins are unadjudicated. There is no established governance structure regulating the groundwater basins within the San Dieguito River watershed. The San Dieguito Basin Task Force (composed of nine water supply and wastewater agencies) is currently evaluating the feasibility of groundwater management and a 4,000 to 8,000 AFY conjunctive use project in the lower San Dieguito Basin. The city of San Diego is preparing a groundwater management plan for the San Pasqual Basin.

Interactions with Adjoining Basins

There are no formal agreements governing flow between and among the Central San Diego County Basins.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Lower Santa Margarita River Basins, the San Luis Rey River Valley Basins, and the San Dieguito River Basins. Facilities include groundwater production wells, 114 acres of spreading basins, a seawater intrusion barrier operated by Camp Pendleton and a desalter operated by the City of Oceanside.

Active Production Wells

The following provides a description of the existing active municipal production wells in the Central San Diego County Basins. Data are summarized in **Table 22-4**.

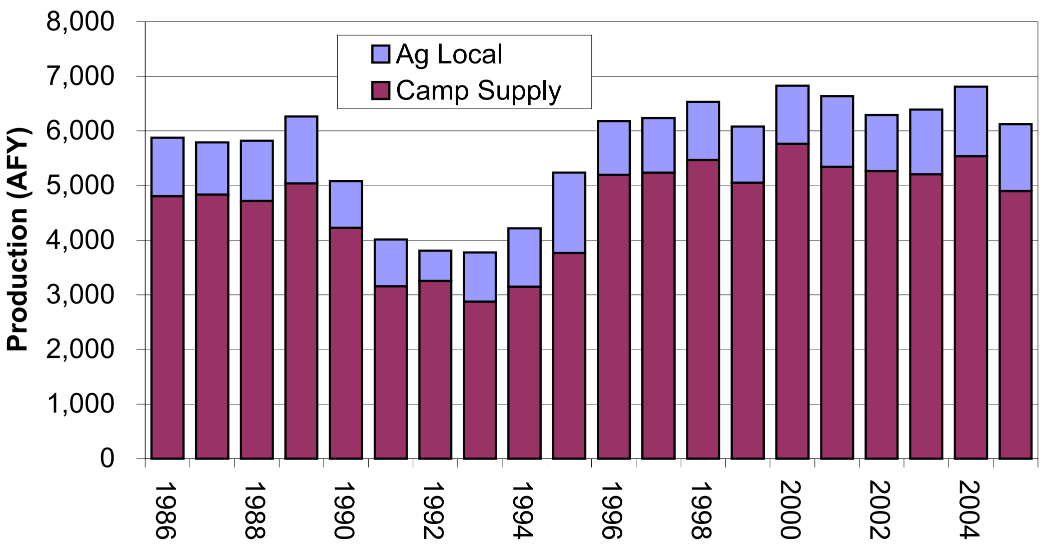
Lower Santa Margarita River Basins

According to Camp Pendleton, there are 15 wells in the Lower Santa Margarita River Basin, with 80 percent for domestic use and the remaining 20 percent of the production for agriculture.

The Santa Margarita River Watermaster reports the groundwater production for Camp Pendleton, as shown in **Figure 22-3**. This production excludes the adjacent Naval Weapons Station, which has received imported water from the Fallbrook Public Utility District since 1969.

Groundwater from the Upper Ysidora and Chappo Basins provides more than 90 percent of the supply of potable water for the southern portion of Camp Pendleton (groundwater outside the Lower Santa Margarita River Basin serves the northern portion of Camp Pendleton.). Camp Pendleton also uses groundwater from the Lower Ysidora Basin, primarily to irrigate agricultural lands leased to contracting agricultural businesses.

Figure 22-3
Historical Groundwater Production in the Lower Santa Margarita River Basin
Camp Pendleton



Source: Santa Margarita River Watermaster, 2006

San Luis Rey River Valley Basins

A summary of the principal use and the approximate annual use of groundwater by basin is shown in **Table 22-4**.

Table 22-4
Summary of Production in Central San Diego County Basins

<table>
<tr><th>Category</th><th>Number of Wells</th><th>Estimated Production Capacity (AFY)</th><th>Average Production (AFY)</th><th>Well Operation Cost ($/AF)</th></tr>
<tr><td>Lower Santa Margarita River Basins</td><td></td><td rowspan="21">Data not available</td><td></td><td rowspan="21">Data not available</td></tr>
<tr><td>Municipal</td><td>15</td><td rowspan="2">5,800</td></tr>
<tr><td>Private</td><td>0</td></tr>
<tr><td>San Luis Rey River Valley Basins</td><td></td><td></td></tr>
<tr><td>Mission Basin</td><td rowspan="17">Data not available</td><td></td></tr>
<tr><td>• Municipal</td><td>2,200</td></tr>
<tr><td>• Private</td><td>2,000</td></tr>
<tr><td>Bonsall Basin</td><td></td></tr>
<tr><td>• Municipal</td><td>0</td></tr>
<tr><td>• Private</td><td>2,500</td></tr>
<tr><td>Pala/Pauma Basin</td><td></td></tr>
<tr><td>• Municipal</td><td>2,700</td></tr>
<tr><td>• Private</td><td>5,000</td></tr>
<tr><td>Moosa Canyon</td><td>Unknown</td></tr>
<tr><td>Warner</td><td></td></tr>
<tr><td>• Municipal</td><td>7,000</td></tr>
<tr><td>• Private</td><td>Unknown</td></tr>
<tr><td>San Dieguito River Basins</td><td></td></tr>
<tr><td>San Dieguito Valley</td><td>2,500</td></tr>
<tr><td>San Pasqual Valley</td><td>4,000</td></tr>
<tr><td>Santa Maria</td><td>250</td></tr>
</table>

Sources: Camp Pendleton, 2006; SDCWA, 1997; Ramona Municipal Water District, Urban Water Management Plan, 2005; Vista Irrigation District, 2006; City of San Diego, 2006

San Dieguito River Basins

There are no active municipal water wells in the San Dieguito Valley Basin. There are no existing municipal production wells in the San Pasqual Valley Basin. The Ramona Municipal Water District (RMWD) owns three wells in the Santa Maria Basin with a capacity of 330 gpm and a potential yield of 200 AFY. The RMWD wells are currently not used due to high nitrates and will require recertification to place back in service. However, local landowners are using groundwater extensively. A summary of the principal use and the approximate annual use of groundwater by basin in the San Dieguito River watershed is shown in **Table 22-4**.

Other Production

There are an unknown number of private wells throughout the Central San Diego County Basins. Available production data are summarized in **Table 22-4**.

ASR Wells

There are no ASR wells in the Central San Diego County Basins.

Spreading Basins

There are approximately 65 acres of spreading basins in the Central San Diego County Basins.

Lower Santa Margarita River Basins

A Camp Pendleton off-channel surface water spreading system, in operation since 1960, replenishes water pumped from the groundwater basins. This existing system consists of a steel sheet pile diversion weir constructed across the Santa Margarita River and an earthen channel to convey river diversions to a series of five interconnected groundwater recharge ponds and to Lake O'Neill. Lake O'Neill is a 1,680 AF reservoir located on Fallbrook Creek, a minor tributary to the Santa Margarita River. Most of the water stored in the lake is diverted from the nearby Santa Margarita River. Information on these spreading basins is shown in **Table 22-5**.

Table 22-5
Summary of Spreading Basins in the Lower Santa Margarita River Basins

Recharge Basins	Area (acres)	Recharge Capacity (cfs)	Recharge Capacity (AFY)	Source Water	Owner
Pendleton Diversion Ponds	45	Data not available	4,000	River	Camp Pendleton

Source: Camp Pendleton; USBR, Santa Margarita River Conjunctive Use Project, Pre-Feasibility Plan Formulation Study, 2005

San Luis Rey River Valley Basins

There are no spreading basins within the San Luis Rey River Valley Basins.

San Dieguito River Basins

There are no spreading basins in the San Dieguito River Basins.

Seawater Intrusion Barriers

There is one seawater intrusion barrier in the Central San Diego County Basins. The details are discussed below.

Lower Santa Margarita River Basins

Camp Pendleton operates the Red Beach seawater barrier using recycled water. This barrier has six injection wells. Camp Pendleton reports that this barrier is in the process of being shut down with the effluent to be sent to a new tertiary treatment plant near the city of Oceanside.

San Luis Rey River Valley Basins

There are no seawater intrusion barriers in the San Luis Rey River Valley Basins.

San Dieguito River Basins

There are no seawater barriers in the San Dieguito River Basins.

Desalters

There is one desalter in the Central San Diego County Basins. The details of this facility are described below.

Lower Santa Margarita River Basins

There are no desalters in the Lower Santa Margarita River Basins.

San Luis Rey River Valley Basins

The City of Oceanside's current local water supply source is the Mission Basin Groundwater Purification Facility (MBGPF) where brackish groundwater is extracted and desalted. The MBGPF is currently producing about 3 MGD, with a planned expansion to 6.37 MGD.

San Dieguito River Basins

There are no desalters in the San Dieguito River Basins.

GROUNDWATER LEVELS

Groundwater in the Central San Diego Basins is generally shallow with depths to groundwater ranging from near the ground surface to about 100 feet. Limited water level data are available – available data for each basin is discussed below.

Lower Santa Margarita River Basins

Camp Pendleton measures groundwater levels at four wells on a monthly basis. Depth to water ranges from 10 to 100 feet. Camp Pendleton reports that the basin is successfully operating within the prescribed range of management levels.

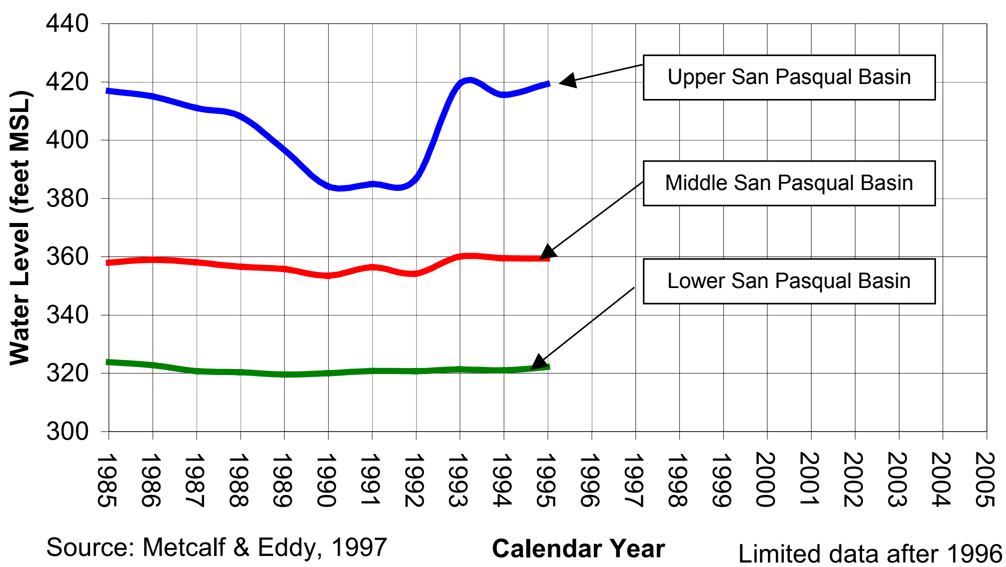
San Luis Rey River Valley Basins

Water levels in the basin declined drastically in the 1950s and 1960s due to groundwater development and over pumping. Since the advent of imported water sources, groundwater levels have risen to near pre-development levels and averages range from zero to 20 feet below land surface.

San Dieguito River Basins

The City of San Diego monitors the groundwater levels in nine wells in the San Pasqual Valley Basin. The historical groundwater levels for three of these wells are presented in **Figure 22-4**.

Figure 22-4
Historical Water Levels in the San Pasqual Valley Basin



GROUNDWATER QUALITY

The following section describes the water quality issues in the Central San Diego County Basins.

Groundwater Quality Monitoring

There is no formal groundwater quality-monitoring program for the Central San Diego County Basins. Wells are monitored as required under Title 22.

Groundwater Contaminants

Constituents of concern in the Central San Diego Basins include: total dissolved solids (TDS), magnesium, sulfate, chloride, fluoride, iron, manganese and selenium. Other constituents of regional concern including nitrate, volatile organic compounds (VOCs) and perchlorate are also summarized in **Tables 22-6, 22-7 and 22-8**.

Lower Santa Margarita River Basins

Constituents of concern for the Lower Santa Margarita River Basin are summarized in **Table 22-6**. Groundwater in the northwestern part of the basin is largely suitable for domestic and irrigation uses. Groundwater in the southwestern part of the basin is marginal to inferior for domestic and irrigation uses. Magnesium, sulfate, chloride, nitrate, and TDS concentrations are locally high for domestic use; whereas, chloride, boron, and TDS concentrations are locally high for irrigation use.

San Luis Rey River Valley Basins

Constituents of concern in the San Luis Rey River Valley Basins are shown in **Table 22-7**.

San Dieguito River Basins

Constituents of concern in the San Dieguito River basins are presented in **Table 22-8**.

Blending Needs

Data regarding blending needs are not available for the Central San Diego County Basins.

Groundwater Treatment

The following describes the groundwater treatment activities in the Central San Diego County Basins.

Lower Santa Margarita River Basins

Camp Pendleton operates iron and manganese treatment plants treating the groundwater used for municipal uses.

Table 22-6
Summary of Constituents of Concern in the Lower Santa Margarita River Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	325 to 1,260	In 1956, TDS concentrations ranged as high as 337 to 9,030 mg/l.
Nitrate (as N) Primary MCL = 10	mg/L	0.1 to 8	Meets drinking water standards
VOCs (TCE and PCE) Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	Data not available	Data not available
Perchlorate Notification level = 6	µg/L	ND	Perchlorate not detected
Magnesium No MCL	mg/L	23 to 39	Magnesium, sulfate, chloride, nitrate, and TDS concentrations are locally high for domestic use; whereas, chloride, boron, and TDS concentrations are locally high for irrigation use.
Sulfate Secondary MCL = 250	mg/L	100 to 400	
Chloride Secondary MCL = 250	mg/L	10 to 335	
Fluoride Primary MCL = 2	mg/L	0.11 to 6.4	

Source: USBR, 2005

Table 22-7
Summary of Constituents of Concern in San Luis Rey River Valley Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/l	168 to 3,400	TDS concentrations in the Mission Basin range from 500 to 2,000 mg/l. TDS concentrations in Bonsall Basin range from 600 to 3,400 mg/l. In Pala/Pauma Basins, TDS ranges from 200 to 900 mg/l. For Moosa Canyon Basin, TDS ranges from 650 to 1,380 mg/l. TDS in Warner Basin ranges from 168 to 638 mg/l.
Nitrate (as N) Primary MCL = 10	mg/l	Data not available	May not comply with Drinking Water Standards in Pala/Pauma Basins.
VOCs **(TCE and PCE)** Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	Data not available	Data not available
Perchlorate Notification level = 6	µg/L	ND	Perchlorate not detected
Iron Secondary MCL = 0.3	mg/l	Data not available	May not comply with Drinking Water Standards in Mission Basin.
Manganese Secondary MCL = 0.05	mg/l	Data not available	May not comply with Drinking Water Standards in Mission Basin.

Source: SDCWA 1997

Table 22-8
Summary of Constituents of Concern in the San Dieguito River Basins

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	320 to 27,000	TDS concentrations in the lower portions of the San Dieguito Basin range from 1,000 to 27,000 mg/l. In the San Pasqual Basin, TDS ranges from 600 to 2,500 mg/L. TDS concentrations in Santa Maria Basin range from 320 to 1,680 mg/L.
Nitrate (as N) Primary MCL = 10	mg/L	0.2 to 385	Nitrate found in Santa Maria Basin wells owned by Ramona Municipal Water District (RMWD) forced shutdown of wells. Nitrate found in San Pasqual Valley Basin.
VOCs **(TCE and PCE)** Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	Data not available	Data not available
Perchlorate Notification level = 6	µg/L	ND	Perchlorate not detected
Selenium Primary MCL = 50	mg/L	Data not available	Selenium found in Santa Maria basin wells owned by RMWD forced shutdown of wells.

Source: SDCWA, 1997; City of San Diego, 2006

San Luis Rey River Valley Basins

As described above, the city of Oceanside currently operates its Mission Basin Groundwater Purification Facility (MBGPF) that uses a reverse osmosis treatment process for desalination and for removal of iron and manganese. Oceanside is in the process of expanding the facility from three MGD to 6.37 MGD.

San Dieguito River Basins

Groundwater is not treated in the San Dieguito River Basins.

CURRENT GROUNDWATER STORAGE PROGRAMS

The following describes the current groundwater storage programs in the Central San Diego County Basins.

Lower Santa Margarita River Basins

There are no groundwater storage agreements in the Lower Santa Margarita River Basins.

San Luis Rey River Valley Basins

There are currently no groundwater storage programs within the San Luis Rey groundwater basins. The Final Lower San Luis Rey River Valley Groundwater Storage and Recovery Feasibility Study (March 2005) completed for SDCWA identified the potential use of groundwater storage for the City of Oceanside, Carlsbad MWD, and Rainbow MWD.

San Dieguito River Basins

There are no groundwater storage agreements in the San Dieguito River Basins.

BASIN MANAGEMENT CONSIDERATIONS

The following provides a brief description of the basin management considerations.

Lower Santa Margarita River Basins

- The basin has high levels of iron and manganese requiring treatment for potable use. According to Camp Pendleton, the base pumps only the amount needed to satisfy demand and facility needs have been factored into the estimate of useable storage capacity.

San Luis Rey River Valley Basins

- High TDS levels are found in the groundwater of all the basins, with lower groundwater TDS values found in certain areas of some of the basins allowing for domestic use. Still, many locations may require desalination treatment prior to use as a domestic water supply. The City of Oceanside operates a groundwater desalination facility (Mission Basin Groundwater Purification Facility.)

- Recharge is primarily limited to streambeds as there are no spreading basins. It is unclear if basins could be readily replenished, through natural or artificial means to allow increased pumping under conjunctive use programs.

San Dieguito River Basins

- There are high TDS levels in all three basins and high nitrate and selenium levels in the Santa Maria Basin that limit municipal use without some form of treatment.

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San Pasqual Valley Groundwater Basin: Website: http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/9-10.pdf Accessed 6/27/07.
San Maria Valley Groundwater Basin: Website: http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/9-11.pdf Accessed 6/27/07.
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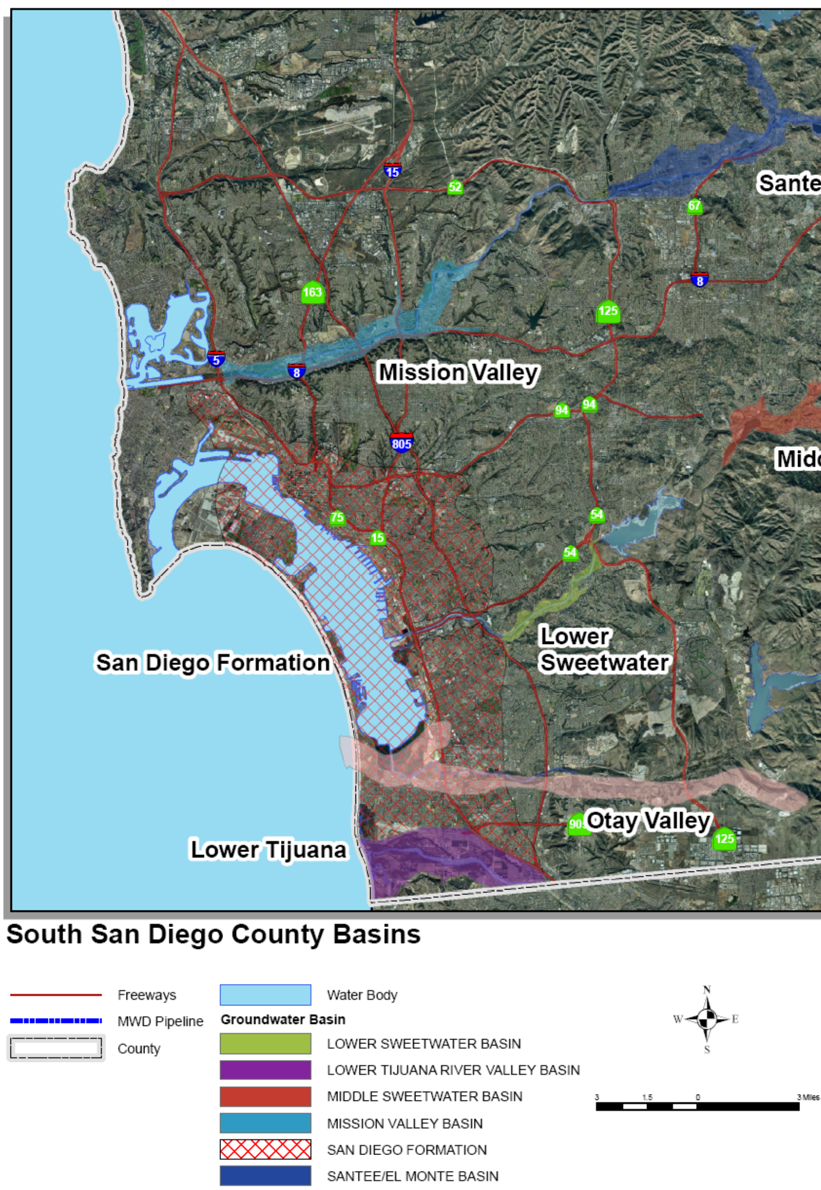
The groundwater basins in south San Diego County discussed in this section include: Lower Sweetwater Basin, Middle Sweetwater Basin, San Diego Formation, Santee-El Monte Basin, Mission Valley Basin, Otay Valley Basin, and Lower Tijuana River Valley Basin. Because available data are limited for several of the smaller basins, basin descriptions are combined where applicable. The South San Diego County Basins underlie the service area of the San Diego County Water Authority (SDCWA). A map of the South San Diego County Basins is presented in **Figure 23-1**.

Figure 23-1
Map of the South San Diego County Basins



Source: SDCWA

BASIN CHARACTERIZATION

The following section provides a physical description of the Sweetwater Basins, the San Diego Formation, and the Santee-El Monte Basin including its geographic location and hydrogeologic character.

Basin Producing Zones and Storage Capacity

Table 23-1 provides a summary of hydrogeologic parameters of the South San Diego County Basins. Each basin is discussed separately in the following section.

Sweetwater Basins-San Diego Formation

The Sweetwater Basins underlie an alluvial valley of the Sweetwater River that empties into the San Diego Bay near the cities of National City and Chula Vista. The basins include the Lower Sweetwater Basin and the Middle Sweetwater Basin. The San Diego Formation is part of a thick wedge of sediments that was deposited along the coast in the San Diego Bay area in southwestern San Diego County. The San Diego Formation is believed to be at least 1,000 feet thick in an area that underlies the cities of Imperial Beach, Chula Vista, and National City, and southern portions of the city of San Diego.

The Sweetwater Basins within the alluvial plain of the Sweetwater River are unconfined. The San Diego Formation is confined, with a basin ground surface area of 79,724 acres. San Diego County Water Authority estimates a groundwater storage capacity of 13,000 AF in the Lower Sweetwater Basin, 28,900 AF in the Middle Sweetwater Basin, and about 960,000 AF in the San Diego Formation. These values suggest a total storage capacity of about 973,000 AF for the Sweetwater Basins-San Diego Formation. DWR (1986) estimated that between 17,000 and 20,000 AF of groundwater was in storage. Based upon current understanding of the hydrogeology of the San Diego Formation, the usable and more cost-effective storage in the formation has been approximated to be on the order of 40,000 to 90,000 AFY.

Santee-El Monte Basin

The Santee-El Monte Basin is an unconfined groundwater basin located in the eastern portion of the San Diego River watershed near the cities of Santee, La Mesa, El Cajon, and Lemon Grove. The groundwater basin is comprised of commingling alluvial valleys of the San Diego River, San Vicente Creek, Forester Creek, Los Coches Creek, and Sycamore Canyon Creek.

The alluvial aquifer ranges in thickness up to 230 feet or more and is thickest in the eastern portion of the basin. In Santee, the alluvium thickness is limited, ranging from less than 10 feet to approximately 30 feet. According to Helix Water District (Helix WD), a water purveyor in the basin, numerous studies have been performed on the El Monte Basin with estimates of total storage capacity ranging from 18,000 to 50,000 AF. Other reports suggest a range from 70,000 to 97,000 AFY (Anchor Environmental, 2004). The basin yield during a drought period, with an initially full basin, was modeled to be approximately 24,000 AF.

Table 23-1
Summary of Hydrogeologic Parameters for South San Diego County Basins

Parameter	Sweetwater Basins and San Diego Formation	Santee-El Monte Basin	Other South San Diego County Basins
Structure			
Aquifer(s)	Sweetwater Basins Unconfined San Diego Formation Confined	Unconfined	Unconfined
Depth of groundwater basin	Up to 1,200 feet	Up to 405 feet	Data not available
Thickness of water-bearing units	Data not available	10 to 230 feet	
Yield and Storage			
Natural Safe Yield	Lower Sweetwater 2,400 AFY Middle Sweetwater 3,000 AFY San Diego Formation 3,000 to 5,000 AFY	3,000 to 4,000 AFY	Mission Valley 2,000 to 4,000 AFY Lower Tijuana River 5,000 to 6,800 AFY Otay Valley Unknown
Total Storage	Lower Sweetwater 13,000 AF Middle Sweetwater 28,900AF San Diego Formation 960,000 AF	18,000 to 57,000 AF	Mission Valley 40,000 to 42,000 AF Lower Tijuana River 50,000 to 80,000 AF Otay Valley Unknown
Unused Storage Space	Unknown	20,000 AF	Unknown
Portion of Unused Storage Available for Storage	Unknown	18,860 AF	

Source: Helix Water District, 2006; Sweetwater Authority, 2006; City of San Diego, 2006

Historically, agricultural users have been the greatest private consumers of groundwater in the basin. Since 1960, groundwater use in the basin has declined. A major reason for the decline in groundwater use is the shift in land use from predominantly agricultural and rural residential to urban land use, particularly in Santee and Lakeside and as water agencies began distributing imported water.

Other South San Diego County Basins

There are three other alluvial basins in the south county region: Mission Valley Basin, Otay Valley Basin, and the Lower Tijuana River Valley Basin that are smaller, with less groundwater development potential. Limited data are available for these basins.

The Mission Valley underlies an east-west trending valley, which is drained by the San Diego River to Mission Bay in the city of San Diego. Storage capacity estimates range from 40,000 to 42,000 AF (DWR, 2004).

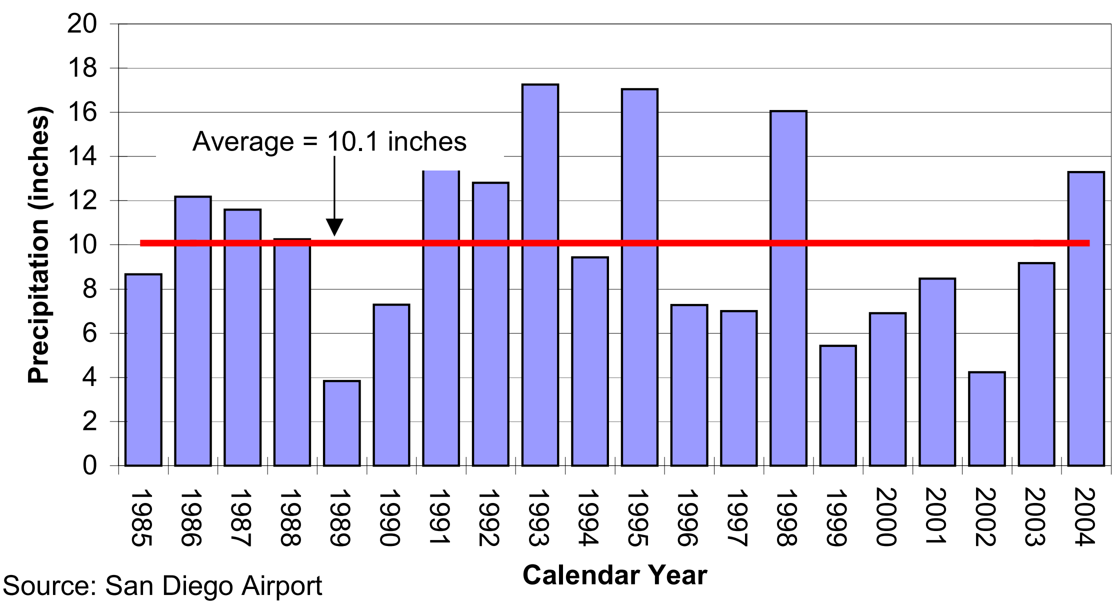
The Otay Valley is adjacent to the Pacific coast in southwestern San Diego County along the Otay River. Storage capacity is unknown.

The Lower Tijuana River Valley underlies the Tijuana River along the California-Mexico Border. Storage capacity is unknown.

Safe Yield/Long-Term Balance of Recharge and Discharge

South San Diego County is relatively dry with average precipitation of 10.1 inches per year. **Figure 23-2** presents the historical precipitation data from San Diego Weather Service Office (WSO) at Lindbergh Field. These data suggest below average precipitation in 1985, 1989, 1990, 1996, 1997, and the period from 1999 to 2003. Above average precipitation occurred in 1986, 1987, 1991 to 1993, 1995, 1998, and 2004.

Figure 23-2
Historical Precipitation in the South San Diego County Basins



Source: San Diego Airport

Sweetwater Basins-San Diego Formation

SDCWA reports the safe yield of the Lower Sweetwater Basin at 2,400 AFY, the Middle Sweetwater Basin at 3,000 AFY, and the San Diego Formation at 3,000-5,000 AFY.

Santee-El Monte Basin

The primary source of recharge to the Santee-El Monte Basin is infiltration from the San Diego River. Recharge to the alluvial aquifer is greatest in the eastern portion of the basin where precipitation is greater and runoff is generated on the steep bedrock slopes adjacent to the river valley. Based on water level trends, it was concluded that recharge occurs infrequently, during only the wettest periods. The most significant recharge only occurs in response to large spills from El Capitan and San Vicente Reservoirs. Numerous studies have been performed on the safe yield for the Santee-El Monte Basin. Estimates of safe yield range from 3,000 to 4,000 AFY.

Other South San Diego County Basins

The city of San Diego reports that the safe yield of the Mission Valley Basin is estimated at 2,000 to 4,000 AFY. Additionally, the city reports that the safe yield of the Lower Tijuana River Valley Basin is estimated at 5,000 to 6,800 AFY. Information was not available on the safe yield for the Otay Valley Basin.

GROUNDWATER MANAGEMENT

The following section describes the status of groundwater management in the Sweetwater Basins, the San Diego Formation and the Santee-El Monte Basin, and the smaller basins of Mission Valley, Otay Valley and Lower Tijuana River Valley.

Basin Governance

The following describes the governing structure within the Sweetwater and Santee-El Monte Basins.

Sweetwater Basins-San Diego Formation

The Sweetwater Basin and the San Diego Formation are unadjudicated and do not have an adopted groundwater management plan. However, these basins are managed by the Sweetwater Authority. The basin does not have a formal governance structure or process. There is a self-imposed constraint of limiting groundwater production so seawater intrusion and land subsidence does not occur. This is accomplished through the Sweetwater Authority Interim Groundwater Management Plan that was adopted in November of 2001.

Santee-El Monte Basin

The Santee-El Monte basin is an unadjudicated basin and there is no formal governance structure. There are no constraints or limitations imposed upon the basin's operation. The Santee-El Monte Basin is largely within the property owned by the Helix WD. In addition to potentially competing institutional interests, water rights issues are not resolved. The City of San Diego maintains Pueblo rights to the surface flow of the San Diego River and the associated "underground flow". Helix WD also claims long-standing rights to groundwater in the Santee-El Monte basin.

Other South San Diego County Basins

The city of San Diego reports that a conceptual Groundwater Management Plan has been prepared for the Mission Valley Basin and there is an adopted Groundwater Management Plan for the Lower Tijuana River Valley Basin. Information was not available on groundwater management in the Otay Valley Basin.

Table 23-2
Summary of Management Agencies in the Santee-El Monte Basin

<table>
<tr><th>Agency</th><th>Role</th></tr>
<tr><td>Helix WD</td><td>Primary producer from basin</td></tr>
<tr><td>City of San Diego</td><td>Maintain several wells for emergency supply</td></tr>
<tr><td>Riverview Water District</td><td rowspan="2">Use groundwater and imported supply. Agencies connect with Helix WD treatment plant</td></tr>
<tr><td>Lakeside Water District</td></tr>
</table>

Source: SDCWA Groundwater Report, 1997; Riverview Water District, 2005

Interactions with Adjoining Basins

There are no governing agreements regarding flow into or from the South San Diego County Basins.

WATER SUPPLY FACILITIES AND OPERATIONS

The following provides a summary of the facilities within the Sweetwater Basins, the San Diego Formation and the Santee-El Monte Basin.

Active Production Wells

The following provides a description of the existing active municipal production wells in the Sweetwater-San Formation and the Santee-El Monte Basins. Data are summarized in **Table 23-3**.

Table 23-3
Summary of Production Wells in the South San Diego County Basins

<table>
<tr><th>Category</th><th>Number of Wells</th><th>Estimated Production Capacity (AFY)</th><th>Average Production (AFY)</th><th>Well Operation Cost ($/AF)</th></tr>
<tr><td>Municipal Production</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Lower Sweetwater</td><td rowspan="3">13</td><td rowspan="3">Data not available</td><td rowspan="3">4,590</td><td rowspan="7">Data not available</td></tr>
<tr><td>Middle Sweetwater</td></tr>
<tr><td>San Diego Formation</td></tr>
<tr><td>Santee-El Monte Basin</td><td>18
(9 inactive)</td><td>0.7 cfs</td><td>1,600</td></tr>
<tr><td>Mission Valley</td><td colspan="2" rowspan="3">Data not available</td><td>807</td></tr>
<tr><td>Otay Valley</td><td>Data not available</td></tr>
<tr><td>Lower Tijuana River Valley</td><td>887</td></tr>
<tr><td>Other Production</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Lower Sweetwater</td><td colspan="2" rowspan="3">Data not available</td><td>900</td><td rowspan="4">Data not available</td></tr>
<tr><td>Middle Sweetwater</td><td>2,000</td></tr>
<tr><td>San Diego Formation</td><td>-</td></tr>
<tr><td>Santee-El Monte Basin</td><td>19</td><td>Data not available</td><td>4,000</td></tr>
<tr><td>Mission Valley</td><td colspan="4" rowspan="3">Data not available</td></tr>
<tr><td>Otay Valley</td></tr>
<tr><td>Lower Tijuana River Valley</td></tr>
<tr><td>Total Production</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sweetwater and S.D. Formation</td><td>13</td><td>Data not available</td><td>7,490</td><td rowspan="6">Data not available</td></tr>
<tr><td>Santee-El Monte</td><td>37</td><td>>0.7 cfs</td><td>5,600</td></tr>
<tr><td>Mission Valley</td><td colspan="2" rowspan="3">Data not available</td><td>807</td></tr>
<tr><td>Otay Valley</td><td>Data not available</td></tr>
<tr><td>Lower Tijuana River Valley</td><td>887</td></tr>
<tr><td>Total with available data</td><td>>50</td><td></td><td>14,784</td></tr>
</table>

Sources: Sweetwater Authority, 2006; Helix Water District, 2006; SDCWA Groundwater Report, 1997; City of San Diego, 2006

Sweetwater Basins-San Diego Formation

There are 13 municipals wells in the basin serving the cities of Chula Vista and National City and the unincorporated area of Bonita. The total production capacity of these wells is 16.4 cfs. At its National City wells, Sweetwater obtains fresh water from the San Diego Formation. At its Reynolds Groundwater Desalination Facility in Chula Vista, Sweetwater Authority extracts brackish water from the alluvium of the Sweetwater River, and from the San Diego Formation. Total average municipal production from the Lower Sweetwater, Middle Sweetwater, and San Diego Formation basins is reported at 4,590 AFY (Sweetwater Authority, 2006).

Santee-El Monte Basin

Prior to the importation of water into the San Diego region, Helix WD operated as many as a dozen wells in the El Monte Basin. When imported water became available, Helix WD reduced groundwater production from the basin to several hundred AFY. The final remaining Helix WD well, Well No. 100, failed in 1994. Helix WD constructed a new well, Well 101, to replace Well No. 100. The production goal for the new well is 400 to 500 AFY. Because of high concentrations of iron and manganese in the groundwater, Helix WD intends to blend the recovered groundwater with its surface water supply. Existing production is reported by Helix WD to be about 250 AFY.

Under an agreement between Helix WD and the city of San Diego, Helix WD maintains 10,000 AFY of surface water storage rights in the El Captain Reservoir. This same agreement, however, states that groundwater taken from the El Monte Basin by Helix WD is subtracted from the 10,000 AF of local runoff storage rights.

Other average municipal production in the Santee-El Monte basin includes Lakeside Water District at 1,000 AFY and Riverview Water District at 350 AFY (SDCWA, 1997). Thus, total average municipal production for the Santee-El Monte basin is estimated at 1,600 AFY.

Other Production

There are an indeterminate number of other wells in the South San Diego County Basins that serve agricultural, industrial and private users throughout the various basins. Known information from each basin is discussed below.

Sweetwater Basins-San Diego Formation

There are an unknown number of other wells serving agriculture, industrial, and domestic uses. The SDCWA estimates annual groundwater production at 900 AFY from the Lower Sweetwater Basin and 2,000 AFY from the Middle Sweetwater Basin.

Santee-El Monte Basin

According to Helix WD, there are 19 non-municipal wells in the Santee-El Monte Basin. These wells serve 90 percent private domestic, five percent industrial and five percent agricultural users. SDCWA reports this production at 4,000 AFY.

Mission Valley Basin, Lower Tijuana River Valley Basin, and Otay Valley Basin

The City of San Diego reports the average production in the Mission Valley Basin at 500 gpm, or 807 AFY, and the average production in the Lower Tijuana River Valley Basin at 550 gpm, or 887 AFY. Production information on the Otay Valley Basin was not available.

ASR Wells

There are currently no ASR wells in the South San Diego County Basins. However, future plans include the use of ASR wells. These future plans are discussed below.

Sweetwater Basins-San Diego Formation

There are currently no ASR wells in the Sweetwater Basins or the San Diego Formation. A 1999 report on aquifer storage and recovery in the San Diego Formation recommended four potential ASR projects for further study.

Santee-El Monte Basin

There are no ASR wells in the Santee-El Monte Basin. Helix WD is currently evaluating a put-and-take groundwater recharge project using recycled water on Helix-owned land.

Spreading Basins

The following section describes current spreading basin facilities in the Sweetwater and Santee-El Monte Basins.

Sweetwater Basins-San Diego Formation

There are no spreading basins in the Sweetwater Basins and San Diego Formation. Recharge is derived from the runoff of seasonal precipitation in the upper reaches of the Sweetwater River Valley, discharge from the Sweetwater Reservoir, and underflow from the reservoir. Subsurface flow may also contribute recharge.

Santee-El Monte Basin

No spreading grounds currently exist in the El Monte Basin. However, as part of Helix's proposed El Monte Groundwater Recharge Project, spreading basins are proposed.

Seawater Intrusion Barriers

There are no seawater intrusion barriers in the South San Diego County Basins.

Desalters

The following section describes the desalters in the South San Diego County Basins.

Sweetwater Basins-San Diego Formation

The Richard A. Reynolds Groundwater Desalination Facility, formerly known as a Demineralization Facility, uses reverse-osmosis treatment (RO) to remove dissolved salts and microscopic particles, such as bacteria and other contaminants which could be found in alluvial groundwater. The TDS of the feedwater is approximately 2,500 mg/L. Four alluvial wells and six deep formation wells, located along the north side of the Sweetwater River, provide source water for the facility. Whenever alluvial wells are in use, at least one formation well must operate for blending. The RO product water is blended with untreated well water to raise the TDS to prevent corrosion, and chlorine and ammonia are added to further assure disinfection. The facility, completed in 1999, can produce four million gallons of drinking water per day.

Santee-El Monte Basin

There are no desalters in the Santee-El Monte Basin.

GROUNDWATER LEVELS

Groundwater in the South San Diego County Basins is generally shallow with depths to groundwater ranging from less than five feet in the Santee-El Monte Basin to about 100 feet in the San Diego Formation. Limited water level data are available – available data for each basin is discussed below.

Sweetwater Basins-San Diego Formation

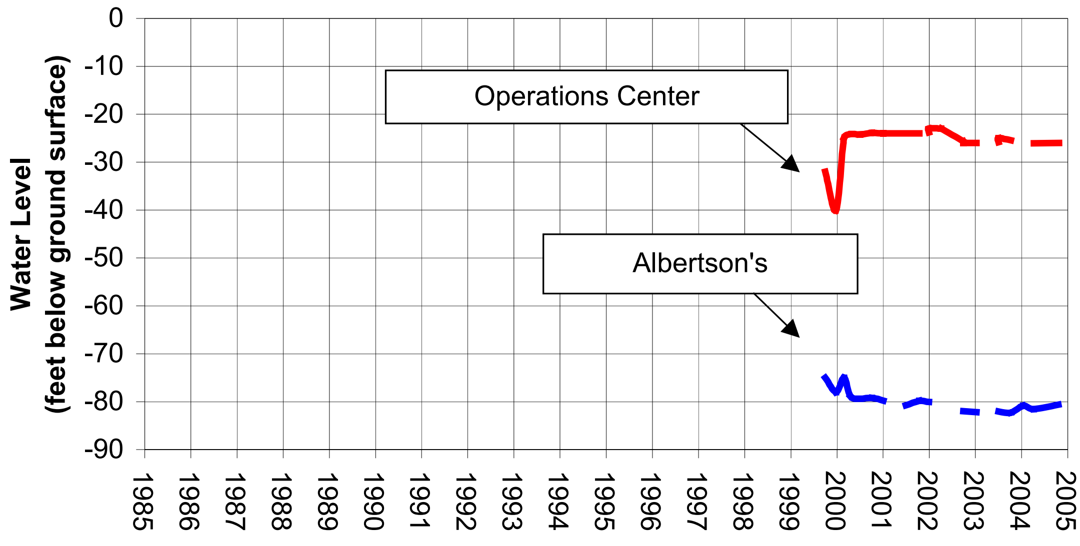
Historical analysis of groundwater level data by DWR showed that the groundwater surface in the early 1980s was relatively stable, and higher than in the years preceding 1959. This is attributed to decreased groundwater pumping due to the importation of Colorado River water. A study by the Sweetwater Authority indicates that water levels in production wells near National City have remained stable since about 1957. Groundwater flow follows surface flow of the Sweetwater River.

Basin water levels are closely monitored and managed by the Sweetwater Authority to avoid overpumping of the San Diego Formation. Sweetwater Authority monitors nine wells within the alluvial deposits of the Sweetwater Basins and seven wells in the San Diego Formation. Water levels in the San Diego Formation range from about 20 to 100 feet below ground surface (bgs). Historical groundwater levels monitored by Sweetwater Authority are shown in **Figure 23-3**.

Santee-El Monte Basin

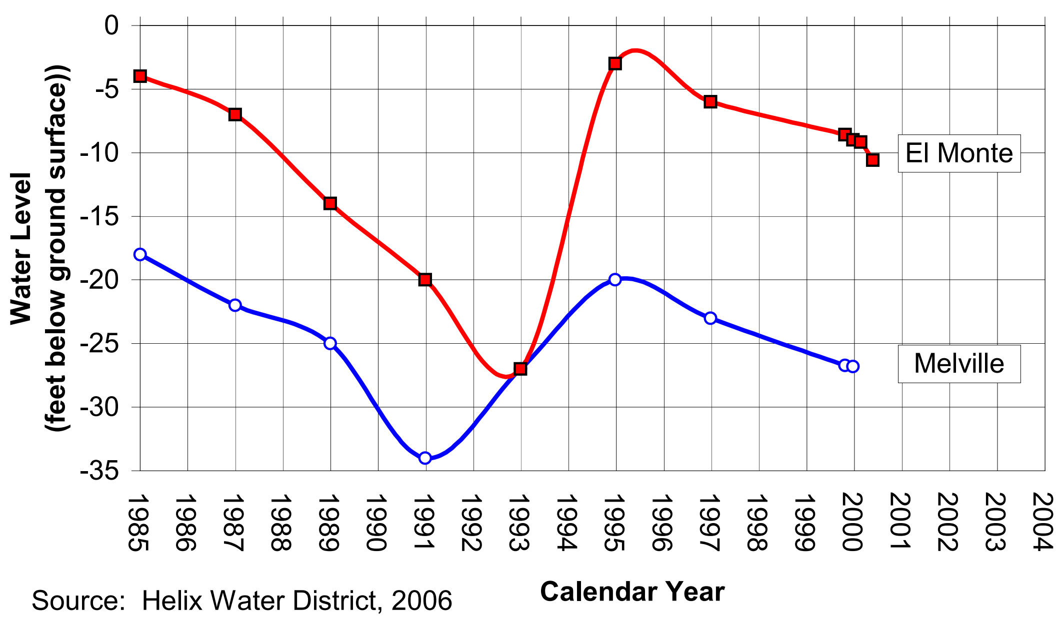
According to Helix WD, depth to groundwater in the Santee-El Monte Basin ranges from less than five to 70 feet bgs. Without recharge, water levels drop at a steady pace in the El Monte portion of the basin in response to pumping, evapotranspiration, and down gradient flow. Water levels in the Santee portion of the basin appear to be maintained over time due to urban runoff, sub-basin inflow from El Cajon and Sycamore Canyon, and groundwater flow from the east. Between 1984 and 1993, water levels gradually declined in response to below-average precipitation and ongoing pumping. In 1993, water levels rose to pre-1984 levels in response to above-average precipitation. Historical groundwater levels monitored by Helix WD are shown in **Figure 23-4.**

Figure 23-3
Historical Water Levels in the San Diego Formation



Source: Sweetwater Authority, 2006 Data not available prior to 1999

Figure 23-4
Historical Water Levels in the Santee-El Monte Basin



Source: Helix Water District, 2006

GROUNDWATER QUALITY

The following section describes the water quality issues in the Sweetwater Basins, San Diego Formation and the Santee-El Monte Basin.

Groundwater Quality Monitoring

Groundwater quality is monitored as required under Title 22. No additional monitoring program is utilized in the South San Diego County Basins.

Groundwater Contaminants

Constituents of concern in the South San Diego County Basins include: total dissolved solids (TDS), chloride, iron and manganese. Other constituents of regional concern including nitrate, volatile organic compounds (VOCs) and perchlorate are also summarized in **Tables 23-4 and 23-5**.

Sweetwater Basins-San Diego Formation

The San Diego Formation historically has been a brackish groundwater basin. The high TDS is not from overpumping, but is a characteristic of the groundwater when it was deposited in the formation. There are no maps on the extent and concentration of TDS in the San Diego Formation. Contaminants of concern are summarized in **Table 23-4**.

Santee-El Monte Basin

Contaminants of concern for the Santee-El Monte Basin are summarized in **Table 23-5**. Groundwater quality in the eastern portion of the Santee-El Monte Basin is excellent, with low TDS concentrations, and low concentrations of iron and manganese. Groundwater quality in the central portion of the Santee-El Monte Basin is variable. Groundwater TDS concentrations range from 500 to 900 mg/L in this portion of the basin. Iron and manganese treatment is required in this area with concentrations exceeding secondary drinking water standards. Nitrate concentrations in the central portion of the basin also exceed drinking water standards with maximum concentrations of 17.8 mg/L (Regional Board, 2006). Groundwater quality in the western portion of the Santee-El Monte Basin contains high concentrations of TDS (~3,000 mg/L). Treatment is required in this area to meet drinking water standards.

Other South San Diego County Basins

Groundwater quality in the Mission Valley, Otay Valley and Lower Tijuana Basins is generally poor. Groundwater quality in the Mission Valley Basin is generally poor with concentrations of TDS ranging from 520 to 4,089 mg/L, chloride concentrations ranging from 80 to 1,640 mg/L, sulfite concentrations ranging from 68 to 607 mg/L, and nitrate concentrations ranging from 0 to 105 mg/L (City of San Diego, 2006). Groundwater quality in the Lower Tijuana River Valley Basin also has poor quality as the basin experiences problems with seawater intrusion. In this basin, TDS concentrations range from 379 to 1,749 mg/L and chloride concentrations range from

83 to 650 mg/L (City of San Diego, 2006). Groundwater in the Otay Valley is fair to poor with concentrations of TDS ranging from 500 to 2,000 mg/L (DWR, 2004).

Blending Needs

There is no blending in the Sweetwater, Santee-El Monte Basins, or other South San Diego County Basins.

Groundwater Treatment

As discussed above, treatment is required for TDS, iron and manganese.

Table 23-4
Summary of Constituents of Concern in the Sweetwater Basins-San Diego Formation

Constituent	Units	Range		Description
		Sweetwater Basins	San Diego Formation	
TDS Secondary MCL = 500	mg/L	300 to 50,000	600 to 1,600	Data from 13 public supply wells shows TDS concentration ranging from 600 to 3,320 mg/L, with an average of approximately 2,114 mg/L. Groundwater in the alluvium of the Sweetwater Basins is of a sodium-calcium chloride character.
Nitrate (as N) Primary MCL = 10	mg/L	ND to 1.2	ND	Nitrate concentrations are low in this basin
VOCs **TCE and PCE** Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	ND	ND	VOCs not detected in this basin
Perchlorate Notification level = 6	µg/L	ND	ND	Perchlorate is not detected in this basin.
Chloride Secondary MCL = 250	mg/L	692 to 1,192	359 to1,590	Generally exceeds the recommended limits for drinking water.

Source: DWR, Bulletin 118, updated 2004; Regional Board, 2006

Table 23-5
Summary of Constituents of Concern in the Santee-El Monte Basin

Constituent	Units	Range	Description
TDS Secondary MCL = 500	mg/L	260 to 2,870	Groundwater quality in the basin is generally good in the eastern portion of the basin (<1,000 mg/L TDS) and generally poor in Lakeside and Santee (~ 3,000 mg/L TDS).
Nitrate (as N) Primary MCL = 10	mg/L	ND to 17.8	Concentrations in 4 wells exceed nitrate MCL in central portion of basin.
VOCs **TCE and PCE** Primary MCL for TCE = 5 Primary MCL for PCE = 5	µg/L	ND to 2.2 for PCE ND for TCE	Concentrations do not exceed drinking water standards
Perchlorate Notification level = 6	µg/L	ND	Perchlorate is not detected in any known well.
Iron Secondary MCL = 0.3	mg/L	ND to 4.4	Iron concentrations exceed secondary drinking water standards in central portion of basin
Manganese Secondary MCL = 0.05	mg/L	ND to 6.02	Manganese concentrations exceed secondary drinking water standards in central portion of basin

Sources: DWR, Bulletin 118, updated 2004; SDCWA, Groundwater Management Planning Study, Santee-El Monte Basin, Phase III Report, 2001; Regional Board, 2006

In general, VOCs and perchlorate are not detected in the Santee-El Monte Basin.

Sweetwater Basins-San Diego Formation

Sweetwater Authority provided information on groundwater treatment and associated costs as shown in **Table 23-6**.

Table 23-6
Summary of Groundwater Treatment in the Sweetwater Basins-San Diego Formation

Treatment Type	Number of Wells	Constituents(s) of Concern	Treatment Target	Treatment Cost ($/AF)	Amount Treated (AFY)
Reverse Osmosis	10	TDS	500 mg/L	$430	2,000

Source: Sweetwater Authority, 2006

Santee-El Monte Basin

Well production from Helix WD's municipal production well is connected to an imported water pipeline that delivers raw water to their R.M. Levy Water Treatment Plant. All water (imported and blended groundwater from the municipal well) is treated at the R.M. Levy Water Treatment Plant to meet drinking water maximum contaminant levels (MCLs.)

Iron and manganese treatment groundwater treatment facilities in the Santee-El Monte Basin were online in 1996.

CURRENT GROUNDWATER STORAGE PROGRAMS

The following section describes the current groundwater storage programs in the South San Diego Basins.

Sweetwater Basins-San Diego Formation

There are no groundwater storage agreements in the basins.

Santee-El Monte Basin

There are currently no groundwater storage programs in the Santee-El Monte basin. The Padre Dam Municipal Water District (PDMWD) and Helix WD have investigated a groundwater conjunctive use program that could develop approximately 8,500 AFY of potable water supply from the basin by groundwater recharge with PDMWD reclaimed water and a program of injection/recharge wells for imported water developing approximately 1,300 AFY of potable water supply.

BASIN MANAGEMENT CONSIDERATIONS

The following section describes the basin management considerations for the South San Diego Basins.

Sweetwater Basins-San Diego Formation

- There are no pumping limitations relating to the use of additional available storage capacity in the Sweetwater Basins or the San Diego Formation. However, water quality is fair to poor and limits the ultimate use of this basin.

Santee-El Monte Basin

- As an unadjudicated basin, there are no constraints or limitations imposed on the basin's operation. The potential for groundwater storage and production from the Santee portion of the aquifer is extremely limited due to the limited ability to store and transmit water as well as poor water quality. The eastern portion of the basin was found to have the thickest alluvial deposits and the greatest recharge rates. Based on this observation and the modeling simulations, it appears that the greatest potential for groundwater storage and development projects are in the eastern portion of the basin, particularly in El Monte, where groundwater storage is the greatest and TDS is low.

Other South San Diego County Basins

- The ability to store and extract water in the South San Diego County Basins is limited primarily by water quality. As such, there are virtually no municipal supply wells in these basins.

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CHAPTER IV

GROUNDWATER BASIN REPORTS

OTHER BASINS

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The following section provides a brief description of groundwater basins within the Metropolitan service area, which because of limited available data or groundwater resources, are not covered in detail in this report. These basins include:

Los Angeles County

- Spadra Basin
- Malibu Valley Basin

Orange County

- La Habra Basin

Ventura County

- Conejo Valley Basin
- Tierra Rejada Basin
- Thousand Oaks Basin (portion in Los Angeles County)
- Hidden Valley Basin
- Simi Valley Basin
- Russell Valley Basin (portion in Los Angeles County)

San Diego County

- San Marcos Basin
- Escondido Valley Basin
- Batiguitos Lagoon Basin
- San Elijo Valley Basin
- Poway Valley Basin
- El Cajon Basin

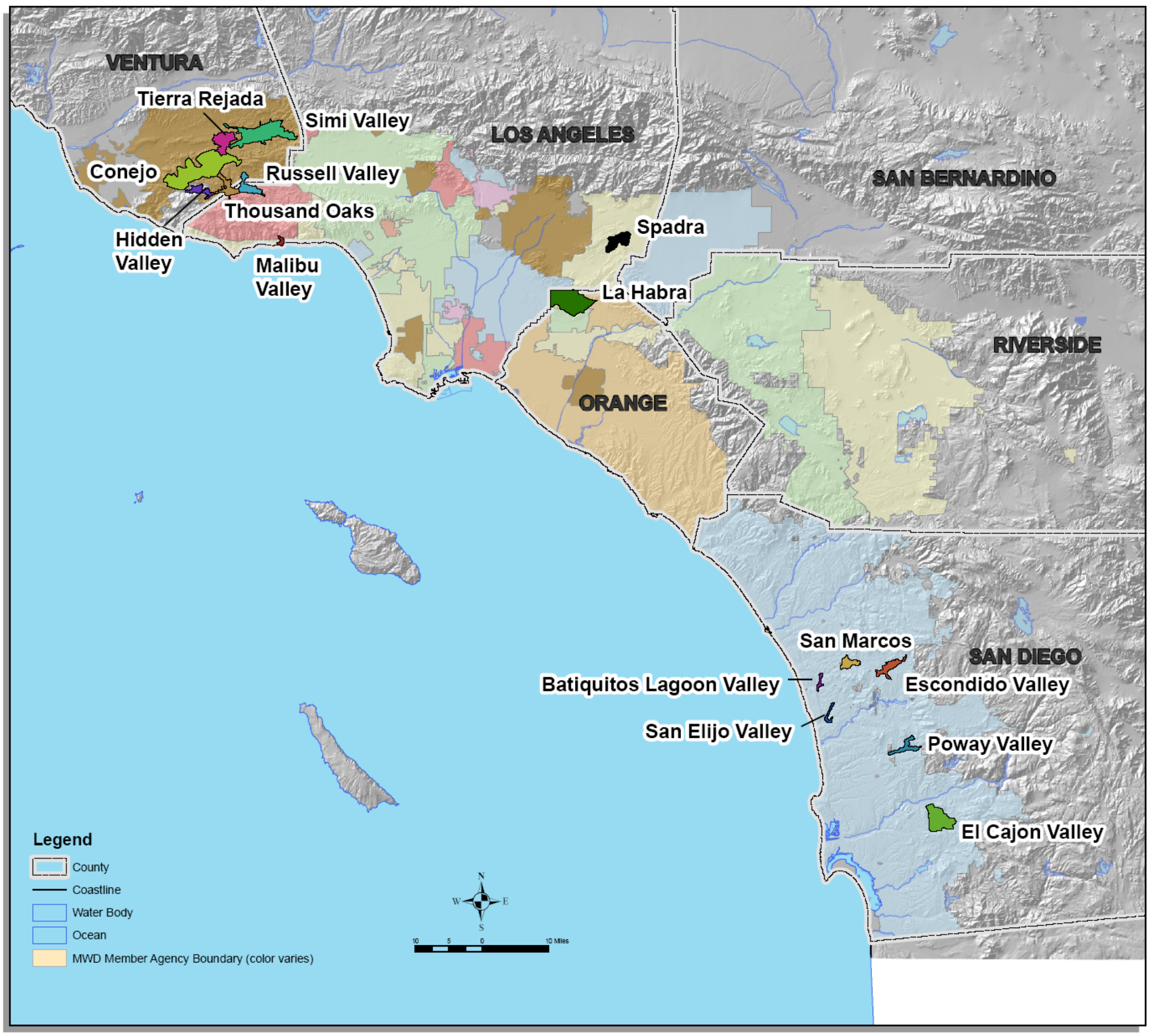
The locations of these basins are shown on **Figure 24-1**. Available data for each basin are summarized below.

SPADRA BASIN

The Spadra Basin is located in Los Angeles County south of the Six Basins within the city of Pomona. The Spadra Basin underlies the service areas of Metropolitan member agency Three Valleys Municipal Water District (Three Valleys MWD). The Spadra Basin is currently unmanaged. Primary producers are the City of Pomona and Cal-Poly Pomona. The conversion of agricultural land to urban in the Spadra Basin and the lining of San Jose Creek have limited groundwater recharge in the Spadra Basin. Estimated groundwater production capacity is approximately 1,500 AFY with an average production of 850 AFY (Three Valleys MWD, 2002b).

Based upon available water quality data from 1990 to 2002, concentrations of TDS and nitrate have been above applicable MCLs in the Spadra Basin. TDS concentrations during this period ranged from about 440 mg/L to 780 mg/L. Nitrate concentrations ranged from 1 mg/L to about 17 mg/L. Perchlorate, trichloroethylene (TCE) and tetrachloroethylene (PCE) have also been detected in various wells in this Basin. Maximum concentrations of perchlorate have been 11 μg/L (Regional Board, 2006). Water quality may limit the ability to store and extract water in this basin.

Figure 24-1
Map of Basins not Covered



MALIBU VALLEY BASIN

The Malibu Valley Basin is a small alluvial basin located along the Los Angeles County coastline in the Malibu area. The basin is within the service areas of West Basin MWD and Las Virgenes MWD and served by the Los Angeles County Department of Public Works (LACDPW). Groundwater occurs primarily in alluvial, beach and terrace deposits. In addition, groundwater may be present in some sandstone rock formations underlying the recent deposits (Malibu Bay Company, 2003). Thickness of the alluvium ranges from 90 to 140 feet (DWR, 2004). Groundwater is as shallow as five feet but increases inland. Prior to 1965, when imported water was introduced to the area, groundwater was the primary source of drinking water in the Malibu area. In the past, there were more than 30 private wells in the Malibu area. In addition, public water supply wells were operated by the Malibu Water Company and LACDPW. All known wells have been abandoned. Limited water quality data are available for this basin; however, historical data seem to suggest TDS concentrations of 1,310 mg/L and evidence for historical seawater intrusion (DWR, 2004). According to LACDPW, the Malibu Valley Basin lacks capability to produce sufficient water supplies and is not included in their water supply planning (LACDPW, 2005).

LA HABRA BASIN

The La Habra Basin is located in northern Orange County, north of the Orange County Basin, within the cities of La Habra and Brea. The La Habra Basin underlies Metropolitan member agencies Municipal Water Districts of Orange County (MWDOC) and the City of Fullerton. It comprises a shallow alluvial depression between the Coyote Hills and the Puente Hills. Little groundwater production occurs in the La Habra Basin due to low transmissivity and poor water quality (high total dissolved solids, or TDS, sulfates, nitrates and color). Potable groundwater production out of the basin has been about 1,200 AFY over the past several years by the City of La Habra. Treatment consists of air-stripping to remove hydrogen sulfide and addition of hexametaphosphate to sequester the iron and manganese; the City of La Habra has plans to expand production to a total of about 2,400AFY. (MWDOC, 2006). Hydrogeologic studies have indicated that 2,200 to 5,500 AFY of groundwater flows out of the La Habra Basin southerly into the Orange County Basin and westerly into Central Basin (OCWD, 2004). The basin is currently unmanaged.

CONEJO VALLEY BASIN

The Conejo Valley Basin underlies the Conejo Valley in southern Ventura County. It is within the service area of Calleguas Municipal Water District (Calleguas MWD). The Conejo Valley Basin is currently unmanaged. The primary water-bearing units are unconfined alluvium and the sedimentary and volcanic rocks of the Modelo, Topanga and Conejo Formations. Average yield is about 100 gpm and is used primarily for agricultural irrigation. The alluvium is generally only a few feet thick but can be up to 60 feet thick (DWR, 2004) and is not a significant source of groundwater. The sedimentary and volcanic rocks, the primary sources of groundwater, can reach a combined thickness of about 19,500 feet. Total storage capacity of this basin has been estimated to be about 7,106 AF (Panaro, 2000;DWR, 2004). In 1999, the available storage in this basin was estimated to be about 1,776 AF (Panaro 2000, DWR, 2004). Recent pumping was estimated to be less than 100 AFY (Panaro 2000; DWR, 2004). Available groundwater quality data suggest that the quality of the water produced from the sedimentary and volcanic units is generally poor. Future use of this basin is limited.

TIERRA REJADA BASIN

The Tierra Rejada Basin is near the headwaters of the Arroyo Santa Rosa in southern Ventura County. It is within the service area of Calleguas MWD. The Tierra Rejada Basin is currently unmanaged. The primary water-bearing units are unconfined alluvium and the sedimentary and volcanic rocks of the Modelo, Topanga and Conejo Formations. The alluvium is only found in the center of the basin and is estimated to be only about 25 thick and is not a significant source of groundwater (DWR, 2004). The sedimentary and volcanic rocks can reach a combined thickness of more than 8,500 feet. Average well yield is approximately 172 gpm. Total storage capacity of this basin is estimated be approximately 39,320 AF. In 1999, about 9,830 AF was available for storage (DWR, 2004; Panaro 2000). Annual production from wells is estimated to be about 1,500 AFY and is generally used for irrigation. According to DWR (2004), maximum TDS concentrations in 1996 were 930 mg/L and nitrate concentrations were 16 mg/L and high nitrate concentrations could occur locally in the basin.

THOUSAND OAKS BASIN

The Thousand Oaks Basin underlies a small valley between Lake Sherwood and Thousand Oaks in southeastern Ventura and western Los Angeles Counties. It is located with the service areas of Calleguas MWD and Las Virgenes Municipal Water District (Las Virgenes MWD). The Thousand Oaks Basin is currently unmanaged. Groundwater is generally found in the unconfined alluvium, although some groundwater is found in the underlying sedimentary rocks of the Modelo and Topanga Formations and fractures within the volcanic Conejo Formation. Total storage capacity of the basin is estimated to be about 130,000 AF (DWR, 2004) and had an available storage space in 1999 of about 17,000 AF (DWR 2004; Panaro, 2000). Groundwater quality is generally poor with TDS concentrations ranging from 1,200 to 2,300 mg/L (DWR, 2004). Municipal production is limited.

HIDDEN VALLEY BASIN

The Hidden Valley Basin underlies the Hidden Valley in southwestern Ventura County. It is within the service area of the Metropolitan member agency Calleguas MWD. The Hidden Valley Basin is unmanaged. The basin is bounded by the Santa Monica Mountains and drains into Sherwood Lake. Produced groundwater primarily comes from fractures with the volcanic rocks of the Conejo Formation and the overlying alluvium (DWR, 2004). Water level data suggest that the basin responds rapidly to precipitation. Water quality has been reported to be good to fair with TDS concentrations below 800 mg/L (DWR, 2004). Limited additional data are available for this basin.

SIMI VALLEY BASIN

The Simi Valley Basin underlies the Simi Valley in southeastern Ventura County. It is within the service areas of Metropolitan member agency Calleguas MWD. The Simi Valley Basin is unmanaged. The basin is bounded on the north and northeast by the Santa Susana Mountains and the Simi fault and on the south and southwest by the Simi Hills. The primary water-bearing unit is unconfined alluvium. The maximum thickness is estimated to be approximately 730 feet (DWR, 2004). Total estimated groundwater storage is approximately 180,000 AF (Panaro, 2000; DWR, 2004). Total space available in 1999 was estimated to be about 8,000 AF (Panaro, 2000; DWR, 2004). Pumping is estimated to be less than 5,500 AFY (Panaro, 2000; DWR, 2004). Based upon data from public supply wells between 1990 and 1998, the TDS of the groundwater within the Simi Valley Basin ranges from about 580 mg/L to 820 mg/L (Regional Board, 2006). According to DWR (2004), there are some problems with volatile organic compounds in shallower portions of the basin and TDS concentrations can reach up to 1,580 mg/L. Groundwater from the Simi Valley Basin is generally not utilized for municipal supply.

RUSSELL VALLEY BASIN

The Russell Valley Basin is a relatively small alluvial basin within northwestern Los Angeles and southern Ventura County. It underlies the service area of Metropolitan member agencies Calleguas MWD and Las Virgenes MWD. The basin is bounded by the Santa Monica Mountains to the north, south and east and the Thousand Oaks Basin to the west. The Russell Valley Basin is currently unmanaged. The primary water-bearing formation is unconfined alluvium but some groundwater is extracted from the underlying sedimentary and volcanic rocks of the Conejo Formation. The alluvium average about 35 to 55 thick (Las Virgenes MWD, 2005). It is estimated that the alluvium may have a total storage capacity of 11,000 AF (Las Virgenes MWD, 2005). Wells within the Conejo Formation typically yield about 200 to 400 gpm (Las Virgenes, 2005). Storage space available in the Conejo Formation is currently unknown but may range from 30,000 to 80,000 AF. Production from the Russell Valley Basin is estimated to be about 600 AFY (DWR, 2004) and is not used for municipal supply. The TDS concentrations in the Russell Valley Basin usually range from 800 to 1,200 mg/L but have also been reported to range from 400 to 2,800 mg/L. TDS and sulfate both exceed their MCL for some wells in the basin. Future utilization of this basin for municipal supply is limited.

SAN MARCOS VALLEY BASIN

The San Marcos Valley Basin is a small groundwater basin located in western part of central San Diego County. The basin underlies the service area of the San Diego County Water Authority (SDCWA). San Marcos Creek drains this valley southwestward into Lake San Marcos. The principle water bearing materials are weathered bedrock and alluvium, with the alluvium reaching a thickness of 175 feet (DWR 2004). The basin is unmanaged. Total storage capacity, groundwater in storage, and annual groundwater production are unknown. Wells in the basin yield as much as 60 gpm from the alluvium. The basin is recharged by percolation of rainfall and ephemeral stream flow, with some additional recharge potentially occurring from water applied to landscaping. TDS concentrations measured prior to 1967 ranged between 500 and 750 mg/L. Groundwater is suitable for domestic use and marginal irrigation in the northern part of the basin, but inferior in the south (DWR 1967).

BATIQUITOS LAGOON VALLEY BASIN

The Batiquitos Lagoon Valley Basin underlies Green Valley and San Marcos Creek Valley in the western part of central San Diego County, within the service area of SDCWA. San Marcos and Encinitas Creeks drain the valleys westward into Batiquitos Lagoon. The primary water-bearing unit is alluvium deposits that reach a maximum thickness of about 100 feet (DWR 1967). The basin is unmanaged. Total storage capacity, groundwater in storage, and annual groundwater production are unknown. Average TDS content is about 1,280 mg/L with a range from about 788 to 2,362 mg/L. The groundwater was rated inferior for irrigation because of high chloride content and marginal for domestic use because of high sulfate and TDS concentrations (DWR 1967).

SAN ELIJO VALLEY BASIN

The San Elijo Valley Basin is located in the western part of central San Diego County and underlies the service area of SDCWA. Escondido Creek flows occasionally through the upper northeast portions of the valley, discharging into San Elijo Lagoon. The primary water bearing units consist of alluvium and part of the sedimentary La Jolla Group. Well yields range from 10 to 1,800 gpm. Additionally, the Santiago Peak volcanics have well yields generally less than two gpm, but may reach 125 gpm (DWR 2004). The basin alluvium has an average thickness of less than 50 feet. The La Jolla Group has a maximum thickness of 1,650 feet (DWR 1967). Recharge of the alluvial aquifer is primarily from percolation in Escondido Creek, with return irrigation waters and water from residential use as additional recharge contributors. The basin is unmanaged. The total groundwater storage capacity and annual groundwater production are unknown. Groundwater in storage was estimated to be approximately 8,500 AF in 1983. TDS concentration ranges from 1,170 to 5, 090 mg/L, with concentrations lowest in the eastern part of the basin and increasing toward the west (DWR 2004).

ESCONDIDO VALLEY BASIN

The Escondido Valley Basin is located in central San Diego County and is within the service area of SDCWA. The valley is drained by Escondido Creek. The primary water-bearing deposits include alluvium and weathered bedrock. The alluvium, primarily confined to Escondido Creek, is probably not thick enough to be water bearing. Groundwater production is largely from the weathered bedrock, however, many wells extract groundwater from fractures in the underlying crystalline rocks (DWR 1967). Groundwater is generally found at less than 50 feet in depth (DRW 1967). The basin is unmanaged. The groundwater storage capacity is estimated at 24,000 AF (DWR 1975). Groundwater in storage as well as annual production is unknown. Well yields are as high as 190 gpm, averaging 50 gpm (DWR 1975). TDS content ranges from 250 to more than 5,000 mg/L (DWR 1967). Local sources of groundwater are categorized as suitable to inferior for domestic use, with the inferior water typically containing high nitrates, TDS, or sulfate content (DWR 1967).

POWAY VALLEY BASIN

The Poway Valley Basin is a small groundwater basin located in central San Diego County within the service area of SDCWA. The basin is drained by Poway and Los Panasquitos Creeks to the Pacific Ocean. The principal water-bearing units include alluvium and weathered bedrock. The alluvium thickness ranges from 10 to 75 feet, with an average of 40 feet. Weathered bedrock reaches about 70 feet in thickness (DWR 1967). A ridge of impermeable Santiago Peak Volcanics along the western basin boundary inhibits the flow of groundwater to the west and raises the water level in the western portion of the basin yielding a spring in the past. Natural recharge is from direct precipitation on the valley floor and infiltration along Poway Creek. Septic tank effluent and irrigation waters provide some recharge. Groundwater flow is generally to the west. The basin is unmanaged. Groundwater storage capacity and annual groundwater production are unknown. Stored groundwater was estimated at 2,330 AF. TDS content ranges from about 750 to 1,500 mg/L (DWR 1967). Water from one public well had a TDS content of 610 mg/L. The high chloride content results in marginal to inferior ratings for irrigation use in some parts of the basin (DWR 1967). A marginal rating for domestic use in some parts of the basin is due to high TDS content (DWR 1967).

EL CAJON BASIN

The El Cajon Basin is in southern San Diego County and within the service area of SDCWA. The basin is within the San Diego River watershed and the basin drains to the north to the San Diego River. Water-bearing materials in the basin include alluvium, the Poway Conglomerate, and an older underlying sandy siltstone unit (DWR 1986). In addition, water is produced from the underlying fractured crystalline rocks. The alluvium ranges to 50 feet thick, with wells yielding as much as 250 gpm (DWR 1986). The Poway Conglomerate ranges to more than 300 feet thick. The sandy siltstone to mudstone underlies the Poway Conglomerate and reaches a maximum of about 325 feet thick (DWR 1986). Recharge is from percolation of precipitation, with lesser contributions from underflow from underlying fractured crystalline rocks. Additional recharge is from return of applied irrigation water and percolation of septic tank effluent. Groundwater moves in a northwestward direction towards the San Diego River. The basin is unmanaged. Total basin capacity is estimated to be about 32,500 AF (DWR 1986). Stored groundwater was estimated in 1984 to be about 27,800 AF (DWR 1986). Subsurface outflow to the northwest is estimated to be 100 to 140 AFY (DWR 1986). Annual groundwater production is unknown. Well yields ranged to 250 gpm (DWR 1986). TDS concentrations range from 637 to 3,960 mg/L with an average value of 1,640 mg/L (DWR 1986). Water from one public well had a TDS of 2,340 mg/L. Groundwater analyzed in 1984 had nitrate concentrations up to 185 mg/L, with a mean concentration of 69 mg/L. Chloride concentrations ranged from 186 to 1,910 mg/L, with a mean concentration of 412 mg/L. Sulfate concentrations ranged from 78 to 680 mg/L, with a mean concentration of 345 mg/L (DWR 1986).

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APPENDICES

APPENDIX A

GROUNDWATER BASIN DESIGNATIONS

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Table A-1
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
Las Posas Valley	4-8	Ventura County Basins	West Las Posas East Las Posas South Las Posas	Basin boundaries of DWR and subbasin designations have been modified by studies performed by the USGS for the Fox Canyon GMA, Updated boundaries were used in this study.
Santa Clara River Valley	4.4.02		Oxnard Forebay Oxnard Plain	
Pleasant Valley	4-6		Pleasant Valley	
Arroyo Santa Rosa Valley	4-7		Santa Rosa	
San Fernando Valley	4-12	Upper Los Angeles River Area Basins	San Fernando Sylmar Verdugo Eagle Rock	Basin boundaries of DWR have been modified by the City of Los Angeles. Updated boundaries were used in this study.
Coastal Plain of Los Angeles County – Central Basin	4-11.04	Central Basin	--	DWR basin boundaries were used in this study.

Table A-1 (continued)
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
Coastal Plain of Los Angeles County – West Coast Basin	4-11.03	West Coast Basin	--	DWR basin boundaries were used in this study.
Coastal Plain of Los Angeles County – Santa Monica Basin	4-11.01	Santa Monica Basin	Arcadia Charnock Crestal Coastal Olympic	DWR basin boundaries were used in this study.
Coastal Plain of Los Angeles County – Hollywood Basin	4-11.02	Hollywood Basin	--	DWR basin boundaries were used in this study.

Table A-1 (continued)
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	BasinName(s) (This Study)	Comments
San Gabriel Valley	4-13	Main San Gabriel and Puente Basins	Main San Gabriel Puente	Basin boundaries of DWR were modified by the Main San Gabriel Watermaster. Updated boundaries were used in this study.
		Six Basins	Upper Claremont Lower Claremont Pomona Live Oak Canyon Ganesha	Basin boundaries of DWR have been modified by Three Valleys Municipal Water District. Updated boundaries were used in this study.
Raymond Basin	4-23	Raymond Basin	Monk Hill Pasadena Santa Anita	Basin boundaries of DWR have been modified by the Raymond Basin Management Board. Subbasin boundaries provided by the Raymond Basin Management Board Updated boundaries were used in this study.

Table A-1 (continued)
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
Coastal Plain of Orange County	8-1	Orange County Basin	Yorba Linda Main Irvine	Basin boundaries of DWR have been modified slightly by the Santa Ana Watershed Project Authority. Unlike the DWR boundary, the La Habra Basin was not included in the Orange County Basin in this study. Updated boundaries were used in this study.
San Juan Valley	9-1	San Juan Basin	--	Basin boundaries of DWR were used in this study.
Upper Santa Ana Valley – Chino Subbasin	8-2.01	Chino and Cucamonga Basins	Chino Cucamonga	Basin boundaries of DWR have been modified by the Chino Basin Watermaster. Updated boundaries were used in this study.
Upper Santa Ana Valley – Cucamonga Subbasin	8-2.02			

Table A-1 (continued)
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
Upper Santa Ana Valley – Riverside-Arlington Subbasin	8-2.03	Riverside Basin	Riverside North Riverside South	Basin boundaries of DWR have been modified by the Santa Ana Watershed Project Authority. Updated boundaries were used in this study.
		Arlington Basin	--	Basin boundaries of DWR have been modified by the Santa Ana Watershed Project Authority. Updated boundaries were used in this study.
Elsinore (Northern portion)	8-4	Temescal Valley Basins	Bedford Coldwater Lee Lake	Basin boundaries of DWR have been modified by the Santa Ana Watershed Project Authority. Updated boundaries were used in this study.
Upper Santa Ana Valley – Temescal Subbasin	8-2.09		Temescal	

Table A-1
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
Elsinore (Southern portion)	8-4	Elsinore Basin	--	Basin boundaries of DWR have been modified by the Santa Ana Watershed Project Authority. Updated boundaries were used in this study.
San Jacinto	8-5	West San Jacinto Basins	Perris North Perris South Lakeview Menifee San Jacinto Lower Pressure	Basin boundaries of DWR have been modified by Eastern Municipal Water District. Updated boundaries were used in this study.
		Hemet-San Jacinto Basins	Canyon San Jacinto Upper Pressure Hemet North Hemet South	Basin boundaries of DWR have been modified by Eastern Municipal Water District. Updated boundaries were used in this study.
Temecula Valley	9-5	Temecula-Murrieta Basin	--	Basin boundaries of DWR have been modified by Anchor Environmental Updated boundaries were used in this study.

Table A-1 (continued)
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
San Mateo	9-2	North San Diego Basins	San Mateo	Basin boundaries of DWR were used in this study for San Mateo and San Onofre Basins. Las Flores Basin boundaries provided by San Diego County Water Authority. Updated boundaries were used in this study.
San Onofre	9-3		San Onofre	
			Las Flores	
Santa Margarita Valley	9-4	Central San Diego Basins	Lower Santa Margarita	Basin boundaries of DWR have been modified slightly by the San Diego County Water Authority. Updated boundaries were used in this study.
San Luis Rey Valley	9-7		Mission Moosa Canyon Bonsall Pala Pauma	
San Dieguito Creek	9-12		San Dieguito	
Santa Maria Valley	9-11		Santa Maria	

Table A-1 (continued)
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
Warner Valley	9-8	Central San Diego Basins (continued)	Warner	Basin boundaries of DWR have been modified slightly by the San Diego County Water Authority. Updated boundaries were used in this study.
San Pasqual Valley	9-10		San Pasqual	
Mission Valley	9-14	South San Diego Basins	Mission	Basin boundaries of DWR have been modified slightly by the San Diego County Water Authority. Updated boundaries were used in this study.
San Diego River Valley	9-15		Santee-El Monte	
Sweetwater Valley	9-17		Middle Sweetwater Lower Sweetwater San Diego Formation	
Otay Valley	9-18		Otay Valley	
Tia Juana	9-19		Lower Tijuana	

Table A-1 (continued)
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin(s) (This Study)	Comments
San Gabriel Valley (Southeast portion)	4-13	Other Basins Not Covered	Spadra	Spadra Basin boundary provided by Three Valleys Municipal Water District.
Malibu Valley	4-22		Malibu Valley	Basin boundaries of DWR were used in this study.
Coastal Plain of Orange County	8-1		La Habra	Basin boundaries of DWR have been modified by the Santa Ana Watershed Project Authority. Updated boundaries were used in this study.
Conejo Valley	4-10		Conejo Valley	Basin boundaries of DWR were used in this study.
Tierra Rejada	4-15		Tierra Rejada	Basin boundaries of DWR were used in this study.
Thousand Oaks Area	4-19		Thousand Oaks	Basin boundaries of DWR were used in this study.

Table A-1
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
Hidden Valley	4-16	Other Basins Not Covered (continued)	Hidden Valley	Basin boundaries of DWR were used in this study.
Simi Valley	4-9		Simi Valley	Basin boundaries of DWR were used in this study.
Russell Valley	4-20		Russell Valley	Basin boundaries of DWR were used in this study.
San Marcos Area	9-32		San Marcos	Basin boundaries of DWR were used in this study.
Escondido Valley	9-9		Escondido Valley	Basin boundaries of DWR were used in this study.
Batiguitos Lagoon	9-22		Batiguitos Lagoon	Basin boundaries of DWR were used in this study.
San Elijo Valley	9-23		San Elijo Valley	Basin boundaries of DWR were used in this study.

Table A-1
Summary of Basin Designations

DWR Basin Name(s)	DWR Basin Number(s)	Basin Report Name (This Study)	Basin Name(s) (This Study)	Comments
Poway Valley	9-13	Other Basins Not Covered (continued)	Poway Valley	Basin boundaries of DWR were used in this study.
El Cajon	9-16		El Cajon	Basin boundaries of DWR were used in this study.

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APPENDIX B

SUMMARY OF GROUNDWATER BASIN MANAGEMENT

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Table B-1
Groundwater Basin Management

Groundwater Basin	Governance Type	Characteristics
Ventura County Basins Oxnard Plain, Oxnard Forebay, Santa Rosa, East, West, and South Las Posas Basins	Managed via 1982 State statute creating the Fox Canyon Groundwater Management Agency	Specifies the establishment of a representative board of directors to govern the Fox Canyon GMA. Specifies the scope of the GMA to planning, managing, controlling, preserving, and regulating the extraction and use of groundwater within it service territory, and may adopt ordinances to carry out these purposes. Statute recognizes conjunctive use of surface and groundwater and long-term storage of water in a groundwater basin. Requires the preparation and implementation of a groundwater management plan. The GMA adopted its Groundwater Management Plan in 1985 and updated the plan in 2006.
Upper Los Angeles River Area Basins	Adjudicated in 1979. Prior stipulated judgments from 1958 through 1965 are merged into the 1979 judgment	The judgment distinguishes the San Fernando, Sylmar, Verdugo and Eagle Rock basins, finds them to be separate basins and sets out separate and distinct rights within each basin. The judgment sets out the separate conditions of the basins with respect to overdraft and safe yield and sets out the rights of the parties to surface and groundwater. Judgment expressly recognizes stored water -- imported or reclaimed water that is intentionally spread or safe yield water that is stored in-lieu and provides for separate accounting and recapture subject to specific requirements. Judgment provides for appointment of a watermaster and specifies powers and duties of the watermaster. Judgment establishes an administrative committee.
Central Basin	Adjudicated in 1965 and amended in 1991	The judgment sets out the annual pumping rights of each of the parties; appoints DWR as watermaster; specifies the duties, powers and responsibilities of watermaster; provides for carryover of 20% of annual pumping rights for one year, or 35% carryover under the 'drought carryover' provisions; 20% overpumping to be paid back the following year, or prorated over the following 5 years under specified conditions; provides for an exchange pool wherein a right not used by one party can be made available to another. Judgment makes no provision for storage and recapture of stored water beyond the specified extraction right and specifies that 'no party…has any right to extract ground water from Central Basin except as herein affirmatively determined.'

Table B-1 (continued)
Groundwater Basin Management

Groundwater Basin	Governance Type	Characteristics
West Coast Basin	Adjudicated in 1977 and most recently amended in 1989	The judgment sets out the annual pumping rights of each party, provides for carryover of 10% of annual pumping rights for one year, overpumping of 10% to be replaced the following year, an exchange pool wherein a right not used by one party can be made available to another, emergency overpumping up to a total of 10,000AF under specified conditions, and appoints DWR as watermaster.
Santa Monica Basin	Unadjudicated	The primary producer in the basin is the city of Santa Monica.
Hollywood Basin	Unadjudicated	Ordinances adopted by the city of Beverly Hills address dewatering of groundwater.
Main San Gabriel Basin	Adjudicated in 1973 and as amended in 1989	Judgment defines natural safe yield under 1967 cultural conditions, specifies annual pumping rights, allows one year for carry-over of unused water rights, enjoins unauthorized recharge, restricts export of groundwater. Judgment establishes watermaster to administer the judgment including assumption of Make-Up obligation on behalf of the basin, storage of supplemental water, and concern with water quality matters. Judgment provides for determination of annual operating safe yield, specifies basin operating criteria that replacement water shall not be spread when the water level at the Key Well exceeds elevation 250 and that replacement water shall be spread as practicable to maintain the water level at the Key Well above elevation 200. Judgment Exhibit H estimates that a usable volume of 400,000 AF of storage space within the operating range of elevations 200 to 250. Judgment allows overproduction of rights, but this production incurs replacement water assessment.
Puente Basin	Adjudicated in 1986	Judgment provides for a watermaster, and authorizes the watermaster to determine the annual operating safe yield and the annual pumping rights. The judgment provides for carryover of 100% of pumping rights, excess pumping of up to 10%, and restricts exportation of groundwater. The judgment makes no provisions for storage of surplus water supplies within the basin.

Table B-1 (continued)
Groundwater Basin Management

Groundwater Basin	Governance Type	Characteristics
Raymond Basin	Adjudicated in 1943. Judgment modified and restated in 1984	Judgment specifies safe yield in the Eastern and Western units of the basin, addresses rights to capture surface water for spreading and percolation and rights to recapture spread water, specifies groundwater pumping rights of the parties, allows for 10% overpumping to be made up in the following year, and 10% carryover for one year. Judgment establishes the Raymond Basin Management Board as watermaster with specified powers and responsibilities including: protecting the long-term quantity and quality of the groundwater supply, utilizing the groundwater storage capacity of the basin for the maximum advantage of the parties, integrating surface and groundwater supplies, and mutual cooperation.
Six Basins	Adjudicated in 1998	Judgment sets out the safe yield for Six Basins inclusive of active spreading and imported water return flows. Establishes procedure for setting annual operating safe yield for 4 of the 6 basins (Canyon, Upper and Lower Claremont Heights, and Pomona basins), allows overproduction but with obligation for replacement water, establishes annual surface water and groundwater production rights, provides for storage and recovery beyond annual production rights, establishes a watermaster, allows portability of rights within the 4 basins subject to specified conditions, and sets out priorities for use of groundwater storage capacity.
Orange County Basin	Managed via 1933 State statute, as amended, creating the Orange County Water District	The OCWD Act establishes the Orange County Water District and sets out its powers for the purpose of managing the groundwater basin and managing, replenishing, regulating, and protecting groundwater supplies including: provide for conjunctive use of ground and surface waters; regulate and control the storage of water and use of groundwater basin storage space; purchase and import water; appropriate and acquire water and water rights; determine the Basin Pumping Percentage; levy a basin equity assessment on parties who produce more than the BPP; prevent interference with basin water, water rights, impacts to water quality, and unlawful exportation of basin water; and to be a party to all groundwater storage agreements within the basin. The Act specifies that use of the groundwater basin for replenishing and managing the groundwater supplies shall have priority over use of the groundwater basin for storage of water. OCWD manages the basin utilizing its Groundwater Management Plan prepared in 1989 and 1990, updated in 1994 and 2004.

Table B-1 (continued)
Groundwater Basin Management

Groundwater Basin	Governance Type	Characteristics
San Juan Basin	Unadjudicated	Informally managed by San Juan Basin Authority, however, private producers do not participate or report to San Juan Basin Authority. Groundwater pumping rights governed by State Water Resources Control Board water rights.
Chino Basin	Adjudicated in 1978	Judgment appoints Chino Basin Watermaster to administer and enforce the Judgment and any subsequent instructions or orders of the Court. Judgment provides numeric value for natural safe yield and allocates this natural safe yield among three pools of producers. The judgment also provides for 5,000AFY (200,000 AF of controlled overdraft averaged over 40 years (operating safe yield)). Pumping in excess of safe yield is allowed, but incurs a replenishment obligation. The judgment expressly provides for groundwater storage and conjunctive use. The Court directed the Watermaster to develop the Optimum Basin Management Program (OBMP) addressing enhancement of basin water supplies, protection and enhancement of water quality, enhancement of basin management, and equitable financing of the OBMP. In 2004, the Water Quality Control Board, Santa Ana Region, incorporated the Maximum Benefit Basin Plan into its Water Quality Control Plan for the Santa Ana River Basin.
Cucamonga Basin	Adjudicated in 1959	Judgment specifies water rights for individual groundwater producers and specifies the amount that can be exported to non-overlying areas for use by individual producer. Judgment specifies requirement for spreading. No annual report is prepared to document implementation of judgment requirements.
Riverside Basin	Adjudicated in 1959 and superseded in 1969 and effective 1971	Judgment distinguishes the portions of Riverside Basin in San Bernardino and Riverside counties and sets out the average annual extraction for each portion of the Riverside Basin. Judgment establishes a watermaster to administer and enforce the judgment provisions. Judgment provisions for extraction without replenishment obligation: extraction from the San Bernardino County portion for use *outside* San Bernardino Valley and from the Riverside County portion is each limited over 5 years to 5 times the annual average. Replenishment is required if the extraction in any year is 20% more than the annual average in a basin portion. Extractions from the Riverside Basin within San Bernardino County for use *within* San Bernardino Valley are not limited except that static water levels in the area shall not fall below a specified water elevation. Judgment specifies that it does not limit rights to spread, store and recapture imported water.

Table B-1 (continued)
Groundwater Basin Management

Groundwater Basin	Governance Type	Characteristics
Arlington Basin	Unadjudicated	There are no formal restrictions on basin production. Western MWD reports on basin water extractions and operates the Arlington Desalter.
Temescal Valley Basins—Temescal, Bedford, Coldwater, Lee Lake basins	Unadjudicated	The city of Corona is preparing a groundwater management plan for Temescal Basin estimated for completion in 2007. Temescal Valley Basins subject to 1970 Santa Ana River Judgment requiring minimum annual average adjusted baseflow at Prado Dam.
Elsinore Basin	Groundwater Management Plan adopted in 2004	The Groundwater Management Plan addresses basin hydrogeology, geology, groundwater balance, water quality and identifies groundwater management issues, groundwater management strategies, reviews alternatives, presents an implementation plan and a basin monitoring plan.
West San Jacinto Basins	Groundwater Management Plan adopted in 1995	The Groundwater Management Plan addresses active recharge, recovery of degraded groundwater to be blended with imported water, recovery of brackish water, conjunctive use, and agricultural groundwater exchange.
Hemet-San Jacinto Basins	Canyon and San Jacinto Upper Pressure subject to the 1954 Fruitvale Judgment. Other basins are unadjudicated.	Groundwater management plan in process for the Hemet-San Jacinto Basins and will supersede the Fruitvale Judgment. The Groundwater Management Plan addresses reducing groundwater production, implementing the San Jacinto River Recharge and Recovery Project, groundwater replenishment, in-lieu water use, additional water conservation measures and water monitoring.
Temecula-Murrieta Basin	Adjudicated by the Court with decree with decree entered on April 6,1966	The Temecula-Murrieta Basin is part of the Santa Margarita watershed and subject to the Santa Margarita River adjudication. Judgment does not quantify water rights, but specifies certain operational requirements and facts, defines the scope of the watershed and lands and current owners within the jurisdiction of the court, and retains continuing jurisdiction for the court to quantify the water rights at a future time. Since the judgment was entered, several memoranda and agreements have been adopted for operations throughout the watershed basin. There are pending lawsuits concerning water rights and stream flows in the Santa Margarita River watershed.
Lower Santa Margarita River Basins		Adjudication administered by the Court and the Santa Margarita River Watermaster with assistance from the Watershed Steering Committee. See discussion of Temecula-Murrieta Basin.

Table B-1 (continued)
Groundwater Basin Management

Groundwater Basin	Governance Type	Characteristics
San Luis Rey River Valley Basins	Unadjudicated	The San Luis Rey River Valley basins are informally managed by the San Luis Rey Watershed Council. The Council adopted the San Luis Rey Watershed Management Guidelines in 2000.
San Dieguito River Basins	Unadjudicated	The San Dieguito Basin Task Force is evaluating feasibility of groundwater management.
Lower and Middle Sweetwater Basins and San Diego Formation	Unadjudicated	Managed pursuant to Sweetwater Authority Interim Groundwater Management Plan adopted in 2001. The Interim Plan sets out groundwater management strategies: maintain groundwater levels, protect groundwater quality, monitor seawater intrusion, monitor groundwater quality and quantity; and implementation and data collection and management directives.
Lower Tijuana River Basin	Managed	Groundwater management plan adopted in 1995.
Mission Valley Basin	Unadjudicated	Conceptual groundwater management plan developed.
Santee-El Monte, San Mateo, San Onofre, Las Flores/Las Pulgas basins	Unadjudicated	No management structure for these basins.

Sources for Table B-1, Groundwater Basin Management

California Water Service Company, et al., vs. City of Compton, et al., Superior Court of the County of Los Angeles. Case No. 506,806 Amended Judgment (Declaring and establishing water rights in the West Coast Basin, imposing a physical solution therein and in joining extraction therefrom in excess of specified quantities.), March 21, 1980.

Central and West Basin Water Replenishment District etc., v. Charles E. Adams, et al., and City of Lakewood, v. Charles E. Adams, et al., Superior Court of the County of Los Angeles. Case No. 786,656 Second Amended Judgment (Declaring and establishing water rights in Central Basin and enjoining extractions therefrom in excess of specified quantities.) May 6, 1991.

Chino Basin Municipal Water District v. City of Chino, et al., Superior Court of the County of San Bernardino. Case No. 164327 Judgment. Jan 30, 1978

City of Beverly Hills. Agenda Report: An Ordinance of the City of Beverly Hills Relating to the removal of groundwater and amending the Beverly Hills municipal code. August 21, 2006.

The City of Los Angeles vs. City of San Fernando, et al., Superior Court of the County of Los Angeles. Case No. 650079 Judgment. January 26, 1979.

City of Pasadena, vs. City of Alhambra et al., Superior Court of the County of Los Angeles. Case No. Pasadena C-1323 Judgment (As Modified and Restated March 26, 1984).

Elsinore Basin Groundwater Management Plan. Elsinore Valley Municipal Water District. June 2003.

Fox Canyon Groundwater Management Agency Act. September 13, 1982. Chapter 1023 of Statues of 1982.

Groundwater Management Plan, Fox Canyon Groundwater Management Agency. October 2006.

Groundwater Management Plan, Orange County Water District. March 2004.

Groundwater Management Plan, West San Jacinto Groundwater Basin, Eastern Municipal Water District (Eastern MWD), 1995.

Hemet-San Jacinto Water Management Area 2005 Annual Report, Eastern Municipal Water District (Eastern MWD), 2006.

Orange County Water District Act, as amended and effective January 1, 2003. West's Annotated California Codes, Water Code Appendix, Chapter 40, as amended; and Derring's California Codes, Annotated, Water—Uncodified Acts, Act 5683, as amended.

Puente Basin Water Agency et al., vs. The City of Industry, et al., Superior Court of the County of Los Angeles. Case No. C 369 220 Judgment. [no signature or filing date on copy]

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Santa Margarita River Watershed Annual Watermaster Report Water Year 2004-05. United States v. Fallbrook Public Utility District, et al., August 2006.

Southern California Water Company vs. City of La Verne, et al., Superior Court of the County of Los Angeles. Case No. ___ Judgment (Complaint Filed, September 28, 1998)

Upper San Gabriel Valley Municipal Water District vs. City of Alhambra, et al., Superior Court of the County of Los Angeles. Case No. 924128 Amended Judgment. August 24, 1989.

Western Municipal Water District of Riverside County vs. East San Bernardino County Water District, et al., Superior Court of the County of Riverside. Case No. 78426 Judgment. April 17, 1969.-