Basin 8-1 Alternative

Submitted by: Orange County Water District
City of La Habra
Irvine Ranch Water District

Submitted to: California Department of Water Resources

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BASIN 8-1 ALTERNATIVE OVERVIEW

The Sustainable Groundwater Management Act (SGMA) requires all high- and medium-priority basins, as designated by the Department of Water Resources (DWR), be sustainably managed. DWR designated the Coastal Plain of Orange County Groundwater Basin ("Basin 8-1" or "Basin") as a medium-priority basin, primarily due to heavy reliance on the Basin's groundwater as a source of water supply.

Compliance with SGMA can be achieved in one of two ways:

1) A Groundwater Sustainability Agency (GSA) is formed and a Groundwater Sustainability Plan (GSP) is adopted, or
2) Special Act Districts created by statute, such as OCWD, and other agencies may prepare and submit an Alternative to a GSP.

The agencies within Basin 8-1 have agreed to collaborate together in order to submit an Alternative to a GSP. Within this document, this Alternative to a GSP will be referred to herein as the "Basin 8-1 Alternative" or "Alternative". In accordance with Water Code §10733.6(b)(3), this Alternative presents an analysis of basin conditions that demonstrates that the Basin has operated within its sustainable yield over a period of at least 10 years. In addition, the Alternative establishes objectives and criteria for management that would be addressed in a GSP and is designed to be "functionally equivalent" to a GSP. As will be shown in the Basin 8-1 Alternative, Basin 8-1 has been operated within its sustainable yield for more than 10 years without experiencing significant and unreasonable (1) lowering of groundwater levels, (2) reduction in storage, (3) water quality degradation, (4) seawater intrusion, (5) inelastic land subsidence, or (6) depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water. Please note that the boundaries of Basin 8-1 described in this document are based on the scientific boundary modifications as accepted by DWR in 2016 as part of the Basin Boundary Modification Process.

The Basin 8-1 Alternative has been jointly prepared by the Orange County Water District (OCWD), Irvine Ranch Water District (IRWD); and the City of La Habra (collectively the "Submitting Agencies"); pursuant to this Alternative, the Submitting Agencies will ensure the entire Basin 8-1 continues to be sustainably managed and data reported as required by SGMA. Other agencies within Basin 8-1 and at least partially outside of OCWD's boundaries support submission of the Basin 8-1 Alternative and either have participated in preparing the Alternative and/or reviewed the Alternative. These agencies include the cities of Brea, Corona, and Chino Hills; the Counties of Orange, Riverside, and San Bernardino; Yorba Linda Water District; and El Toro Water District. Pursuant to Water Code §10733.6(b)(3), the Basin 8-1 Alternative has been prepared by or under the direction of a professional geologist or professional engineer.

For the purpose of compliance with the SGMA requirement that the entire basin be covered by this Basin 8-1 Alternative, Submitting Agencies have divided Basin 8-1 into four management areas: La Habra-Brea, OCWD, South East, and Santa Ana Canyon Management Areas, shown in Figure 1-1.

Historically, the majority of Basin 8-1 (90% of the land area) has been managed by OCWD, which includes the land area within the OCWD Management Area and a small portion of the land area within the Santa Ana Canyon Management Area. The percentage of the land area within Basin 8-1 in each of the management areas is shown in Figure 1-2.

Although the land areas outside of OCWD's jurisdiction in the Santa Ana Canyon and South East Management Areas have not been formally "managed" by OCWD, the hydrogeological conditions in these areas are essentially an extension of the managed basin. OCWD has incorporated data, when available, from these areas into the OCWD data base. For example, precipitation runoff from the mountains along the eastern border (in the South East Management Area) is estimated and incorporated into OCWD's basin water budget. The Santa Ana Canyon Management Area, created in this report in order to include land within and outside of OCWD's service area, is upstream of OCWD recharge operations. While OCWD does not have jurisdiction over all the land in this area, OCWD does have the rights to all the water in the Santa Ana River released from Prado Dam. In this respect, OCWD is actively engaged in managing the flow of surface water within the Santa Ana Canyon irrespective of land ownership.

While the four management areas are described separately in this report, it is important to understand that actual "management" is not as distinct, and existing collaborative efforts between agencies in managing groundwater resources will continue. In the case of the La Habra-Brea Management Area, the City of La Habra has already been deemed the exclusive GSA for the La Habra/Brea area and intends to prepare a Groundwater Sustainability Plan (GSP). When La Habra submits a GSP, this Basin 8-1 Alternative will no longer include the La Habra/Brea area within the area designated by the GSP.

As authorized by 23 CCR § 354.20, this Basin 8-1 Alternative describes four management areas as shown in Figure 1. The rationale for designating these management areas within Basin 8-1 is explained as follows:

- La Habra-Brea Management Area includes the northern portion of Basin 8-1 that is located outside of the OCWD service area and is within the cities of La Habra and Brea. The City of La Habra currently manages this portion of Basin 8-1. Although this management area is hydrologically distinct from the OCWD Management Area there is an estimated 1,000 afy of subsurface groundwater flow from the La Habra-Brea Management Area to the OCWD Management Area. Surface water that recharges the OCWD portion of Basin 8-1 does not replenish the La Habra-Brea Management Area.

- The OCWD Management Area includes approximately 89 percent of the land area of Basin 8-1. Ninety-eight percent of all groundwater production within 8-1 occurs in this management area. This area includes the portion of Basin 8-1 that is within OCWD's service area, except for an approximately 7-square mile portion of OCWD's service area that is in the Santa Ana Canyon Management Area. OCWD has been managing the majority of Basin 8-1 since its formation in 1933.

- The South East Management Area includes the southern and southeastern portion of Basin 8-1 that is hydrogeologically connected to the OCWD Management Area but is outside of OCWD's service area. This area consists of several, disconnected, small fringe areas that are within the DWR designated boundary of Basin 8-1. This management area includes areas under the jurisdiction of the IRWD, the El Toro Water District and the City of Orange. The groundwater basin in this area is thin and contains more clay and silt deposits than aquifers in the OCWD Management Area. Groundwater historically has flowed out of this area into the OCWD Management Area. Production has been minimal in this area due to hydrogeological conditions with little potential for significant future increases.

- The Santa Ana Canyon Management Area includes the easternmost section of Basin 8-1. This area includes land under the jurisdiction of several cities, two counties, and two water districts, including a portion that is within the OCWD service area. Groundwater production is relatively minor compared to groundwater production in the OCWD Management Area. The western boundary of this management area is located at Imperial Highway in the city of Anaheim where the basin thickness begins to increase. Imperial Highway crosses the Santa Ana River where OCWD begins to divert river water into the recharge facilities for percolation into the groundwater basin.

The Basin 8-1 Alternative is organized as follows:

- Overview: Provides a map and description of Basin 8-1 and a brief description of the basin management areas.

- Hydrogeology of Basin 8-1: Provides a description of the hydrogeology of Basin 8-1 including a description of the basin, the aquifer systems, fault zones, total basin volume, basin cross-sections, basin characteristics, and general groundwater quality.

- La Habra-Brea Management Area: Provides a description of sustainable management of the La Habra-Brea Management Area

- OCWD Management Area: Provides a description of sustainable management of the OCWD Management Area

- South East Management Area: Provides a description of sustainable management of the South East Management Area

- Santa Ana Canyon Management Area: Provides a description of sustainable management of the Santa Ana Canyon Management Area

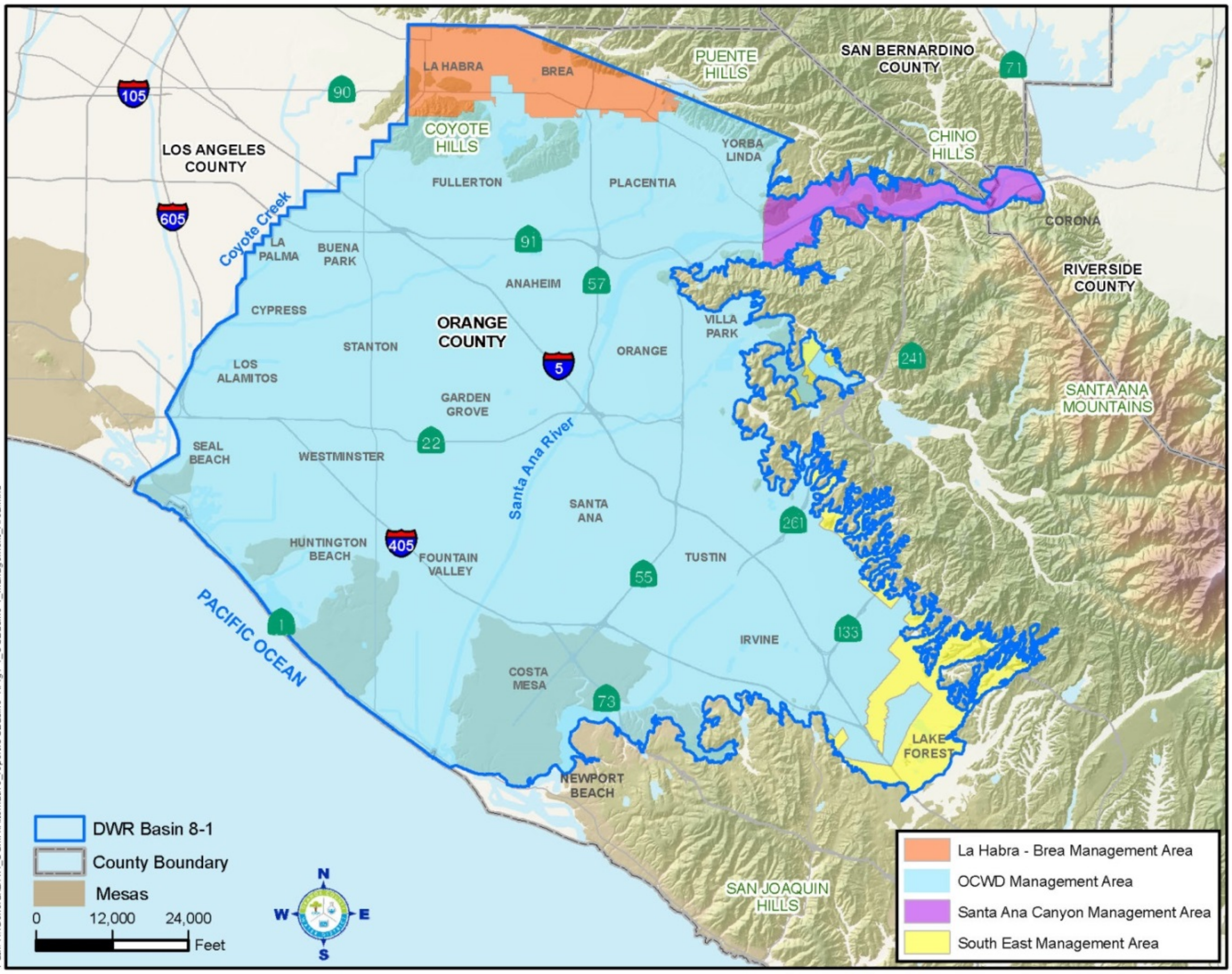


Figure 1-1: Basin 8-1 Management Area Boundaries

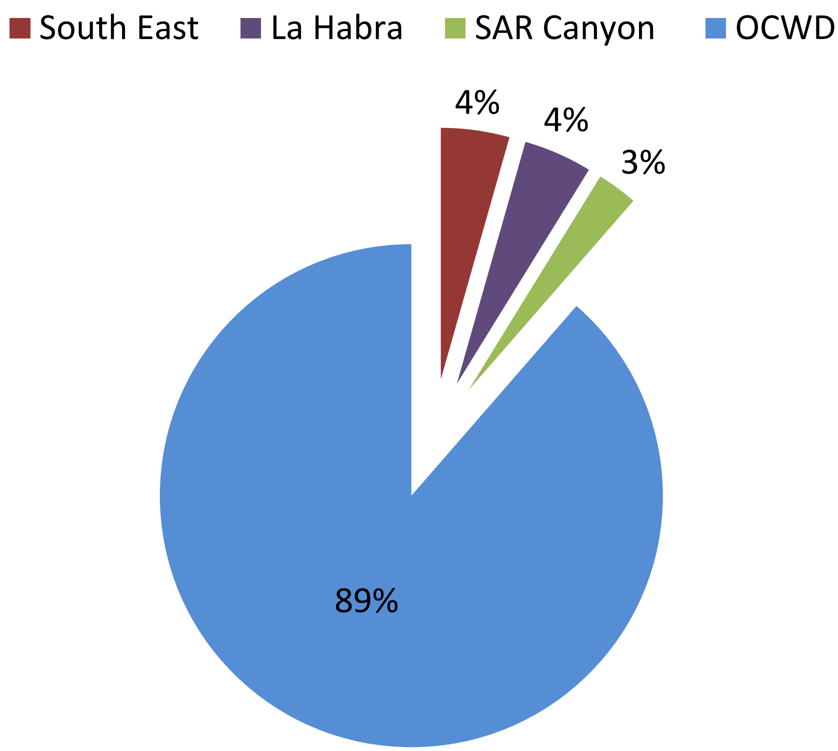


Figure 1-2: Percentage of Land Area in Basin 8-1 within Management Areas

1. LA HABRA-BREA MANAGEMENT AREA

The La Habra-Brea Management area covers the northern portion of Basin 8-1. The City of La Habra has been deemed the exclusive GSA under SGMA for this management area. This management area is part of Basin 8-1, but is hydrogeologically distinct from the OCWD Management Area and is not under the jurisdiction of OCWD. The City adopted a resolution to establish the La Habra Basin as a separate basin from Basin 8-1. OCWD adopted a resolution to support the City's request to DWR for an internal jurisdictional boundary modification in the OC Basin that follows the city limits of La Habra and Brea as is outside of the Orange County Water District's jurisdictional boundary.

The La Habra-Brea Management Area is included with this Alternative to facilitate collaboration among groundwater agencies within Basin 8-1 as required by SGMA. The City of La Habra and portions of the City of Brea comprise the La Habra-Brea Management Area. This area overlies the extents of the proposed La Habra Groundwater Basin, referenced herein.

The La Habra-Brea Management Area is currently monitored for groundwater elevations and for groundwater quality through productions wells and historical data from monitoring wells within the La Habra-Brea Management Area and surrounding area.

As the City of La Habra currently depends on local groundwater to meet approximately 40 percent of its water consumption; preserving the sustainability of the La Habra-Brea Management Area is essential. Currently (and historically), the City of La Habra manages (and has managed) the La Habra-Brea Management Area through management plans and programs for groundwater levels, basin storage, and water quality. By January 2020, the City will manage the La Habra-Brea Management Area through a Groundwater Sustainability Plan under SGMA, which will describe the monitoring program and ensure that no undesirable results occur in the future.

2. OCWD MANAGEMENT AREA

The OCWD Management Area covers an area of approximately 260 square miles within Basin 8-1, which represents approximately 89 percent of the land area of Basin 8-1. Ninety-eight percent of the groundwater production within Basin 8-1 occurs in the OCWD Management Area. Groundwater produced within the OCWD Management Area provides approximately 70 percent of the total water supply for a population of around 2.4 million residents.

Since its formation by the California Legislature in 1933, OCWD has been the managing agency for the majority of Basin 8-1, also referred to as the Coastal Plain of Orange County Groundwater Basin. As a special act district listed in Water Code § 1072(c)(1), OCWD is the exclusive local agency within its jurisdictional boundaries with powers to comply with SGMA.

Water demands within the OCWD Management Area have grown from approximately 150,000 acre-feet per year (afy) in the mid-1950s to a high of approximately 366,000 afy in water year 2007-08. OCWD operates an extensive network of recharge basins to increase recharge of surface water into the groundwater basin to support groundwater production. OCWD monitors the basin by collecting groundwater elevation and quality data from nearly 700 wells, including over 400 OCWD-owned monitoring wells, manages an electronic database that stores water elevation, water quality, production, recharge and other data on over 2,000 wells and facilities within and outside OCWD boundaries.

An OCWD-operated water recycling plant provides up to 100 million gallons per day of advanced tertiary-treated wastewater that supplies recharge operations and a seawater intrusion barrier operated to protect the basin’s water quality. OCWD manages groundwater storage and water levels within an established operating range which has resulted in sustainable conditions with no unreasonable and significant undesirable results.

The Sustainability Goal for the OCWD Management Area is to continue to sustainably manage the groundwater basin to prevent conditions that would lead to significant and unreasonable (1) lowering of groundwater levels, (2) reduction in storage, (3) water quality degradation, (4) seawater intrusion, (5) inelastic land subsidence and (6) adverse impacts on hydrologically connected surface water.

3. SOUTH EAST MANAGEMENT AREA

The South East Management Area contains portions of Irvine Ranch Water District (IRWD), El Toro Water District (ETWD), and the City of Orange. The area covered this management area is essentially an extension of the main basin and was formed to comply with the requirement that the entirety of Basin 8-1 be covered by a responsible agency.

There is relatively little existing, or potential, groundwater development within the South East Management Area. What pumping does occur is less than 200 acre-feet-per-year (afy), which is much less than the total recharge to the area. Water levels and storage levels are steady.

The Sustainability Goal for the South East Management Area is to recognize it is a small part of the larger groundwater basin that is managed by OCWD. Nevertheless, groundwater levels and water quality will be monitored to assure that conditions do not lead to significant and unreasonable (1) lowering of groundwater levels, (2) reduction in storage, (3) water quality degradation, (4) inelastic land subsidence, (5) unreasonable adverse effect on surface water resources, and (6) adverse impacts on hydrologically connected surface water.

4. SANTA ANA CANYON MANAGEMENT AREA

The Santa Ana Canyon Management Area covers the easternmost extent of Basin 8-1. The water resources in the Santa Ana Canyon Management Area include the Santa Ana River and groundwater. Groundwater is primarily located in a thin alluvial aquifer that is 90 to 100 feet thick and is a combination of infiltrated surface water and groundwater inflow from the adjacent foothills.

Groundwater pumping in this management area is primarily used for irrigation with a minimal amount used for potable purposes. The amount of groundwater pumping is small relative to the large volumes of flow in the canyon provided by the Santa Ana River and monitoring indicates there are no depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water. There are no groundwater withdrawals within the areas covered by the Cities of Anaheim, Chino Hills, and Yorba Linda; Riverside County; and Yorba Linda Water District.

OCWD has water rights to all Santa Ana River flows released through Prado Dam. For the area within its boundary, OCWD has the legal authority through the OCWD Act to require reporting of groundwater production and to charge groundwater pumping assessments for groundwater production. OCWD also monitors surface water flow and quality as well as groundwater levels and quality throughout the Santa Ana Canyon Management Area.

The Sustainability Goal for the Santa Ana Canyon Management Area is to continue monitoring sustainable conditions and monitor to ensure that no significant and unreasonable results occur in the future.

ABBREVIATIONS AND ACRONYMS

afy	acre-feet per year
AWPF	Advanced Water Purification Facility
basin	Orange County groundwater basin
Basin Model	OCWD groundwater model
BEA	Basin Equity Assessment
BPP	Basin Production Percentage
CDPH	California Department of Public Health
cfs	cubic feet per second
DATS	Deep Aquifer Treatment System
DOC	dissolved organic compound
DWR	Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
EDCs	Endocrine Disrupting Compounds
EIR	Environmental Impact Report
EPA	U.S. Environmental Protection Agency
FY	fiscal year
GAC	granular activated carbon
GIS	geographic information system
GWRS	Groundwater Replenishment System
IAP	Independent Advisory Panel
IRWD	Irvine Ranch Water District
LACDWP	Los Angeles County Department of Public Works
maf	million acre feet
MCAS	Marine Corps Air Station
MCL	maximum contaminant level
MF	microfiltration
MODFLOW	Computer modeling program developed by USGS
mgd	million gallons per day
mg/L	milligrams per liter
MTBE	methyl tertiary-butyl ether
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
NDMA	n-Nitrosodimethylamine
NF	nanofiltration
ng/L	nanograms per liter
NBGPP	North Basin Groundwater Protection Program
NO_2	nitrite
NO_3^-	nitrate
NPDES	National Pollution Discharge Elimination System
NWRI	National Water Research Institute

ABBREVIATIONS AND ACRONYMS

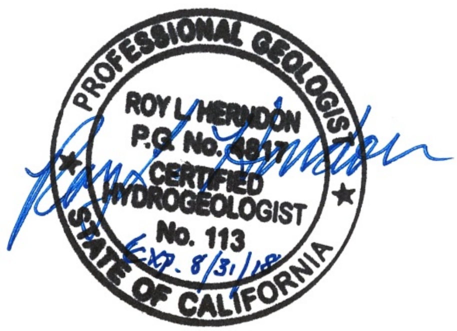
O&M	operations and maintenance
OCHCA	Orange County Health Care Agency
OCSD	Orange County Sanitation District
OC Survey	Orange County Survey
OCWD	Orange County Water District
PCE	perchloroethylene
PPCPs	pharmaceuticals and personal care products
Producers	Orange County groundwater producers
RA	replenishment assessment
RO	reverse osmosis
Regional Water Board	Regional Water Quality Control Board
SARI	Santa Ana River Interceptor
SARMON	Santa Ana River Monitoring Program
SARWQH	Santa Ana River Water Quality and Health
SAWPA	Santa Ana Watershed Project Authority
SBGPP	South Basin Groundwater Protection Program
SDWA	Safe Drinking Water Act
SOCs	synthetic organic chemicals
SWP	State Water Project
SWRCB	State Water Resources Control Board
TCE	trichloroethylene
TDS	total dissolved solids
TIN	total inorganic nitrogen
µg/L	micrograms per liter
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
UV	ultraviolet light
VOCs	volatile organic compounds
WACO	Water Advisory Committee of Orange County
WEI	Wildermuth Environmental Inc.
WF-21	Water Factory 21
WLAM	Waste Load Allocation Model
WRD	Water Replenishment District of Southern California
WRMS	Water Resources Management System

Hydrogeology of Basin 8-1

January 1, 2017

Basin 8-1 Alternative

Hydrogeology of Basin 8-1



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SECTION 1 INTRODUCTION

The Coastal Plain of Orange County Groundwater Basin (Basin 8-1) underlies a coastal alluvial plain in the northwestern portion of Orange County with a small portion in Riverside and San Bernardino counties at the easternmost edge. The basin is designated as Basin 8-1 in the Department of Water Resources Bulletin 118. The basin is bounded by consolidated sedimentary rocks exposed on the north in the Puente Hills and Chino Hills, on the east in the Santa Ana Mountains, and on the south in the San Joaquin Hills. The basin is bounded by the Pacific Ocean on the southwest and by a low topographic divide approximated by the Orange County-Los Angeles County line on the northwest. The basin underlies the lower Santa Ana River watershed and a portion of the Coyote Creek Watershed (Coyote Creek is a tributary to the San Gabriel River).

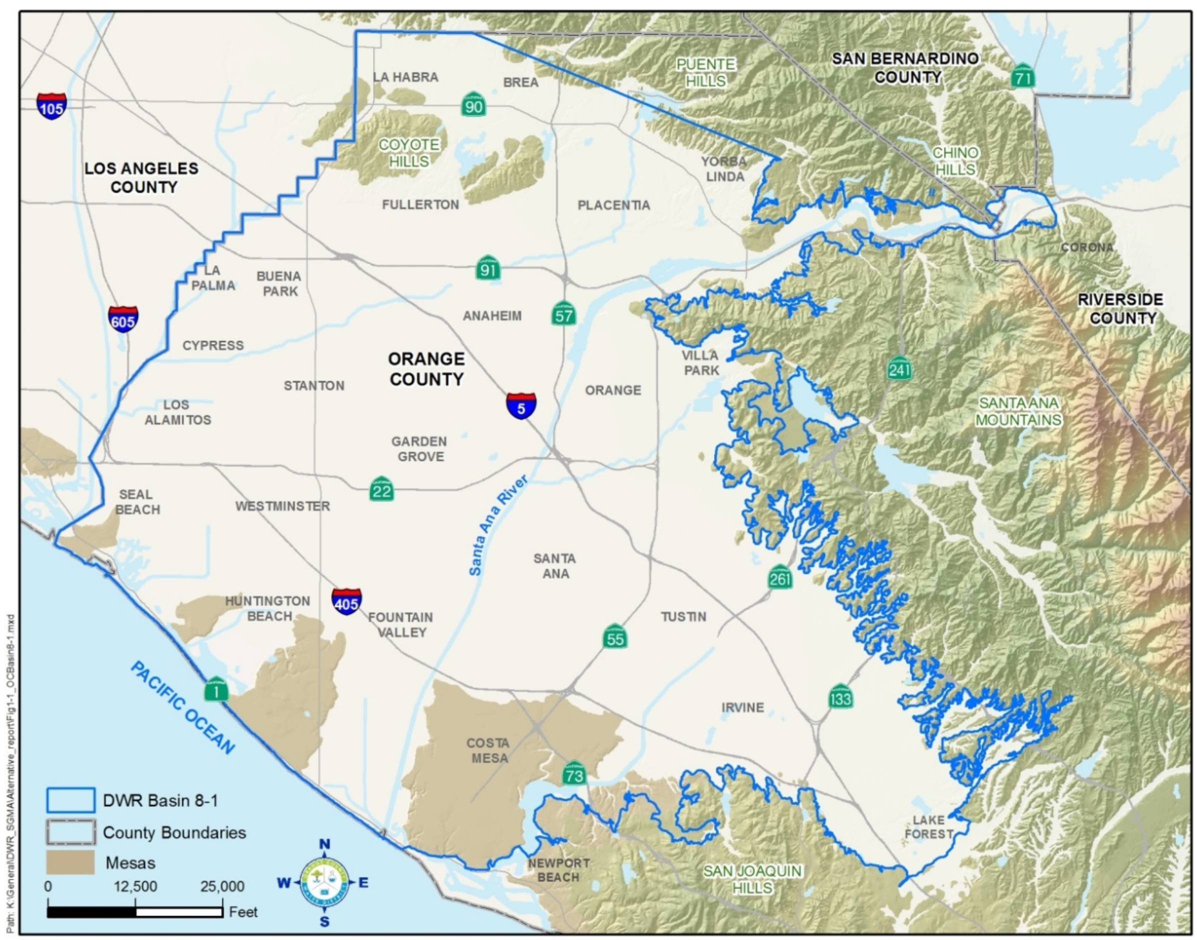


Figure 1-1: Coastal Plain of Orange County Groundwater Basin, Basin 8-1

SECTION 2 BASIN HYDROGEOLOGY

2.1 BASIN DESCRIPTION

Basin 8-1 underlies north and central Orange County beneath broad lowlands known as the Tustin and Downey plains. The basin covers an area of approximately 350 square miles, bordered by the Puente Hills and Chino Hills to the north, the Santa Ana Mountains to the northeast, and the Pacific Ocean to the southwest. The basin boundary extends to the Orange-Los Angeles county line to the northwest, where groundwater flow between Basin 8-1 and the Central Basin (Basin 4-11.04) is unrestricted. The Newport-Inglewood fault zone forms the southwestern boundary of all fresh water-bearing zones but the Shallow Aquifer, which extends to the ocean in coastal erosional gaps between the mesas.

The groundwater basin formed in a synclinal, northwest-trending trough that deepens as it continues beyond the Orange-Los Angeles county line. The Newport-Inglewood fault zone, San Joaquin Hills, Puente Hills, and Santa Ana Mountains form the uplifted margins of the syncline. The total thickness of sedimentary rocks in the basin surpasses 20,000 feet, of which only the upper 2,000 to 4,000 feet contain fresh water. In the southeastern area underlying the city of Irvine and along the basin margins, the thickness of fresh water-bearing sediments is less than 1,000 feet (Herndon and Bonsangue, 2006).

Basin 8-1 includes the La Habra Groundwater Basin which is separated from the rest of Basin 8-1 by the Coyote Hills. The La Habra Groundwater Basin lies in the synclinal trough between the Puente Hills and the Santa Fe Springs - Coyote Hills uplift. The Whittier fault, located in the Puente Hills, forms the northern limit of the La Habra syncline.

Structural folding and faulting along the basin margins, together with down warping and deposition within the basin, have occurred since Oligocene time (last 23 million years). The Newport-Inglewood fault zone, comprising the most significant structural feature in the basin from a hydrogeologic standpoint, consists of a series of faulted blocks which are generally up thrown on the southwest side. Folding and faulting along the Newport-Inglewood fault zone have created a natural restriction to seawater intrusion into the groundwater basin (Herndon and Bonsangue, 2006).

Formations of Miocene or older age constitute the base of water-bearing strata, as they are consolidated units with minimal water transmissive capacity. The tops of Miocene-aged units, including the non-marine Sespe formation, marine Vaqueros formation, and Monterey shale, form the base of water bearing sediments in the coastal and Irvine areas of the basin, whereas the tops of the Miocene-aged marine Puente and Topanga formations and El Modeno volcanics define the base of permeable sediments along inland boundary of the basin from the city of La Habra to the city of Villa Park.

Fresh water-bearing formations within the groundwater basin are comprised of Pliocene or younger (last 5 million years), semi-consolidated to unconsolidated sedimentary units. The upper Pliocene-aged Pico formation is reportedly present throughout much of the basin, and is significant in that the base of its upper unit is reported to form the base of the fresh water aquifer system where it exists. Other Pliocene-aged sediments, including the Fernando and Repetto formations, are believed to contain producible quantities of fresh water; however, they are relatively untapped in the center of the basin, as they fall below economically viable depths to which to construct water wells (>2,000 feet).

Unconsolidated sands and gravels of the Pleistocene-aged San Pedro, Lakewood, and La Habra formations, and to a lesser extent, the Coyote Hills formation and Palos Verdes sand, constitute the primary production aquifers within the groundwater basin. The non-marine Coyote Hills and La Habra formations underlie the Fullerton and Anaheim areas, whereas the marine Lakewood and San Pedro formations underlie the majority of the central and coastal portions of the basin. The Coyote Hills and La Habra formations are present in the La Habra Basin portion of Basin 8-1 and are underlain by the San Pedro formation. These marine and non-marine formations are time correlative and are thought to interfinger throughout the basin. Total depths of the base of these formations range from approximately 500 to 2,000 feet.

Overlying the Pleistocene deposits are younger, Recent-aged alluvial sediments that range from less than 50 feet to approximately 300 feet thick. These sediments include coarse-grained channel deposits laid down by the Santa Ana River, which has flowed into the Pacific Ocean as far north as the present-day San Gabriel River mouth and as far south as Newport Bay. It is these channel deposits, which have not been substantially offset by the Newport-Inglewood fault zone, that provide the conduits for seawater to migrate inland toward groundwater pumping depressions.

Pleistocene or younger aquifers within the basin form a complex series of interconnected sand and gravel deposits. In coastal and central portions of the basin, these deposits are extensively separated by lower-permeability clay and silt deposits or aquitards. In the inland areas, the clay and silt deposits become thinner and more discontinuous, allowing larger quantities of groundwater to flow more easily between shallow and deeper aquifers (DWR, 1967).

2.2 AQUIFER SYSTEMS

The current "conceptual model' of the basin is based on studies by the DWR in the mid-1960s which described the existence of three major aquifer systems. In OCWD's management of the groundwater basin, these aquifer systems are referred to as the Shallow, Principal, and Deep Aquifers (see Figure 2-1).

Because of the groundwater basin's synclinal and faulted structure, the Shallow Aquifer system extends over a larger area than the underlying Principal and Deep aquifer systems. Potentiometric head differences measured in over 60 multi-depth, discretely-screened monitoring wells have been the primary means by which the vertical delineation of these aquifer systems has been interpreted. These head differences range from negligible to several tens of feet depending on the degree of hydraulic continuity and local pumping and recharge. Generally, aquifers in the "Forebay area" have a higher degree of vertical hydraulic continuity than aquifers in the "Pressure area" (see Section 2.4). This is due to thinner and less laterally extensive low-permeability sediments in the Forebay area as compared to the Pressure area.

The Shallow Aquifer system overlies the entire basin and includes the transmissive Talbert Aquifer, which covers an approximate three-mile wide swath along today's Santa Ana River. It generally occurs from the surface to approximately 200 feet below ground surface. The majority of groundwater from the Shallow Aquifer is pumped by small water systems for industrial and agricultural use, although the cities of Garden Grove and Newport Beach, and the Yorba Linda Water District, operate wells that pump from the Shallow Aquifer for municipal use.

Over 90 percent of groundwater production occurs from wells that are screened within the Principal Aquifer system at depths between 200 and 1,300 feet, which underlies the Shallow Aquifer system and is up to 2,000 feet deep in the center of the basin. Underlying the Principal Aquifer System is the Deep Aquifer system, which reaches depths of up to 4,000 feet. The depth and presence of amber colored groundwater in some coastal areas hinders production from the Deep Aquifer system.

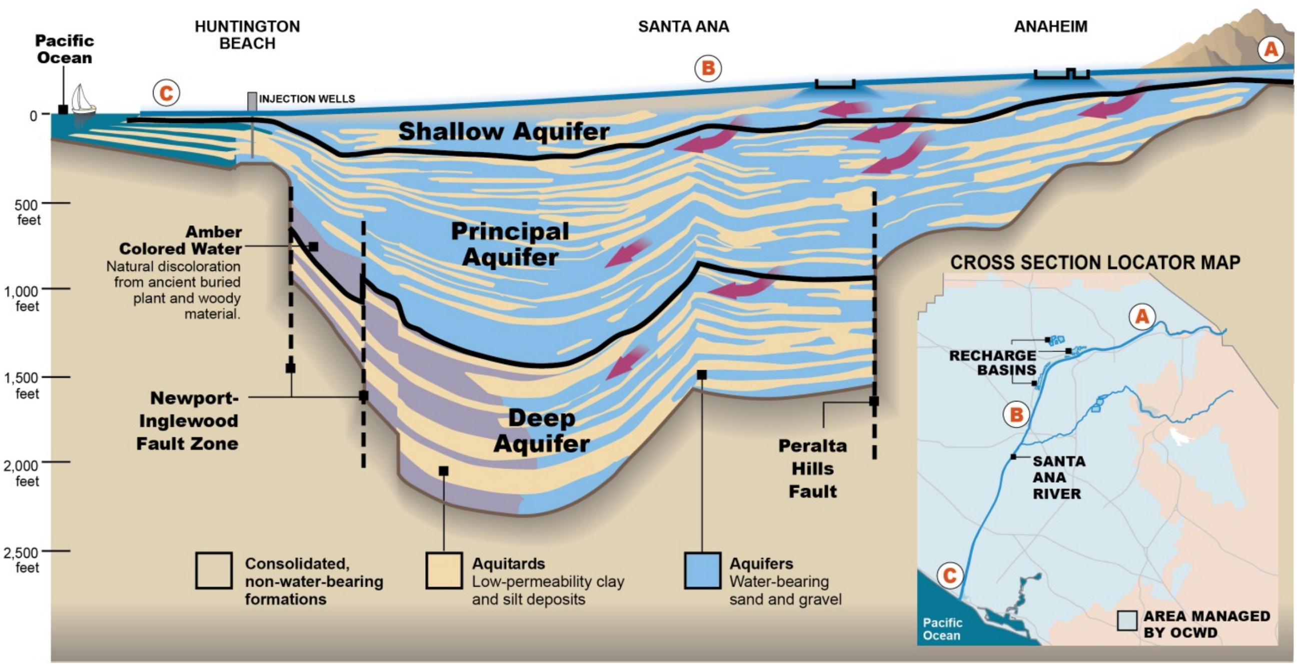


Figure 2-1: Basin 8-1 Aquifer Systems

The La Habra Groundwater Basin was studied by the DWR in the mid-1930s (DWR, 1934) and mid-1940s (DWR, 1947). It has been characterized as a layered aquifer system consisting of the near-surface alluvium, the La Habra Aquifer, and the San Pedro Aquifer (Montgomery, 1977; Geoscience, 2009).

The alluvial aquifer is typically about 100 feet thick. The older alluvium covers most of the surface of the eastern La Habra Groundwater Basin with younger alluvium deposited in Coyote Creek and Brea Creek stream channels. The La Habra aquifer is composed of nonmarine pebbly sandstones within the La Habra formation and underlying the Coyote Hills formation. This aquifer can reach a thickness of 1,200 feet near the center of the basin. Underlying the Coyote Hills formation is the San Pedro formation which contains the San Pedro aquifer, representing the most productive aquifer in the La Habra Groundwater Basin. This confined aquifer is thickest along the axis of the syncline in the basin.

2.3 FAULT ZONES AND GROUNDWATER FLOW

The following is a description of the fault zones in Basin 8-1 from Bulletin 118 (DWR, 2003):

> There are three fault zones within this basin that impede groundwater flow (DWR 1967). The most prominent is the Newport-Inglewood fault zone, which trends northwest and is responsible for formation of the Newport Inglewood uplift. This fault zone forms a barrier to groundwater flow to the southwest and marks the southwest edge of the thick aquifer materials important for groundwater production in the basin (DWR 1967). This barrier is breached by erosional channels filled with alluvium at the Alamitos and Talbert Gaps. Another northwest-trending system is the Whittier fault zone which forms the northeastern boundary of the basin along the Puente Hills. This fault forms a groundwater barrier except where it is breached by recent alluvial channels (DWR 1967). The Norwalk fault trends eastward along the southern edge of the Coyote Hills and is responsible for a lower groundwater level to the south (DWR 1967).

Figure 2-2 shows the major fault zones in Basin 8-1. Because of its variable stratigraphy, large thickness, and annual recharge and production volume, Basin 8-1 possesses a complex subsurface flow regime. Groundwater generally flows in a southwesterly direction from the Forebay recharge areas toward coastal pumping depressions.

The Peralta Hills fault follows a northwest trend crossing the Santa Ana River just north of Lincoln Avenue in the city of Anaheim. This fault has been mapped along the southern flank of the Peralta Hills, and its extension across the Santa Ana River has been inferred from a perennial steep potentiometric gradient in the vicinity of Lincoln Avenue. The fault is believed to partially restrict groundwater flow in this area (OCWD, 1991).

OCWD prepares a groundwater elevation contour map for each of the Shallow, Principal and Deep aquifers within the basin on an annual basis. These maps are useful in assessing the direction of lateral groundwater flow and annual change in groundwater storage in the basin. Data from over 60 depth-specific monitoring wells throughout the basin are used to determine the vertical hydraulic gradients between aquifers as well as temporal changes in groundwater elevation within each of the three major aquifers.

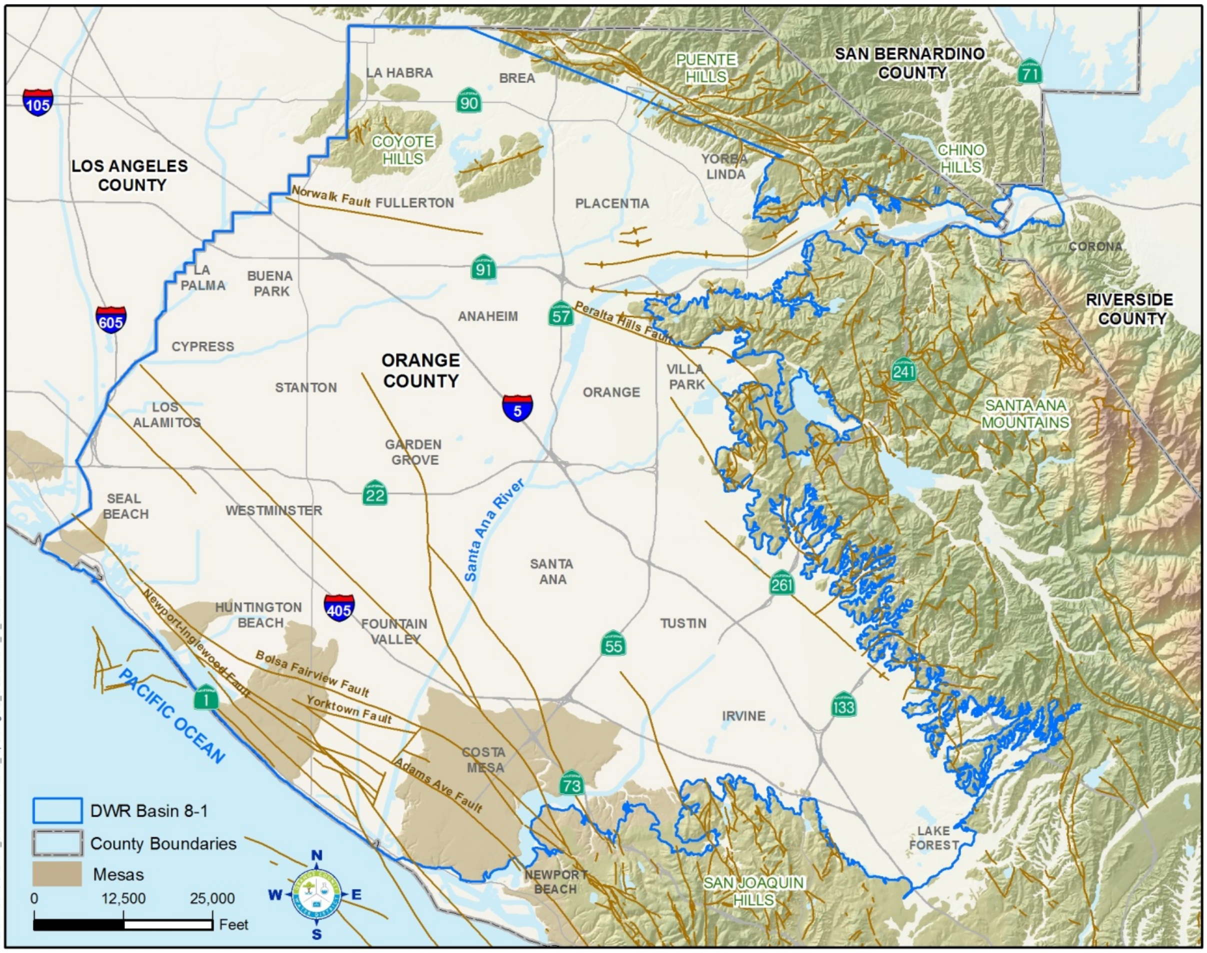


Figure 2-2: Fault Zones

2.4 FOREBAY AND PRESSURE AREAS

The Department of Water Resources (DWR, 1934) divided the basin into two primary hydrologic divisions, the Forebay and Pressure areas, as shown in Figure 2-3. The Forebay/Pressure area boundary generally delineates the areas where surface water or shallow groundwater can or cannot move downward to the first producible aquifer in quantities significant from a water supply perspective. From a water quality perspective, the amount of vertical flow to deeper aquifers from surface water or shallow groundwater may be significant in terms of impacts of past agricultural or industrial land uses (e.g., fertilizer application and leaky underground storage tanks).

The Forebay refers to the area of intake or recharge where the major basin aquifers are replenished by either direct percolation from surface water or downward groundwater flow from overlying, hydraulically-connected aquifers. The area is characterized by a stratigraphic sequence of relatively coarse-grained deposits of sands and gravels with occasional lenses of clay and silt. These clay and silt lenses do not generally impede groundwater flow from one aquifer to another. In fact, it is the lack of continuous aquitards which make aquifer delineation and correlation in the Forebay extremely difficult. Aquifers within the Forebay typically exhibit unconfined to semiconfined conditions. The Forebay area encompasses most of the cities of Anaheim, Fullerton, and Villa Park and portions of the cities of Orange and Yorba Linda.

The Pressure Area is generally defined as the area of the basin where large quantities of surface water and near-surface groundwater are impeded from percolating into the major producible aquifers by clay and silt layers at shallow depths (upper 50 feet). This area is characterized by semi-perched groundwater at depths of less than 50 feet, with substantially clayey or silty sediments in the shallow subsurface. Piezometric head differentials of 50 to 100 feet are common between the shallow-most aquifers and underlying production aquifers in the Pressure Area. The main production aquifers in the Pressure Area, generally at depths between 300 and 1,500 feet, behave as confined or "pressure" aquifers, with seasonal piezometric level fluctuations of several tens of feet between pumping and non-pumping conditions. Most of the central and coastal portions of the basin fall within the Pressure Area.

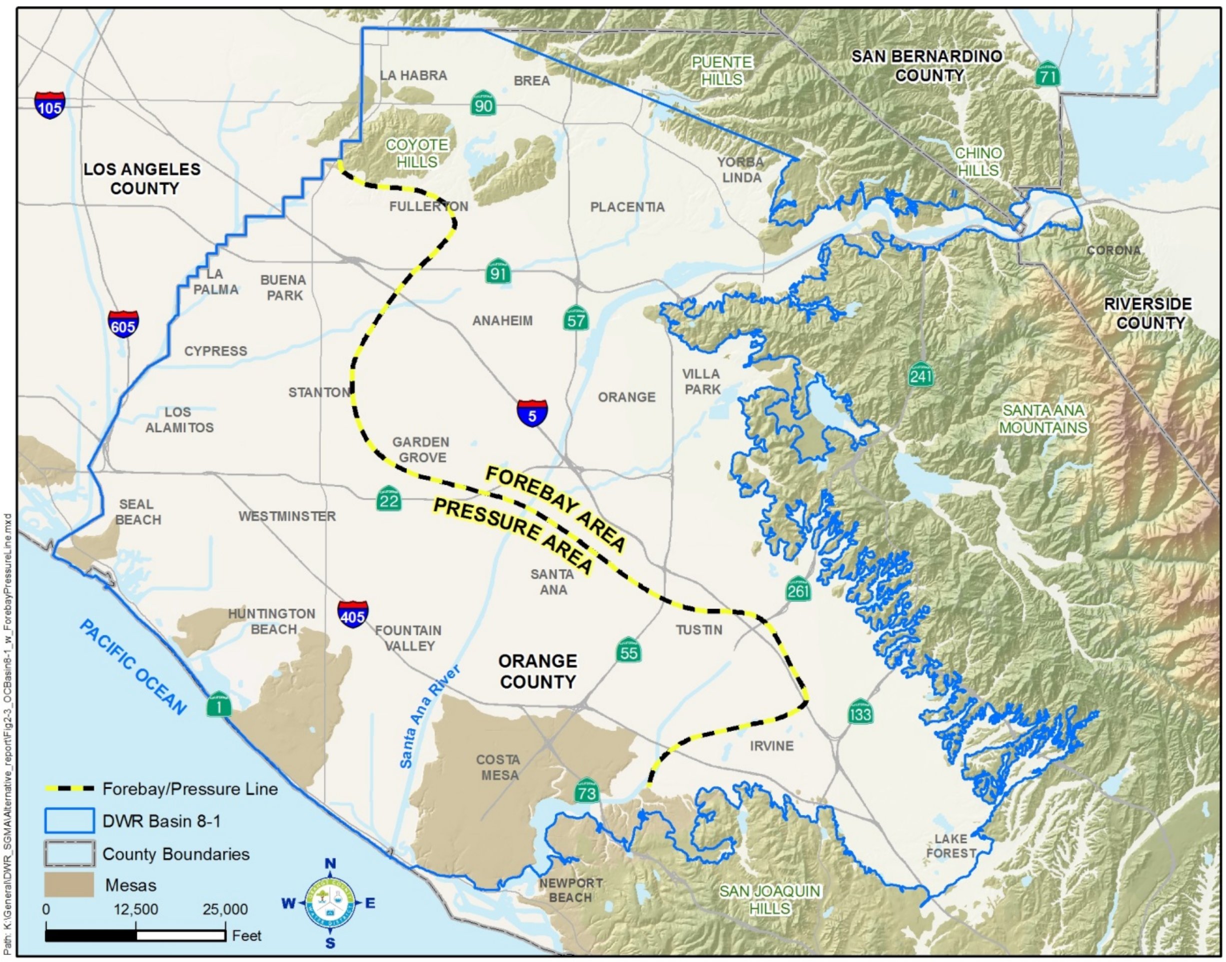


Figure 2-3: Basin 8-1 Forebay and Pressure Areas and Mesas

2.5 COASTAL AREAS

Four relatively flat elevated areas, known as mesas, occur along the coastal boundary of the basin. These mesas, shown in Figure 2-3, were formed by ground surface uplift along the Newport Inglewood Fault Zone. Concurrent with the coastal uplift, alternating courses of the ancient Santa Ana River carved notches through the uplifted area and left behind sand- and gravel-filled deposits beneath the lowland areas between the mesas, known as gaps (Poland et al., 1956).

2.6 TOTAL BASIN VOLUME

A vast amount of fresh water is stored within the basin, although only a fraction of this water can be removed practically using pumping wells and without causing physical damage such as seawater intrusion or the potential for land subsidence. Nonetheless, it is important to note the total volume of groundwater that is within the active flow system, i.e., within the influence of pumping and recharge operations.

OCWD used its geographic information system and the aquifer system boundaries to calculate the total volume of each of the three major aquifer systems as well as the intervening aquitards. The total volume was calculated by multiplying the area and thickness of each hydrogeologic unit. Because groundwater fills the pore spaces that represent typically between 20 and 30 percent of the total volume, the total volume was multiplied by this porosity percentage to arrive at a total groundwater volume. Assuming the basin is completely full, based on District estimates, the total amount of fresh groundwater stored in the basin is approximately 66 million acre-feet, as shown in Table 2-1.

For comparison, DWR (1967) estimated that about 38 million acre-feet of fresh water is stored in the groundwater basin when full. DWR used a factor known as the specific yield to calculate this volume. The specific yield (typically between 10 and 20 percent) is the amount of water that can be drained by gravity from a certain volume of aquifer and reflects the soil's ability to retain and hold a significant volume of water due to capillary effects. Thus, DWR's *drainable* groundwater volume can be considered consistent with OCWD's estimate of *total* groundwater volume in the basin.

2.7 BASIN CROSS SECTIONS

Figure 2-1 shows a schematic basin cross-section prepared by OCWD that shows a representation of the aquifer zones, bottom of basin, and general configuration of aquifers and aquitards. OCWD has developed a series of cross-sections depicting major stratigraphic and structural features in the basin. The twenty-six cross-section profile lines are shown in Figure 2-4. Three representative cross-sections are shown in Figures 2-5 to 2-7.

Table 2-1: Estimated Basin Groundwater Storage by Hydrogeologic Unit (Volumes in Acre-feet)

HYDROGEOLOGIC UNIT	PRESSURE AREA	FOREBAY	TOTAL
Shallow Aquifer System	3,800,000	1,200,000	5,000,000
Aquitard	900,000	200,000	1,100,000
Principal Aquifer System	24,300,000	8,600,000	32,900,000
Aquitard	1,600,000	300,000	1,900,000
Deep Aquifer System	18,800,000	6,300,000	25,100,000
TOTAL	49,400,000	16,600,000	66,000,000

Notes: (1) Volumes calculated using the 3-layer basin model surfaces with ArcInfo Workstation GRID. (2) A porosity of 0.25 was assumed for aquifer systems. (3) A porosity of 0.30 was assumed for aquitards.

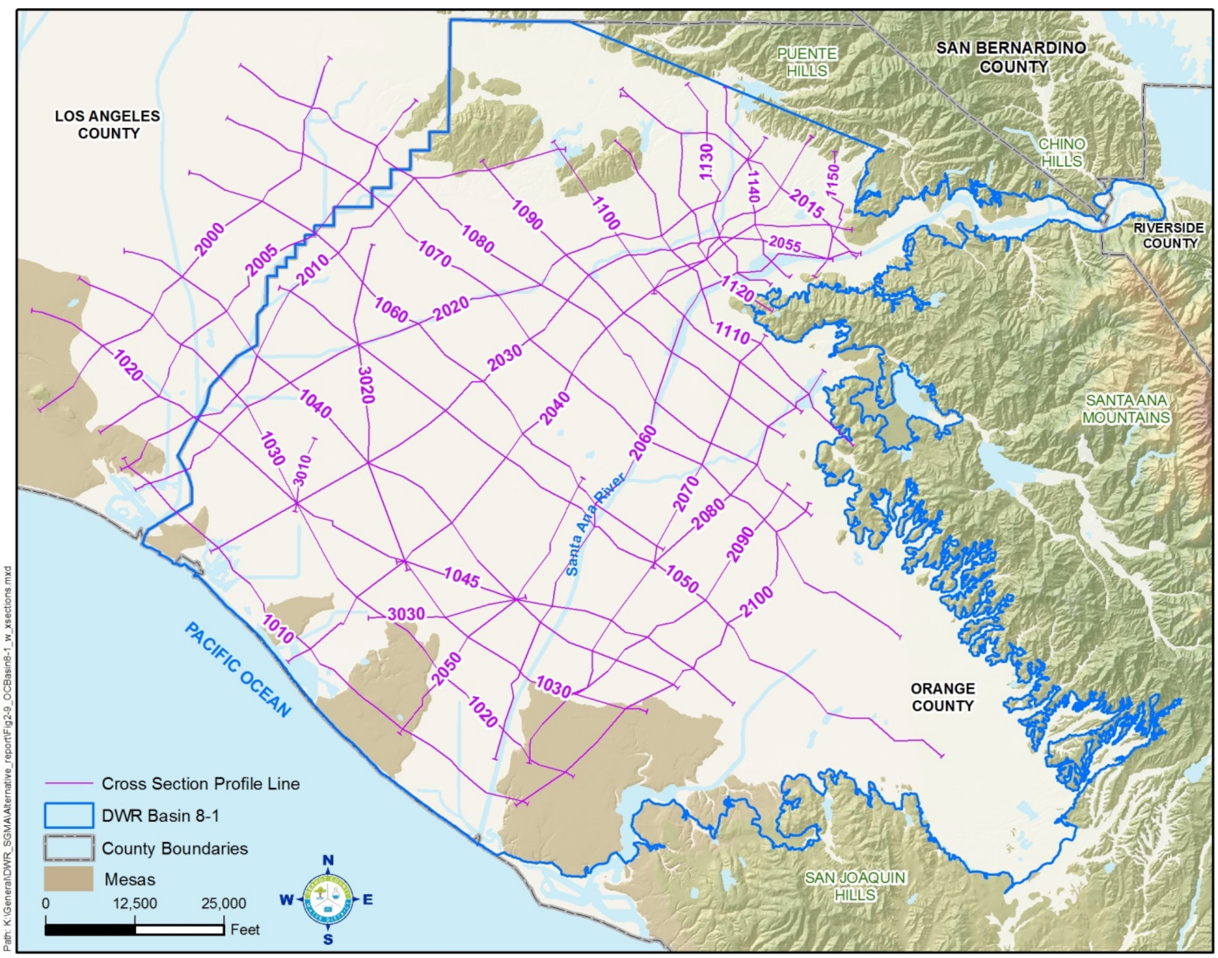
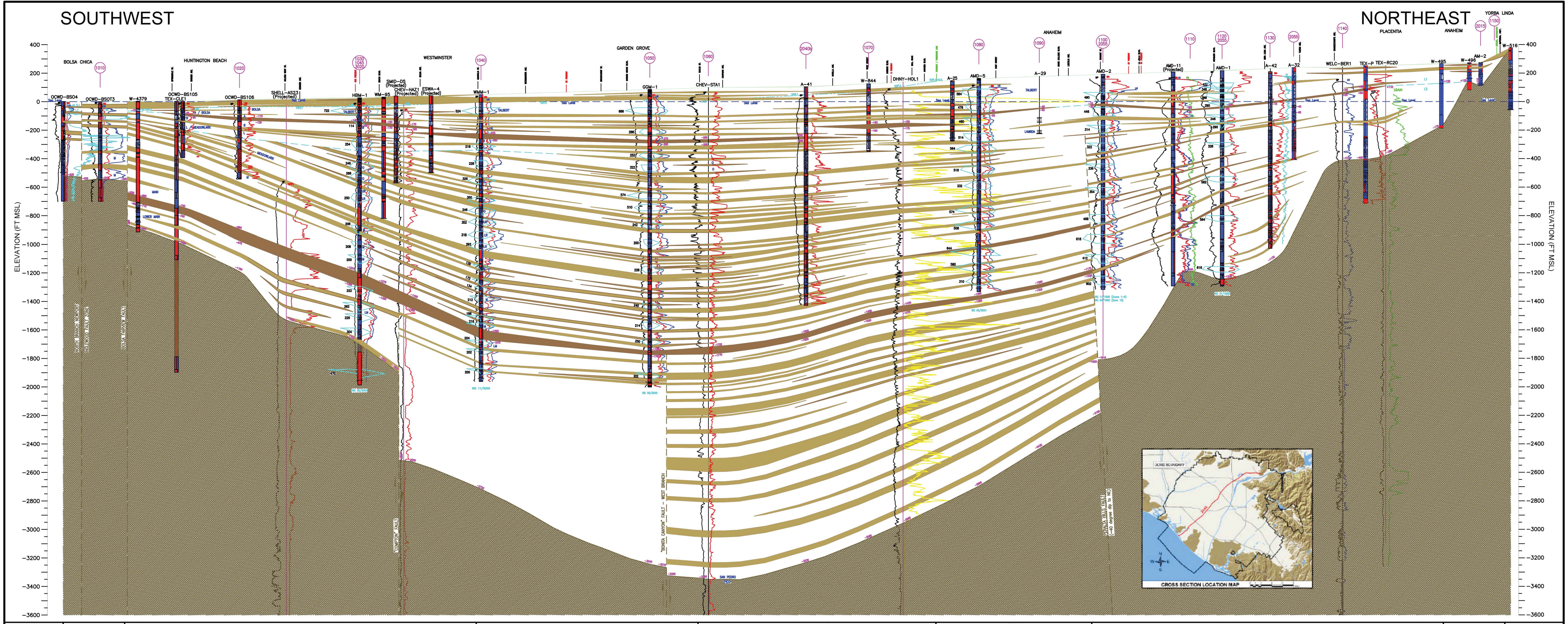


Figure 2-4: Groundwater Basin Cross-Sections



CROSS SECTION ID:

2040

GEOLOGIC CROSS SECTION FOR 3-LAYER BASIN MODEL

HORIZONTAL SCALE (FEET) 0 2000 4000 6000 8000

High Permeability Sediments
Low Permeability Sediments
Low Permeability Sediments & Piezometric System Break
Consolidated Low Permeability Sediments
Area Of Interpreted Colored Water (> 15 cu)
TL1 TOPL1 Top Of Model Layer 1
L1 L2 Model Layer Boundary
Unconformity

1050 Intersection With Numbered Cross Section

WELL NAME — Well with Screened Intervals, Electric Logs, Aquifer Designations, Color Water Values (Color Units) and Depths of Layer Boundaries (feet mean sea level)

TDS — Na + K, Ca, Mg, Cl, HCO3, SO4 — 10 0 10 meq./ liter

100% Gravel
75% Gravel, 25% Sand
50% Sand, 50% Silt
75% Silt, 25% Clay
100% Clay
100% Sand With Shells
100% Sand With Wood

Revised By	Date	Description	Checked By	Approved By
AJC	07/16/96	PROFILE DRAWN	RH	RH
AJC	06/10/97	PARTIAL CORRELATION DIGITIZED	RH	RH
TS	08/19/99	MODEL B3 REVISIONS DRAWN	TS	RH
JR	07/01/03	MODEL B3 REVISIONS DIGITIZED	TS	RH
JR	10/09/03	REMAINING CORRELATION DIGITIZED	RH	RH
MP	01/06/04	REVISED STIFF DIAGRAMS	JR	RH
JR	01/06/04	ADDED MAP, LEGEND AND BORDER / UPDATED HATCH AND COLORS	TS	RH

FILE LOCATION: S:/ BASINMOD / XSC / XSC-2040.DWG

Figure 2-5: Cross Section 2040

CROSS SECTION ID:

2040

CROSS SECTION ID:

1050

GEOLOGIC CROSS SECTION FOR 3-LAYER BASIN MODEL

0 2000 4000 6000 8000
HORIZONTAL SCALE (FEET)

High Permeability Sediments
Low Permeability Sediments
Low Permeability Sediments & Piezometric System Break
Consolidated Low Permeability Sediments
Area Of Interpreted Colored Water (> 15 cu)
TL1 TOPL1 Top Of Model Layer 1
L1 L2 Model Layer Boundary
Unconformity

1050 Intersection With Numbered Cross Section
WELL NAME
Well with Screened Intervals, Electric Logs, Aquifer Designations, Color Water Values (Color Units) and Depths of Layer Boundaries (feet mean sea level)
TDS Na + K Ca Mg Cl HCO3 SO4
10 0 10
meq./ liter

100% Gravel
75% Gravel, 25% Sand
50% Sand, 50% Silt
75% Silt, 25% Clay
100% Clay
100% Sand With Shells
100% Sand With Wood

Revisions

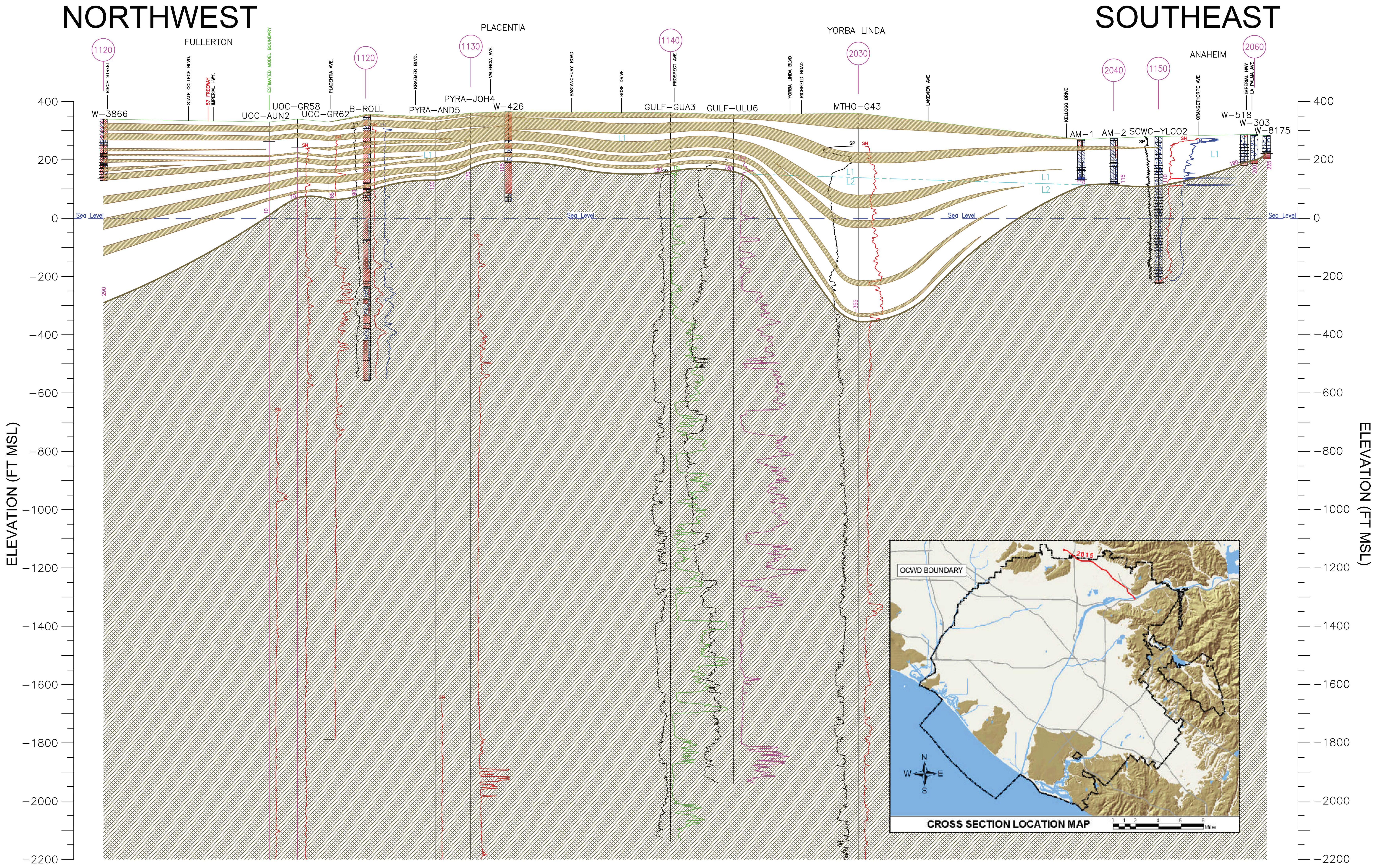
Revised By	Date	Description	Checked By	Approved By
AJC	06/20/96	CORRELATION DRAWN	RH	RH
JR	08/05/97	CORRELATION DIGITIZED	RH	RH
TS	FALL 1999	MODEL B3 REVISIONS DRAWN	TS	RH
JR	01/02/02	MODEL B3 REVISIONS DIGITIZED	TS	RH
DF	01/02/02	STIFF DIAGRAMS REVISED	JR	RH
JR	01/09/04	ADDED MAP, LEGEND AND BORDER / UPDATED HATCH AND COLORS	TS	RH

FILE LOCATION: S:/ BASINMOD / XSC / XSC-1050.DWG

Figure 2-6: Cross Section 1050

CROSS SECTION ID:

1050



GEOLOGIC CROSS SECTION FOR 3-LAYER BASIN MODEL

0 2000 4000 6000 8000
HORIZONTAL SCALE (FEET)

- High Permeability Sediments
- Low Permeability Sediments
- Low Permeability Sediments & Piezometric System Break
- Consolidated Low Permeability Sediments
- Area Of Interpreted Colored Water (> 15 cu)
- Top Of Model Layer 1
- Model Layer Boundary
- Unconformity

1050 Intersection With Numbered Cross Section

WELL NAME — Well with Screened Intervals, Electric Logs, Aquifer Designations, Color Water Values (Color Units) and Depths of Layer Boundaries (feet mean sea level)

TDS — Na + K, Cl, Ca, HCO3, Mg, SO4 — 10 0 10 meq./ liter

- 100% Gravel
- 75% Gravel, 25% Sand
- 50% Sand, 50% Silt
- 75% Silt, 25% Clay
- 100% Clay
- 100% Sand With Shells
- 100% Sand With Wood

Revisions

Revised By	Date	Description	Checked By	Approved By
AJC	10/28/94	PROFILE DRAWN	TS	RH
JR	05/30/97	BOTTOM OF 3D MODEL DRAWN	TS	RH
JR	10/23/03	CORRELATION DIGITIZED	TS	RH
JR	02/26/04	ADDED MAP, LEGEND AND BORDER / UPDATED HATCH AND COLORS	TS	RH

FILE LOCATION: S:/ BASINMOD / XSC / XSC-2015.DWG

Figure 2-7: Cross Section 2015

CROSS SECTION ID:

2015

ORANGE COUNTY WATER DISTRICT
SINCE 1933

2.8 BASIN CHARACTERISTICS

Physiographic characteristics of Basin 8-1 are shown in Figures 2-8 to 2-11. These figures show the USGS topographic information, surface soil characteristics, recharge areas and surface water bodies that are significant to the management of the basin, and surficial geology.

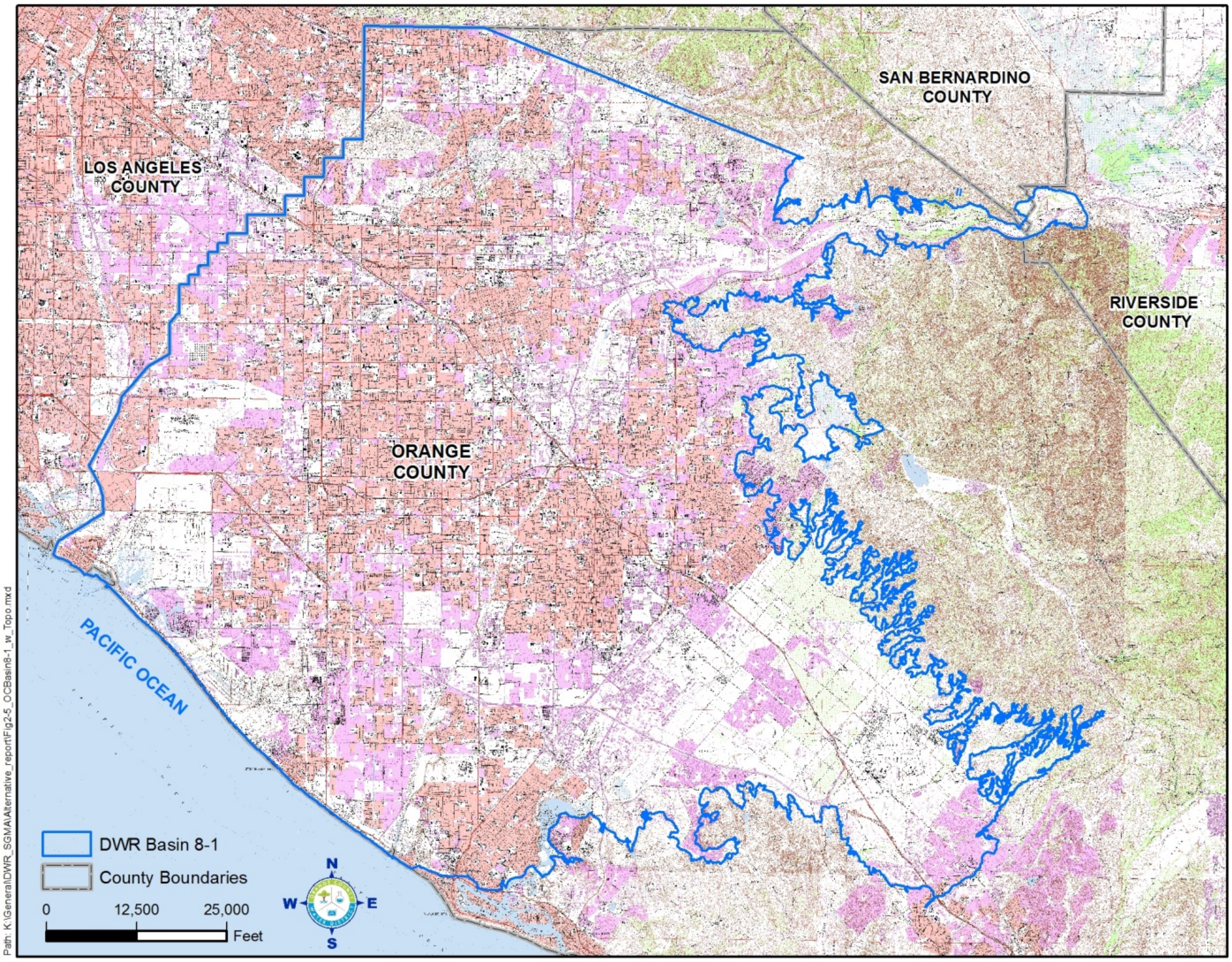


Figure 2-8: United States Geological Survey Topographic Map

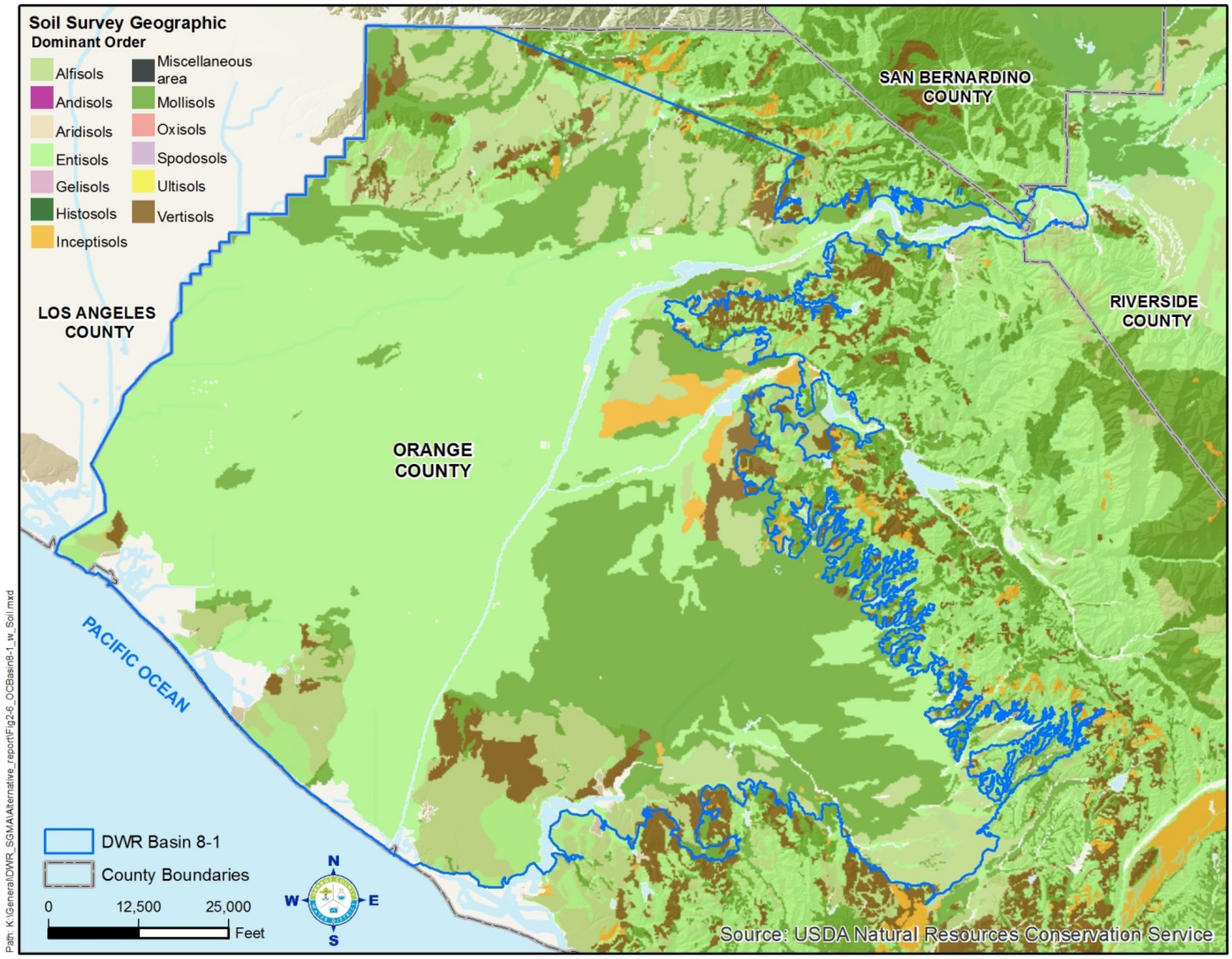


Figure 2-9**:** Surficial Soil Characteristics

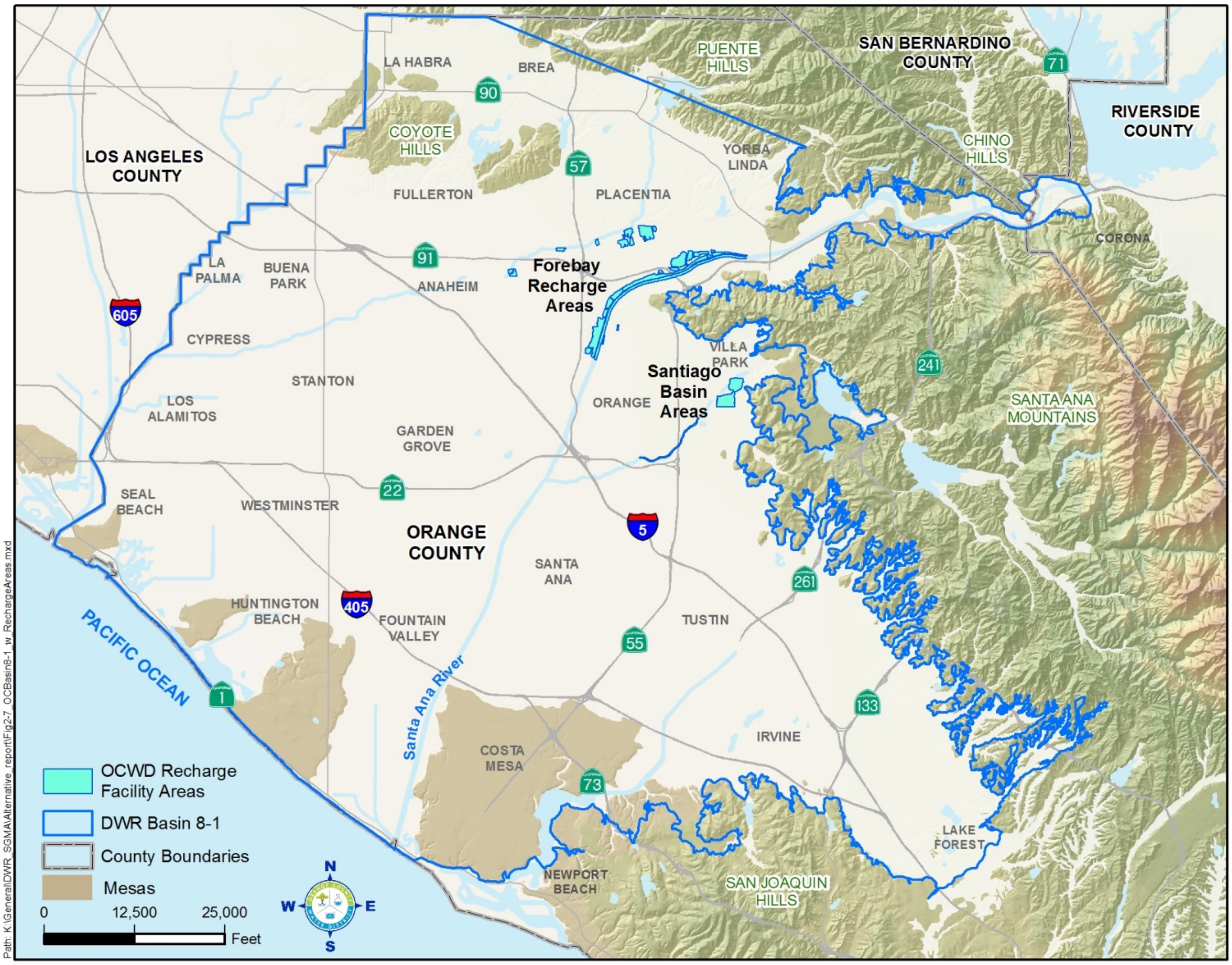


Figure 2-10**:** Recharge Areas

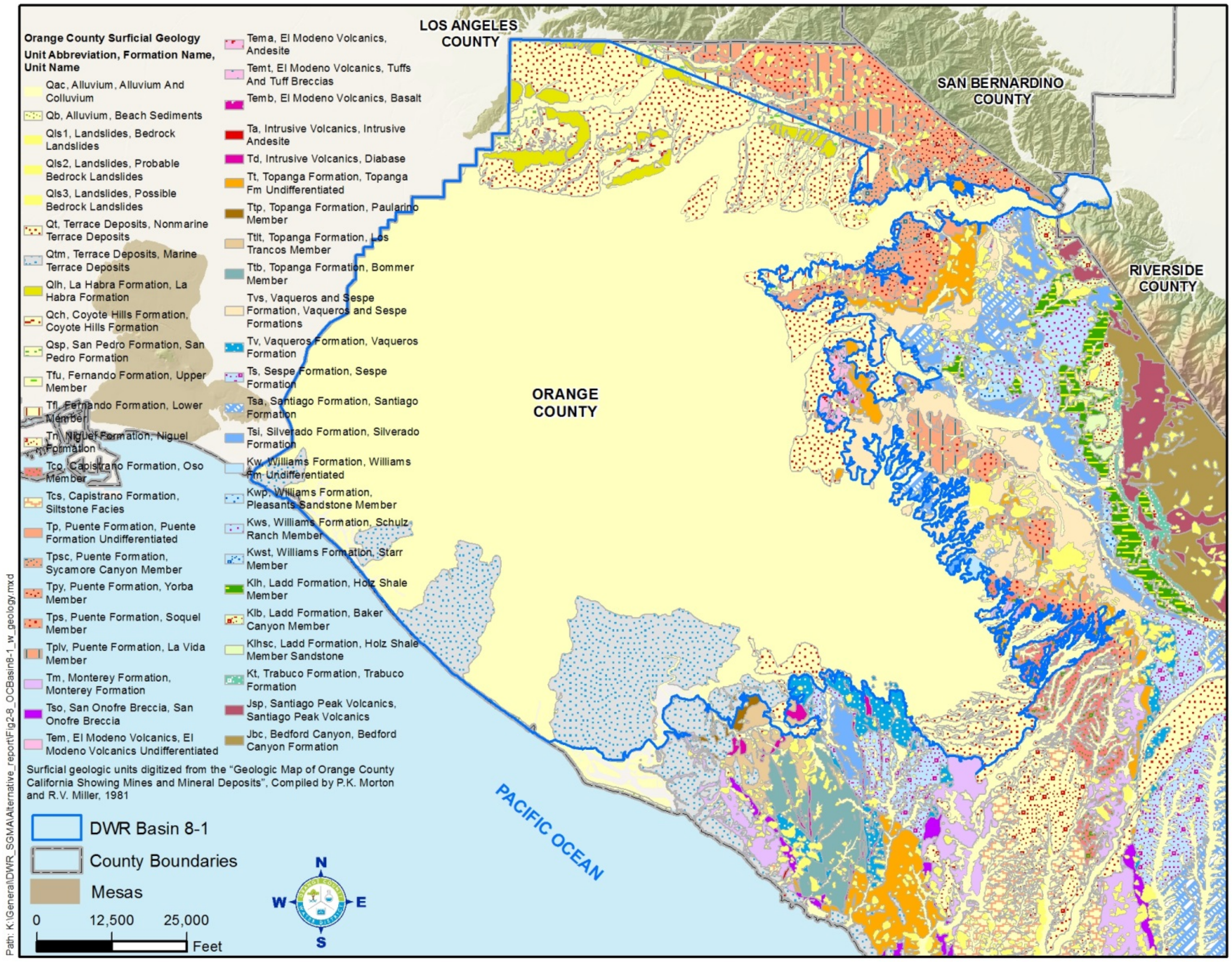


Figure 2-11: Surficial Geology

SECTION 3 BENEFICIAL USES AND BASIN WATER QUALITY

3.1 BASIN PLAN

The State Water Resources Control Board (State Board) and nine Regional Water Quality Control Boards have responsibility to protect the quality of California's waters. Basin 8-1 is under the jurisdiction of the Santa Ana Regional Board (Regional Water Board). The Regional Water Board first adopted, in 1975, the Water Quality Control Plan (Basin Plan) for the Santa Ana Region. The Santa Ana Region, shown in Figure 3-1, includes the area drained by the Santa Ana River and a portion of the Coyote Creek Watershed drained by the San Gabriel River.

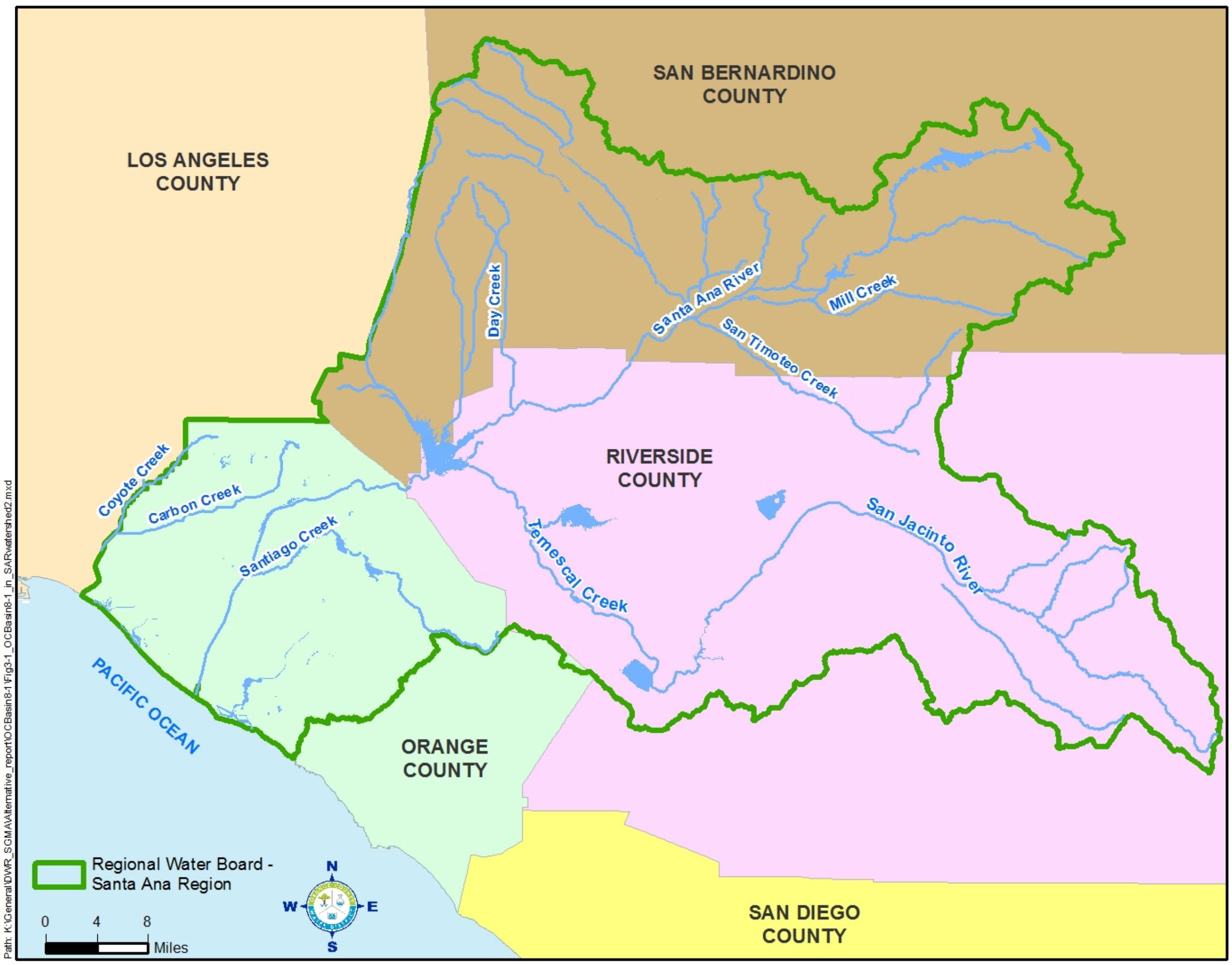


Figure 3-1: Regional Water Quality Control Board, Santa Ana Region

The Santa Ana River begins in the San Bernardino Mountains, flows through parts of Riverside and San Bernardino Counties and discharges to the Pacific Ocean in Orange County. Since the initial adoption of the Basin Plan, it has been periodically updated. The Basin Plan is the basis for the Regional Water Board's regulatory programs and salt and nutrient management programs. It establishes beneficial uses and water quality standards for surface water and groundwater in the region and a wasteload allocation for discharges to the Santa Ana River and its tributaries for total dissolved solids and nitrate.

3.2 BENEFICIAL USE DESIGNATIONS

Groundwater Management Zones established by the Regional Board in Basin 8-1 are shown in Figure 3-2. Beneficial uses designated for Groundwater Management Zones within Basin 8-1 are shown in Table 3-1.

Figures 3-3 and 3-4 show the surface water body designations for water bodies within the Santa Ana Region. Beneficial Uses designated for surface water bodies that may influence the quality of groundwater in Basin 8-1 are shown in Table 3-4.

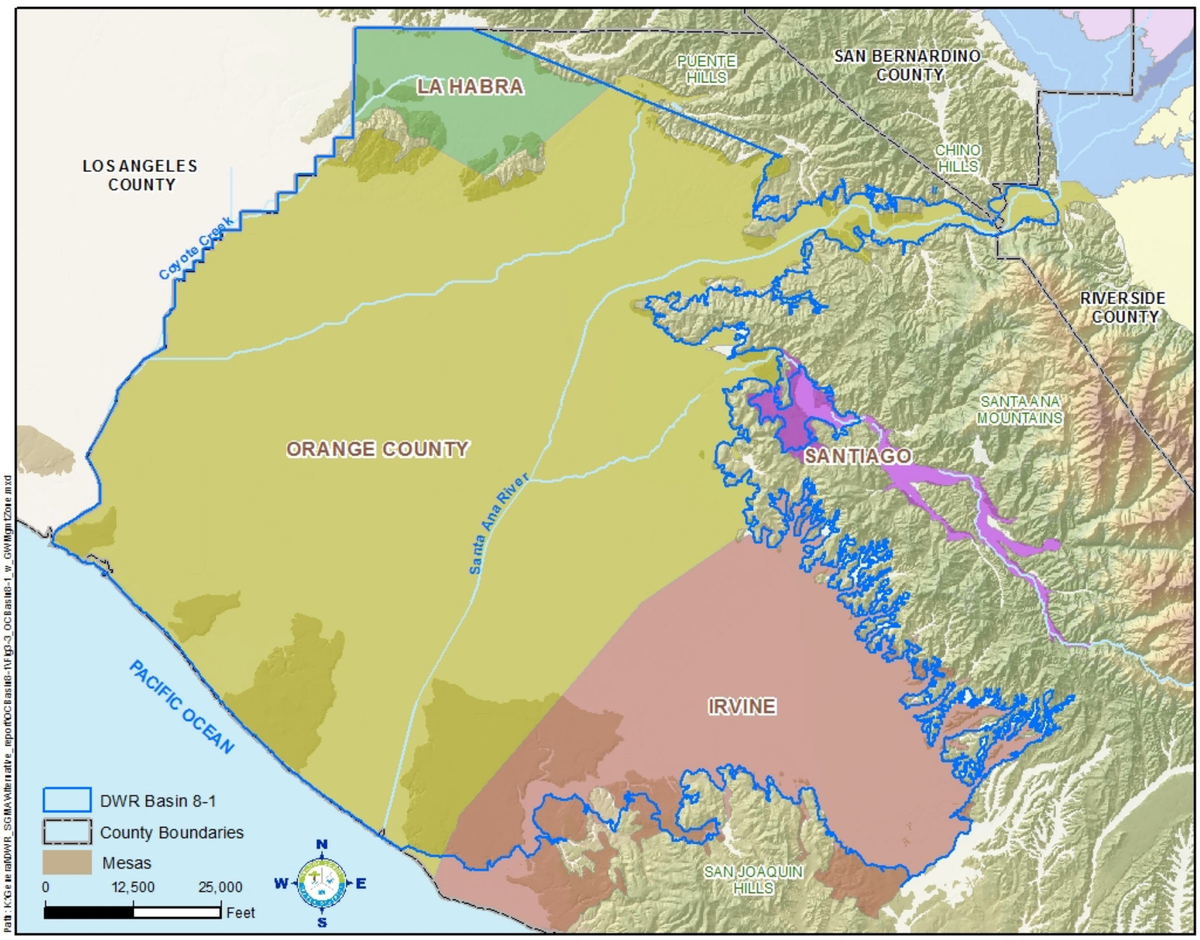


Figure 3-2: Basin 8-1 Groundwater Management Zones

Table 3-1: Beneficial Use Designations for Groundwater Management Zones

Groundwater Management Zone	Existing or Potential Beneficial Use			
	Municipal and Domestic Supply	Agricultural Supply	Industrial Service Supply	Industrial Process Supply
La Habra	X	X		
Santiago	X	X		
Orange	X	X	X	X
Irvine	X	X	X	X

Source: Santa Ana Basin Plan X= existing or potential Beneficial Use

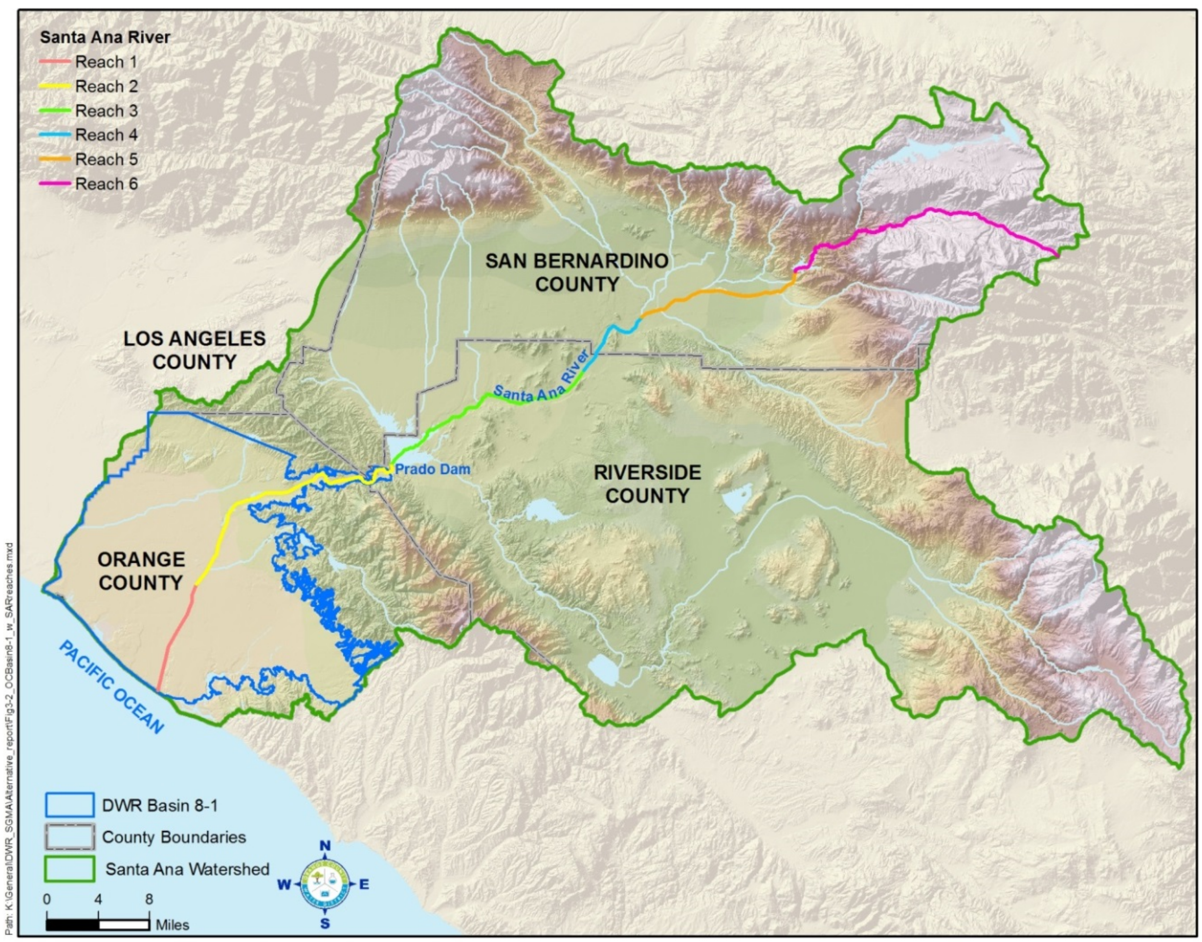


Figure 3-3: Santa Ana River Reaches

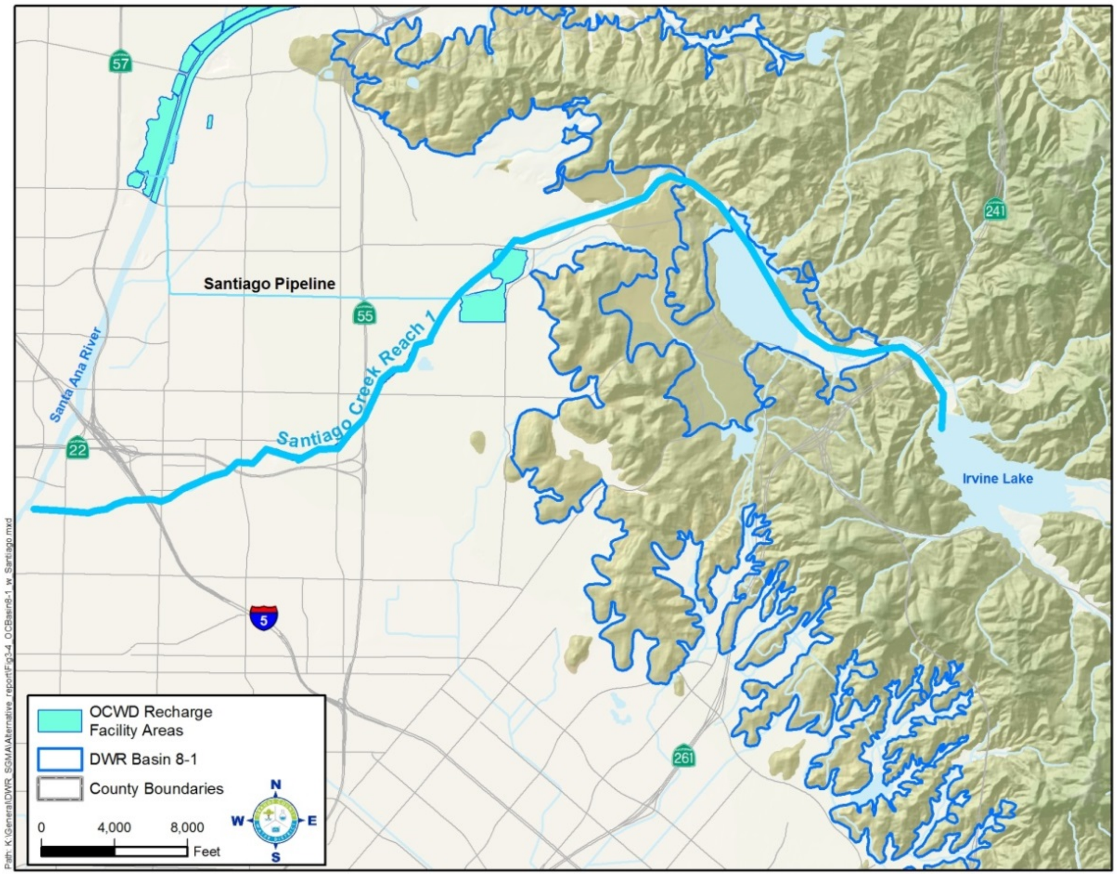


Figure 3-4: Santiago Creek and Santiago Basins

Table 3-2: Beneficial Use Designations for Surface Water Bodies

Surface Water Body	Existing or Potential Beneficial Use*							
	MUN	AGR	GWR	REC 1	REC 2	WARM	WILD	RARE
Santa Ana River, Reach 2- 17th Street in Santa Ana to Prado Dam		X	X	X	X	X	X	X
Santiago Creek, Reach 1- below Irvine Lake	X		X	X	X	X	X	
Coyote Creek (within Santa Ana Regional Boundary)	X			X	X	X	X	

*MUN- municipal and domestic supply; AGR-agricultural supply; GWR-groundwater recharge; REC 1-water contact recreation; REC 2-non-contact water recreation; WARM-warm freshwater habitat; WILD-wildlife habitat; RARE-rare, threatened, or endangered species

Source: Santa Ana Basin Plan X= Existing or Potential Beneficial Use

3.3 WATER QUALITY OBJECTIVES

3.3.1 Regulation of Groundwater Quality

The 1975 Basin Plan established groundwater subbasin boundaries in the Santa Ana Region for the purpose of designating water quality objectives for specified geographic areas. These subbasin boundaries were revised with the creation of Management Zones by amendments to the Basin Plan in 2004. The new Management Zones were defined on the basis of separation by impervious rock formations or other groundwater barriers, distinct flow systems defined by consistent hydraulic gradients that prevent widespread intermixing, and distinct differences in water quality.

Along with the creation of Management Zones, the Regional Water Board adopted water quality objectives for total dissolved solids (TDS) and nitrate-nitrogen for a majority of the management zones. The water quality objectives were based on historical concentrations of TDS and nitrate-nitrogen from 1954 to 1973. In Basin 8-1, the Regional Board established four management zones: La Habra, Santiago, Orange County, and Irvine (see Figure 3-2). For La Habra and Santiago Management Zones, the Regional Water Board did not established numeric objectives. For these two management zones, water quality is regulated by narrative objectives in the Basin Plan. For Orange County and Irvine Management Zones, numeric water quality objectives were adopted for TDS and nitrate-nitrogen (as N), as shown in Table 3-3.

Table 3-3: Groundwater Water Quality Objectives

MANAGEMENT ZONE	WATER QUALITY OBJECTIVE	
	Total Dissolved Solids (TDS)	Nitrate-nitrogen (as N)
La Habra*	---	---
Santiago*	---	---
Orange County	580 mg/L	3.4 mg/L
Irvine	910 mg/L	5.9 mg/L

* Numeric objectives not established; narrative objectives apply
Source: Regional Board, 2008

3.3.2 Regulation of Surface Water Quality

Water quality objectives for the Santa Ana River are a significant part of the Basin Plan, in part because the river water is a major source of groundwater recharge for Basin 8-1.

The Regional Water Board divides the Santa Ana River into five reaches (see Figure 3-3). The dividing line between Reaches 2 and 3 of the river, and between the upper and lower Santa Ana Basins, is Prado Dam, a flood control facility built and operated by the U.S. Army Corps of Engineers. The dam includes a subsurface groundwater barrier, and as a result all ground and surface waters from the upper basin are forced to pass through the dam (or over the spillway).

The quality of the Santa Ana River is a function of the quantity and quality of the base flows and storm flows. The base flow is primarily comprised of wastewater discharges. OCWD captures and recharges nearly all of the base flow and a portion of the storm flow in the river that is released through Prado Dam.

OCWD also recharges surface water within the Santiago Creek bed and in recharge basins located adjacent to the creek. Santiago Creek is the primary drainage for the northwest portion of the Santa Ana Mountains and ultimately drains into the Santa Ana River. Water from Santiago Creek is impounded by Santiago Dam, creating Irvine Lake, which is owned by the Irvine Ranch Water District and Serrano Water District. Downstream of Santiago Dam is Villa Park Dam, which is a flood-control facility owned and operated by the Orange County Flood Control District. OCWD owns and operates recharge basins downstream of Villa Park Dam.

The water quality objectives established in the Basin Plan for Santa Ana River, Reach 2 and Santiago Creek, Reach 1, are shown in Table 3-4. The Regional Board has not established numeric objectives for the portion of Coyote Creek within the Santa Ana Basin boundary.

Table 3-4: Surface Water Quality Objectives

SURFACE WATER BODY	WATER QUALITY OBJECTIVES Total Dissolved Solids (mg/L)
Santa Ana River, Reach 2	650 (5-year moving average)
Santiago Creek, Reach 1- below Irvine Lake	600
Coyote Creek (within Santa Ana Regional Boundary)	*

*Numeric objectives not established; narrative objectives apply

3.4 GENERAL WATER QUALITY OF THE PRINCIPAL AQUIFER

TDS concentrations in the Principal Aquifer in the OCWD Management Zone of Basin 8-1 generally range from 300 to 400 mg/L in the Pressure Area and from 500 to 700 mg/L in the Forebay Area. In the Irvine Management Zone, TDS concentrations range from approximately 400 mg/L west of Culver Drive to 1,000 mg/L in the area northeast of Interstate 5.

Nitrate (as N) concentrations in the OCWD Management Zone of Basin 8-1 generally range from less than 1 to 4 mg/L in the Pressure Area and from 4 to 7 mg/L in the Forebay Area. In the Irvine Management Zone, nitrate (as N) concentrations are generally less than 1 mg/L in the area west of Culver Drive and increase to 10 to 25 mg/L in the area northeast of Interstate 5.

The Regional Water Board requires that the ambient quality of groundwater in each of the Management Zones be recomputed every three years for TDS and nitrate. The most recent re-computation was completed in 2014 for the period ending in 2012. Ambient water quality concentrations for the Basin 8-1 Management Zones are shown in Table 3-5

Table 3-5: Ambient Water Quality

MANAGEMENT ZONE	AMBIENT WATER QUALITY	
	Total Dissolved Solids (TDS)	Nitrate-nitrogen (as N)
Orange County	610 mg/L	2.9 mg/L
Irvine	940 mg/L	6.7 mg/L
La Habra	963 mg/L	2 mg/L

Source: Wildermuth Environmental, Inc. 2014; City of La Habra

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Basin 8-1 Alternative

La Habra-Brea
Management Area

Submitted by: City of La Habra

On behalf of: City of La Habra

City of Brea

January 1, 2017

Basin 8-1 Alternative

La Habra-Brea Management Area

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Stetson Engineers, Inc.
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Covina, CA 91724

Prepared for the Department of Water Resources, pursuant to Water Code §10733.6(b)(3)

January 1, 2017

Section **Page**

Figure

Table

SECTION 1. EXECUTIVE SUMMARY

The La Habra-Brea Management area covers the northern corner of the Department of Water Resources (DWR) Basin 8-1, Coastal Plain of Orange County Groundwater Basin. The City of La Habra is established as the GSA under SGMA for the La Habra-Brea Management Area. This management area is part of Basin 8-1, but is hydrogeologically distinct from the OCWD Management Area and is not under the jurisdiction of OCWD. The City of La Habra adopted a resolution to establish the La Habra Groundwater Basin as a separate basin from Basin 8-1. OCWD adopted a resolution to support the City's request to DWR for an internal jurisdictional boundary modification in the OC Basin that follows the city limits of La Habra and Brea and is outside of the Orange County Water District's jurisdictional boundary. .

The La Habra-Brea Management Area is included with this Basin 8-1 Alternative to facilitate collaboration among groundwater agencies within Basin 8-1 as required by SGMA. The City of La Habra and portions of the City of Brea comprise the La Habra-Brea Management Area. This management area overlies the extents of the proposed La Habra Groundwater Basin, referenced herein. Figure 1-1 shows the extent of the La Habra Groundwater Basin and the cities (La Habra and Brea) with jurisdiction in the La Habra-Brea Management Area.

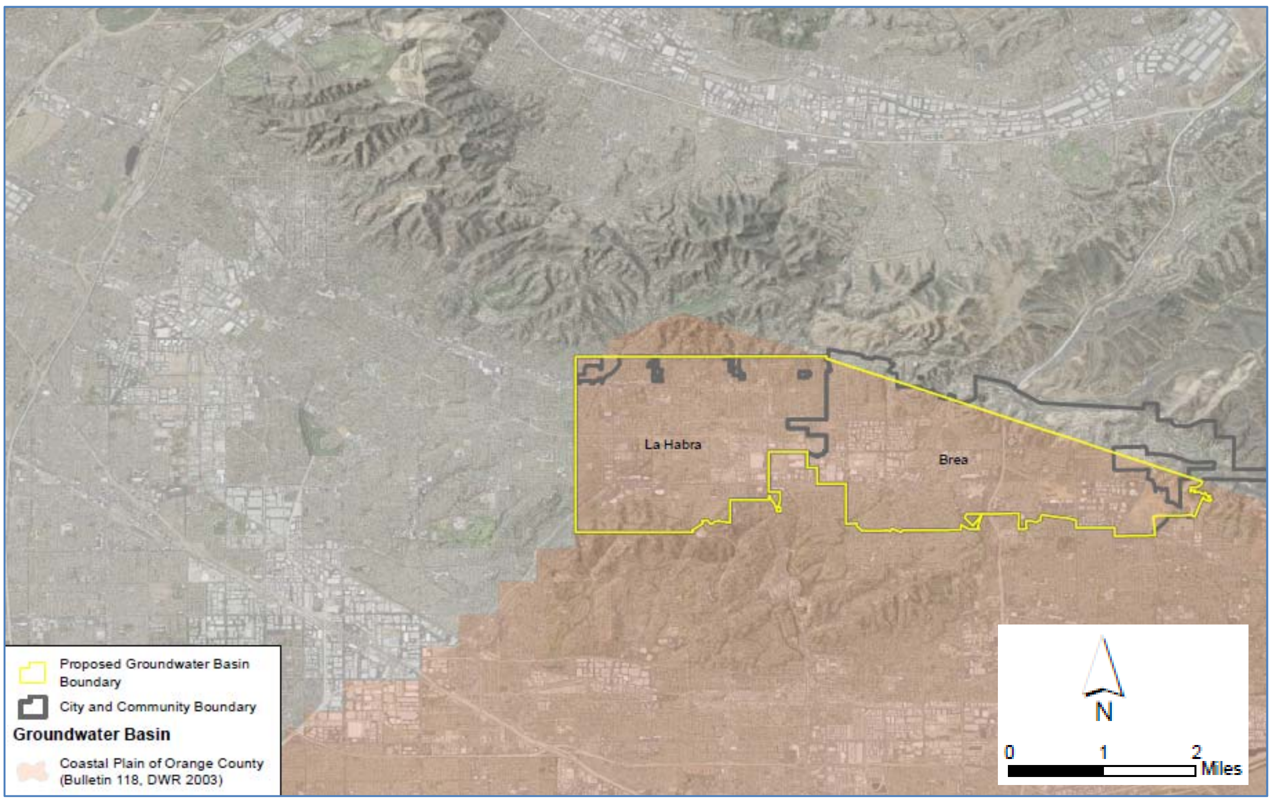

Figure 1-1: La Habra Groundwater Basin

The geologic structure of the La Habra Groundwater Basin is dominated by the La Habra Syncline, a northwest trending, U-shaped down-fold. The syncline is deepest in the Brea area and becomes increasingly shallower towards the City of Whittier and is bounded by the Whittier Fault within the Puente Hills to the north and the Coyote Hills to the south (Montgomery, 1977). The La Habra Syncline produces the La Habra Valley, a naturally-occurring valley, where significant amounts of groundwater have accumulated over the past 150,000 years (Malcolm Pirnie, 2011a).

Groundwater within the La Habra Groundwater Basin generally flows from the Puente Hills in a south or southwesterly direction. A groundwater level hydrograph for a well completed in the Alluvium shows water levels declining to their lowest level in the 1950s, and recovering during the 1970s. More recent data from a nearby well shows a leveling off of water levels through the 1990s. Wells completed in the San Pedro Formation show rising groundwater levels. The lowest groundwater levels in this aquifer were observed during the 1930s and 1940s, with water levels recovering about 60 feet through 1972. More recent data show an overall rising trend of 50 to 60 feet in groundwater levels from 1970 through 2007 and a slight decline during the last three years of data.

The City of La Habra pumps local groundwater from the La Habra Groundwater Basin from three production wells: the Idaho Street Well, the La Bonita Well, and the Portola Well. The City of Brea owns and operates one non-potable groundwater well used for irrigation at Brea Creek Golf Course.

The La Habra Groundwater Basin is currently monitored for groundwater elevations and for groundwater quality through productions wells and historical data from monitoring wells within the La Habra Groundwater Basin and surrounding area.

Groundwater resources protection is considered a critical component for safeguarding the long-term sustainability of the La Habra Groundwater Basin. Groundwater resources protection includes water resources planning as well as groundwater protection programs including well construction, abandonment, and destruction policies, wellhead protection, and the control of the migration and remediation of contaminated, poor quality, or saline water.

As the City of La Habra currently depends on local groundwater to meet approximately 40 percent of its water consumption, preserving the sustainability of the La Habra Groundwater Basin is essential for the well-being of the City. Currently (and historically), the City of La Habra manages (and has managed) the La Habra Groundwater Basin through management plans and programs for groundwater levels, basin storage, and water quality. By January 2020, the City will manage the La Habra Groundwater Basin through a Groundwater Sustainability Plan ("GSP") under SGMA, which will describe the City's monitoring program and ensure that no undesirable results occur in the future.

SECTION 2. AGENCY INFORMATION

2.1 HISTORY OF AGENCIES IN LA HABRA GROUNDWATER BASIN

Two cities overly the La Habra Groundwater Basin within Basin 8-1: the City of La Habra and the City of Brea, which are the only groundwater producers in the La Habra Groundwater Basin. See Figure 2-1.

The City of La Habra is located in the northwestern corner of Orange County. The City of La Habra serves a population of approximately 63,000 throughout its 7.3 square-mile service area. Los Angeles County borders the City of La Habra on the north and west, the City of Brea on the east, and the City of Fullerton on the south and southeast.

The City of Brea is located in the northwestern corner of Orange County. The City of Brea serves a population of approximately 40,377 throughout its 10.7 square-mile service area. Los Angeles County borders the City of La Habra on the north and west, the City of Brea on the east, and the City of Fullerton on the south and southeast.

Historically, the Cities of La Habra and Brea have managed the groundwater resources in the La Habra Groundwater Basin.

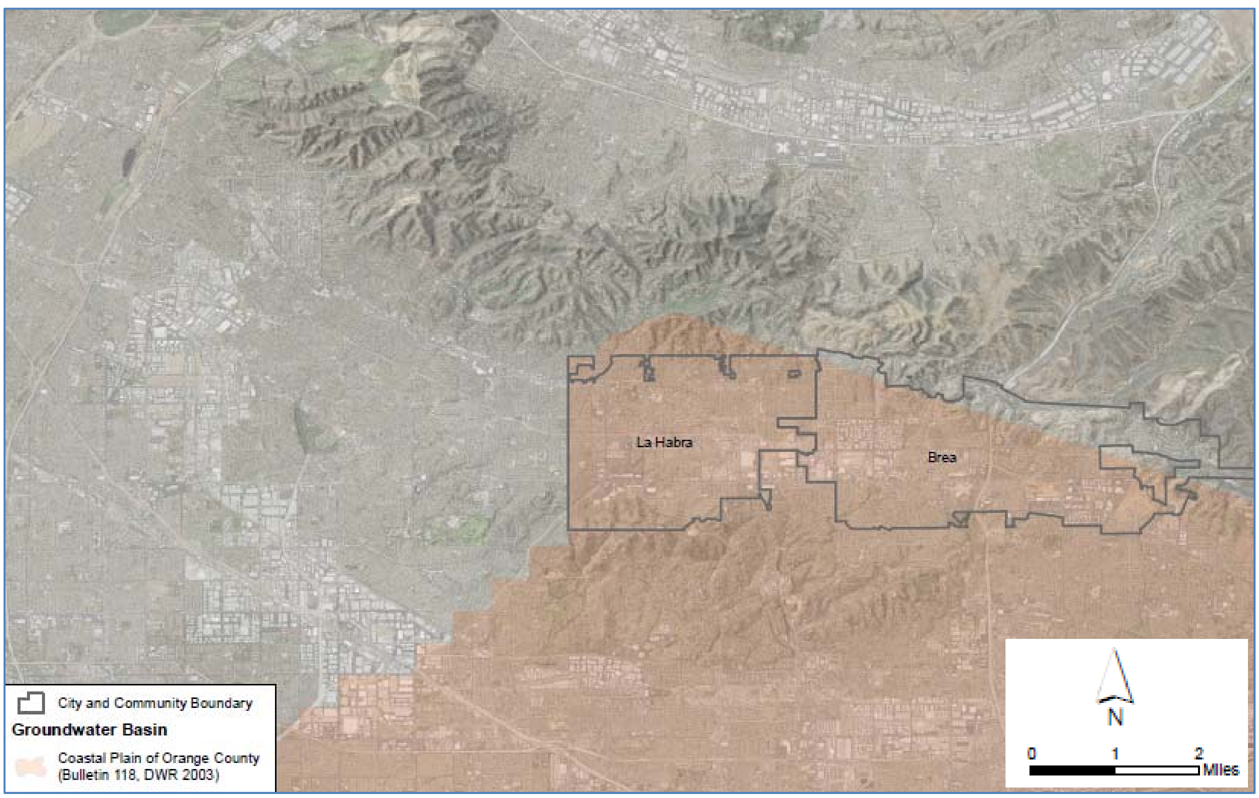

Figure 2-1: Cities of La Habra and Brea within Basin 8-1

2.2 GOVERNANCE AND MANAGEMENT STRUCTURE

Pursuant to California Water Code 10723 of the Sustainable Groundwater Management Act (SGMA), the City of La Habra, under a memorandum of agreement with the City of Brea, has been established as the Groundwater Sustainability Agency (GSA) for the La Habra Groundwater Basin. On December 21, 2015, the La Habra City Council adopted Resolution No. 5714 to establish La Habra as a GSA and formally notified the Department of Water Resources on May 11, 2016. The Department of Water Resources has listed the La Habra GSA as an "exclusive" GSA within the areas of the Basin identified in La Habra's GSA notification, meaning the 90 day notice period has expired and La Habra is the exclusive GSA for that portion of the basin, i.e. the La Habra-Brea Management Area.

2.3 LEGAL AUTHORITY

Apart from SGMA, the Cities of La Habra and Brea have the legal authority to make and enforce ordinances and regulations not in conflict with general laws within their jurisdictions, pursuant to California Constitution Article XI Section 7; and to establish ordinances not in conflict with the Constitution and State and Federal laws, pursuant to Government Code Title 4 Division 3 Part 2 Chapter 3 Section 37100. Pursuant to both Article XI, Section 7 and Article X, Section 2, the City of La Habra adopted Ordinance No. 1767 to prohibit extraction and exportation of groundwater underlying the City for use outside of the City.

As local government, the Cities can establish, purchase, and operate public works, including water services, pursuant to California Constitution Article XI Section 9. Likewise, Government Code Title 4 Division 3 Part 2 Chapter 10 Article 5 Section 38730 grants cities legal authority to acquire water, water rights, and all suitable water infrastructure to supply water to the City and its inhabitants.

As discussed in Section 2.2, the City of La Habra has been established as the GSA for the portions of the Cities of La Habra and Brea within a portion of Basin 8-1 that is outside of OCWD's jurisdiction, i.e. the La Habra-Brea Management Area.

Therefore, the Cities of La Habra and Brea have the authority independently, as Cities, and through the memorandum of agreement and establishment of the GSA, to manage the groundwater resources in the La Habra-Brea Management Area.

2.4 BUDGET

The costs for managing groundwater within the La Habra-Brea Management Area are for data collection and reporting. The budget for costs required to comply with this plan have not been estimated due to the minimal nature of the effort to collect and report groundwater production, level and water quality data.

The following funding sources are available to the La Habra GSA to finance groundwater projects. These sources are briefly described below.

- Grants and Loans from State and Federal Agencies: La Habra GSA has the option to pursue funding opportunities from DWR and other governmental agencies.
- Local Groundwater Assistance Program: Under AB 303 (the Local Groundwater Assistance Program), grants are awarded to public agencies with up to $250,000 to conduct groundwater studies or carry out groundwater monitoring and management programs.
- Capital Improvement Fees: La Habra GSA has the authority to collect repayment charges from beneficial parties of capital improvement projects such as a groundwater recharge or banking project.
- Water User Fees and Assessments: La Habra GSA has the authority to fund groundwater projects through water use fees and assessments collected regularly from City residents and businesses.

SECTION 3. MANAGEMENT AREA DESCRIPTION

3.1 LA HABRA GROUNDWATER BASIN SERVICE AREA

The La Habra-Brea Management Area refers to the northwestern portion of Basin 8-1, as defined by DWR Bulletin 118, overlying the La Habra Groundwater Basin. This management area is outside of the jurisdiction of OCWD. As discussed in Section 2.2, the City of La Habra adopted a resolution establishing it as a GSA, under a memorandum of agreement with the City of Brea, for management of the La Habra Groundwater Basin underlying the two cities. The City adopted a second resolution to establish the La Habra Basin as a separate basin from Basin 8-1. OCWD adopted a resolution to support the City's establishment of the La Habra Basin.

3.1.1 Jurisdictional Boundaries

The historical La Habra Groundwater Basin as described in DWR Bulletin 45 (1934) and Bulletin 53 (1947) is located in both Los Angeles (western basin) and Orange Counties (eastern basin) (see Figure 3-1). The majority of the historical La Habra Basin located in Los Angeles County is within Basin 4-11, the Coastal Plain of Los Angeles, as depicted in DWR Bulletin 118 (2003 update); the entirety of the La Habra Basin located in Los Angeles County is within the area subject to the terms of the Central Basin Adjudication. The majority of the historical La Habra Basin located in Orange County is within Basin 8-1, the Coastal Plain of Orange County as depicted in DWR Bulletin 118. Only a small portion of the historical La Habra Basin in Orange County is within the boundaries of the Orange County Water District.

The Cities of La Habra and Brea overlie a portion of the La Habra Groundwater Basin that is not within the area subject to the terms of the Central Basin Adjudication, nor within the boundaries of the Orange County Water District. The La Habra Groundwater Basin referred to herein, includes all of the City of La Habra and the portion of the City of Brea within Basin 8-1 but not within the jurisdiction of Orange County Water District, overlying the historical La Habra Groundwater Basin (see Figure 3-2).

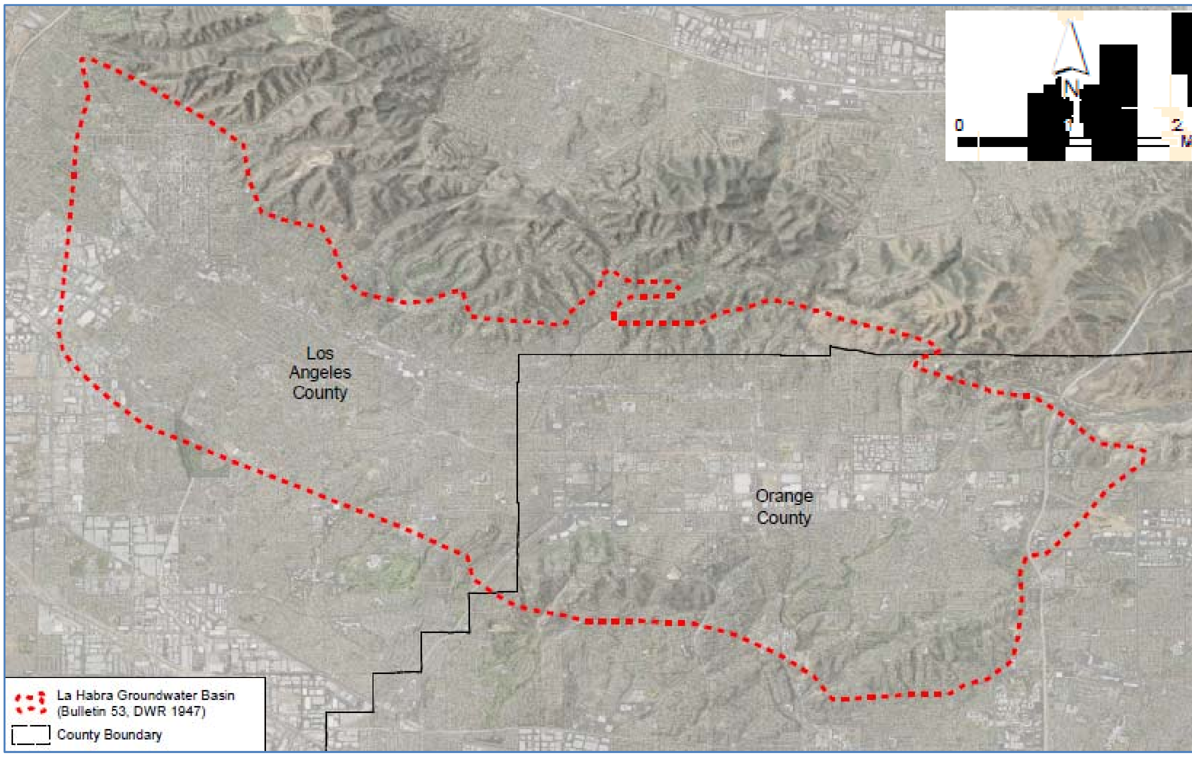

Figure 3-1: Historical La Habra Groundwater Basin (DWR, 1934. DWR, 1937)

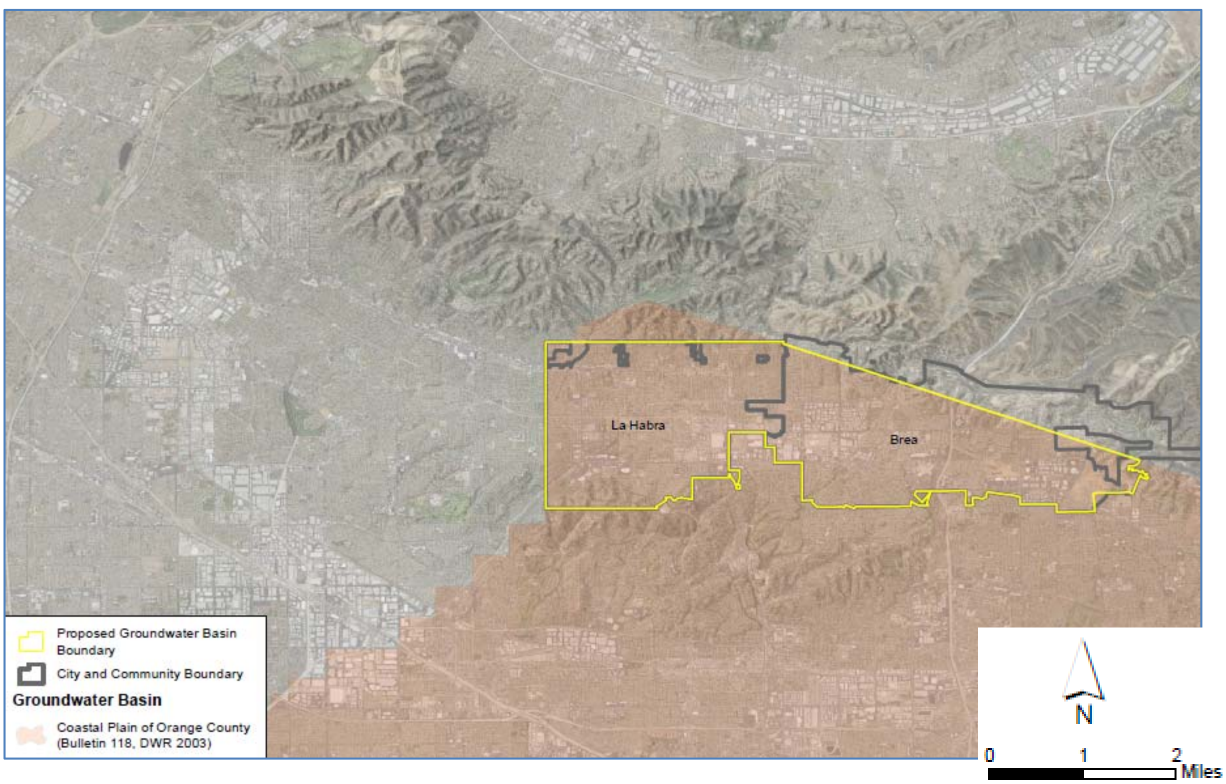

Figure 3-2 La Habra Groundwater Basin

3.1.2 Existing Land Use Designations

The major land use within the City of La Habra is low-density residential with pockets of medium-density residential areas. Portions of La Habra consist of commercial and light industrial land uses. Likewise, land use within the City of Brea is primarily residential with sections of commercial and industrial facilities.

3.2 GROUNDWATER CONDITIONS

The geologic structure of the La Habra Groundwater Basin is dominated by the La Habra Syncline, a northwest trending, U-shaped down-fold. The syncline is deepest in the Brea area and becomes increasingly shallower the west and is bounded by the Whittier Fault within the Puente Hills to the north and the Coyote Hills to the south (Montgomery, 1977). The La Habra Syncline produces the La Habra Valley, a naturally-occurring valley, where significant amounts of groundwater have accumulated over the past 150,000 years (Malcolm Pirnie, 2011a).

3.2.1 Groundwater Elevation

Groundwater within the La Habra Groundwater Basin generally flows from the Puente Hills in a south or southwesterly direction. Subsurface flow out of the basin occurs near Coyote and La Mirada Creeks into the Coastal Plain of Los Angeles and at the gap between the East and West Coyote Hills into the Coastal Plain of Orange County (Stetson, 2014).

A groundwater level hydrograph for a well completed in the Alluvium shows water levels declining to their lowest level in the 1950s, and recovering during the 1970s. More recent data from a nearby well shows a leveling off of water levels through the 1990s. Two other wells completed in the alluvium also show relatively flat water levels from the 1970s through the 1990s (Stetson, 2014).

Wells completed in the San Pedro Formation show rising groundwater levels. The lowest groundwater levels in this aquifer were observed during the 1930s and 1940s, with water levels recovering about 60 feet through 1972. This corresponds to DWR Bulletin No. 53 (1947) stating that the La Habra Groundwater Basin was in overdraft. More recent data show an overall rising trend of 50 to 60 feet in groundwater levels from 1970 through 2007 and a slight decline during the last three years of data. There were no water levels available for the La Habra Formation. See Section 3.2.3 for more information.

3.2.2 Regional Pumping Patterns

The transmissivity of a groundwater basin is the rate at which groundwater flows horizontally through the aquifer. Based on Montgomery (1977), the following are the estimated transmissivities in gallons per day per foot (gpd/ft) for each of the water-bearing zones of the La Habra Groundwater Basin.

- Alluvium: 200 gpd/ft to 10,000 gpd/ft

- La Habra Formation: 25,000 gpd/ft
- San Pedro Formation: 60,000 gpd/ft

Historically, all three water-bearing zones of the La Habra Groundwater Basin were developed for domestic and irrigation purposes, with most wells drilled between 1916 and 1940. The City of La Habra originally drilled three production wells in the deeper aquifers. Groundwater production in these wells ceased in 1968 (Montgomery, 1977). Based on Montgomery (1979), the Alluvium and La Habra Formations are not considered to have groundwater development potential for the following reasons: the Alluvium is limited in thickness and extent, has low permeability characteristics, and is of poor water quality while the La Habra Formation's permeable sand and gravel zones are thin and discontinuous. Groundwater production in the San Pedro Formation continues to this day. Based on Montgomery (1977), the following are expected well yields for each of the water-bearing zones of the La Habra Groundwater Basin.

- Alluvium: 200 gpm
- La Habra Formation: 100 gpm to 400 gpm
- San Pedro Formation: 300 gpm to 800 gpm

The City of La Habra pumps local groundwater from the La Habra Groundwater Basin from three production wells: the Idaho Street Well, the La Bonita Well, and the Portola Well. The Idaho Street Well has a capacity of 2,000 gpm but is regulated at 1,500 gpm. Water pumped from the Idaho Street Well requires treatment before entering into the distribution system. This treatment consists of chlorination, air-stripping to remove ammonia and hydrogen sulfide, and the addition of sodium hexametaphosphate to sequester iron and manganese (Malcolm Pirnie, 2011a). The capacity of La Bonita Well and Portola Well is 850 gpm and 1,200 gpm, respectively.

The City of Brea owns and operates one non-potable groundwater well used for irrigation at Brea Creek Golf Course (Brea, Water Master Plan Update, November 2009). The maximum capacity of this well is 450 gpm.

Table 3-1: Groundwater Production in La Habra Groundwater Basin (afy)

City	2011	2012	2013	2014	2015
City of La Habra	1,849	1,865	3,073	4,094	3,630
City of Brea	76	86	82	121	50
TOTAL	1,925	1,951	3,155	4,215	3,680

Source: 2015 Urban Water Management Plans (Arcadis, 2016).

Table 3-2: La Habra Groundwater Basin Wells

Well Owner	Well Name	Well Use	Well Depth (ft)	Well Capacity (gpm)
City of La Habra	Idaho Street	Potable	970	2,000
City of La Habra	La Bonita	Potable	890	850
City of La Habra	Portola	Potable	1,010	1,200
City of Brea	Irrigation Well	Irrigation	--	450

3.2.3 Long-Term Groundwater Elevation Hydrograph

Groundwater level data were compiled from DWR's Water Data Library for eight wells with sufficient data to analyze trends within the La Habra Groundwater Basin. The DWR groundwater data were available for 1970 through 2010. Montgomery's hydrographs from 1922 through 1975 are also included to capture earlier groundwater trends when there was more agricultural groundwater pumping for crop irrigation. Five of the ten monitoring wells had accompanying well logs to determine which aquifer was represented by the data. Figure 3-3 shows the location of these wells and the inferred direction of groundwater flow based on the groundwater level data (Stetson, 2014).

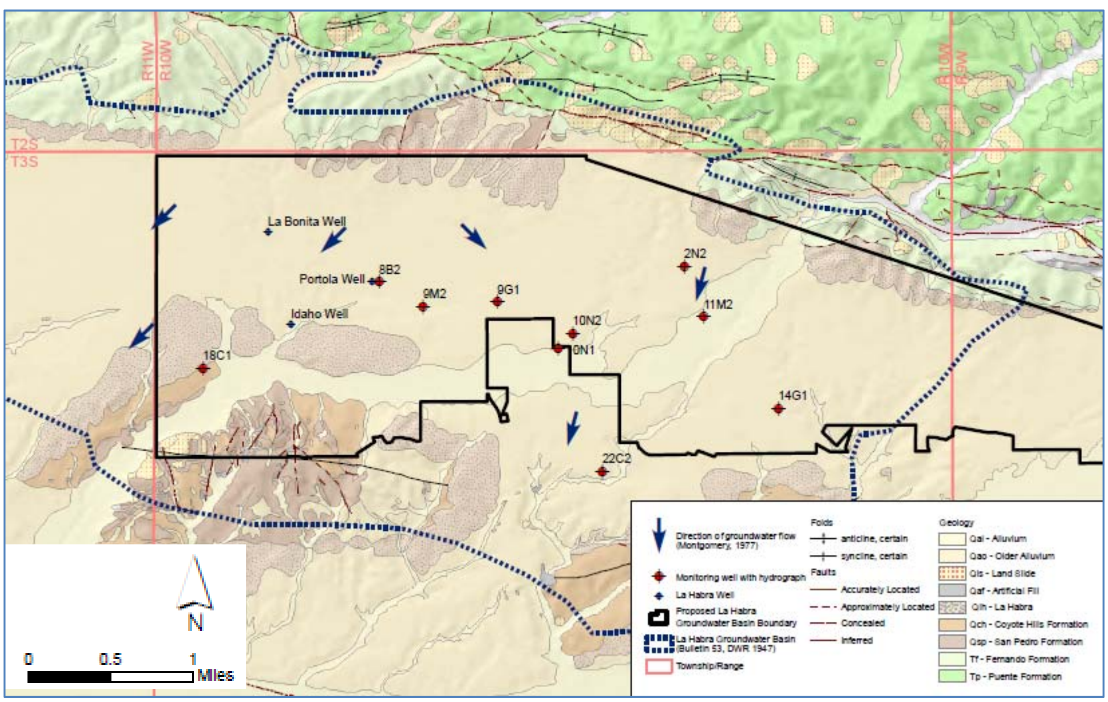

Figure 3-3: Groundwater Elevation Monitoring Wells

The groundwater level hydrograph for a well completed in the alluvial aquifer (Figure 3-4; T3/R10-10N1) shows water levels declining to their lowest level in the 1950s, and recovering during the 1970s. More recent data from a nearby well (Figure 3-5; T3/R10-10N2) shows a leveling off of water levels through the 1990s. Two other wells completed in the alluvium (T3/R10-2N2 and -9M2) also show relatively flat water levels from the 1970s through the 1990s, (Stetson, 2014).

Wells completed in the San Pedro aquifer show rising groundwater levels. The lowest groundwater levels in this aquifer were observed during the 1930s and 1940s, with water levels recovering about 60 feet through 1972 at well T3/R10-14G1. This corresponds to DWR Bulletin No. 53 (1947) stating that the La Habra Groundwater Basin was in overdraft. More recent data from well T3/R10-18C1 show an overall rising trend of 50 to 60 feet in groundwater levels from 1970 through 2007 and a slight decline during the last three years of data. There were no water levels available for the La Habra aquifer (Stetson, 2014).

Recent data showing the depth to groundwater are presented in Figure 3-6. Wells T3/R10-9G1 and -8B2 show a similar pattern of rising groundwater levels through 2007 as seen at well T3/R10-18C1 completed in the San Pedro aquifer. The alluvial aquifer well data present a relatively flat groundwater level from 10 to 40 feet below land surface. The depth to groundwater graph shows groundwater levels in the San Pedro Aquifer recovering to levels observed in the alluvial aquifer (Stetson, 2014).

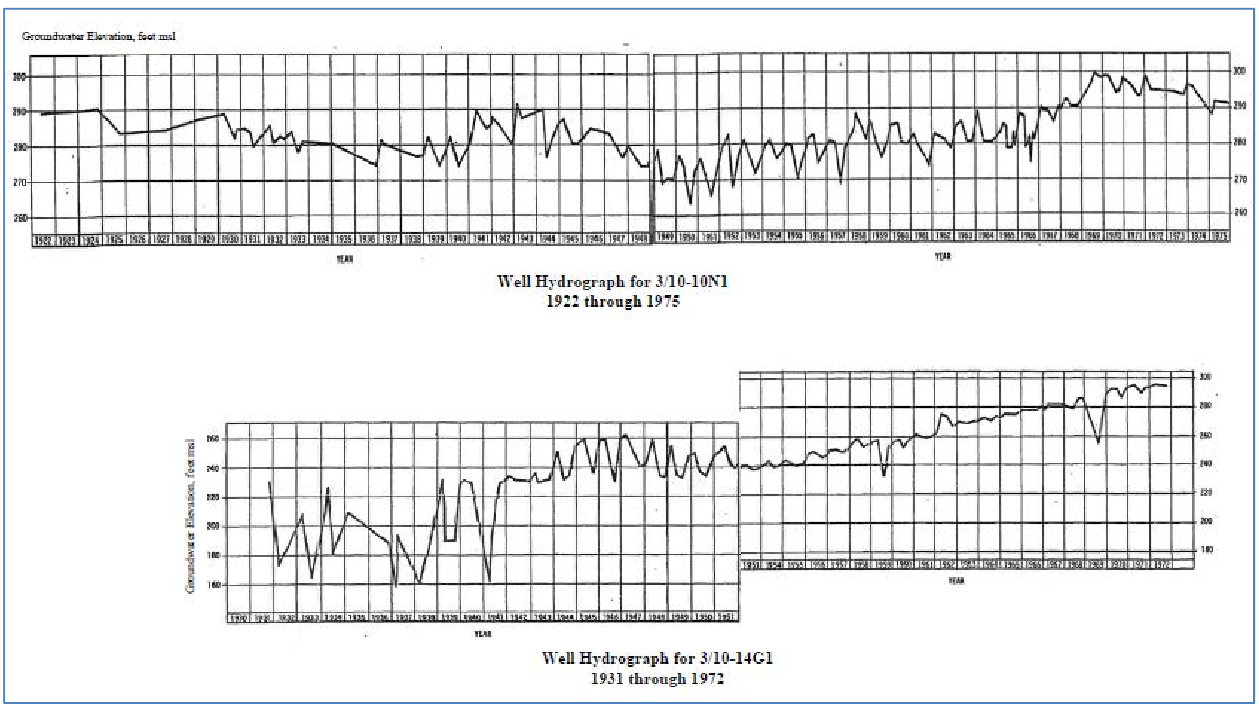

Figure 3-4: Early Well Hydrograph (1922-1975)

Source: Montgomery, 1977.

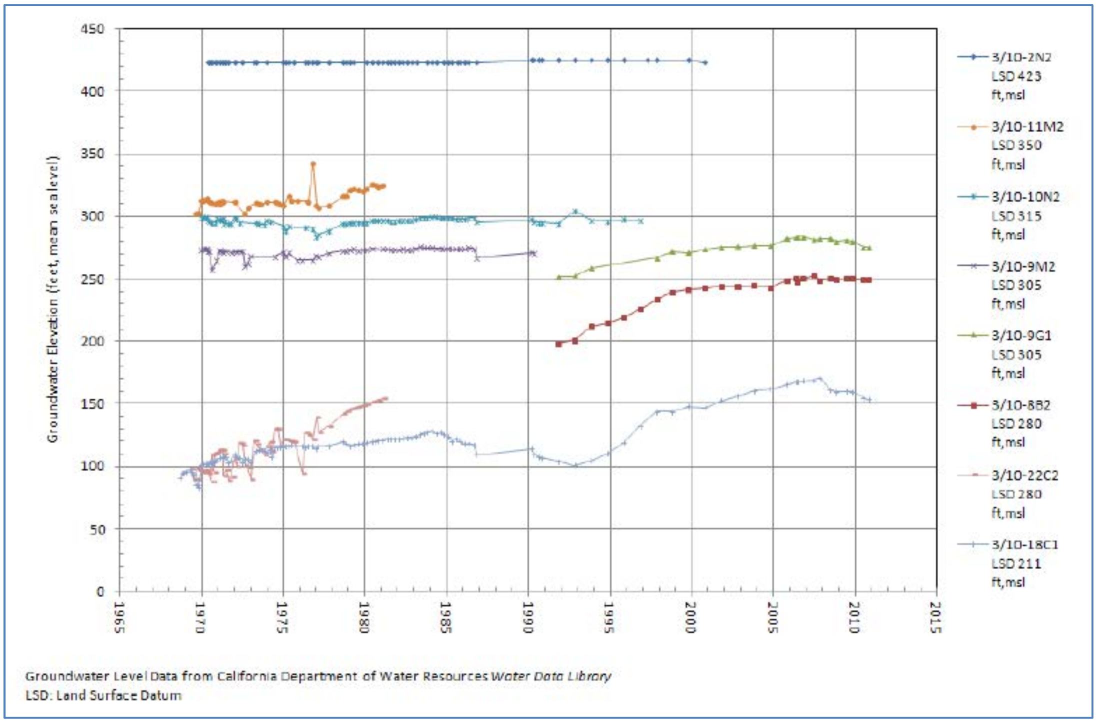

Figure 3-5: Groundwater Level Hydrographs

Source: Stetson, 2014.

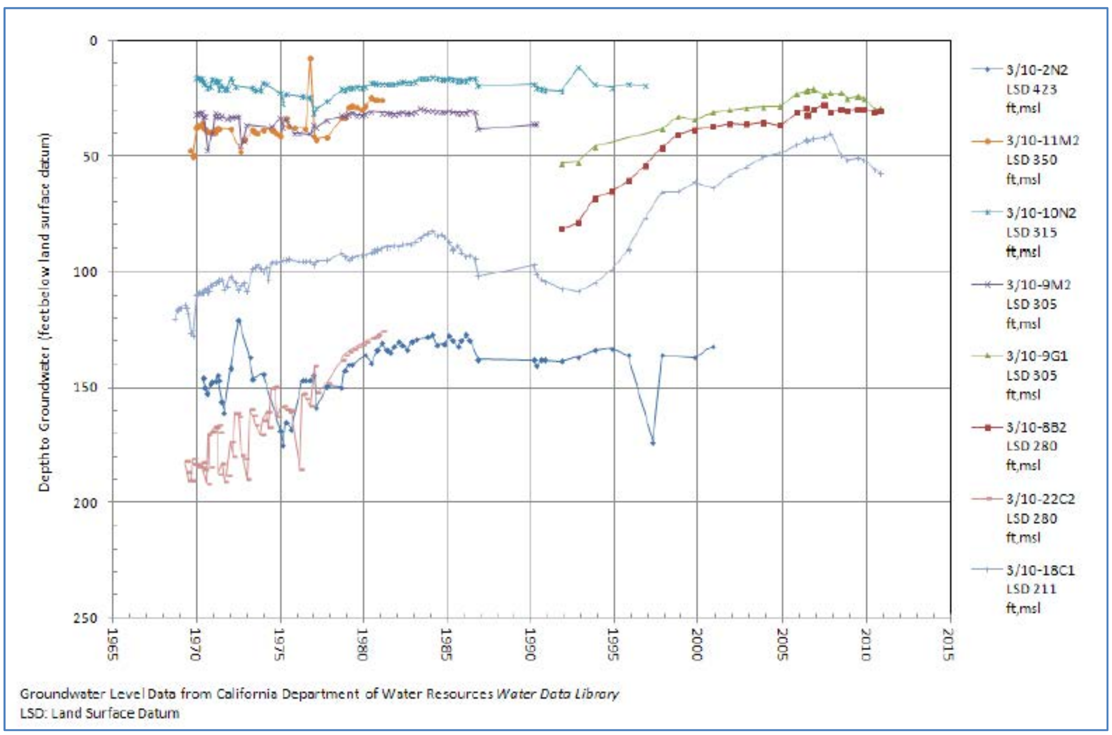

Figure 3-6: Depth to Groundwater

Source: Stetson, 2014.

3.2.4 Groundwater Storage Data

According to the DWR Bulletin 45 (1934), the storage capacity of the historical La Habra Groundwater Basin is approximately 153,000 acre-feet. Approximately 57 percent of the historical La Habra Groundwater Basin is in the eastern portion of the basin which is now designated within Basin 8-1. The Cities of La Habra and Brea overlie approximately 60 percent of the eastern portion of the historical La Habra Groundwater Basin (Stetson, 2014). Accordingly, the storage capacity of the current La Habra Groundwater Basin is approximately 55,000 acre-feet.

3.2.5 Groundwater Quality Conditions

Previous investigations of water quality within the La Habra Basin determined that the quality is extremely variable. It was shown that shallow regions within the central portion of the basin as well as areas recharged by surface water along the basin boundary are of a bicarbonate and chloride character. Sulfate concentration increased with depth in the La Habra and San Pedro water-bearing zones. The historical data also shows that total dissolved solids (TDS) concentrations have remained relatively stable (Montgomery, 1977). The current TDS concentration in La Habra wells is approximately 960 mg/L. Overall, groundwater from the San Pedro Aquifer is considered to be of fair to good quality (Montgomery, 1979).

Water from the La Bonita and Portola Wells is chlorinated and then blended with water purchased from the California Domestic Water Company in a 250,000-gallon forebay to reduce the concentration of minerals prior to entering the City of La Habra's distribution system (La Habra, 2014).

The City of Brea's non-potable well is strictly used for irrigation purposes as the groundwater beneath the city has poor water quality and would require extensive treatment and blending with higher quality water to meet public health standards (Malcolm Pirnie, 2011).

Table 3-3: Historical Constituent Concentrations (1927-1977)

Constituent	Minimum	Maximum	Average
Specific Conductance	255	2,235	1,324
Total Dissolved Solids	269	1,696	943
Sulfate	0	672	174
Chloride	18	460	161
Nitrate	0	185	44
Fluoride	0	1.6	0.44
Total Hardness	75	931	489

Source: Montgomery, 1977.

3.2.6 Land Subsidence

Based on Orange County Water District's 2015 Update to its Groundwater Management Plan, there is no evidence that the observed minimal land surface changes in portions of Orange County has caused, or are likely to cause, any structural damage within the area (OCWD, 2015). As long as groundwater elevations and storage within the basin are maintained within their historical operating ranges, the potential for problematic land subsidence is reduced.

Additionally, the United States Geological Survey (USGS) does not show the La Habra Groundwater Basin as an area where there have been historical or current subsidence recorded due to either groundwater pumping, loss of peat, or oil extraction (USGS, 2016).

3.2.7 Groundwater and Surface Water Interactions and Groundwater Dependent Ecosystems

The La Habra Groundwater Basin lies entirely within the Coyote Creek Watershed (see Figure 3-7). The Coyote Creek Watershed drains approximately 165 square miles of densely populated areas of residential, commercial, and industrial areas as well as areas of open space (Atkins, 2012). Coyote Creek is a tributary to the San Gabriel River. Major Creeks within the watershed are: Coyote Creek, Brea Creek, Fullerton Creek, Carbon Creek, Moody Creek, and Los Alamitos Channel.

Coyote Creek, Brea Creek, and La Mirada Creek (a non-major creek) all flow into and drain out of the La Habra Valley. The total drainage area of these three creeks within the valley is approximately 12,950 acres (Stetson, 2013). Coyote Creek and La Mirada Creek are surface waters flowing through the boundaries of the City of La Habra. Montgomery (1977) determined that about 30% of the runoff available in an average rainfall year percolates to the aquifers underlying the La Habra Valley.

Within the La Habra Valley, direct percolation of precipitation also occurs. The 40-year average rainfall (14 inches) results in a water supply from precipitation within the 10,160-acre drainage area of approximately 11,870 AFY (Stetson, 2013).

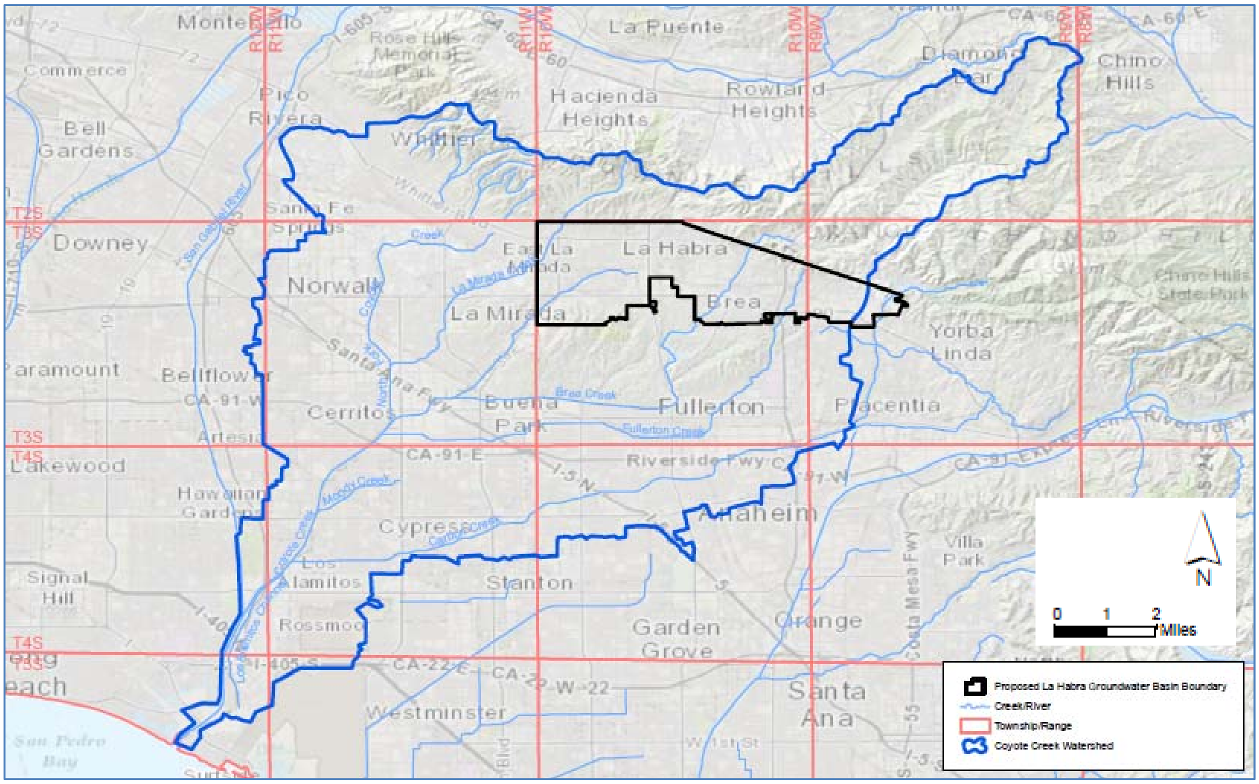

Figure 3-7: Coyote Creek Watershed

SECTION 4. WATER BUDGET

4.1 BUDGET COMPONENTS

The components of the water budget generally include recharge from precipitation and runoff, recharge from subsurface inflow, subsurface outflow, and groundwater production.

Groundwater production in the La Habra Groundwater Basin has ranged from approximately 2,000 AFY to 4,200 AFY in recent years (See Table 3-1). Subsurface flow out of the groundwater basin occurs near Coyote and La Mirada Creeks into the Coastal Plain of Los Angeles, and at the gap between the East and West Coyote Hills into the Coastal Plain of Orange County (Stetson, 2014). The remaining breakdown of the water budget components in the La Habra Groundwater Basin is not well known; therefore, a formal water budget has not been established but will be established in accordance with DWR regulations as part of the GSP development that is anticipated to occur within the La Habra-Brea Management Area before 2020.

As discussed in the section below, based on water level measurements the water budget appears to be in balance over the past ten years. Changes in groundwater storage are monitored through the monitoring of groundwater elevations and have shown rising trends since the 1970s.

4.2 ESTIMATE OF SUSTAINABLE YIELD

In 1977, Montgomery Engineers completed a groundwater study for the City of La Habra and estimated the "probable long-term groundwater basin yield" of the La Habra Groundwater Basin. Stetson conducted a re-evaluation of Montgomery's 1977 safe yield analysis in 2013. The average of these two methods results in an approximate safe yield of 4,500 AFY.

The City of La Habra has been producing groundwater since the late 1990s and monitoring non-pumping and pumping groundwater elevations since 2008. Previous investigations into groundwater levels and the safe yield have been used to manage the La Habra Groundwater Basin for over 10 years.

Groundwater production within the La Habra-Brea Management Area will be managed by the establishment of the safe yield so that the groundwater levels and storage capacity in the La Habra Groundwater Basin will be maintained.

SECTION 5. WATER RESOURCE MONITORING PROGRAMS

5.1 OVERVIEW

The La Habra Groundwater Basin is currently monitored for groundwater elevations and for groundwater quality through productions wells and monitoring wells within the City of La Habra. Surface water is currently not monitored in the Cities of La Habra and Brea overlying the La Habra Groundwater Basin. Recycled water is not used within the La Habra-Brea Management Area. Imported surface water and groundwater are used within the La Habra-Brea Management Area for potable supply. These potable water sources are monitored prior to delivery and not directly monitored by the Cities of La Habra and Brea.

5.2 GROUNDWATER MONITORING PROGRAMS

<u>Groundwater Elevations</u>

Since 2008, the City of La Habra has measured non-pumping and pumping groundwater elevations at its production wells to review general trends in groundwater elevations in the Basin.

The City of La Habra will supplement its existing groundwater elevation monitoring program by including water level measurements reported by DWR for three monitoring wells in the La Habra Basin. Groundwater elevations are reported by DWR for wells 3/10-9G1, 3/10-8B2, and 3/10-18C1. By January 2020, the City's monitoring program will be governed by its GSP under SGMA.

<u>Groundwater Quality</u>

Currently, the City samples for constituents at its production wells pursuant to Title 22 of the California Code of Regulations (Title 22). Under Title 22, the City monitors and reports groundwater quality for constituents that are regulated by the State Water Resources Control Board Division of Drinking Water pertaining to maximum contaminant levels (MCLs). The City of La Habra also monitors areas of contamination, as described in its Drinking Water Source Assessments provided to the Division of Drinking Water for its production wells. The City of La Habra plans to continue to review and comment on documents regarding these areas within the City limits as well as be aware of any areas outside of its jurisdiction that may affect the water quality of the Basin through surface or subsurface flow.

The City of La Habra plans to continue its existing groundwater water quality monitoring program and will evaluate the need for additional monitoring above its current program in accordance with DWR GSP regulations.

5.3 OTHER MONITORING PROGRAMS

Currently the City of La Habra does not perform any surface water quality monitoring; however, the City of La Habra will investigate any existing programs for the Coyote Creek Watershed including monitoring programs being developed in response to regulations set forth for the watershed by the local Regional Water Quality Control Board (Coyote Creek is shown on the Clean Water Act's 303(d) list of impaired waters). The City of La Habra will consider developing and implementing its own surface and subsurface inflow quality monitoring programs for the local watershed in accordance with DWR GSP regulations.

Likewise, the City of La Habra does not monitor land subsidence within the La Habra-Brea Management Area. However, the City may develop a program to monitor and measure the rate of land surface subsidence in accordance with DWR GSP regulations.

SECTION 6. WATER RESOURCE MANAGEMENT PROGRAMS

Groundwater resources protection is considered a critical component for safeguarding the long-term sustainability of the La Habra Groundwater Basin. Groundwater resources protection includes water resources planning and an ordinance to prohibit the extraction and exportation of groundwater underlying the City for use outside the City as well as groundwater protection programs including well construction, abandonment, and destruction policies, wellhead protection, and the control of the migration and remediation of contaminated, poor quality, or saline water.

6.1 LAND USE ELEMENTS RELATED TO BASIN MANAGEMENT

The Cities of Brea and La Habra participate in two water resources management planning documents: the Integrated Regional Water Management Plan, and the Urban Water Management Plan.

<u>Integrated Regional Water Management Plan</u>

Integrated Regional Water Management (IRWM) is a collaborative approach of implementing water management solutions on a regional scale in order to address water resources needs. The Greater Los County Region has been designated as an IRWM region and is comprised of the following subregions: North Santa Monica Bay, South Bay, Upper Los Angeles River, Upper San Gabriel and Rio Hondo Rivers, and Lower San Gabriel and Los Angeles Rivers. The Coyote Creek watershed, which overlies the La Habra Groundwater Basin, is within the Lower San Gabriel and Los Angeles Rivers IRWM subregion. The La Habra Groundwater Basin contributes a small portion of the groundwater produced within the subregion.

<u>Urban Water Management Plan</u>

Water Code Sections 10610 through 10656 of the Urban Water Management Planning Act require every urban water supplier providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre-feet (AF) of water annually to prepare, adopt, and file an Urban Water Management Plan (UWMP) with the California Department of Water Resources (DWR). The Cities of Brea and La Habra both are required to file an UWMP every five years with DWR. The UWMP is a management tool that provides water planning and identifies water supplies needed to meet existing and future water demands.

6.2 GROUNDWATER WATER QUALITY PROTECTION AND MANAGEMENT

Well Construction, Abandonment, and Destruction Policies

The policies that govern well construction, abandonment, and destruction are designed specifically to protect groundwater quality. The administration of these policies has been delegated to individual counties by California legislature. As stated in Orange County Ordinance No. 2607, all well activity within Orange County will comply with the standards set in DWR Bulletin 74, Chapter 2. These standards are enforced by the Orange County Health Care Agency. The Cities of La Habra and Brea properly construct and abandon wells pursuant to Orange County Ordnance No. 2607.

Wellhead Protection Measures

Wellhead protection is a way to prevent drinking water from being contaminated by managing sources of potential contamination within the vicinity of a production well. Surface contaminants can enter a well through the outside edge of the well casing or directly through opening in the well head. These contaminants can travel in two directions: to the groundwater aquifer or to the distribution system. As defined in the Safe Drinking Water Act Amendments of 1986, a wellhead protection area is “the surface and subsurface area surrounding a water well or well field supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field.”

The Cities of La Habra and Brea design and construct wells in accordance with the measures described in DWR Bulletin 74 so that the wellhead is protected from contamination. Important wellhead protection measures described in Bulletin 74 include: methods for sealing the well from intrusion from surface contaminants, site grading to assure drainage is away from the wellhead, and set-back requirements from known pollution sources.

Control of Migration and Remediation of Contaminated Groundwater

Groundwater can become contaminated naturally or through human activity. Based on a 2010 drinking water assessment performed by the City of La Habra, sources of potential groundwater contamination to the La Habra Basin include: car repair and bodywork shops, gas stations, machine and metalwork shops, and sewer collection systems (La Habra, 2013).

The City of La Habra has previously taken the position that oil and gas mining operations in or up gradient of the basin have the potential to release chemicals that could contaminate groundwater, particularly during fracking activities.

The Cities of La Habra and Brea will monitor the migration of contaminants through its water quality monitoring program and will also monitor nearby oil and gas mining operations. This will allow the point and non-point pollution sources to be identified. If contamination becomes a concern in the future, an approach to address the problem will be developed.

Control of Saline Water Intrusion

Raised salinity is a significant water quality problem in many parts of the southwestern United States and southern California, including Orange County. Elevated salinity is of concern as it can limit the implementation of recycling water projects and potentially require water purveyors to perform additional treatment on their water supplies.

The level of salinity is sometimes measured based on Total Dissolved Solids (TDS) concentrations. The TDS concentrations in the La Habra Basin are naturally occurring and it is not believed that current activities in the basin significantly contribute to the TDS loading in the basin. The TDS concentrations are not a result of saline water intrusion. The TDS concentrations in the City of La Habra’s wells are below the secondary Maximum Contaminant Level (MCL) of 1,000 mg/L. TDS is listed as a secondary constituent as it does not directly cause harm to consumers but can affect the aesthetic quality of the water, including taste.

6.3 GROUNDWATER EXPORT PROHIBITION

The protection of the health, welfare, and safety of the residents and economy of the City of La Habra require that the groundwater resources of the City be protected for present and future municipal, industrial, and domestic beneficial uses within the City. The sustainable yield of the portion of the La Habra Basin underlying the City is not sufficient to serve beneficial uses in addition to the beneficial municipal, industrial and domestic uses currently served through the City municipal water system. The best interest of the present and future inhabitants of the City is served by the prohibition against the extraction and exportation of groundwater produced from within the City's jurisdictional boundaries. Accordingly, on December 21, 2015, the City of La Habra adopted Ordinance No. 1767 to prohibit the extraction and exportation of groundwater underlying the City for use outside of the City.

SECTION 7. NOTICE AND COMMUNICATION

7.1 INTRODUCTION

The Cities of La Habra and Brea overlie the La Habra Groundwater Basin and are the only producers of groundwater within the basin. Potential agencies that may additionally have a stake in the successful management of the basin include:

- Central Basin Watermaster (DWR): adjudicated Central Basin (Los Angeles)
- OCWD: actively manages Orange County portion
- City of Fullerton: included in OCWD's service area

7.2 GROUNDWATER PRODUCERS

As the City of Brea is a direct stakeholder in the Orange County portion of the La Habra Basin outside of OCWD's service area, Brea was included in the preparation of this plan.

While the Central Basin Watermaster, OCWD, and the City of Fullerton do not have a direct stake in the Orange County portion of the La Habra Basin outside of OCWD's service area that is the focus of this Plan, the portions of the historical La Habra Basin underlying these entities are hydrologically connected to the portion of the basin that is the subject of this Plan. As such these entities were informed that OCWD was preparing this Plan and the planned management of the basin was discussed with them.

7.3 PUBLIC PARTICIPATION

The City of La Habra has invited the public to participate in City Council meetings where management of the La Habra Basin and future actions have been discussed and presented. On December 21, 2015, La Habra held a public hearing to establish La Habra as a GSA for the La Habra Basin and to establish the La Habra Basin as a separate basin from Basin 8-1. Notice for the public hearing was posted in the Orange County Register in accordance with Government Code Section 6066. The City Council also approved the readings of an ordinance to prohibit the extraction and exportation of groundwater underlying La Habra for use outside of the city on December 21, 2015 and January 19, 2016. This ordinance took effect on February 18, 2016.

The La Habra GSA will strive to involve the public in groundwater management decisions regarding the La Habra-Brea Management Area. In the future, the La Habra GSA plans to provide copies of the periodic groundwater reports that will be prepared to the public at their request and publish information on groundwater management accomplishments on the City's website. The La Habra GSA will also comply with the public participation requirements under SGMA.

7.4 COMMUNICATION PLAN

The La Habra GSA plans to prepare a summary report of the current conditions of the La Habra Groundwater Basin ideally every two to five years using the results from the monitoring program (see Section 5.0). These informative reports will be used to plan future groundwater projects, develop new groundwater policies, and identify any new concerns with the basin.

SECTION 8. SUSTAINABLE MANAGEMENT APPROACH

As the City of La Habra currently depends on local groundwater to meet approximately 40 percent of its water consumption and the City of Brea uses groundwater to meet irrigation needs, preserving the sustainability of the La Habra Groundwater Basin is essential for the well-being of the two cities. Currently (and historically), the City of La Habra manages (and has managed) the La Habra Groundwater Basin through management plans and programs for groundwater levels, basin storage, water quality, groundwater export prohibition, and groundwater-surface water interactions, discussed below in Sections 9, 10, 11, and 14, respectively. Seawater intrusion and land subsidence are not occurring in the La Habra-Brea Management Area and therefore are not actively managed at this time, but will be monitored under the La Habra GSP. By January 2020, the La Habra GSA will manage the La Habra- Brea Management Area through its GSP, which will describe the City’s monitoring program and ensure that no undesirable results occur in the future.

As a key component of sustainable management, the Cities of La Habra and Brea strongly promote conservation as a means to preserve water supplies. Both cities have sections on their websites dedicated to water conservation in addition to including conservation guidance in their annual Consumer Confidence Reports distributed to residents.

SECTION 9. SUSTAINABLE MANAGEMENT RELATED TO GROUNDWATER LEVELS

A solid understanding of groundwater elevations, seasonal fluctuations and response to pumping, existing basin yield, and how groundwater is stored and transmitted through the basin is critical for sustainably managing the La Habra-Brea Management Area.

9.1 HISTORY OF BASIN CONDITIONS AND MANAGEMENT ACTIONS

As shown on Figures 3-4, 3-5, and 3-6, groundwater levels in the La Habra-Brea Management Area have recovered from lows in the 1930 to 1950s and have experienced a general rising trend and leveling off since the 1970s. Given consistent groundwater production within the estimated safe yield of the basin, groundwater levels are expected to remain steady in the future.

9.2 MONITORING OF GROUNDWATER LEVELS

As discussed in Section 5.2, the La Habra GSA has measured non-pumping and pumping groundwater elevations at its production wells since 2008. In addition, DWR reports water level measurements for some monitoring wells in the La Habra Groundwater Basin. Groundwater levels reported by DWR for wells 3/10-9G1, 3/10-8B2, and 3/10-18C1 will be included in the periodic reviews of the condition of the basin.

In accordance with DWR GSP regulations, the City of La Habra will evaluate the need for additional monitoring above its current groundwater elevation monitoring program. The need for standard and multi-level monitoring wells to monitor the three aquifers of the basin will be investigated. Characterization of the conditions of the basin using the City's existing groundwater elevation data from its production wells may not reflect steady state conditions because the wells pump frequently and groundwater within the well does not have enough time to fully recover to obtain a static elevation before the well is put into production once more. Static elevations may be recorded through the use of monitoring wells where no pumping is performed and the well is constantly in a static condition.

If the City constructs a monitoring or production well in the future, the City will perform aquifer tests to determine the hydrologic properties of each aquifer.

9.3 DEFINITION OF SIGNIFICANT AND UNREASONABLE LOWERING OF GROUNDWATER LEVELS

The definition of significant and unreasonable lowering of groundwater levels in the La Habra Management Area is a lowering of groundwater levels such that a significant loss of well production capacity or a significant degradation of water quality occurs which would impact the intended use of the groundwater.

9.4 DETERMINATION OF MINIMUM THRESHOLDS

There are no minimum thresholds established for groundwater levels in the La Habra Groundwater Basin because the basin is currently not in overdraft and is managed within the safe yield of the basin. If chronic or significant lowering of groundwater levels are observed through groundwater level monitoring, the La Habra GSA will evaluate its operations, re-evaluate the safe yield and establish minimum thresholds, where appropriate, and in accordance with SGMA.

SECTION 10. SUSTAINABLE MANAGEMENT RELATED TO BASIN STORAGE

10.1 HISTORY

As discussed in Section 9.1, groundwater levels in the La Habra Groundwater Basin have recovered from lows in the 1930 to 1950s and have experienced a general rising trend and leveling off since the 1970s. Given steady groundwater production within the estimated safe yield of the basin, groundwater levels are expected to remain steady in the future.

10.2 MONITORING STORAGE LEVELS

The monitoring of storage levels is indirectly monitored through the groundwater level monitoring program described in Section 9.2.

10.3 MANAGEMENT PROGRAMS

10.3.1 Establishment of Safe Yield

A “safe yield” is used for ongoing management and future planning of a groundwater basin for sustained beneficial use. It is generally defined as the volume of groundwater that can be pumped annually without depleting the aquifer beyond its ability to recover through natural recharge over a reasonable hydrologic period. In 1977, Montgomery Engineers completed a groundwater study for the City of La Habra and estimated the “probable long-term groundwater basin yield” of the La Habra Groundwater Basin. Stetson conducted a re-evaluation of Montgomery’s 1977 safe yield analysis in 2013. The average of these two methods results in an approximate safe yield of 4,500 AFY.

Based on a review of groundwater elevations performed in January 2014, groundwater elevations in the San Pedro aquifer of the La Habra Basin appear to have risen about 100 feet from the 1940s to the present with an overall rising trend of 50 to 60 feet between 1970 and 2007 (Stetson, 2014). Therefore, it appears that the basin is not currently in an overdraft condition.

The City of La Habra can maintain sustainable groundwater production by maintaining and coordinating groundwater production within the estimated safe yield of the La Habra Groundwater Basin.

10.3.2 Review and Evaluation of Groundwater Levels

The condition of the basin can be verified through a periodic review of groundwater elevations within the basin. The City can utilize and supplement its existing groundwater elevation monitoring program to review general trends in groundwater elevations in the Basin.

In accordance with DWR GSP regulations, the City will evaluate the need for additional monitoring above its current groundwater elevation program. If the City of La Habra chooses to expand its groundwater monitoring program in the future, the City will prepare basin management reports on a periodic basis (every two to five years) using the results of the monitoring program. These informative reports will be used to review whether groundwater production is within the safe yield of the basin, plan future groundwater projects, develop new groundwater policies, and identify any new concerns within the La Habra-Brea Management Area.

10.3.3 Groundwater Recharge of Storage Projects

The City of La Habra currently does not operate any groundwater recharge or storage projects. In the future, the City may perform a basin replenishment study that identifies potential recharge areas and measures to protect these areas. Two areas where a groundwater recharge project could be studied for implementation are shown in Figure 10-1 The San Pedro Formation is naturally recharged directly through aquifer outcrops (exposed formation sediments) in the Los Coyote Hills (south of the intersection of Beach Boulevard and Imperial Highway) and in the Puente Hills (along the foothills north of Whittier Boulevard) [Montgomery, 1977]. The San Pedro Formation could also be indirectly recharged through the uplifted and exposed San Pedro beds that lie just below a thin layer of alluvium along the Coyote Creek valley (Montgomery, 1977).

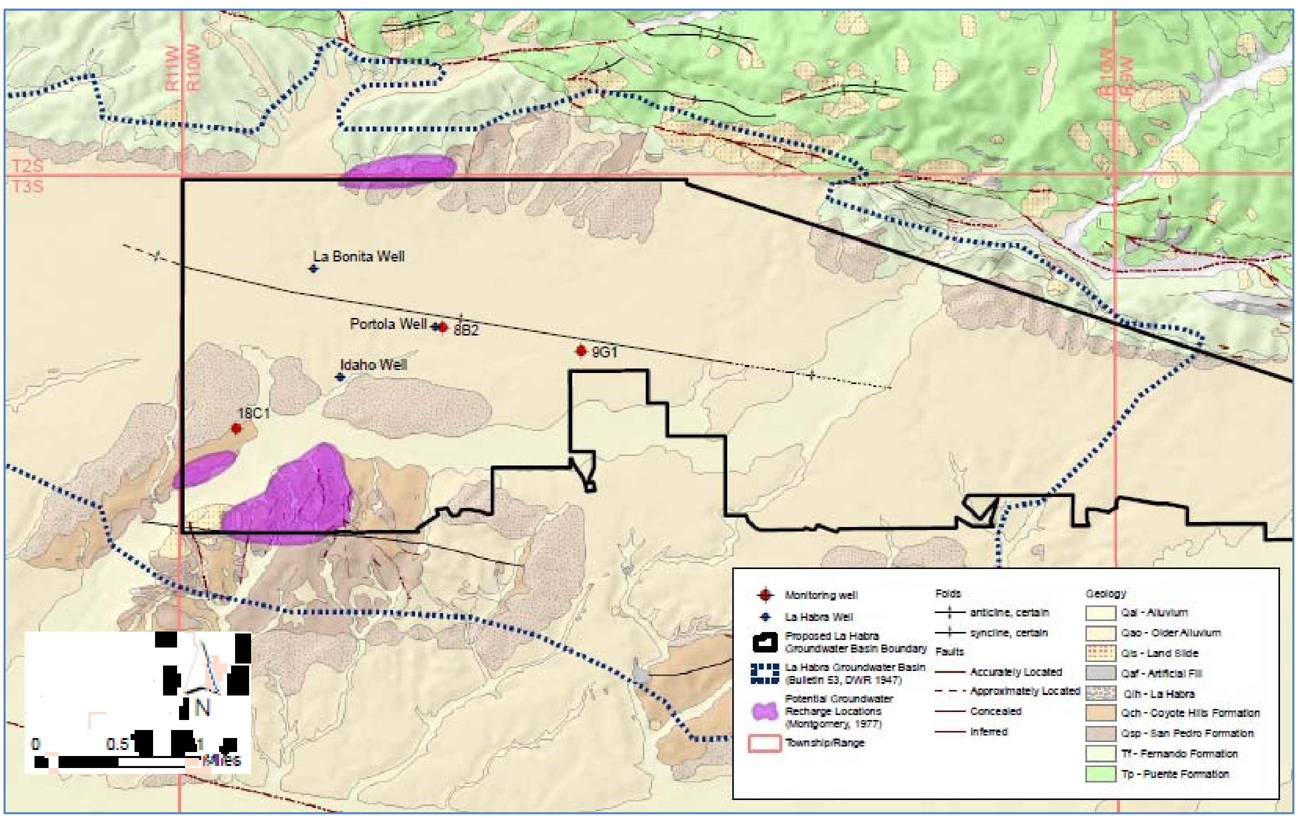

Figure 10-1: Potential Groundwater Recharge Locations

As discussed in Section 2.2, the City of La Habra is located in the Coyote Creek Watershed. The Coyote Creek Watershed is included in the Municipal Separate Storm Sewer System (MS4) Permit for the Orange County Santa Ana Region. The City is implementing new water quality control programs to meet the requirements of the MS4 permit for discharges from storm drains. The programs include Low Impact Development measures to address water quality on residential and commercial properties, new inspection activities, and potential retention and recharge of stormwater runoff. Recharge activities associated with MS4 compliance are anticipated to occur outside of the City of La Habra.

The City of La Habra currently does not operate any conjunctive use projects. The City may study the feasibility of conjunctive use projects in the future.

10.3.4 Potential Management Programs

No known desktop flow model exists for the La Habra Basin. As such, the La Habra GSA will consider developing a desktop flow model for the La Habra-Brea Management Area in the future once a sufficient amount of data are collected (as additional monitoring wells are constructed and monitored, for example). Groundwater models are used to represent natural flow conditions of an aquifer and can predict the effects of hydrological changes (such as pumping and replenishment) on the behavior of the aquifer.

10.4 DEFINITION OF SIGNIFICANT AND UNREASONABLE REDUCTION IN STORAGE

As with groundwater levels, the definition of significant and unreasonable reduction in groundwater storage in the La Habra-Brea Management Area is a lowering of groundwater levels such that a significant loss of well production capacity or a significant degradation of water quality occurs which would impact the intended use of the groundwater.

10.5 DETERMINATION OF MINIMUM THRESHOLDS

As with groundwater levels, minimum thresholds have not been established for changes in groundwater storage. If chronic or significant lowering of groundwater levels is observed through groundwater level monitoring, the La Habra GSA will evaluate its operations, re-evaluate the safe yield and establish minimum thresholds, where appropriate, and in accordance with SGMA.

SECTION 11. SUSTAINABLE MANAGEMENT RELATED TO WATER QUALITY

It is the intent of the La Habra GSA to protect and enhance the groundwater quality in the La Habra-Brea Management Area. This can be achieved through groundwater quality programs, understanding the quality of surface waters and subsurface water that naturally recharge the basin, and implementing measures to protect potential recharge areas.

11.1 HISTORY

Previous investigations of water quality within the La Habra Groundwater Basin determined that the quality is extremely variable. Overall, groundwater from the San Pedro Aquifer is considered to be of fair to good quality (Montgomery, 1979).

11.2 SUMMARY OF GROUNDWATER QUALITY ISSUES

As discussed in Section 3.2.5, Water from the La Bonita and Portola Wells is chlorinated and then blended with water purchased from the California Domestic Water Company in a 250,000-gallon forebay to reduce the concentration of minerals prior to entering the City of La Habra's distribution system (La Habra, 2014).

The City of Brea's non-potable well is strictly used for irrigation purposes as the groundwater beneath the city has poor water quality and would require extensive treatment and blending with higher quality water to meet public health standards (Malcolm Pirnie, 2011).

11.3 MONITORING OF GROUNDWATER QUALITY

The La Habra GSA will continue the City of La Habra's existing water quality monitoring program, described in Section 5.2, and supplement the program as required by SGMA. If the La Habra GSA were to choose to construct monitoring wells for groundwater elevations, these wells can also be sampled for water quality.

The La Habra Basin is recharged through surface runoff and streamflow recharge as well as mountain front recharge (Stetson, 2013). Understanding the quality of the surface and subsurface water that recharges the La Habra Basin is important in protecting and enhancing the water quality of the groundwater basin as the groundwater within the basin originates from these waters. Although the City currently does not have a surface water quality monitoring program for the Coyote Creek Watershed, the La Habra GSA will investigate any existing programs for the watershed including regulations set forth for the watershed by the local Regional Water Quality Control Board (Coyote Creek is shown on the Clean Water Act's 303(d) list of impaired waters). The La Habra GSA will consider developing and implementing its own surface and subsurface inflow quality monitoring programs for the local watershed in the future.

To protect the water quality of the Basin, the La Habra GSA will continue to monitor and review areas of contamination within the La Habra-Brea Management Area, as described in its Drinking Water Source Assessments provided to the California Department of Public Health (CDPH) for its production wells. The La Habra GSA will continue to review and comment on documents within the La Habra-Brea Management Area as well as be aware of any areas outside of its jurisdiction that may affect the water quality of the La Habra-Brea Management Area through surface or subsurface flow.

11.4 DESCRIPTION OF MANAGEMENT PROGRAMS

The management programs intended to protect the water quality of the La Habra-Brea Management Area include well construction, abandonment, and destruction policies, wellhead protection measures, control of migration and remediation of contaminated water, and control of saline water. See Section 6.

11.5 DEFINITION OF SIGNIFICANT AND UNREASONABLE DEGRADATION OF WATER QUALITY

The definition of significant and unreasonable degradation of water quality is a reduction of water quality in the La Habra-Brea Management Area such that the groundwater can no longer be used for the intended purposes even with the implementation of reasonable mitigation measures. Currently, the City of Brea only uses groundwater produced from the La Habra Groundwater Basin for irrigation; however, the City of La Habra uses groundwater for its potable supply, thus requiring a higher level of quality.

11.6 DETERMINATION OF MINIMUM THREHOLDS

Because groundwater from the La Habra Groundwater Basin is used as a potable source, the minimum thresholds for groundwater quality are exceedances of Maximum Contaminant Levels (MCLs) or other applicable regulatory limits that are directly attributable to groundwater management actions in the La Habra-Brea Management Area that prevents the use of groundwater for its intended purpose.

SECTION 12. SUSTAINABLE MANAGEMENT RELATED TO SEAWATER INTRUSION

The La Habra Groundwater Basin is not located near the ocean. Accordingly, there is no need to manage or consider the potential impact of seawater intrusion in the La Habra-Brea Management Area.

SECTION 13. SUSTAINABLE MANAGEMENT RELATED TO LAND SUBSIDENCE

As discussed in Section 3.2.6, there is no evidence that land subsidence is, or will likely become, problematic within the La Habra-Brea Management Area. However, the City of La Habra may develop a program to monitor and measure the rate of land surface subsidence within the La Habra-Brea Management Area in accordance with DWR GSP regulations. The need for land surface subsidence monitoring will be considered on an annual basis.

SECTION 14. SUSTAINABLE MANAGEMENT RELATED TO GROUNDWATER DEPLETIONS IMPACTING SURFACE WATER

As discussed in Section 3.2.7, the La Habra Groundwater Basin lies within the Coyote Creek Watershed with the major creeks in the watershed being Coyote Creek, Brea Creek, Fullerton Creek, Carbon Creek, Moody Creek, and Los Alamitos Channel. The watershed is highly urbanized with densely populated areas of residential, commercial, and industrial areas, as well as open space. Montgomery (1977) determined that about 30% of the runoff available in an average rainfall year percolates to the aquifers underlying the La Habra Valley.

In recent years, the depth to groundwater from the ground surface is approximately 30 feet (see Figure 3-6. However, groundwater production occurs within the confined San Pedro aquifer which is significantly deeper than the perched alluvial aquifer with a depth to groundwater of approximately 140 feet in the year 2000 (see Figure 3-6). Thus, groundwater production is not anticipated impact surface waters and local habitats.

SECTION 15. PROTOCOLS FOR MODIFYING MONITORING PROGRAMS

A Groundwater Advisory Committee will be established by the La Habra GSA which will be responsible for monitoring the progress in implementing the sustainable management strategies and programs of this plan. The Committee will meet once every five years to evaluate and discuss the current conditions of the La Habra-Brea Management Area and the effectiveness of the current programs. This plan will be amended to reflect any new policies or practices relevant to the management of the La Habra-Brea Management Area. It will also be updated to reflect changes in groundwater conditions as necessary.

Monitoring protocols are necessary to ensure consistency and accuracy in monitoring efforts and are required for monitoring assessments to be valid. Consistency should be reflected in factors such as the locations of the sampling points, frequency and seasonality of measurements, sampling procedures, and testing procedures. Accordingly, the La Habra GSA will undertake uniform data gathering procedures to ensure comparable measurements of groundwater are taken.

15.1 ESTABLISHMENT OF PROTOCOLS FOR WATER QUALITY

The following protocols will be followed for future groundwater elevation measurements:

- Annual sampling should be performed at the same time each year.
- Sampling should be performed during periods of both low and high groundwater production from the basin.
- Pump the well for an adequate period of time prior to sampling and document the stabilized parameters.
- Use proper containers, preservatives, and holding times.
- Use proper handling procedures (gloves, ice coolers, etc.).
- Document the time, date, location, and name of the technician on each sample container.
- Document any field notes regarding the condition of the well, sample, etc. if necessary.
- Use secure chain-of-custody procedures.
- Use the same laboratory for all testing, when possible. Select a laboratory that is accredited and state-certified that use proper quality control and quality assurance procedures.
- Include spiked, duplicates, and field-blank samples for comparison to genuine samples.

15.2 ESTABLISHMENT OF PROTOCOLS FOR GROUNDWATER ELEVATION/STORAGE

The following protocols will be followed for future groundwater elevation measurements:

- Document the time, date, location, and name of the technician for each measurement.
- Document the reference point, measuring device, and calibration date for the measuring device for each measurement.
- Annual measurements should be performed at the same time each year.
- When taking measurements for multiple wells, measurements should be taken in as short a period as possible.
- Measure the groundwater elevation twice, or more if necessary, until consistent results are obtained.
- If groundwater contamination is suspected, decontaminate the measuring equipment. In general, measurements should be performed from the least contaminated to most contaminated wells.

SECTION 16. PROCESS TO EVALUATE NEW PROJECTS

The La Habra GSA will evaluate any proposed actions for the La Habra-Brea Management Area pursuant to this Basin 8-1 Alternative in cooperation with the City of Brea. However, if there is a conflict between this Alternative and La Habra GSA's GSP, the GSP will control. Additionally, new projects would be evaluated through the CEQA process (i.e. by reviewing and commenting on draft CEQA documents). Likewise, OCWD would have an opportunity to comment on projects proposed within the La Habra-Brea Management Area, but OCWD has no authority under this Plan to obstruct any action taken by the La Habra GSA regarding the La Habra-Brea Management Area.

SECTION 17. LIST OF REFERENCES AND TECHNICAL STUDIES

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Basin 8-1 Alternative

OCWD Management Area

Prepared by: Orange County Water District

January 1, 2017

Basin 8-1 Alternative

OCWD Management Area

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Prepared for the Department of Water Resources, pursuant to Water Code §10733.6(b)(3)

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SECTION 1 EXECUTIVE SUMMARY

The Orange County Water District (OCWD) is a special district formed in 1933 by an act of the California Legislature, the “OCWD Act”. OCWD manages the groundwater basin that underlies north and central Orange County pursuant to the OCWD Act. Water produced from the basin is the primary water supply for approximately 2.4 million residents living within the service area boundaries. The mission of OCWD includes sustainably managing the Orange County Groundwater Basin, Basin 8-1, over the long-term. Additionally, as a special act district listed in Water Code § 10723 (c)(1), OCWD is the exclusive local agency within its jurisdictional boundaries with powers to comply with SGMA via a groundwater sustainability plan (“GSP”) or via an Alternative prepared in accordance with Water Code § 10733.6.

The OCWD Management Area includes 89 percent of the area designated by the Department of Water Resources (DWR) as Basin 8-1, the “Coastal Plain of Orange County Groundwater Basin” in Bulletin 118 (DWR, 2003). The OCWD Management Area includes the same land area as the OCWD service area within Basin 8-1 except for a small 6.7-square mile area in the northeast corner of the basin that is part of the Santa Ana Canyon Management Area. The boundaries of Basin 8-1, the OCWD service area and the OCWD Management Area are shown in Figure 1-1.

1.1 GROUNDWATER BASIN CONDITIONS

GROUNDWATER ELEVATIONS

OCWD prepares groundwater elevation contour maps for each of the three major aquifer systems (Shallow, Principal, and Deep) annually. In addition to illustrating regional groundwater gradients, the maps are used to prepare water level change maps and to calculate the amount of groundwater in storage and the annual storage change. OCWD’s basin-wide network of monitoring wells is used to monitor groundwater levels and quality, assess effects of pumping and recharge, estimate groundwater storage, characterize basin hydrogeology, and develop and calibrate a numerical flow model of the basin. Groundwater elevation contours in the Principal Aquifer as of June 2016 are shown in Figure 1-2.

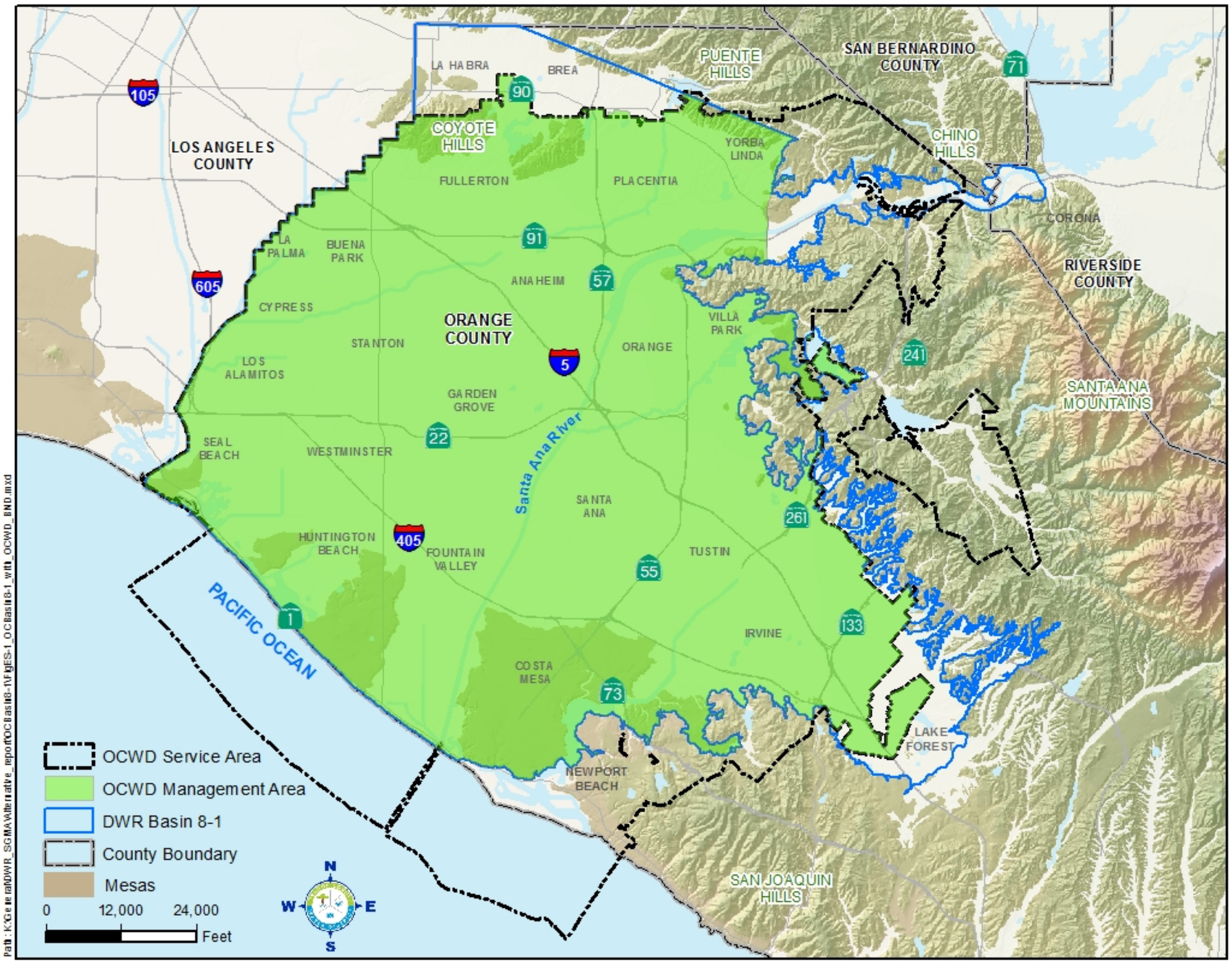


Figure 1-1: Basin 8-1, OCWD Service Area and OCWD Management Area

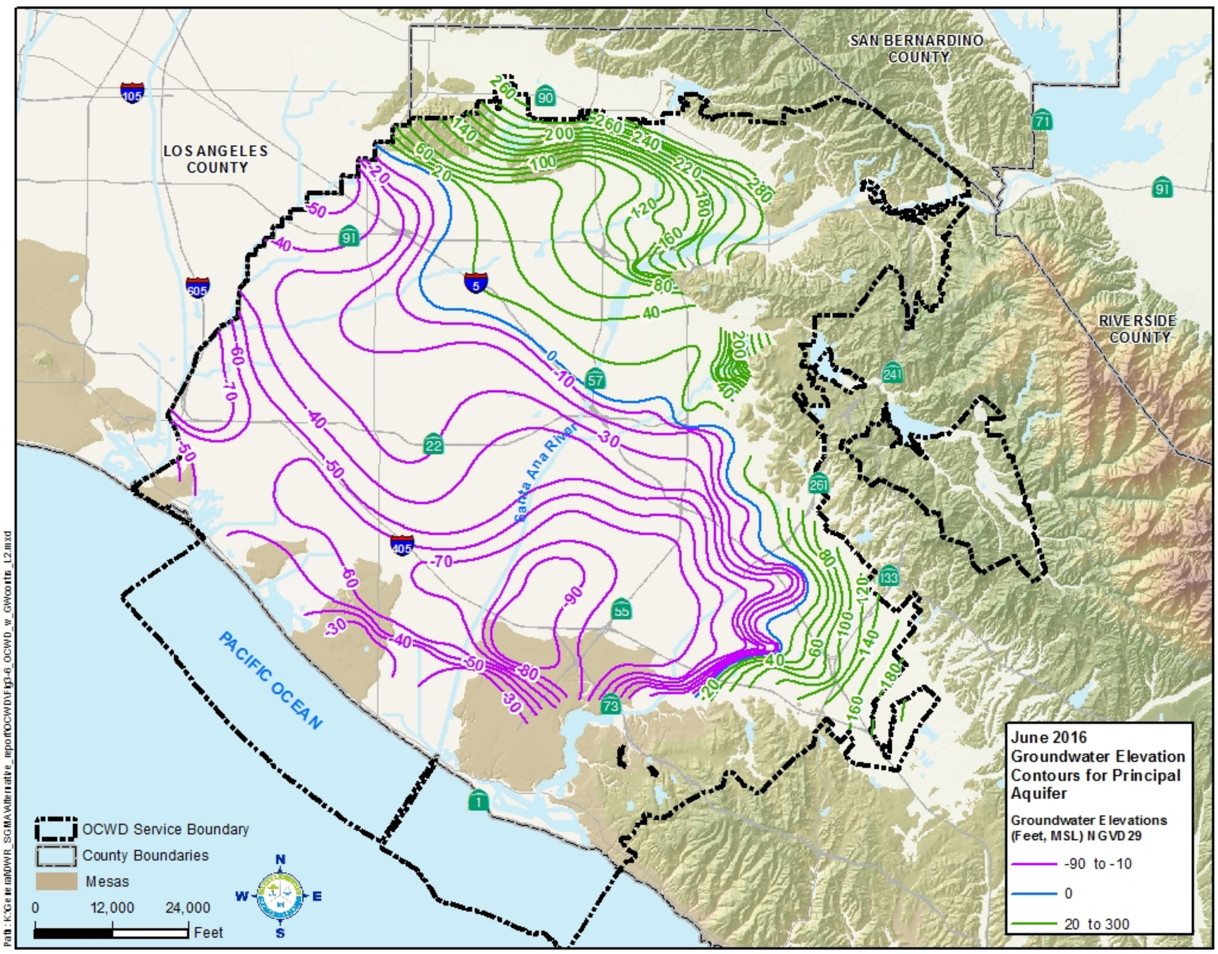


Figure 1-2: Groundwater Elevation Contours for the Principal Aquifer, June 2016

GROUNDWATER STORAGE

The groundwater basin contains an estimated 66 million acre-feet when full. However, OCWD manages the basin within an established operating range of up to 500,000 acre-feet below full condition. This operating range was established to designate the levels of groundwater storage within which the basin that can be maintained without causing adverse impacts. In order to manage the basin within this operating range, OCWD calculates the amount of groundwater in storage on an annual basis. Long-term groundwater storage levels based on OCWD's water year (July 1 to June 30) are shown in Figure 1-3.

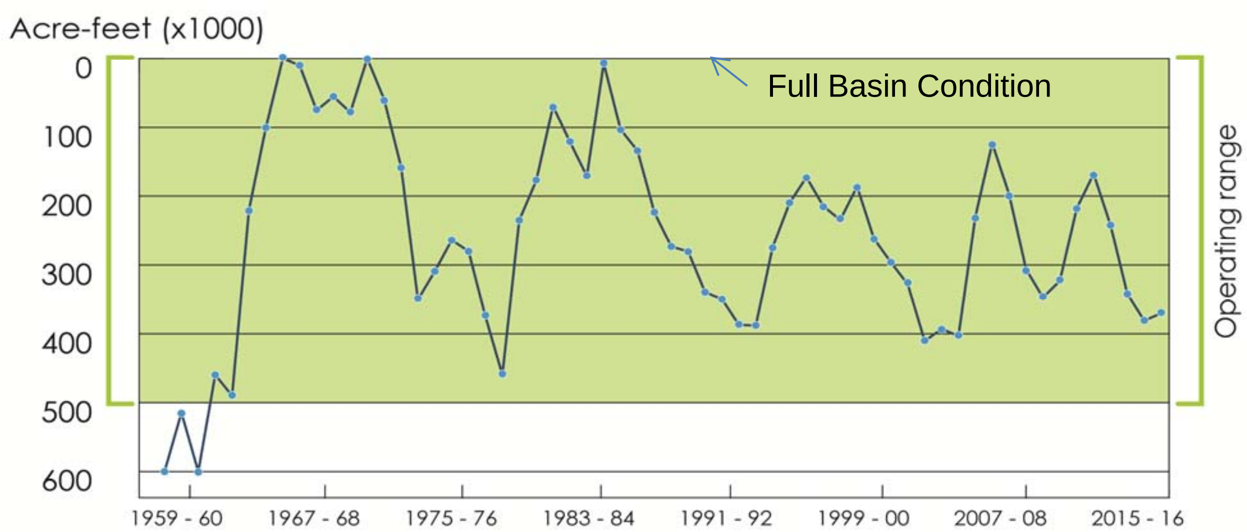


Figure 1-3: Available Basin Storage WY 1958-59 to WY 2015-16

WATER QUALITY

The California Regional Water Quality Control Board, Santa Ana Region (Regional Water Board) is responsible for protection and enhancement of the quality of waters in the watershed, which includes surface water and groundwater in the OCWD Management Area. The watershed's salinity management program, overseen by the Regional Water Board, is managed by the Basin Monitoring Program Task Force. Water quality objectives for total dissolved solids (TDS) and nitrate-nitrogen in groundwater management zones were adopted by the Regional Water Board based on historical water quality data. Every three years the Task Force calculates the current ambient water quality for each groundwater management zone. The most recent recalculation for the groundwater basin was completed in 2014.

There are several regional groundwater contamination plumes within the OCWD Management Area, all of which are under active remediation. The U.S. EPA is the lead agency in remediation of the plume in the North Basin area. Remediation for individual sites within the South Basin area is within the jurisdiction of either the California Department of Toxic Substances Control or the Regional Water Board. The U.S. Navy is taking the lead in remediation of plumes from the former El Toro and Tustin Marine Corps Air Stations and the Naval Weapons Station Seal Beach.

LAND SUBSIDENCE

Land subsidence due to changes in groundwater conditions in the OCWD Management Area is variable and does not show a pattern of widespread, permanent lowering of the ground surface. There is no evidence of permanent, inelastic land subsidence within the OCWD Management Area.

1.2 WATER BUDGET

OCWD developed a hydrologic budget for the purpose of constructing a basin-wide numerical groundwater flow model and for evaluating basin production capacity and recharge requirements. The key components of the budget include measured and unmeasured (estimated) recharge, groundwater production and subsurface outflows.

The groundwater basin is not operated on an annual safe-yield basis. The net change in storage in any given year may be positive or negative; however, over a period of several years, the basin is maintained in an approximate balance. Amounts of total basin production and total water recharged from water year 1999-2000 to 2015-16 are shown in Figure 1-4.

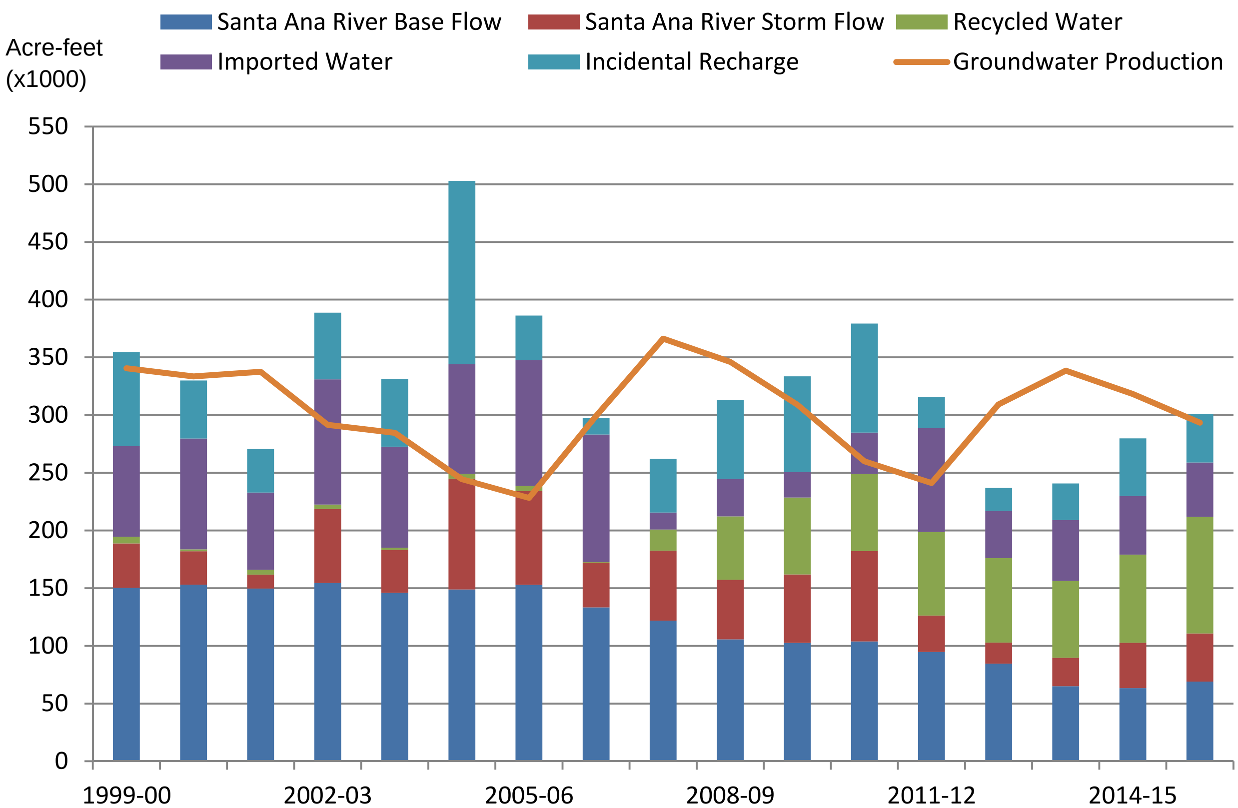


Figure 1-4: Basin Production and Recharge Sources, WY 1999-2000 to WY 2015-16

1.3 WATER RESOURCE MONITORING PROGRAMS

Water resource monitoring programs for groundwater, surface water, recycled water, and imported water are summarized in Table 1-1.

Table 1-1: OCWD Monitoring Programs

MONITORING PROGRAM	PURPOSE
Groundwater Production	Manage basin storage; collect revenues based on production
Groundwater Elevation	Manage basin storage; prepare groundwater level contour maps; manage seawater intrusion barrier injection rates
CA Statewide Groundwater Elevation Monitoring (CASGEM) Program	Compliance with state CASGEM program
Title 22 Water Quality Program	Compliance with CA SWRCB Division of Drinking Water, Title 22 Monitoring for more than 100 regulated and unregulated chemicals at approximately 200 large- and small-system drinking water wells
Groundwater Contamination Plumes	Monitor location of contamination plumes and levels of contamination to protect drinking water wells and basin water quality
Seawater Intrusion	Monitor effectiveness of existing seawater intrusion barriers
Santa Ana River Monitoring Program	Annual review to affirm that OCWD recharge practices are protective of public health
Basin Monitoring Program Task Force	Annual report prepared to comply with Regional Water Board Basin Plan
Santa Ana River Watermaster Monitoring	Determine annual Santa Ana River baseflow and stormflow and TDS at two locations to comply with the 1969 judgment on Santa Ana River water rights
Prado Wetlands	Evaluate changes in water quality and effectiveness of wetlands treatment of surface water used for groundwater recharge
Emerging Constituents	Compliance with federal and state regulations
Recycled Water	Monitor quality of water produced by GWRS
Imported Water	Monitor water quality of supply used for groundwater recharge

1.4 GROUNDWATER MANAGEMENT PROGRAMS

LAND USE

The OCWD Management Area is highly urbanized. As such, OCWD monitors, reviews and comments on local land use plans, environmental documents, and proposed regulatory agency permits to provide input to land use planning agencies regarding proposed projects and programs that could cause short- or long-term water quality impacts to the groundwater basin.

DEMAND MANAGEMENT

Water demands within the OCWD Management Area for water year (WY) 2015-16 totaled approximately 364,000 acre-feet. It is noted that water demands in WY 2015-16 reflect mandatory demand reductions imposed by the State Water Board in response to an extended drought. Between WY1996-97 to present, water demands have ranged between 413,000 afy to 515,000 afy but have generally decreased, as shown in Figure 1-5. OCWD strives to sustainably maximize both production from the basin and recharge of the groundwater basin. Total water demands in the management area are met by a combination of groundwater and imported water.

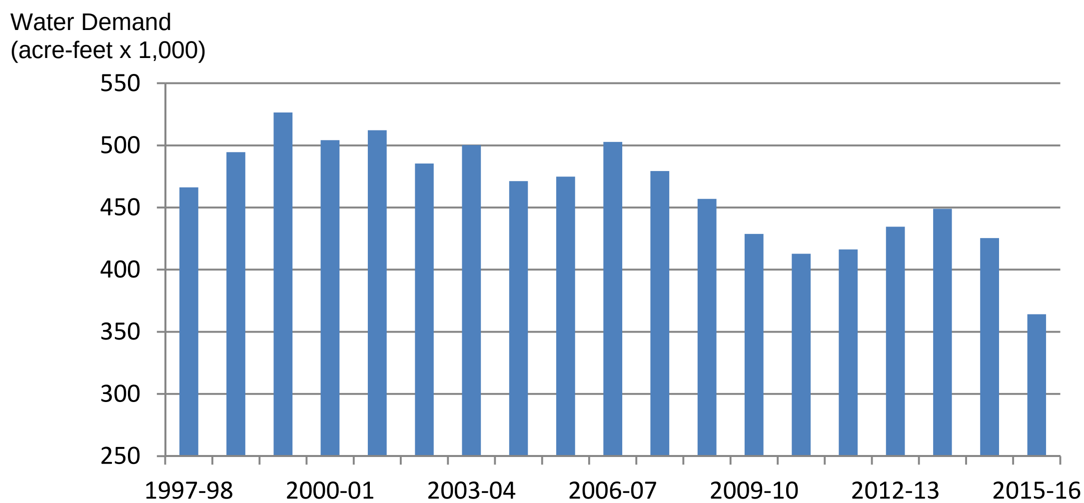


Figure 1-5: Total Water Demands within OCWD, WY 1997-98 to WY 2015-16

GROUNDWATER QUALITY PROTECTION AND MANAGEMENT

OCWD adopted a Groundwater Quality Protection Policy in 1987 and updated it in 2014. This policy guides the actions of OCWD to maintain groundwater quality suitable for all existing and potential beneficial uses; prevent degradation of groundwater quality and protect groundwater from contamination; maintain surface water and groundwater quality monitoring programs, a monitoring well network and data management system; and assist regulatory agencies in remediating contaminated sites.

Salinity Management Programs within the OCWD Management Area include:

- Operation of two seawater intrusion barriers along the coast;
- The Coastal Pumping Transfer Program, a voluntary program that shifts pumping from coastal to inland areas to lessen the potential for seawater intrusion;
- Production of recycled water at OCWD's Groundwater Replenishment System (GWRS) that is used for groundwater recharge and operation of the seawater intrusion barrier;
- Operation of groundwater desalters in Orange, Riverside and San Bernardino Counties to reduce salt buildup in groundwater basins as well as surface water that is used to recharge the Orange County groundwater basin;
- The salt and nutrient management program managed by the Regional Water Board; and
- Removal of nitrates through operation of the city of Tustin's Main Street and 17th Street treatment plants, IRWD's Irvine Desalter and Well 21/22 projects and OCWD's 465-acre Prado Constructed Wetlands.

RECYCLED WATER PRODUCTION

The GWRS produces up to 100 million gallons per day (mgd) of highly treated recycled water. Plans are underway to expand the plant to 130 mgd. GWRS product water is recharged into the groundwater basin and is the primary source of water for the Talbert Seawater Barrier. OCWD also operates the Green Acres Project, a non-potable recycled water supply for irrigation and industrial water users.

CONJUNCTIVE USE PROGRAMS

Recharge water sources include water from the Santa Ana River and tributaries, imported water, and recycled water supplied by the GWRS as well as incidental recharge from precipitation and subsurface inflow. OCWD's conjunctive use program includes over 1,500 acres of land on which there are 1,067 wetted acres of recharge facilities. This network of 25 facilities recharges an average of over 250,000 afy.

MANAGEMENT OF SEAWATER INTRUSION

The Alamitos and Talbert Seawater Intrusion Barriers control seawater intrusion through the Alamitos and Talbert Gaps by injecting fresh water into susceptible aquifers through a series of injection wells to create a hydraulic barrier.

1.5 NOTICE AND COMMUNICATION

The local agencies that produce the majority of the groundwater from the basin include 19 cities, water districts, and water companies. OCWD staff holds monthly meetings with this group to provide information and seek input on issues related to groundwater management. OCWD has a proactive community outreach program that includes conducting an annual Children's Water Education Festival attended by over 7,000 elementary school students and a monthly electronic newsletter with approximately 5,700 subscribers.

1.6 SUSTAINABLE BASIN MANAGEMENT

The sustainability goal for the OCWD Management Area is to:

> Continue to manage the groundwater basin to prevent basin conditions that would lead to significant and unreasonable (1) lowering of groundwater levels, (2) reduction in storage, (3) water quality degradation, (4) seawater intrusion, (5) land subsidence and (6) depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

Existing monitoring and management programs in place today enable OCWD to sustainably manage the groundwater basin. Since its founding in 1933, OCWD has developed a managed aquifer recharge program, constructed hundreds of monitoring wells, developed an extensive water quality monitoring program, installed seawater intrusion barriers, and doubled the volume of groundwater production while protecting the long-term sustainability of the groundwater resource. OCWD's management of the OCWD Management Area will continue to provide long-term sustainable basin management that is able to adapt to changing conditions affecting the groundwater basin.

1.6.1 Sustainable Management: Water Levels

OCWD manages the basin for long-term sustainability by maximizing groundwater recharge and managing basin production within sustainable levels. Long-term data trends demonstrate that groundwater elevations in the basin have not been in the condition of chronic lowering. The undesirable result of "chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply" is not present and is not anticipated to occur in the future in the OCWD Management Area due to OCWD's management programs. Hydrographs representative of long-term water levels in the basin are shown in Figure 1-6. These hydrographs demonstrate that groundwater levels in the OCWD Management Area are being managed at long-term sustainable levels.

1.6.2 Sustainable Management: Basin Storage

OCWD manages the basin within an established operating range of groundwater in storage of up to 500,000 acre-feet below full condition. Maintaining basin storage within this range protects the basin from detrimental impacts such as land subsidence, chronic lowering of groundwater levels and chronic reduction in storage. OCWD manages groundwater pumping such that it is sustainable over the long-term; however, in any given year pumping may exceed recharge or vice versa. Thus, the amount of groundwater stored in or withdrawn from the basin varies from year to year and often goes through multi-year cycles of emptying and filling, which typically correlates with state-wide and/or local precipitation patterns and other factors.

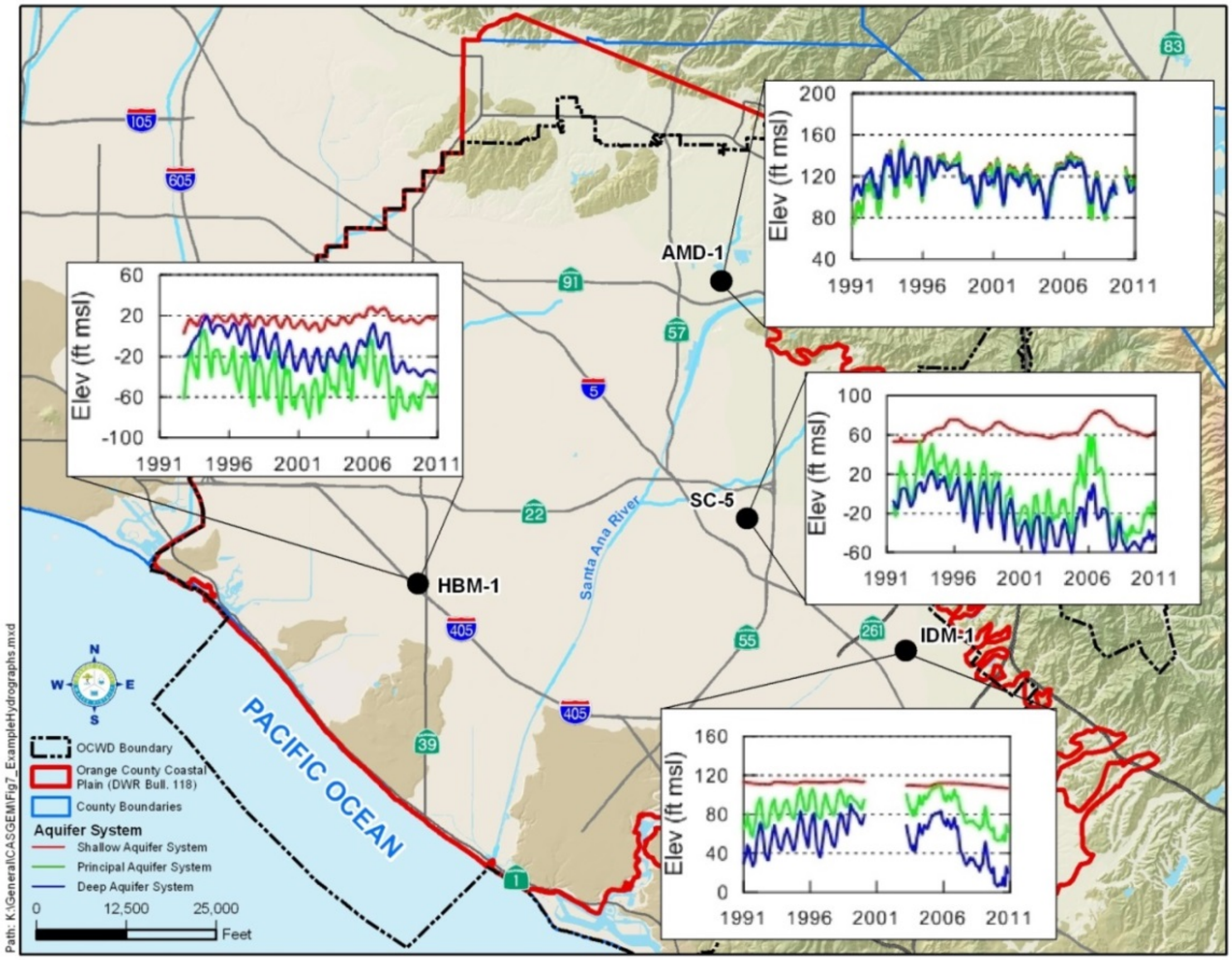


Figure 1-6: Example Hydrographs

Each year OCWD calculates the volume of groundwater storage change from a theoretical "full" benchmark condition based on a calculation using changes in groundwater elevations in each of the three major aquifer systems and aquifer storage coefficients. This calculation is checked against an annual water budget that accounts for all production, measured recharge and estimated unmeasured recharge. The amount of available or unfilled storage from the theoretical full condition is graphed on Figure 1-3. Maintaining the basin storage condition on a long-term basis within the established operating range allows for long-term sustainable management of the basin without experiencing undesirable effects. Therefore, the undesirable result of "significant and unreasonable reduction of groundwater storage" is not present and is not anticipated to occur in the OCWD Management Area in the future due to OCWD's management programs.

1.6.3 Sustainable Management: Water Quality

OCWD has extensive monitoring and management programs in place to monitor and protect the water quality of the groundwater basin. OCWD's network of approximately 400 monitoring wells is generally distributed throughout the basin. Water quality in these wells is tested on a regular basis for a large number of parameters. OCWD also conducts groundwater quality sampling of approximately 200 production wells on behalf of groundwater producers to comply with Title 22 requirements. An additional approximately 200 private, domestic, and irrigation production wells area also sampled periodically.

OCWD has a sampling protocol in place that includes standards for increased monitoring of individual wells. In cases where there is a detection of an organic compound for the first time, for example, OCWD will resample that well and if the detection is confirmed will increase the sampling frequency of that well. Another example is an increased frequency for monitoring when there is a detection of nitrate at 50% of the MCL. These sampling protocols are designed to detect water quality problems at the earliest possible stage. The undesirable result of "significant and unreasonable degradation of water quality including migration of contaminant plumes that impair water supplies" is not present and is not anticipated to occur in the future in the OCWD Management Area due to OCWD's management programs.

1.6.4 Sustainable Management: Seawater Intrusion

OCWD's management of seawater intrusion is implemented through a comprehensive program that includes operating seawater intrusion barriers, monitoring and evaluating barrier performance, monitoring and evaluating susceptible coastal areas, and coastal groundwater management. These programs enable OCWD to sustainably manage groundwater conditions in the basin by preventing significant and unreasonable seawater intrusion.

The Alamitos Seawater Intrusion Barrier manages seawater intrusion in the Alamitos Gap. The Talbert Seawater Intrusion Barrier manages seawater intrusion in the Talbert Gap. The Alamitos Barrier groundwater model is being used to evaluate seawater intrusion in the area of the Sunset Gap.

Monitoring and evaluating barrier performance and potential seawater intrusion consists of sampling monitoring wells semi-annually, measuring water levels at least quarterly, installing monitoring wells when needed to fill data gaps, and conducting other management activities to reduce potential for seawater intrusion, such as construction of additional injection wells and the Coastal Pumping Transfer Program.

The undesirable result of "significant and unreasonable seawater intrusion" is not present and is not anticipated to occur in the future in the OCWD Management Area due to OCWD's management programs.

1.6.5 Sustainable Management: Land Subsidence

Management of the groundwater basin by maintaining storage levels within the established operating range has prevented the undesirable result in the OCWD Management Area of significant and unreasonable land subsidence that substantially interferes with surface uses. Within the OCWD Management Area there is no evidence of long-term inelastic land subsidence, nor any land subsidence that has interfered with surface uses. Therefore, the undesirable result of “significant and unreasonable land subsidence that substantially interferes with surface uses” is not present and is not anticipated to occur in the OCWD Management Area in the future due to OCWD’s management programs.

1.6.6 Sustainable Management: Depletion of Interconnected Surface Waters

There are no surface water bodies within the OCWD Management Area that are interconnected with groundwater in which the groundwater connection to the surface water provides surface water flow to sustain beneficial uses in a surface water body. Therefore, the undesirable result of “depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water due to groundwater conditions occurring throughout the basin” is not present and in the future is not anticipated to occur in the OCWD Management Area due to OCWD’s management programs.

1.7 PROTOCOLS FOR MODIFYING MONITORING PROGRAMS

Protocols that trigger a change in a monitoring program include a change in regulations, a first time detection of a constituent in a water sample, an increase in a constituent in a water sample that approaches or exceeds a regulatory limit or Maximum Contaminant Level, an indication of an adverse water quality trend or water level, a special study, or a recommendation from OCWD’s Independent Expert Panel.

1.8 EVALUATION OF POTENTIAL PROJECTS

OCWD regularly evaluates potential projects and conducts studies to improve existing operations. This may include:

- Increasing the capacity of existing recharge basins;
- Constructing new recharge facilities;
- Constructing new production wells
- Improving seawater intrusion barriers; and
- Constructing water quality improvement projects.

1.9 CONCLUSION

OCWD has been managing the OCWD Management Area since formation of OCWD by the State Legislature in 1933. Monitoring and management programs described in this Alternative, submitted in compliance with CA Code of Regulations (Title 23, Division 2, Chapter 1.5, Subchapter 2) demonstrate that the groundwater basin has been and will continue to be sustainably managed. This report demonstrates that the OCWD Management Area has operated within its sustainable yield over a period of at least 10 years, as required by CCR Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 9, Section 358.2 (c)(3).

SECTION 2 AGENCY INFORMATION

2.1 HISTORY OF OCWD

The Orange County Water District (OCWD) is a special district formed in 1933 by an act of the California Legislature, the OCWD Act. Additionally, as a special act district listed in Water Code § 10723 (c)(1), OCWD is the exclusive local agency within its jurisdictional boundaries with powers to comply with SGMA via a groundwater sustainability plan ("GSP") or via an Alternative prepared in accordance with Water Code § 10733.6.

OCWD manages the groundwater basin that underlies north and central Orange County. Water produced from the basin is the primary water supply for approximately 2.4 million residents living within OCWD's boundaries. With passage of the Sustainable Groundwater Management Act (SGMA) (Water Code §10723(c)) in 2014, OCWD was designated the exclusive local agency within its jurisdictional boundaries with powers to comply with SGMA.

Nineteen major groundwater producers, including cities, water districts, and a private water company, pump groundwater from about 200 large-capacity wells for retail water use. There are also approximately 200 small-capacity wells that pump water from the basin. OCWD protects and manages the groundwater resource for long-term sustainability, while meeting approximately 70 to 75 percent of the water demand within its service area.

Since its founding, OCWD has grown in area from 162,676 to 243,968 acres and has experienced an increase in population from approximately 120,000 to 2.4 million people. OCWD has employed groundwater management techniques to increase the annual yield from the basin including operating over 1,500 acres of recharge basins in the cities of Anaheim, Orange, and unincorporated areas of Orange County. Annual water production increased from approximately 150,000 acre-feet per year (afy) in the mid-1950s to a high of over 366,000 afy in water year 2007-08.

OCWD has managed the basin to provide a reliable supply of relatively low-cost water, accommodating rapid population growth while at the same time avoiding the costly and time-consuming adjudication of water rights experienced in many other major groundwater basins in Southern California. Facing the challenge of increasing demand for water has fostered a history of innovation and creativity that has enabled OCWD to increase available groundwater supply while ensuring the long-term sustainability of the groundwater basin.

A brief history of OCWD is provided in the following timeline:

June 14, 1933: California Legislature creates the Orange County Water District by special act to protect surface water rights and manage the groundwater basin. The new district joins the Irvine Company's lawsuit.

1930s: Groundwater pumping in Orange County exceeds the rate of recharge resulting in groundwater levels dropping. OCWD begins actively recharging the groundwater basin by infiltrating Santa Ana River flows and looking for additional water supplies.

1936: OCWD begins purchasing portions of the Santa Ana River channel with the first purchase of 26 acres.

1941: U.S. Army Corps of Engineers completes construction of Prado Dam.

1949: OCWD begins purchasing imported water from the Colorado River Aqueduct for groundwater recharge.

1951: OCWD initiates legal action against cities upstream of Orange County to protect rights to Santa Ana River flow. Settlement of the suit in 1957 limits use of river water to the amount used in 1946.

1954: The District Act is amended giving OCWD authority to collect groundwater production records and a Replenishment Assessment (RA) from groundwater pumpers to purchase imported water for groundwater recharge. The amendments also enlarged OCWD boundaries, and required the publication of an annual engineer's report on groundwater production and basin conditions.

1956: Groundwater levels drop as much as 40 feet below sea level and seawater intrudes 3½ miles inland. Plans begin to construct seawater intrusion barriers in two areas – Alamitos Gap at the mouth of the San Gabriel River at the Orange County/Los Angeles County border and the Talbert Gap at the mouth of the Santa Ana River in Fountain Valley.

1957: OCWD purchases land and constructs Anaheim Lake, OCWD's first off-river recharge basin.

1963: OCWD files a lawsuit against all upper watershed entities above Prado Dam to ensure a minimum amount of Santa Ana River water for Orange County.

1965: OCWD partners with the Los Angeles County Flood Control District to begin injecting fresh water into the Alamitos Gap to prevent saltwater intrusion.

1968: OCWD purchases land and water rights owned by Anaheim Union Water Company and the Santa Ana Valley Irrigation Company, which includes land upstream of Prado Dam that was acquired to protect Orange County's interest in Santa Ana River water.

1969: The lawsuit against upper watershed entities is settled. (Orange County Water District v. City of Chino, et al., Case no. 117628 – County of Orange). Large water districts agree to deliver at least 42,000 acre-feet of Santa Ana River baseflow to Orange County, and OCWD gains the rights to all stormflows reaching Prado Dam. Parties to the judgment include Western Municipal Water District, San Bernardino Valley Municipal Water District and the Inland Empire Utilities Agency.

1969: The Basin Production Percentage and the Basin Equity Assessment are established.

1973: First water quality laboratory is constructed to analyze samples from the Santa Ana River and to begin analysis of demonstration injection wells for the planned construction of Water Factory 21.

1975: Talbert Seawater Intrusion Barrier begins operation. Control of seawater intrusion in the Talbert Gap requires six times the amount of water needed for the Alamitos Gap. Water Factory 21 is built to supply recycled water to the Talbert Seawater Intrusion Barrier. Secondary-treated wastewater from the Orange County Sanitation District receives advanced treatment and is blended with potable water to produce a safe, reliable supply for barrier operations – the first project of its kind permitted in the United States.

1991: Santiago Creek recharge project is completed, including purchase and development of Santiago Basins along Santiago Creek, a pump station at Burris Basin, and a pipeline to convey water back and forth from recharge basins along the Santa Ana River and Santiago Basins. Two rubber dams are installed on the Santa Ana River, allowing for more efficient diversion of river water to the downstream recharge facilities.

2008: The Groundwater Replenishment System (GWRS) begins operation, replacing Water Factory 21. The largest of its kind in the world, the GWRS is capable of producing up to 72 mgd of purified recycled water for use in Talbert Barrier operations and for groundwater recharge.

2009: New Advanced Water Quality Assurance Laboratory opens to handle over 400,000 analyses of nearly 20,000 water samples each year.

2015: GWRS Initial Expansion is completed, expanding plant capacity from 72 mgd to 100 mgd of product water.

2.2 GOVERNANCE AND MANAGEMENT STRUCTURE

The Orange County Water District was created by the OCWD Act for the purpose of:

> "providing for the importation of water into said district and preventing waste of water in or exportation of water from said district and providing for reclamation of drainage, storm, flood and other water for beneficial use in said district and for the conservation and control of storm and flood water flowing into said district; providing for the organization and management of said district and establishing the boundaries and divisions thereof and defining the powers of the district, including the right of the district to sue and be sued, and the powers and duties of the officers thereof; providing for the construction of works and acquisition of property by the district to carry out the purposes of this act; authorizing the incurring of indebtedness and the voting, issuing and selling of bonds and the levying and collecting of assessments by said district; and providing for the inclusion of additional lands therein and exclusion of lands therefrom." (Stats.1933, c. 924, p. 2400)

OCWD is divided into 10 divisions as specified in the District Act. One director is elected or appointed from each division. The cities of Anaheim, Fullerton, and Santa Ana appoint one member each to serve on the Board. The other seven Board members are elected by voters in the respective divisions. Boundaries of the 10 divisions are shown in Figure 2-1. Appointed members of the Board serve a four-year term and may be removed at any time by a majority vote of the appointing governing body. Elected members of the board serve four-year terms and may be re-elected without limits.

The full Board of Directors meets twice a month, normally on the first and third Wednesdays of the month. Board committees also meet on a monthly basis. These committees include the Water Issues, Communication/Legislation, Administration/Finance, Property Management and Retirement.

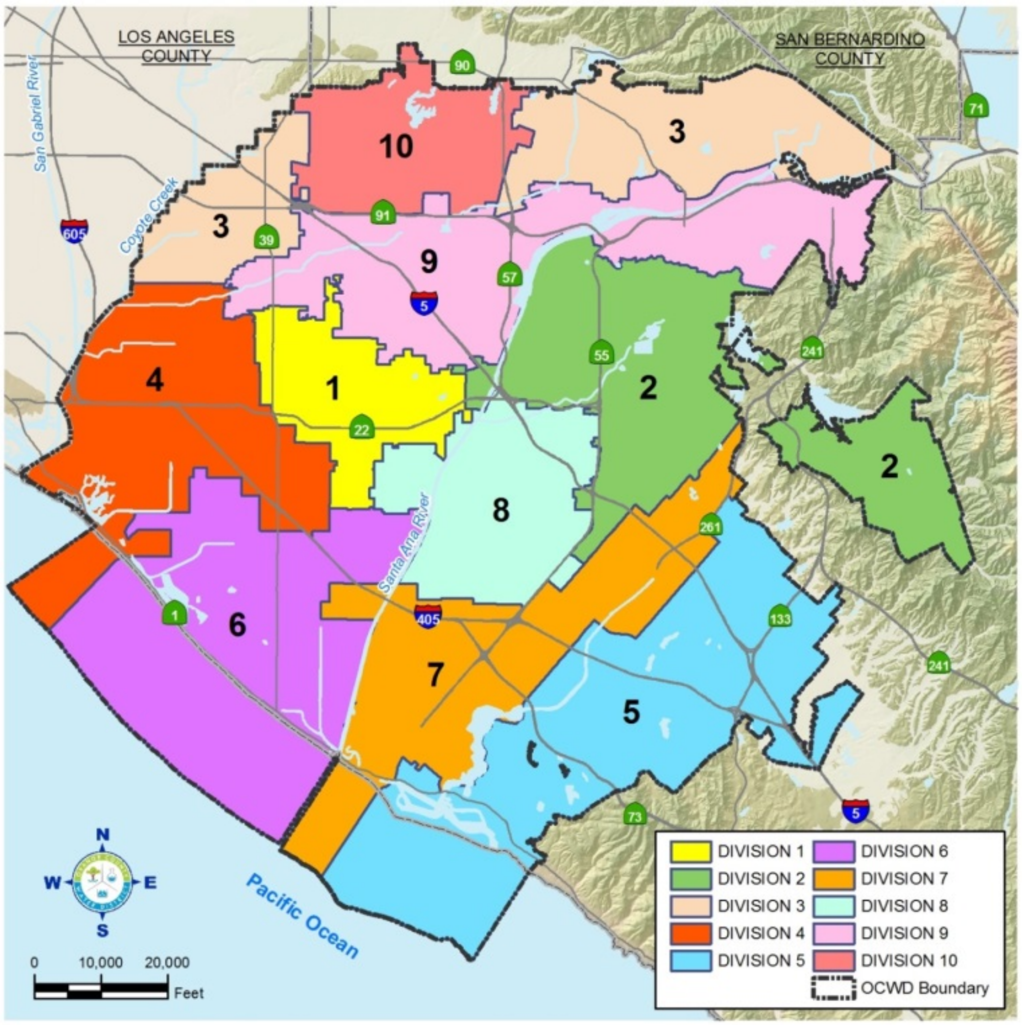


Figure 2-1: Orange County Water District Divisions

The ten divisions are comprised of the following areas:

Division One:	Garden Grove, Stanton, Westminster
Division Two:	Orange, Villa Park, and parts of Tustin
Division Three:	Buena Park, La Palma, Placentia, Yorba Linda, and parts of Cypress

Division Four:	Los Alamitos, Seal Beach, and parts of Buena Park, Cypress, Garden Grove, Huntington Beach, Stanton, and Westminster
Division Five:	Parts of Irvine and Newport Beach
Division Six:	Parts of Fountain Valley and Huntington Beach
Division Seven:	Costa Mesa and parts of Fountain Valley, Irvine, Newport Beach and Tustin
Division Eight:	Santa Ana
Division Nine:	Anaheim
Division Ten:	Fullerton

The nineteen major groundwater producers meet on a monthly basis with OCWD staff to consult with and provide advice on basin management issues. This group is described in more detail in Section 7.1

2.3 LEGAL AUTHORITY

Section 2 of the District Act grants powers to OCWD including, but not limited to:

- To construct, purchase, lease, or otherwise acquire, and to operate and maintain necessary waterworks, water rights, spreading grounds, lands, and rights necessary to replenish the groundwater basin and augment and protect the water quality of the common water supplies of the District;
- Provide for the conjunctive use of groundwater and surface water resources within the district area;
- Store and replenish water in underground basins or reservoirs within or outside the District;
- Regulate and control the storage of water and the use of groundwater basin storage space in the basin;
- Purchase and import water into the District;
- Transport, reclaim, purify, treat, inject, extract, or otherwise manage and control water for the beneficial use of persons or property within the District and to improve and protect the quality of the groundwater supplies;
- Determine the operational range in which groundwater levels may decline or recover during a given water year within the District's boundaries by determining the amount and percentage of water that may be produced by pumpers from the Groundwater Basin within the district in proportion to the total amount of water used within the District (from all sources) by all persons and operators, e.g., setting of a Basin Production Percentage, or "BPP";
- Require groundwater producers who produce more of their total water needs from the groundwater within the District than the basin production percentage ("BPP") determined

annually by the District Board of Directors permits to pay a surcharge, the "Basin Equity Assessment" or "BEA", that removes any financial incentive for over-production from the Basin beyond that set by the OCWD Board each year;

- Provide for the protection and enhancement of the environment within and outside the District in connection with the water activities of the District; and
- To commence, maintain, intervene in, defend, and compromise, and assume the costs and expenses of all actions to prevent interference with water or water rights used within the District or diminution of the quality or pollution or contamination of the water supply of the District.

A copy of the OCWD Act, which has been the basis for OCWD's sustainable management of its portion of the Basin over many years, can be found at:

http://www.ocwd.com/media/2681/ocwddistrictact_201501.pdf

2.4 BUDGET

The mission of OCWD is to provide a reliable, high quality water supply in a cost-effective and environmentally responsible manner and to manage the Orange County groundwater basin in a sustainable manner over the long-term. For the purposes of this report, the District's entire budget is the cost to sustainably manage the basin.

OCWD's fiscal year (FY) begins on July 1 and ends on June 30. The annual operating budget and expected revenues for 2016-17 totaled approximately $158.2 million.

2.4.1 Operating Expenses

OCWD's budgeted operating expenses for FY 2016-17 are summarized in Table 2-1 and described as follows.

Table 2-1: FY 2016-17 Budget Operating Expenses

EXPENSES	Total (in millions)
General Fund	$64.4
Total Debt Service	36.6
Water Purchases	34.7
Capital Projects	6.6
Retiree Health Trust	1.3
Refurbishment and Replacement Transfer	14.6
Total	$158.2

General Fund

The general fund account primarily allows OCWD to operate the recharge facilities in the cities of Anaheim and Orange, GWRS, the Talbert and Alamitos Seawater Intrusion Barriers, the Green Acres Project, and the Prado Wetlands. In addition, the Advanced Water Quality Assurance Laboratory, groundwater monitoring programs, watershed management, planning, and other basin management activities are funded by this account.

Debt Service

The debt service budget provides for repayment of OCWD's debt from issues of previous bonds. OCWD has a comprehensive long-range debt program, which provides for the funding of projects necessary to increase basin production and protect water quality, while providing predictable impacts to the RA. OCWD holds very high credit ratings of AAA from Standard & Poor's, AAA from Fitch, along with an Aa1 rating from Moody's. Because of these excellent credit ratings, OCWD is able to borrow money at a substantially reduced cost.

Water Purchases

The District Act authorizes OCWD to purchase imported water for groundwater recharge to sustain groundwater pumping levels and refill the basin. Imported water is purchased from MWD for basin replenishment. This fund provides the flexibility to purchase water when such supplies are available. The Board of Directors can allocate funds to the Water Reserve Fund so that funds may accumulate in reserve in preparation for water purchases in future years.

New Capital Equipment

This category includes equipment items such as laboratory equipment, vehicles, heavy equipment, tools, computers, and software. These items are expensed and funded using current revenues.

Refurbishment and Replacement Fund

OCWD has over $908 million invested in existing plant and fixed assets. These facilities were constructed to provide a safe and reliable water supply. The Replacement and Refurbishment Fund was established to ensure that sufficient funds are available to repair and replace existing infrastructure, such as pumps, heavy equipment, injection and monitoring wells and water recycling facilities.

2.4.2 Operating Revenues

Expected operating revenues for FY 2016-17 are shown in Table 2-2 and described below.

Table 2-2: FY 2016-17 Operating Revenues

REVENUES	Total (in millions)
Replenishment Assessments	$117.8
Basin Equity Assessments	1.8
Property Taxes	22.9
Investment Revenues	1.6
Gap Sales and LRP Revenues	9.6
Miscellaneous Revenue	4.5
Total	$158.2

Replenishment Assessments

The Replenishment Assessment (RA) is paid for water pumped out of the basin. OCWD invoices Groundwater Producers for their production in July and January. The amount of revenue generated by the RA is directly related to the amount of groundwater production.

Basin Equity Assessment

The Basin Equity Assessment (BEA), as previously referenced, is paid by Producers for groundwater production above the BPP and is one of the primary tools OCWD uses to ensure groundwater levels remain within the pre-established operational range set by the District. This charge is assessed annually in September. The BPP is a percentage of each Producer's water supply that comes from groundwater pumped from the basin (see Section 10.3).

Property Taxes

OCWD receives a small percentage of property taxes, also referred to as ad valorem taxes, collected in the service area. The County of Orange assesses and collects these taxes and transmits them to OCWD at various times during the year. This revenue source has been dedicated to the annual debt service expense.

Investment Revenue

Investment Revenue is generated from OCWD's cash reserves.

GAP Sales and LRP Revenues

OCWD operates the Green Acres Project (GAP), which provides recycled water to customers who purchase the water for landscape irrigation. OCWD receives a subsidy for operation of the Groundwater Replenishment System and the GAP from the Metropolitan Water District of Southern California (MWD) through the Local Resources Program (LRP).

Miscellaneous Revenues

Miscellaneous revenues include annexation fees, producer well loan repayments, and rents and leases.

2.4.3 Reserves

OCWD maintains cash reserves to ensure its financial integrity so that the basin can be successfully managed and protected. Cash reserves ensure that:

- OCWD has sufficient funds for cash flow purposes;
- Funds are available for unexpected events such as contamination issues;
- Funds are available to make necessary replacements and repairs to infrastructure;
- OCWD has access to debt programs with low interest cost;
- A financial hedge is available to manage variable rate debt; and
- Funds are available to purchase MWD water when available.

Reserve Policies

OCWD has reserve policies, which establish reserves in the following categories:

- Operating reserves
- The Replacement and Refurbishment Program
- The Toxic Cleanup Reserve
- Contingencies required by the District Act
- Bond reserve covenants

Operating Reserves

This reserve category helps maintain sufficient funds for cash flow purposes and helps sustain the District's excellent credit rating. Maintaining this reserve, which is set at 15 percent of the operating budget, is particularly important because the principal source of revenue, the RA, is only collected twice a year. Payments for significant activities, such as replenishment water purchases, are typically required on a monthly basis. The reserve provides the financial "bridge" to meet the District's financial obligations on a monthly basis.

Replacement and Refurbishment Program

OCWD maintains a Replacement and Refurbishment Fund to provide the financial resources for replacement and/or repair of the District capital assets. These assets include treatment facilities, monitoring and injection wells, and treatment facilities.

Toxic Cleanup Reserve

Funds are reserved in this account to be used in the event that a portion of the basin becomes threatened by contamination. Over two million residents rely on the basin as their primary source of water. This reserve fund allows OCWD to respond, immediately, to contamination threats in the basin.

General Contingencies

Section 17.1 of the District Act requires the allocation of funds to cover annual expenditures that have not been provided for or that have been insufficiently provided for and for unappropriated requirements.

Debt Service Account

Restricted funds in this account have been set aside by the bonding institutions as a requirement to ensure financial solvency and to help guarantee repayment of any debt issuances. These funds cannot be used for any other purpose. The requirement varies from year to year depending on the OCWD's debt issuance and outstanding state loans.

Capital Improvement Projects

OCWD prepares a Capital Improvements Project budget to support basin production by increasing recharge capacity and operational flexibility, protecting the coastal portion of the basin, and providing water quality improvement.

SECTION 3 MANAGEMENT AREA DESCRIPTION

3.1 OCWD MANAGEMENT AREA

OCWD's service area covers approximately 430 square miles and is co-extensive with the OCWD Management Area for purposes of this Basin 8-1 Alternative, except as identified below. The OCWD service area includes 76 percent of the area designated by the Department of Water Resources (DWR) as Basin 8-1, the "Coastal Plain of Orange County Groundwater Basin" in Bulletin 118 (DWR, 2003). For the purposes of this Basin 8-1 Alternative, the OCWD Management Area contains the same geographical area as the portion of the OCWD service area within Basin 8-1 except for a small 6.7-square mile area in the northeast corner of the basin that is part of the Santa Ana Canyon Management Area. The boundaries of Basin 8-1, the OCWD service area and the OCWD Management Area are shown in Figure 3-1.

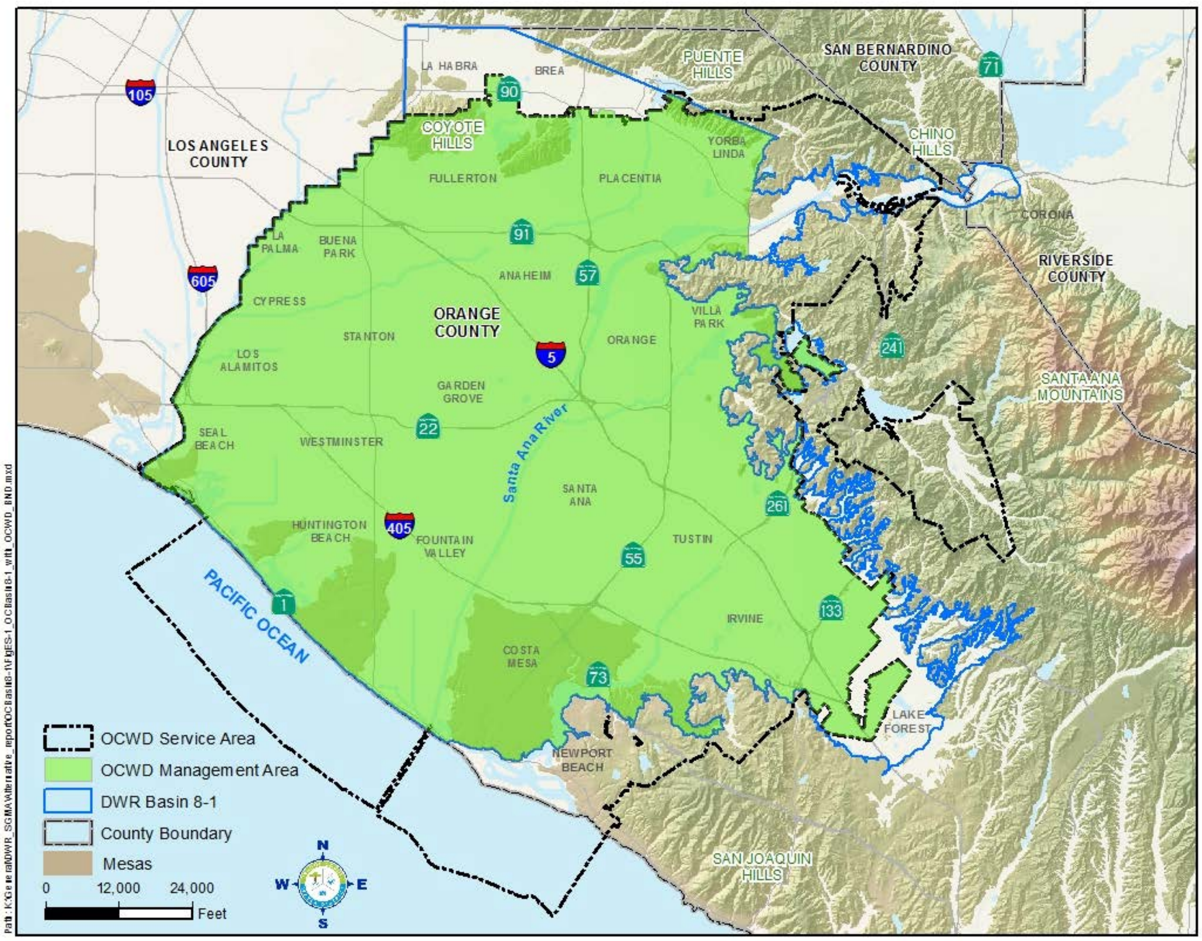


Figure 3-1: Basin 8-1, OCWD Service Area and OCWD Management Area

Jurisdictional Areas within OCWD Management Area

Federal and state lands within the OCWD Management Area as well as city boundaries are shown in Figure 3-2. Retail water providers within OCWD's service area are shown in Figure 3-3. The OCWD Management Area with a population of approximately 2.4 million is highly urbanized, as shown in Figure 3-4. Each of the 22 cities within OCWD's jurisdiction has an adopted general plan. There are no federally recognized tribes with land and there are no adjudicated areas within the OCWD Management Area. The unincorporated areas are managed by the County of Orange. Groundwater supplies are managed as a single, shared resource with no separate water use sectors.

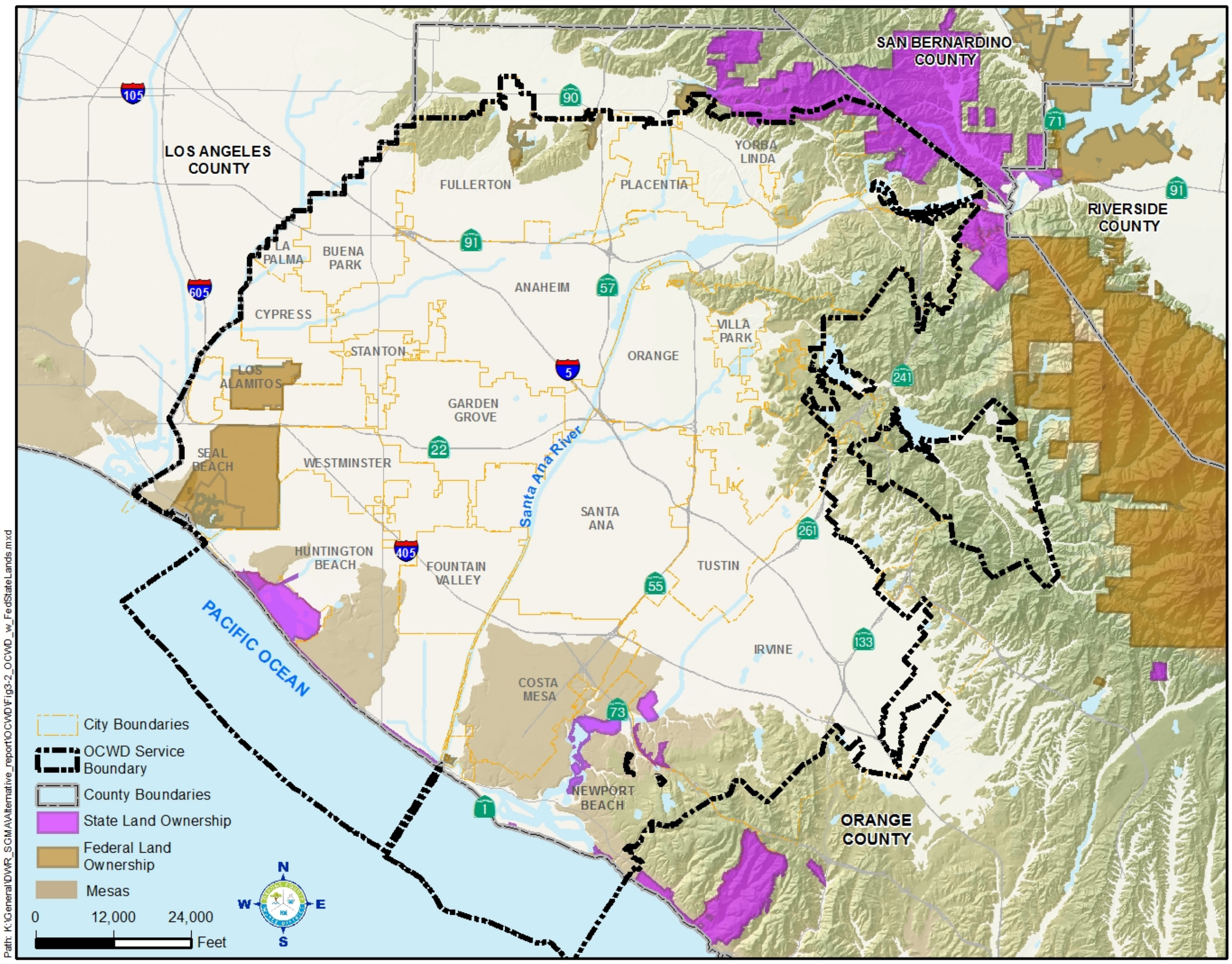


Figure 3-2: Federal and State Lands

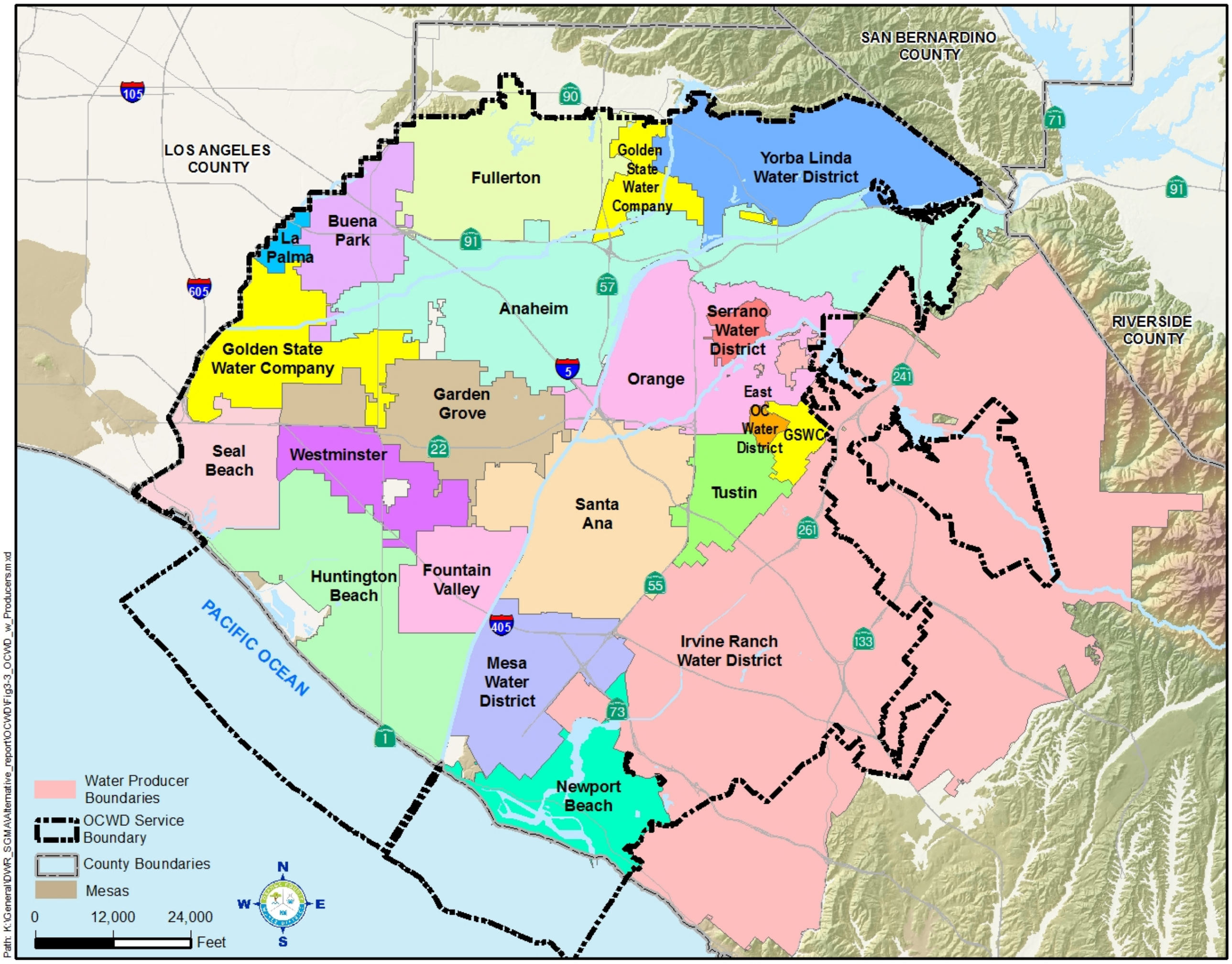


Figure 3-3: Retail Water Supply Agencies

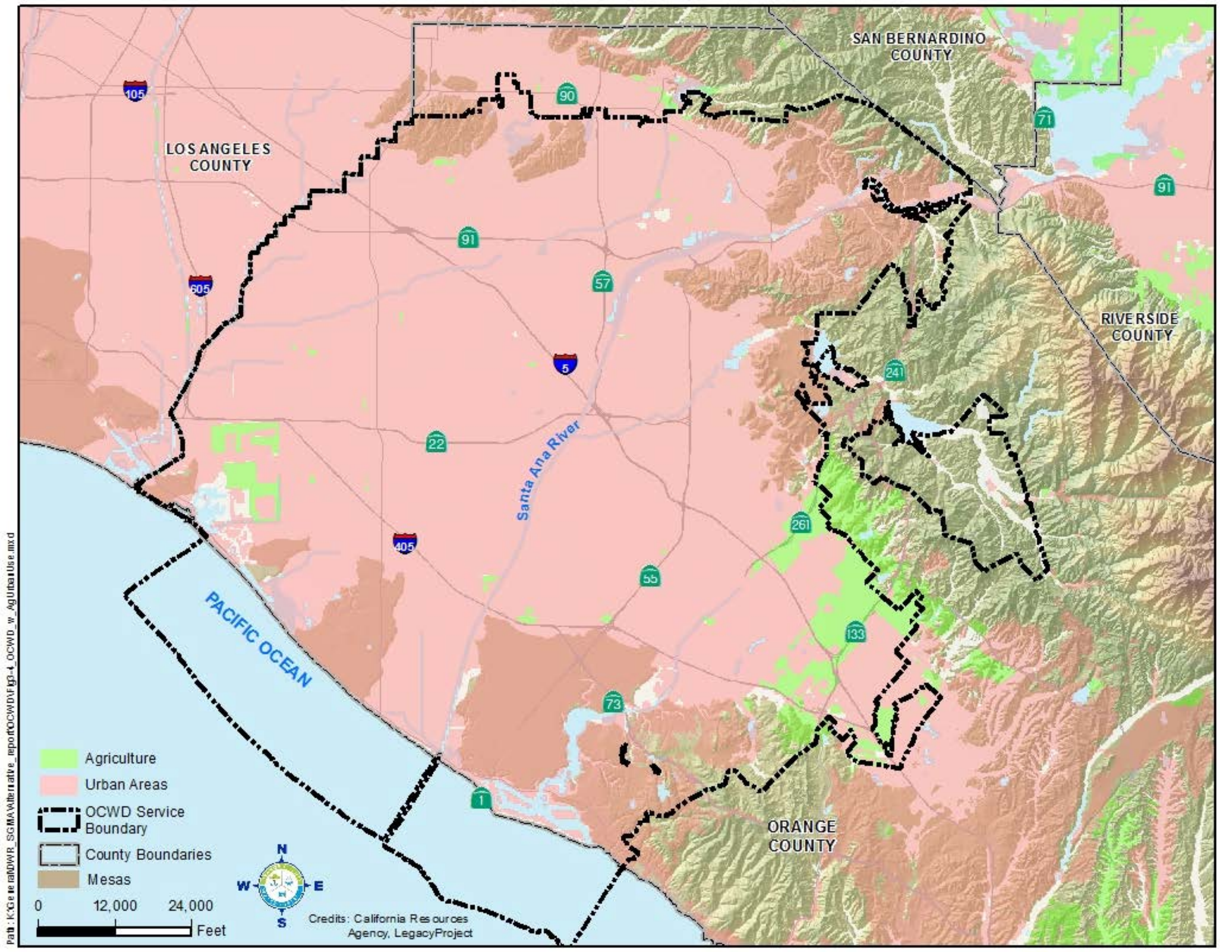


Figure 3-4: Land Uses

3.2 GROUNDWATER CONDITIONS

This section describes the groundwater conditions within the OCWD Management Area. The description includes current and historic groundwater elevation, pumping patterns, storage levels, groundwater quality, historical information concerning land subsidence, seawater intrusion, and interactions between surface water and groundwater. All elevations in this report are in units of feet above mean sea level referenced to vertical datum NGVD29, which can be converted to NAVD88. Geographic locations are reported in GPS State Plane coordinates referenced to NAD83.

3.2.1 Groundwater Elevation Contours

Figures 3-5, 3-6 and 3-7 show the contoured water levels for the Shallow, Principal and Deep Aquifers in June 2016. The contour maps for each of the three aquifer systems are prepared annually. The maps area used to prepare water level change maps for the three major aquifer systems and to calculate the amount of groundwater in storage and the annual storage change.

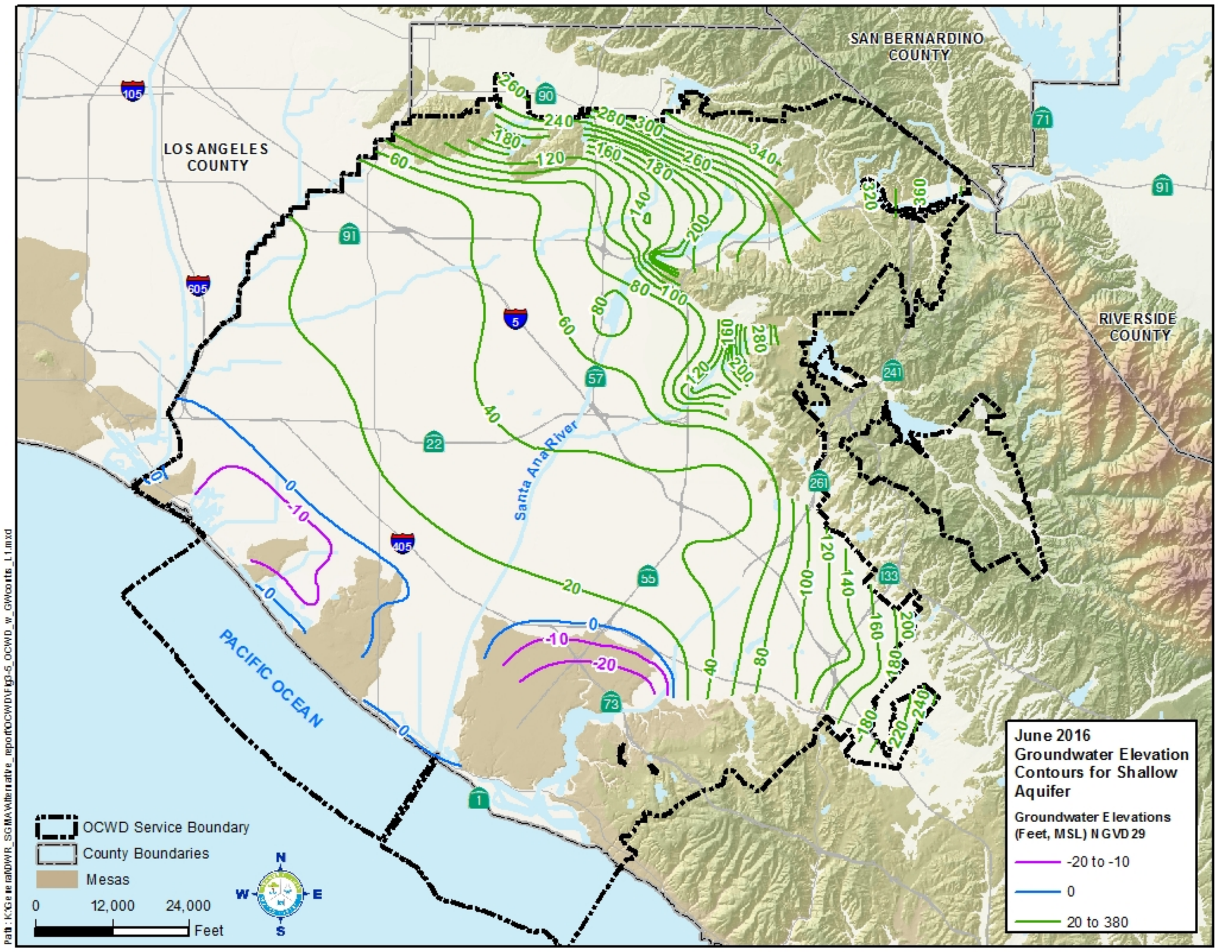


Figure 3-5: Groundwater Elevation Contours for the Shallow Aquifer June 2016

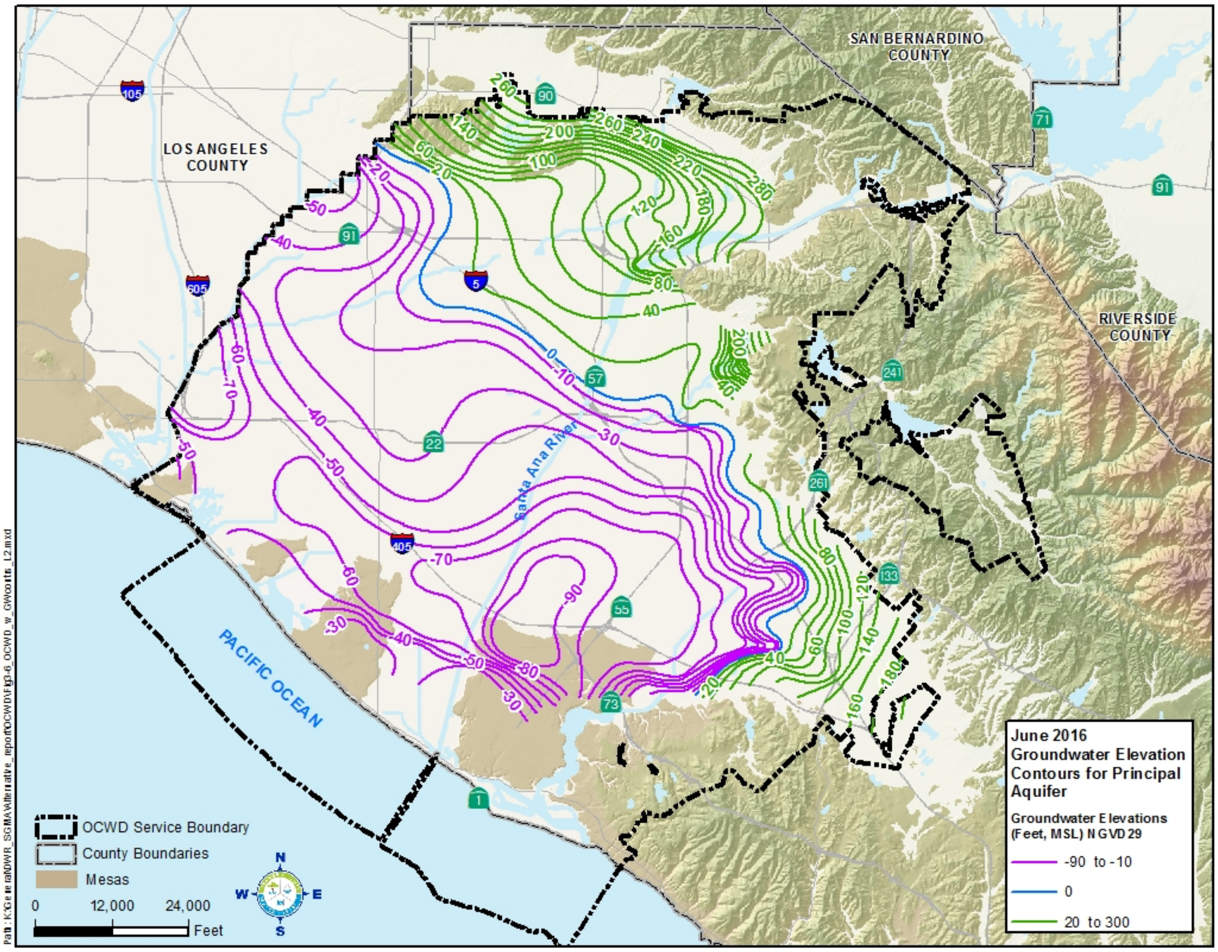


Figure 3-6: Groundwater Elevation Contours for the Principal Aquifer June 2016

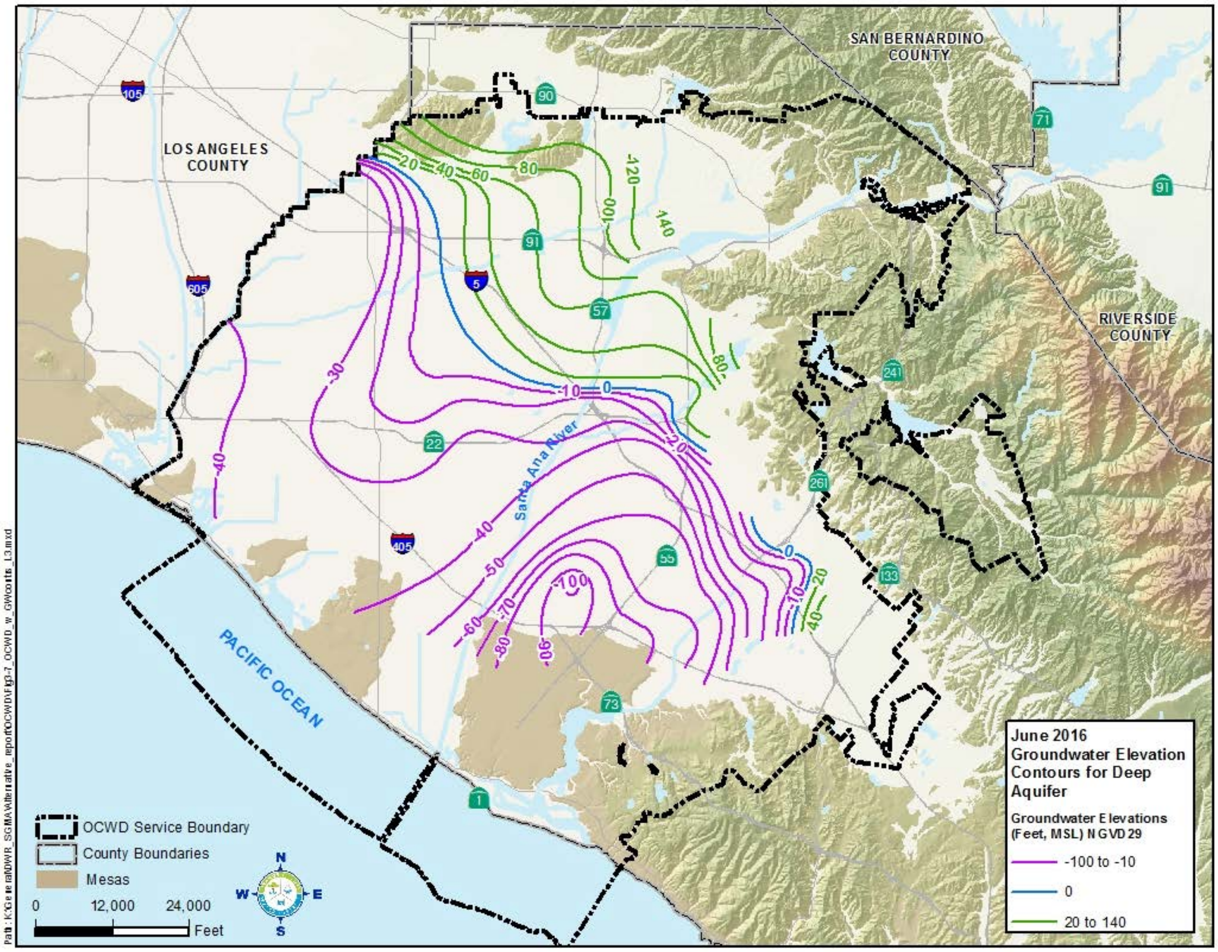


Figure 3-7: Groundwater Elevation Contours for the Deep Aquifer June 2016

3.2.2 Regional Pumping Patterns

Active wells pumping water from the basin are shown in Figure 3-8. The approximately 200 large-system wells account for an estimated 97 percent of the total basin production. The remaining three percent of total basin production includes agricultural and industrial producers, small mutual water companies, domestic well producers, and production from privately-owned wells. As can be seen in Figure 3-8, groundwater production is distributed throughout the productive areas of the basin.

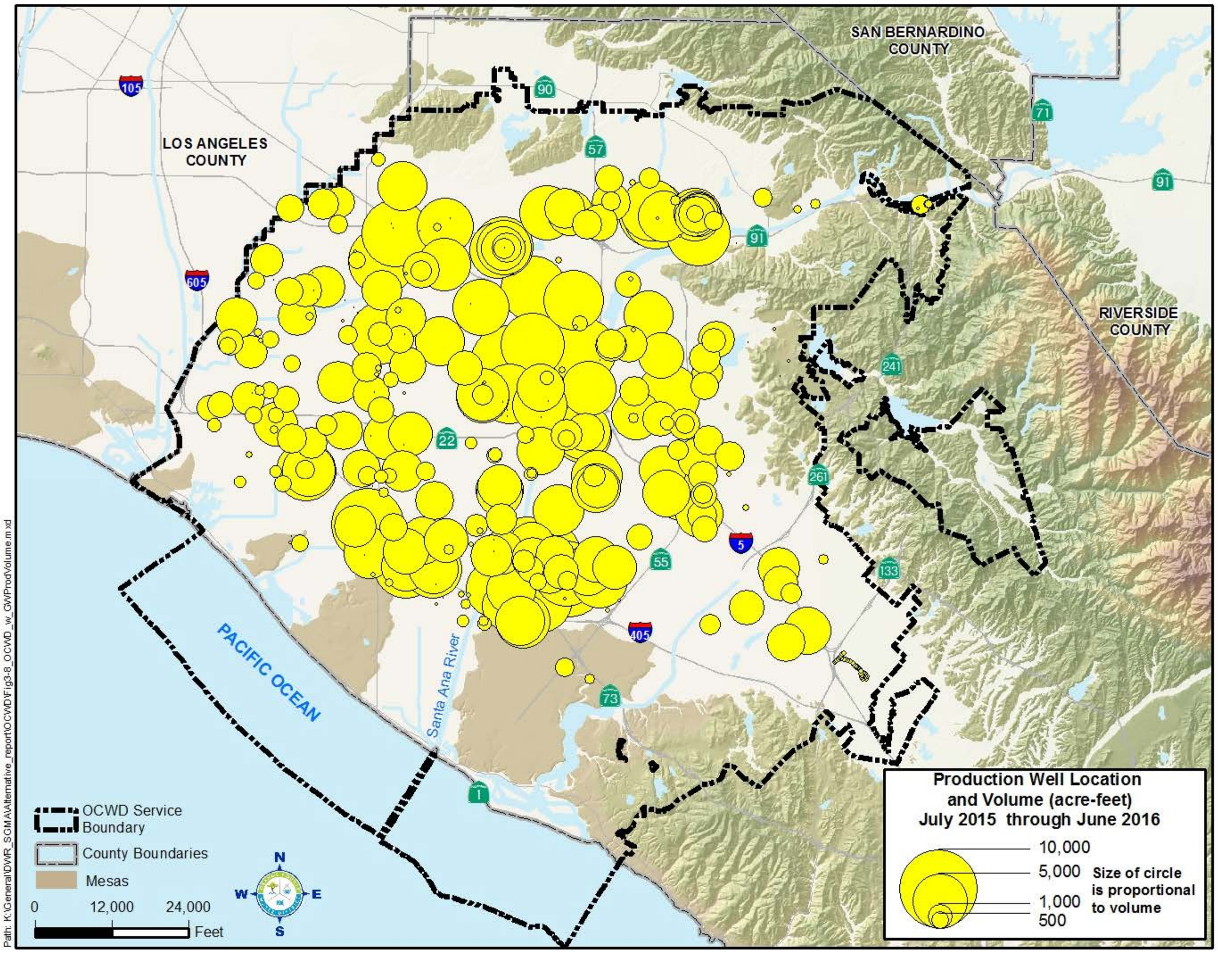


Figure 3-8: Groundwater Production, July 2015 to June 2016

3.2.3 Long-Term Groundwater Elevation Hydrograph

Historical groundwater elevation data within the Orange County groundwater basin dates to the turn of the 20th century and, until the 1980s, is largely derived from measurements of long-screened agricultural and municipal production wells. In the 1950s and 1960s, the United States Geological Survey and DWR conducted focused investigations of seawater intrusion along the coast. These investigations included construction of monitoring wells, some of which are still used today. In 1988, OCWD initiated construction of a basin-wide network of multi-depth monitoring wells which are used to monitor groundwater levels and quality, assess effects of pumping and recharge, estimate groundwater storage, characterize basin hydrogeology, and develop and calibrate a numerical flow model of the basin.

Groundwater elevation trends exhibit both short-term (seasonal) and long-term fluctuations. Seasonal elevation changes reflect short-term variations in pumping and recharge, while multi-year trends reflect the effects of extended periods of above- or below-average precipitation and/or availability of imported water.

OCWD measures elevations in three principal aquifer systems. In general, groundwater elevations in the Shallow Aquifer system show less amplitude than those in the underlying Principal and Deep Aquifer systems due to the higher degree of pumping and confinement of the Principal and Deep Aquifer systems. Because approximately 95 percent of all production occurs from wells screened within the Principal Aquifer system, groundwater elevations within this system are typically lower than those in the overlying Shallow Aquifer system and, in some areas, the underlying Deep Aquifer system. As a result, vertical gradients created by pumping and recharge drive groundwater into the Principal Aquifer system from the overlying Shallow aquifer system and, to a lesser extent, from the Deep Aquifer system.

The groundwater elevation profile for the Principal Aquifer following the Santa Ana River from the ocean to the Forebay in Anaheim, for 1969, 2013, and the theoretical full basin condition are shown in Figure 3-9. A comparison of these profiles shows that groundwater elevations in the Forebay recharge area for all three conditions are similar while in the central and coastal areas of the basin elevations in 2013 are significantly lower. The lowering of coastal area groundwater levels relative to groundwater levels further inland in the Forebay reflects the changes in basin pumping and storage between 1969 and 2013. It also translates into a steeper hydraulic gradient, which drives greater flow from the Forebay to the coastal areas.

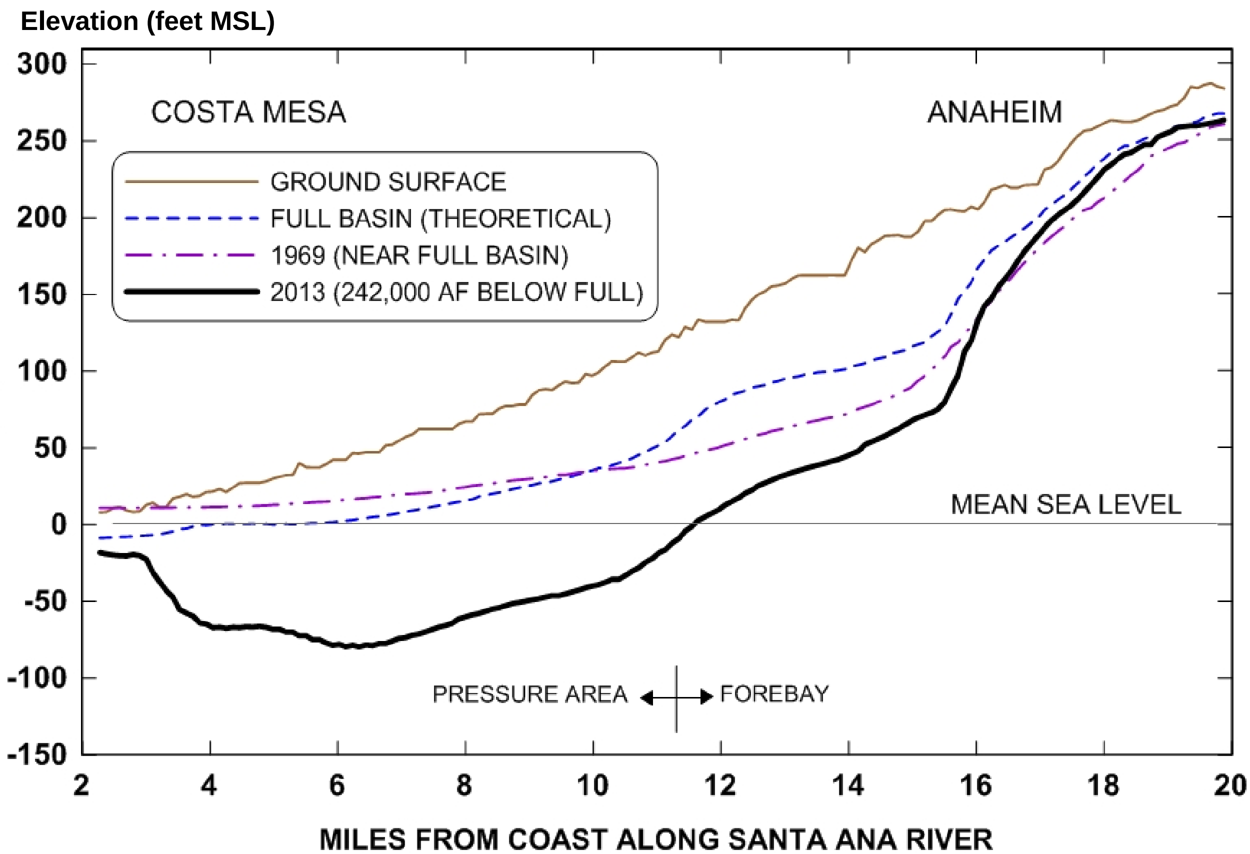


Figure 3-9: Principal Aquifer Groundwater Elevation Profiles, 1969 and 2013

Groundwater elevation trends can be examined using seven wells with long-term groundwater level data, the locations of which are shown in Figure 3-10. Figures 3-11 and 3-12 show water level hydrographs for wells SA-21 and GG-16 representing historical conditions in the Pressure area and well A-27 representing historical conditions in the Forebay. Water level data for well A-27 near Anaheim Lake dates back to 1932 and indicate that the historic low water level in this area occurred in 1951-52. The subsequent replenishment of Colorado River water essentially refilled the basin by 1965. Water levels in this well reached a historic high in 1994 and have generally remained high as recharge has been nearly continuous at Anaheim Lake since the late 1950s.

The hydrograph for well SA-21 indicates that water levels in this area have decreased since 1970. Also noteworthy is the large range of water level fluctuations from the early 1990s to early 2000s. The increased water level fluctuations during this period were due to a combination seasonal water demand-driven pumping and participation in the MWD Short-Term Seasonal Storage Program by local Producers (Boyle Engineering and OCWD, 1997), which encouraged increased pumping from the groundwater basin during summer months when MWD was experiencing high demand for imported water. Although this program did not increase the amount of pumping from the basin on an annual basis, it did result in greater water level declines during the summer during the period of 1989 to 2002 when the program was active.

Figure 3-13 presents water level hydrographs of two OCWD multi-depth monitoring wells, SAR-1 and OCWD-CTG1, showing the relationship between water level elevations in aquifer zones at different depths. The hydrograph of well SAR-1 in the Forebay exhibits a similarity in water levels between shallow and deep aquifers, which indicates the high degree of hydraulic interconnection between aquifers characteristic of much of the Forebay.

The hydrograph of well OCWD-CTG1 is typical of the Pressure Area in that there are large differences in water levels in different aquifers, indicating a reduced level of hydraulic interconnectivity between shallow and deep aquifers caused by fine-grained layers that restrict vertical groundwater flow. Water levels in the deepest aquifer zone at well OCWD-CTG1 are higher than overlying aquifers, in part, because few wells directly produce water from these zones. The lack of production from the deepest aquifers is due to the presences of amber-colored water, the cost to construct very deep wells, and the fact that sufficient high-quality groundwater is readily available within the overlying Principal aquifer.

Two additional hydrographs for wells HBM-1 and IDM-1 show multi-depth water levels representative of the coastal area and the southwestern portion of the management area. The downward trend in water levels at well IDM-1 shows the effects of a water quality improvement project known as the Irvine Desalter Project. This joint project between OCWD and IRWD, in collaboration with the U.S. Department of Navy, went on line in 2006 and consists of production wells, pipelines, and treatment facilities to remove, treat, and put to beneficial use groundwater that contains elevated TDS, nitrate, and/or trichloroethylene. To provide the intended hydraulic containment of this impacted groundwater, lowered groundwater levels in the Irvine area were necessary and expected based on model projections.

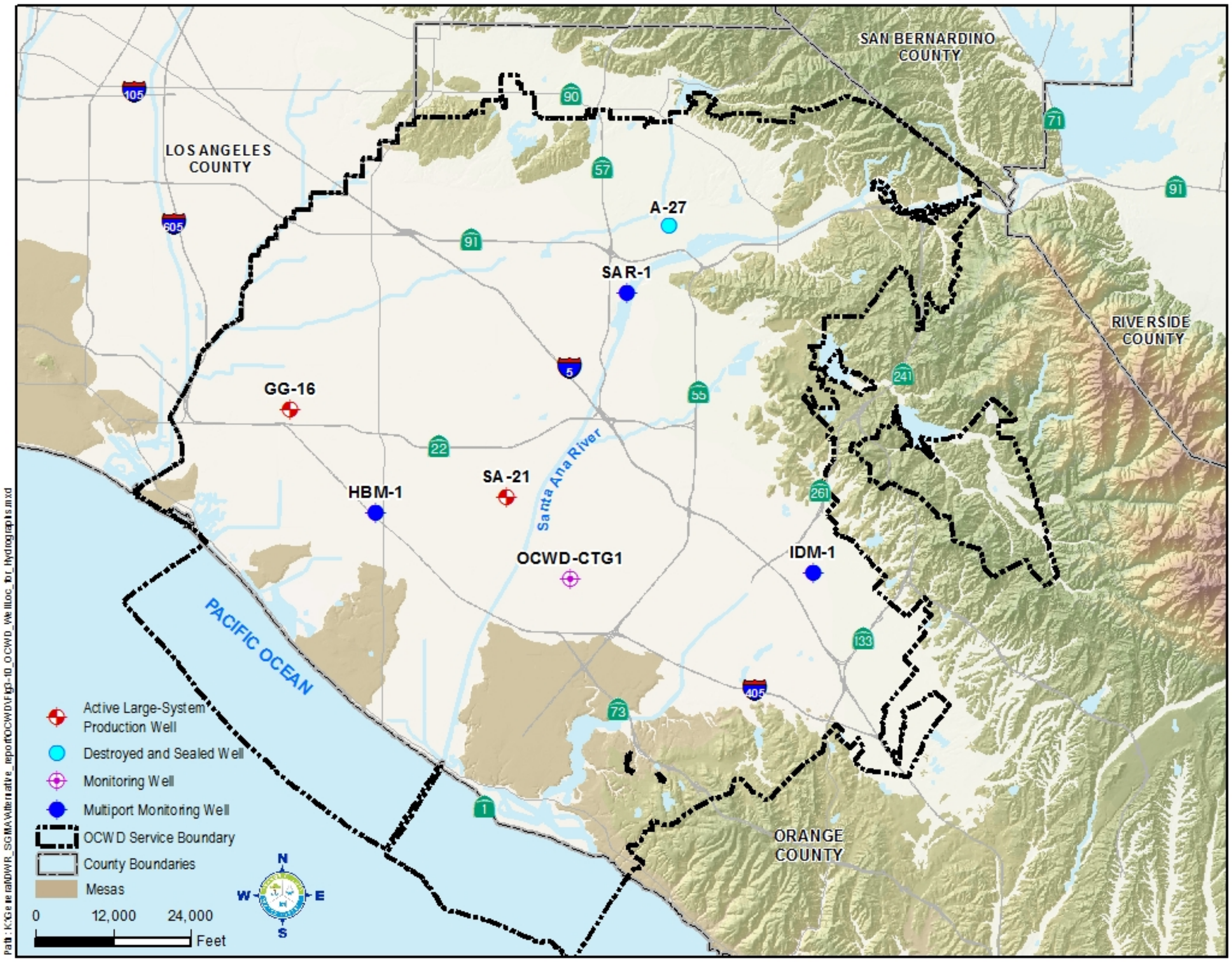
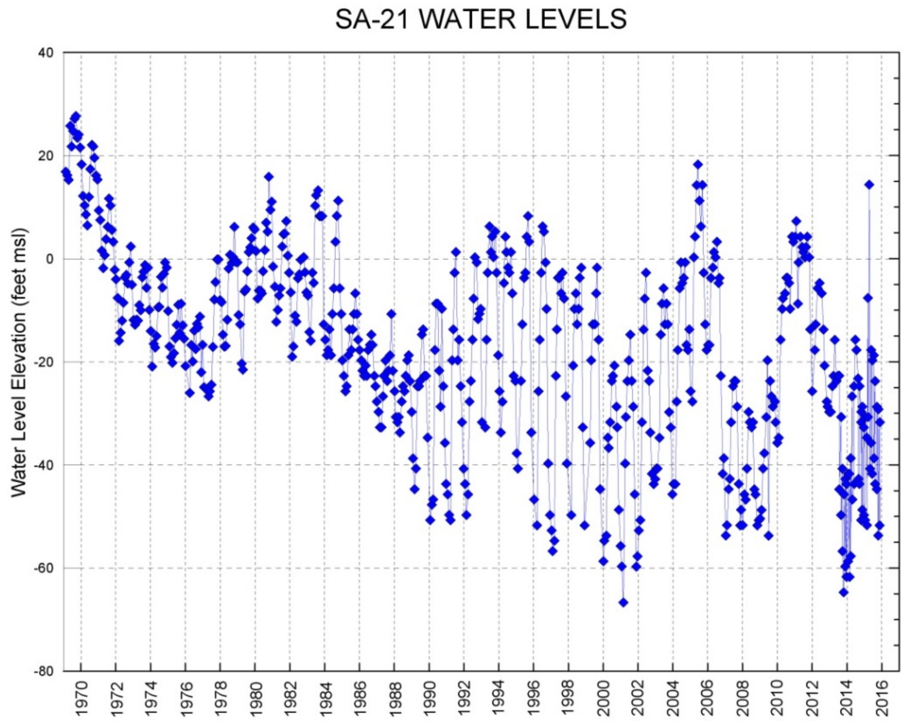


Figure 3-10: Location of Long-Term Groundwater Elevation Hydrographs



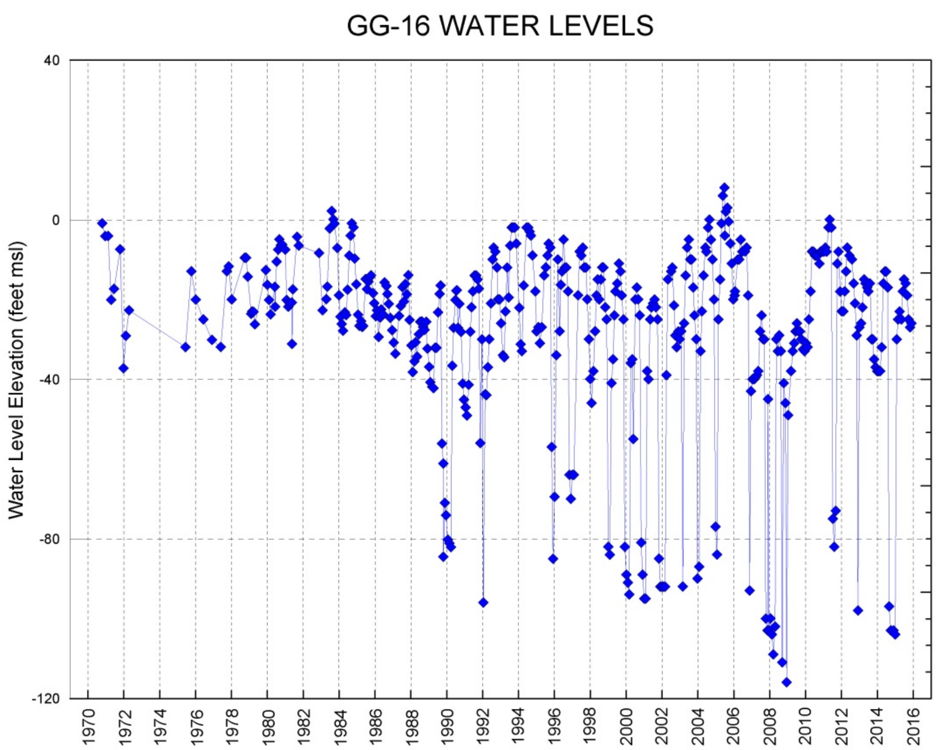


Figure 3-11: Water Level Hydrographs of Wells SA-21 and GG-16 in Pressure Area

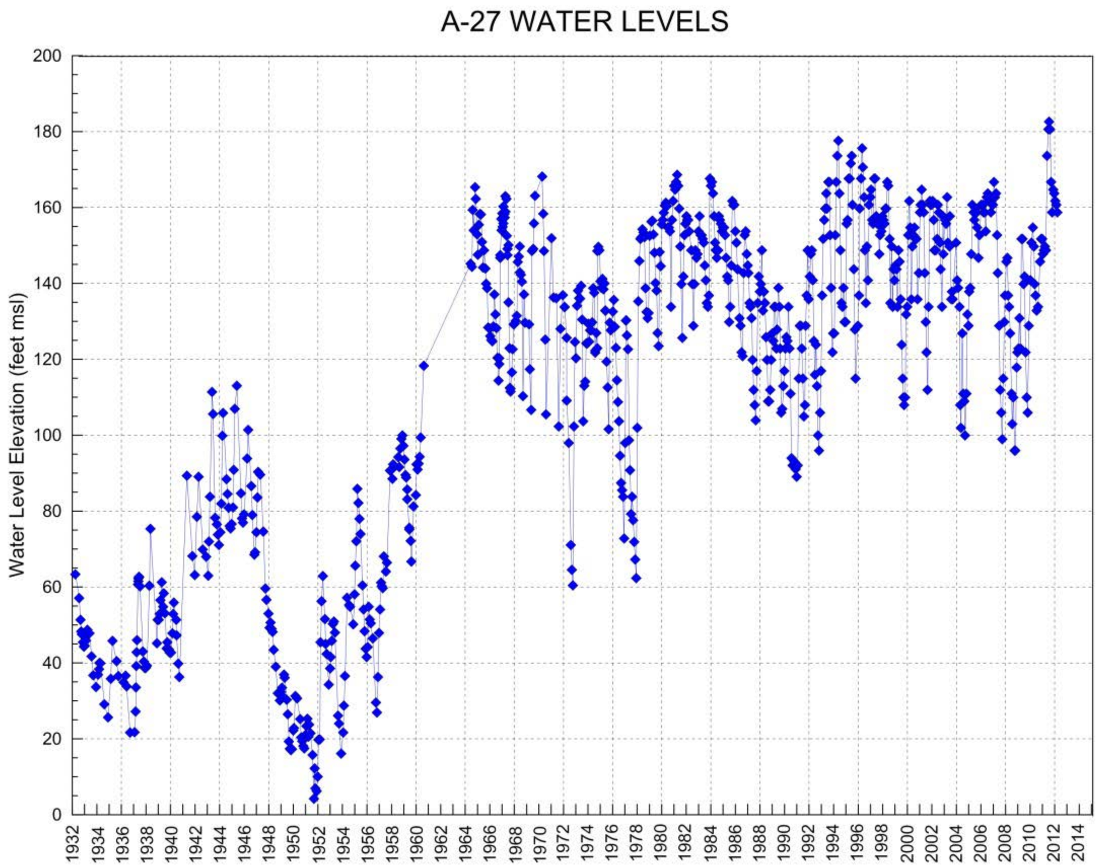


Figure 3-12: Water Level Hydrograph of Well A-27 in Forebay Area

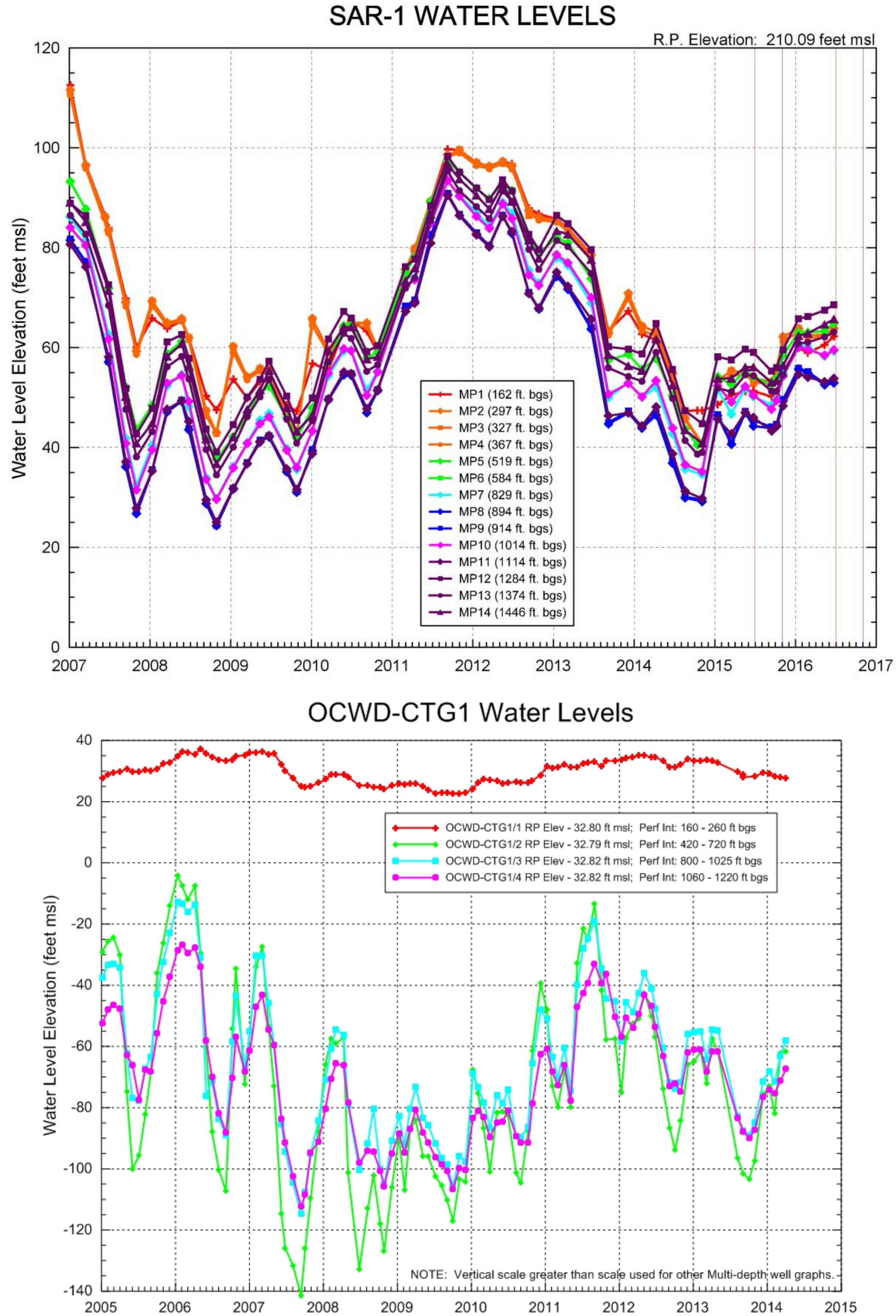


Figure 3-13: Water Level Hydrographs of Wells SAR-1 and OCWD-CTG1

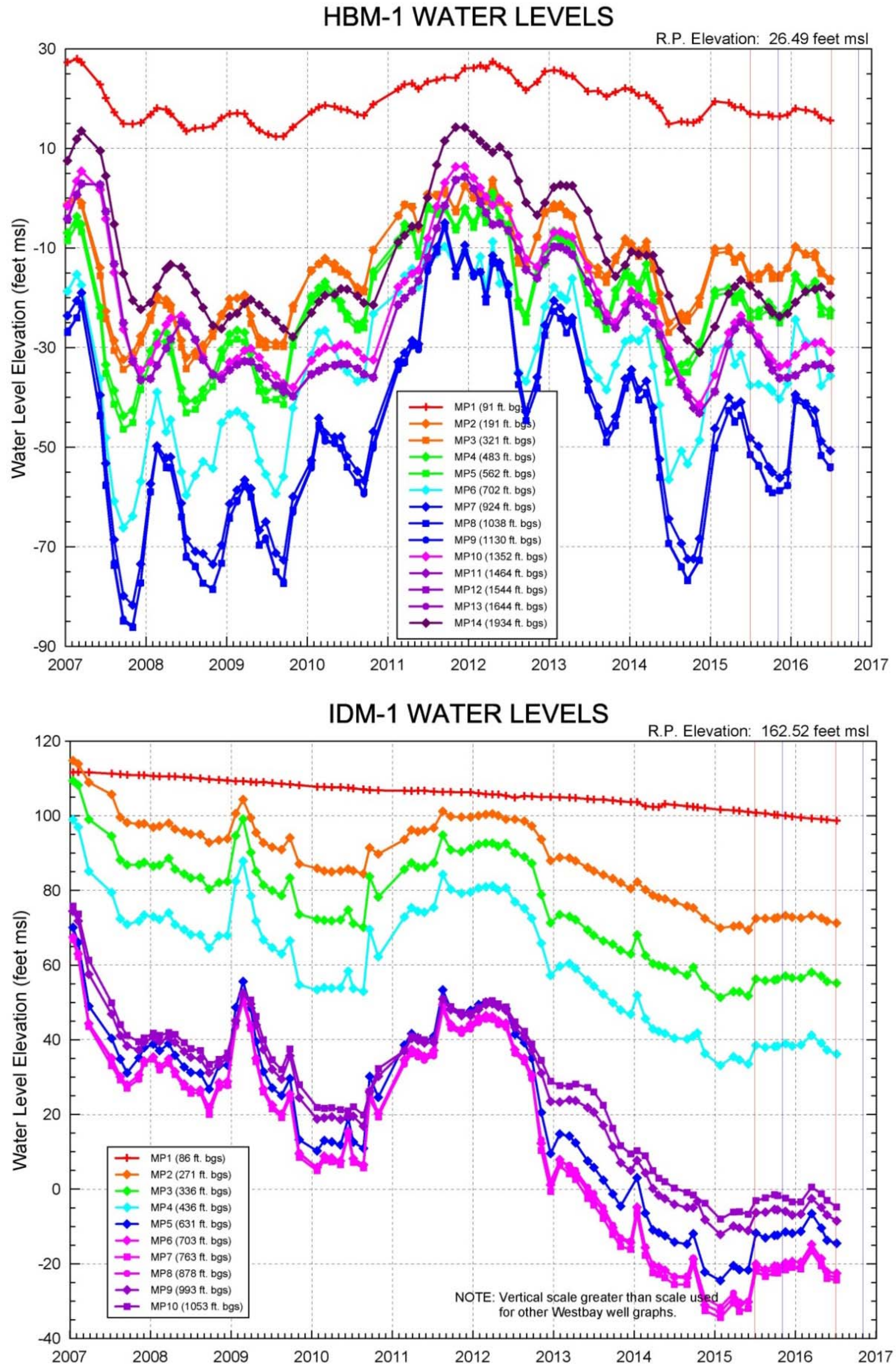


Figure 3-14: Water Level Hydrographs of Wells HBM-1 and IDM-1

3.2.4 Groundwater Storage Data

OCWD operates the basin within an operating range from a full condition to approximately 500,000 acre-feet below full to protect against seawater intrusion, inelastic land subsidence, and other potential undesirable results. On a short-term basis, the basin can be operated at an even lower storage level in an emergency.

In order to manage the basin within this operating range, OCWD calculates the change in storage relative to a full basin condition on an annual basis for the three aquifer layers, an example of which is shown in Figure 3-15. This figure indicates an increase in groundwater in storage from 381,000 acre-feet below full condition in June 2015 to 379,000 acre-feet below full condition in June 2016. In essence, basin storage in June 2015 and June 2016 was almost unchanged, indicating inflows and outflows during that period were virtually balanced, which is not often the case nor necessarily OCWD's goal in any particular year. It is noteworthy that the increase in storage of 2,000 acre-feet is not evenly divided between aquifer layers.

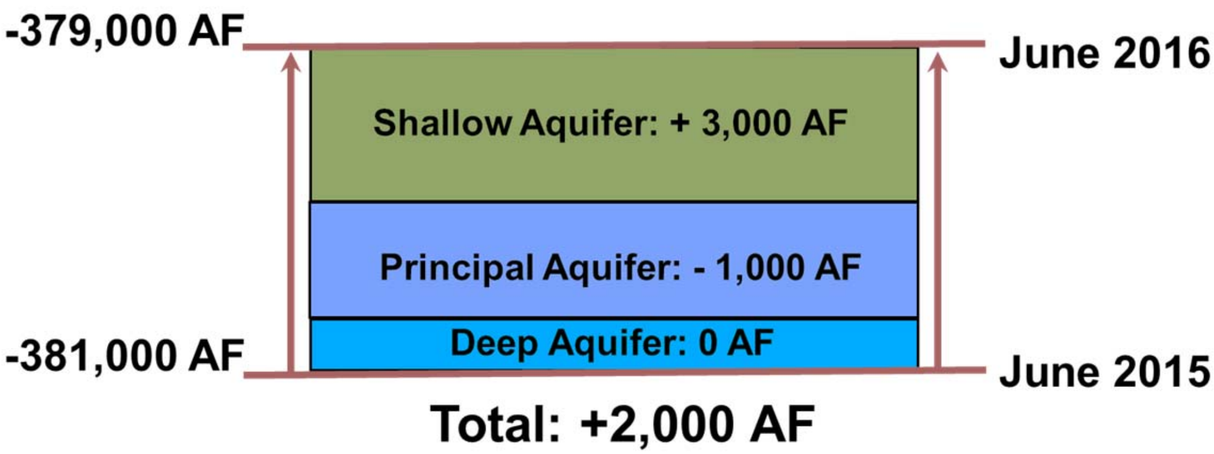


Figure 3-15: Groundwater Storage Level Change, June 2015 to June 2016

3.3 BASIN MODEL

OCWD's basin model encompasses most of Basin 8-1 and extends approximately three miles into the Central Basin in Los Angeles County to provide for more accurate model results than if the model boundary stopped at the county line (see Figure 3-16). The county line is not a hydrogeologic boundary, and groundwater freely flows through aquifers that have been correlated across the county line. The model provides a tool to supplement the storage change calculations that are done each year with actual groundwater elevation data. The model also provides a tool to conduct a wide range of evaluations of proposed projects and operating scenarios.

Coverage of the modeled area is accomplished with grid cells having horizontal dimensions of 500 feet by 500 feet (approximately 5.7 acres) and vertical dimensions ranging from approximately 50 to 1,800 feet, depending on the thickness of each model layer at that grid cell location. Basin aquifers and aquitards are grouped into three composite model layers thought sufficient to describe the three distinguishable flow systems corresponding to the Shallow, Principal, and Deep Aquifers. The three model layers comprise a network of over 90,000 grid cells.

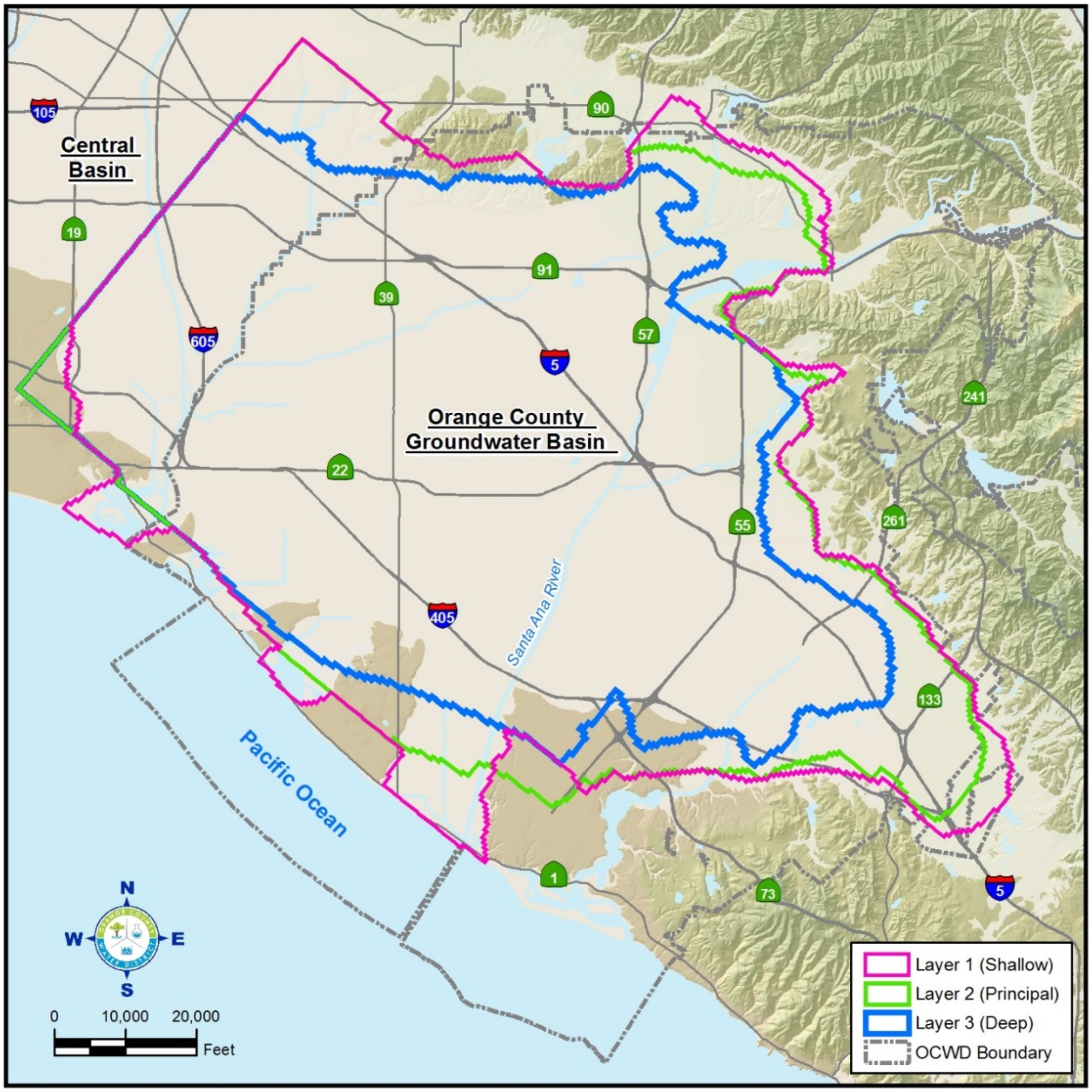


Figure 3-16: Basin Model

The widely-accepted computer program, “MODFLOW,” developed by the USGS, was used as the base modeling code for the mathematical model (McDonald and Harbaugh, 1988). Analogous to an off-the-shelf spreadsheet program needing data to be functional, MODFLOW requires vast amounts of input data to define the hydrogeologic conditions in the conceptual model. The types of information that must be input in digital format (data files) for each grid cell in each model layer include the following:

- Aquifer top and bottom elevations
- Aquifer lateral boundary conditions (ocean, faults, mountains)
- Aquifer hydraulic conductivity and storage coefficient/specific yield
- Initial groundwater surface elevation
- Natural and artificial recharge rates (runoff, precipitation, percolation, injection)
- Groundwater production rates for approximately 200 large system and 200 small system wells

These data originate from hand-drawn contour maps, spreadsheets, and the OCWD Water Resources Management System (WRMS) historical database. Because MODFLOW requires the input of data files in a specific format, staff developed a customized database and GIS program to automate data compilation and formatting functions. These data pre-processing tasks constituted one of the key activities in the model development process.

Before a groundwater model can be reliably used as a predictive tool for simulating future conditions, the model must be calibrated to reach an acceptable match between simulated and actual observed conditions. The basin model was first calibrated to steady-state conditions to numerically stabilize the simulations, to make rough adjustments to the water budget terms, and to generally match regional groundwater flow patterns. Also, the steady-state calibration helped to determine the sensitivity of simulated groundwater levels to changes in incidental recharge and aquifer parameters such as hydraulic conductivity. Steady-state calibration of the basin model is documented in more detail in the *OCWD Master Plan Report* (OCWD, 1999).

Typical transient model output consists of water level elevations at each grid cell that can be plotted as a contour map for one point in time or as a time-series graph at a single location. Post-processing of model results into usable graphics is performed using a combination of semi-automated GIS and database program applications. Figure 3-17 presents a simplified schematic of the modeling process.

Model construction, calibration, and operation were built upon 12 years of effort by OCWD staff to collect, compile, digitize, and interpret hundreds of borehole geologic and geophysical logs, water level hydrographs, and water quality analyses. The process was composed of 10 main tasks comprising over 120 subtasks. The major tasks are summarized as follows:

- Finalize conceptual hydrogeologic model layers and program GIS/database applications to create properly formatted MODFLOW input data files. Over 40 geologic cross sections were used to form the basis of the vertical and lateral aquifer boundaries.
- Define model layer boundaries. The top and bottom elevations of the three aquifer system layers and intervening aquitards were hand-contoured, digitized, and overlain on the model grid to populate the model input arrays with a top and bottom elevation for each layer at every grid cell location. Model layer thickness values were then calculated using GIS.

- Develop model layer hydraulic conductivity (K) grids. Estimates of K for each layer were based on (in order of importance): available aquifer test data, well-specific capacity data, and lithologic data. In the absence of reliable aquifer test or specific capacity data for areas in Layers 1 and 3, lithology-based K estimates were calculated by assigning literature values of K to each lithology type (e.g., sand, gravel, clay) within a model layer and then calculating an effective K value for the entire layer at that well location. Layer 2 had the most available aquifer test and specific capacity data. Therefore, a Layer 2 transmissivity contour map was prepared and digitized, and GIS was used to calculate a K surface by dividing the transmissivity grid by the aquifer thickness grid. Initial values of K were adjusted during model calibration to achieve a better match of model results with known groundwater elevations.
- Develop layer production factors for active production wells simulated in the model. Many production wells had long screened intervals that spanned at least two of the three model layers. Therefore, groundwater production for each of these wells had to be divided among each layer screened by use of layer production factors. These factors were calculated using both the relative length of screen within each model layer and the hydraulic conductivity of each layer. Well production was then multiplied by the layer factors for each individual well. For example, if a well had a screened interval equally divided across Layers 1 and 2, but the hydraulic conductivity of Layer 1 was twice that of Layer 2, then the calculated Layer 1 and 2 production factors for that well would have been one-third and two-thirds, respectively, such that when multiplied by the total production for this well, the production assigned to Layer 1 would have been twice that of Layer 2. For the current three-layer model, approximately 25 percent of the production wells in the model were screened across more than one model layer. In this context, further vertical refinement of the model (more model layers) may better represent the aquifer architecture in certain areas but may also increase the uncertainty and potential error involved in the amount of production assigned to each model layer.
- Develop basin model water budget input parameters, including groundwater production, artificial recharge, and unmeasured recharge. Groundwater production and artificial recharge volumes were applied to grid cells in which production wells or recharge facilities were located. The most uncertain component of the water budget – unmeasured or incidental recharge – was applied to the model as an average monthly volume based on estimates calculated annually for the OCWD *Engineer's Report*. Unmeasured recharge was distributed to cells throughout the model, but was mostly applied to cells along margins of the basin at the base of the hills and mountains. The underflow component of the incidental recharge represents the amount of groundwater flowing into and out of the model along open boundaries. Prescribed groundwater elevations were assigned to open boundaries along the northwest model boundary in Los Angeles County; the ocean at the Alamitos, Bolsa, and Talbert Gaps; the mouth of the Santa Ana Canyon; and the mouth of Santiago Creek Canyon. Groundwater elevations for the boundaries other than the ocean boundaries were based on historical groundwater elevation data from nearby wells. The model automatically calculated the dynamic flow across these open boundaries as part of the overall water budget.
- Develop model layer storage coefficients. Storage coefficient values for portions of model layers representing confined aquifer conditions were prepared based on available aquifer test data and were adjusted within reasonable limits based on calibration results.
- Develop vertical leakage parameters between model layers. Vertical groundwater flow between aquifer systems in the basin is generally not directly measured, yet it is one of the critically-important factors in the model's ability to represent actual basin hydraulic processes. Using geologic cross-sections and

depth-specific water level and water quality data from the OCWD multi-depth monitoring well network, staff identified areas where vertical groundwater flow between the modeled aquifer systems is either likely to occur or be significantly impeded, depending on the relative abundance and continuity of lower-permeability aquitards between model layers. During model calibration, the initial parameter estimates for vertical leakage were adjusted to achieve closer matches to known vertical groundwater gradients.

- Develop groundwater contour maps for each model layer to be used for starting conditions and for visual comparison of water level patterns during calibration. Staff used observed water level data from multi-depth and other wells to prepare contour maps of each layer for November 1990 as a starting point for the calibration period. Care was taken to use wells screened within the appropriate vertical interval representing each model layer. The hand-drawn contour maps were then digitized and used as model input to represent starting conditions.
- Perform transient calibration runs. The nine-year period of November 1990 to November 1999 was selected for transient calibration, as it represented the period corresponding to the most detailed set of groundwater elevation, production, and recharge data. The transient calibration process and results are described in the next section.
- Perform various basin production and recharge scenarios using the calibrated model. Criteria for pumping and recharge, including facility locations and quantities, were developed for each scenario and input for each model run.

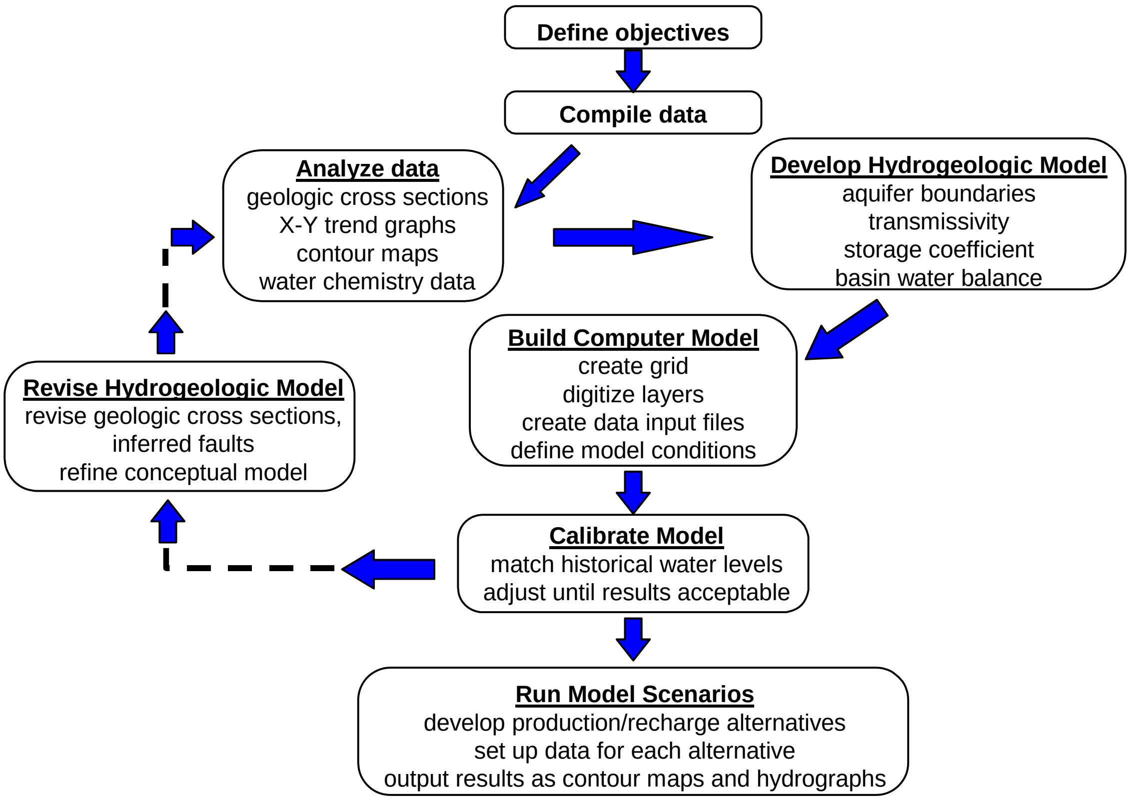


Figure 3-17: Model Development Flowchart

Model Calibration

Calibration of the transient basin model involved a series of simulations of the period 1990 to 1999, using monthly flow and water level data. The time period selected for calibration represents a period during which basic data required for monthly transient calibration were essentially complete (compared to pre-1990 historical records). The calibration period spans at least one "wet/dry" rainfall cycle. Monthly water level data from almost 250 target locations were used to determine if the simulated water levels adequately matched observed water levels. As shown in Figure 3-18, the calibration target points were densely distributed throughout the basin and also covered all three model layers.

After each model run, a hydrograph of observed versus simulated water levels was created and reviewed for each calibration target point. In addition, a groundwater elevation contour map for each layer was also generated from the simulated data. The simulated groundwater contours for all three layers were compared to interpreted contours of observed data (November 1997) to assess closeness of fit and to qualitatively evaluate whether the simulated gradients and overall flow patterns were consistent with the conceptual hydrogeologic model. November 1997 was chosen for the observed versus simulated contour map comparison since these hand-drawn contour maps had already been created for the prior steady state calibration step. Although

November 1997 observed data were contoured for all three layers, the contour maps for Layers 1 and 3 were somewhat more generalized than for Layer 2 due to a lower density of data points (wells) in these two layers.

Depending on the results of each calibration run, model input parameters were adjusted, including hydraulic conductivity, storage coefficient, boundary conditions, and recharge distribution. Time-varying head boundaries along the Orange County/Los Angeles County line were found to be extremely useful in obtaining a close fit with observed historical water levels in the northwestern portion of the model.

Fifty calibration runs were required to reach an acceptable level of calibration in which model-generated water levels were within reasonable limits of observed water level elevations during the calibration period. Figures 3-19 through 3-21 show examples of hydrographs of observed versus simulated water levels for three wells used as calibration targets.

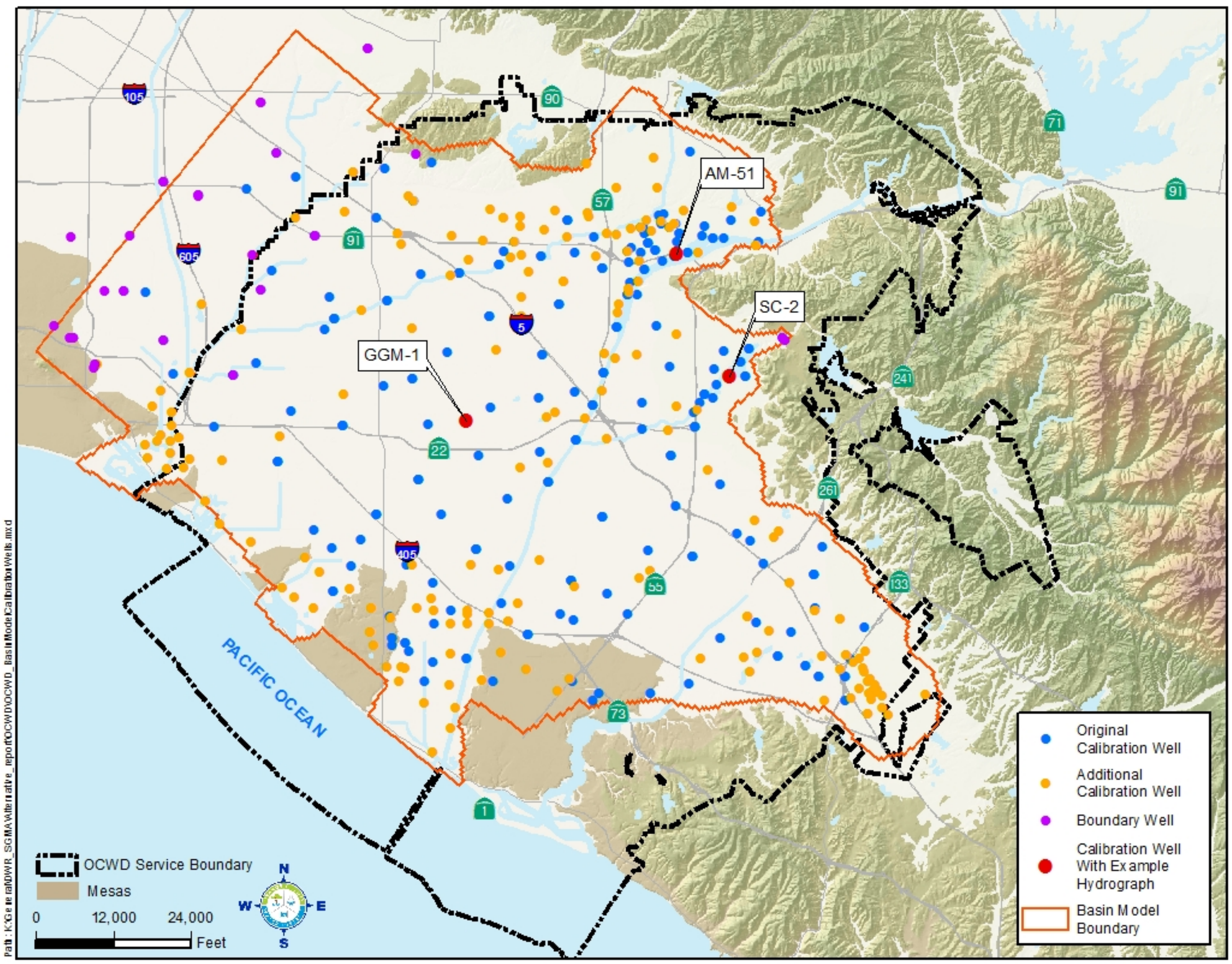


Figure 3-18: Basin Model Calibration Wells

Noteworthy findings of the model calibration process are summarized below:

- The model was most sensitive to adjustments to hydraulic conductivity and recharge distribution. In other words, minor variations in these input parameters caused significant changes in the model water level output.
- The model was less sensitive to changes in storage coefficient, requiring order-of-magnitude changes in this parameter to cause significant changes in simulated water levels, primarily affecting the amplitude of seasonal water level variations.
- The vast amount of observed historical water level data made it readily evident when the model was closely matching observed conditions.
- Incidental (unmeasured) recharge averaging approximately 70,000 afy during the 1990-1999 period appeared to be reasonable, as the model was fairly sensitive to variations in this recharge amount.
- Groundwater outflow to Los Angeles County was estimated to range between 5,000 and 12,000 afy between 1990 and 1999, most of this occurring in Layers 1 and 3.
- Groundwater flow at the Talbert Gap was inland during the entire model calibration period, indicating moderate seawater intrusion conditions. Model-derived seawater inflow ranged from 500 to 2,700 afy in the Talbert Gap and is consistent with chloride concentration trends during the calibration period that indicated inland movement of saline groundwater in these areas.
- Model-derived groundwater inflow from the ocean at Bolsa Gap was only 100-200 afy due to the Newport-Inglewood Fault zone, which offsets the Bolsa aquifer and significantly restricts the inland migration of saline water across the fault.
- Model adjustments (mainly hydraulic conductivity and recharge) in the Santiago Basins area in Orange significantly affected simulated water levels in the coastal areas.
- Model reductions to the hydraulic conductivity of Layer 2 (Principal Aquifer) along the Peralta Hills Fault in Anaheim/Orange had the desired effect of steepening the gradient and restricting groundwater flow across the fault into the Orange area. These simulation results were consistent with observed hydrogeologic data indicating that the Peralta Hills Fault acts as a partial groundwater barrier.
- Potential unmapped faults immediately downgradient from the Santiago Basins appear to restrict groundwater flow in the Principal Aquifer, as evidenced by observed steep gradients in that area, which were reproduced by the model. As with the Peralta Hills Fault, an approximate order-of-magnitude reduction in hydraulic conductivity along these suspected faults achieved the desired effect of reproducing observed water levels with the model.

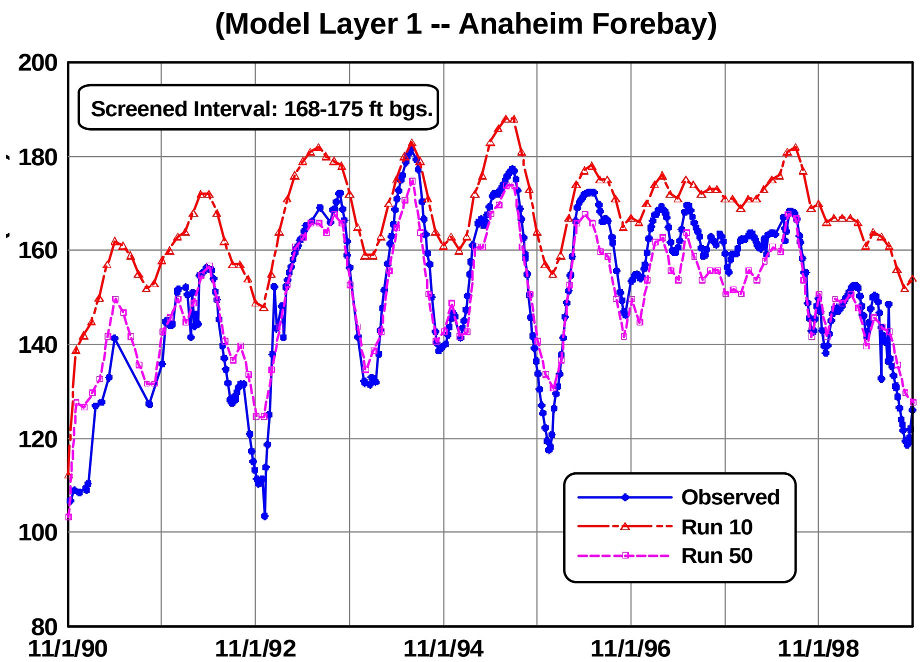


Figure 3-19: Calibration Hydrograph of Monitoring Well AM-5A

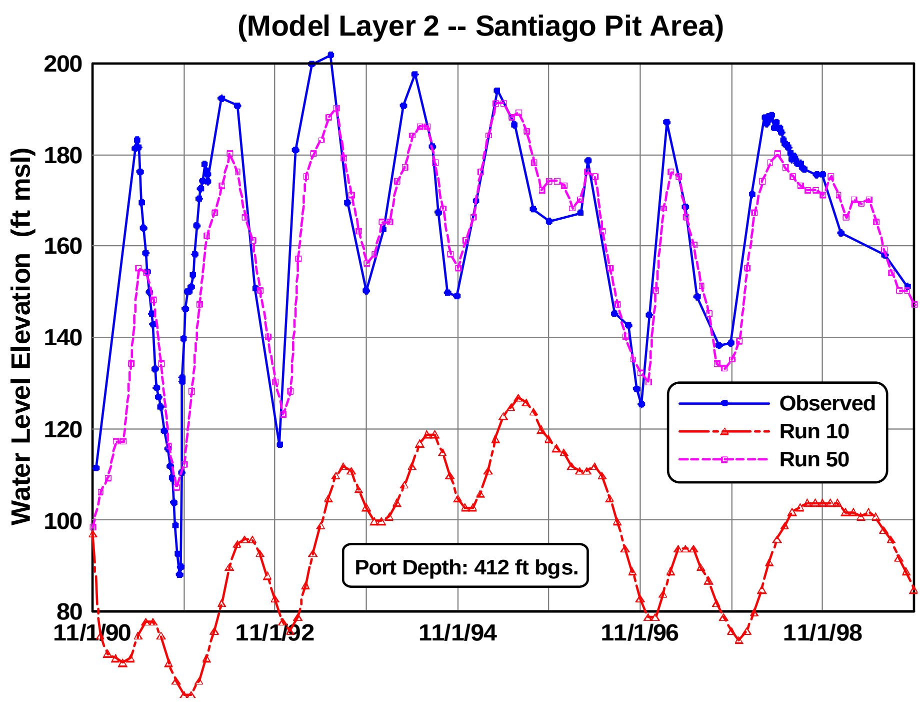


Figure 3-20: Calibration Hydrograph for Monitoring Well SC-2

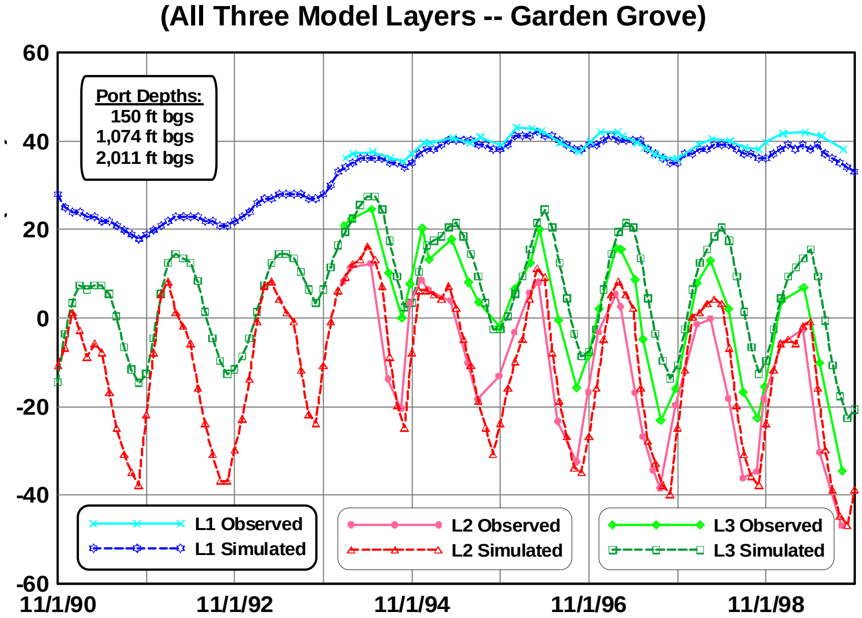


Figure 3-21: Calibration Hydrograph for Monitoring Well GGM-1

Groundwater Model Update and Applications

OCWD staff update the basin groundwater model approximately every three to five years, guided by new information, e.g. new wells in critical areas, warranting the effort or by needed model evaluations using the most recent years, e.g., estimating the groundwater outflow to Los Angeles County. Major changes and improvements over the past five years include:

1. Model conversion from UNIX to PC using the Groundwater Vistas as the Graphical User Interface.
2. Extension of the model transient calibration through WY 2010-11. The new calibration period is November 1990 to June 2011 which includes a wide range of basin storage conditions as well as a wide range of hydrologic conditions.
3. Addition of several new Talbert Barrier injection wells and the addition of two new recharge basins, La Jolla and Miraloma Basins.

Typical applications of the Basin Model include estimating the effects of potential future pumping and recharge projects on groundwater levels, storage, and the water budget. The storage coefficients determined during the original Basin Model calibration are also used to estimate annual change in groundwater storage.

Other applications of the Basin Model were related to operation of the Talbert Seawater Barrier. The first was to guide the planning, location and hydraulic effectiveness of supplemental injection wells for the Talbert Barrier. The second was to estimate the general flow paths and subsurface residence time of barrier injection water to delineate the Talbert Barrier's recycled water retention buffer area.

3.3.1 Groundwater Quality Conditions

Salinity

At the state level, the State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards have authority to manage TDS in water supplies. The salinity management program for the Santa Ana River Watershed is implemented by the Basin Monitoring Program Task Force (Task Force), a group comprised of water districts, wastewater treatment agencies and the Regional Water Board. OCWD is a member of the Task Force.

Historical ambient or baseline conditions were calculated for levels of total dissolved solids (TDS) and nitrate-nitrogen in each of the 39 groundwater management zones in the watershed. Management Zones within the OCWD Management Area are shown in Figure 3-22. The water quality objectives for TDS and ambient water quality levels for the two zones within the OCWD Management Area are shown in Table 3-1.

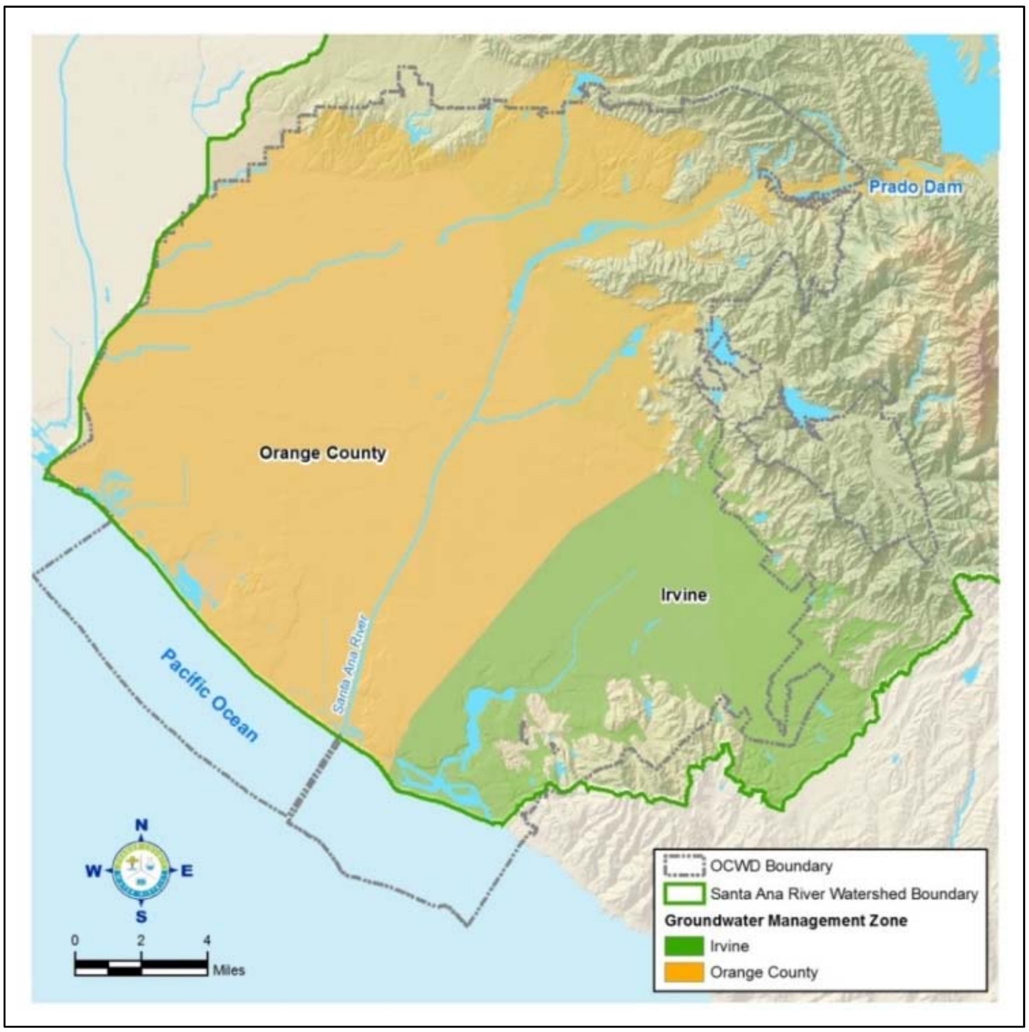


Figure 3-22: Groundwater Management Zones

Table 3-1: TDS Water Quality Objectives for Lower Santa Ana River Basin Management Zones

Management Zone	Water Quality Objective	2012 Ambient Quality
Orange County	580 mg/L	610 mg/L
Irvine	910 mg/L	940 mg/L

(Wildermuth, 2014)

Figure 3-23 shows the average TDS at production wells in the basin for calendar years 2011 to 2015 as well as data available in early 2016. In general, the portions of the basin with the highest TDS levels are located in Irvine, Tustin, Yorba Linda, Anaheim, and Fullerton. There is a broad area in the middle portion of the basin where the TDS generally ranges from 500 to 700 mg/L.

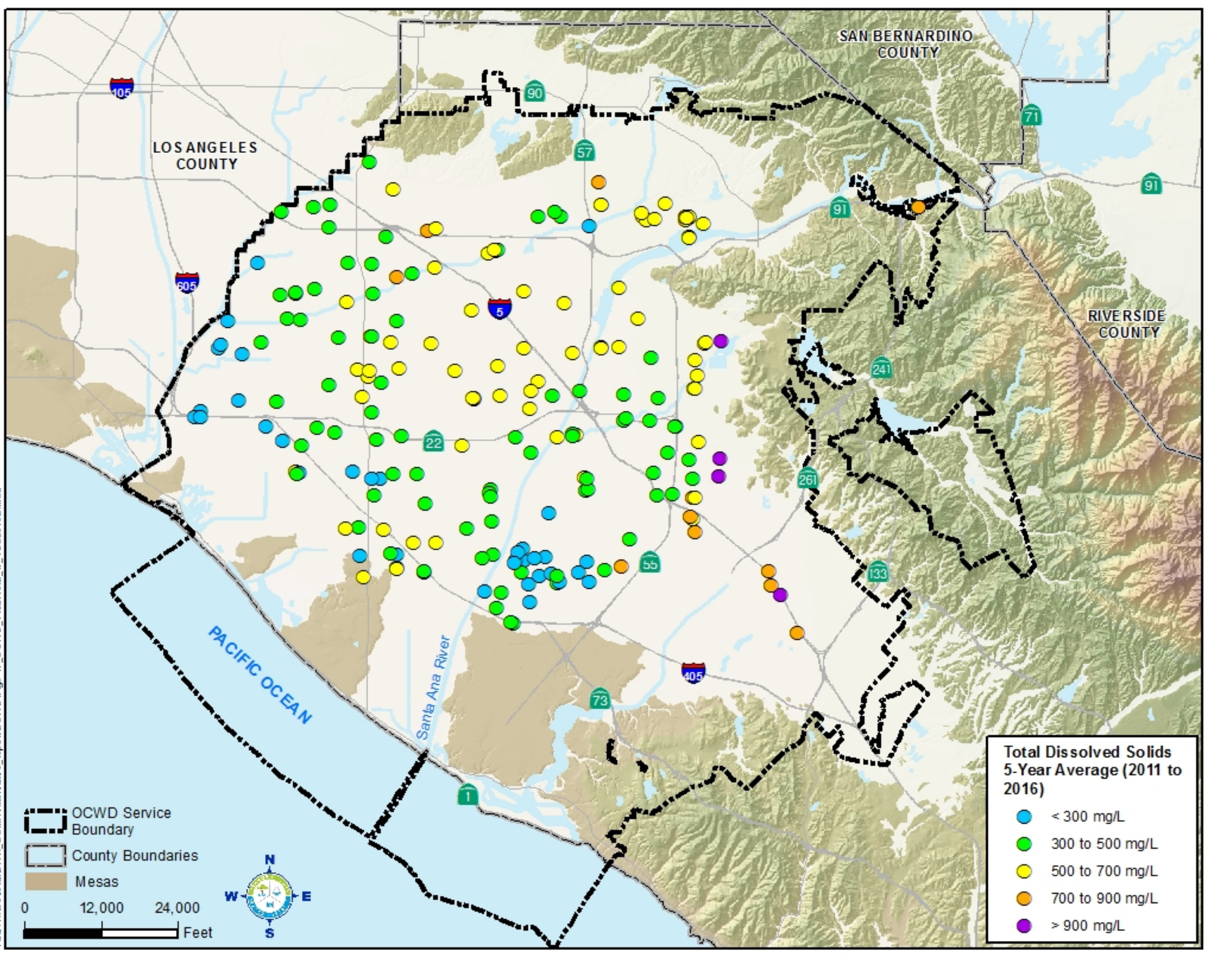


Figure 3-23: TDS in Groundwater Production Wells, 5-year average

Nitrate

Management of nitrate is a component of the salinity management program in the Santa Ana River Watershed. Along with TDS objectives, water quality objectives for nitrate-nitrogen are established for each of the 39 groundwater management zones in the watershed. Water quality objectives and ambient quality levels for the zones within the OCWD Management Area are shown in Table 3-2.

Figure 3-24 shows the 5-year average nitrate-nitrogen levels in production wells for calendar years 2011 to 2015, as well as data available in early 2016. This figure displays data for 306 production wells. Of these 306 wells, twelve exceeded the primary MCL for nitrate-nitrogen of 10 mg/L at least once during the five year period. In cases where pumped groundwater exceeds the MCL, the groundwater producer treats the water to reduce nitrate-nitrogen levels prior to being served to customers.

Table 3-2: Nitrate-nitrogen Water Quality Objective for Lower Santa Ana River Basin Management Zones

Management Zone	Water Quality Objective	Ambient Quality
Orange County	3.4 mg/L	2.9 mg/L
Irvine	5.9 mg/L	6.7 mg/L

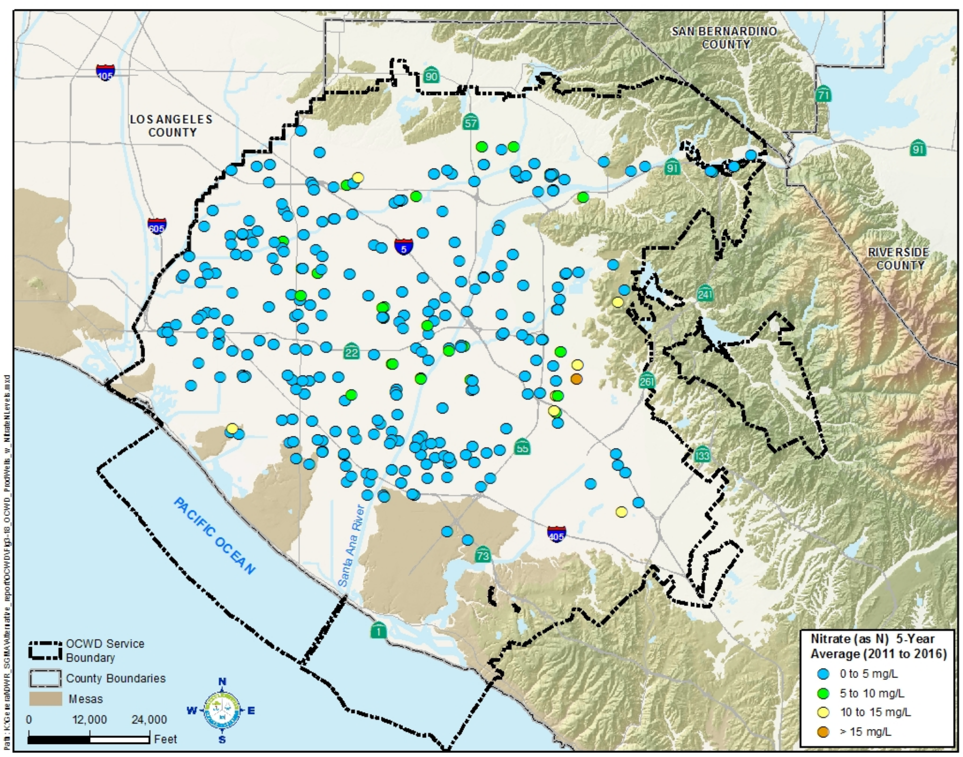


Figure 3-24: Nitrate (as N) Levels in Groundwater Production Wells, 5-year average

Contamination Plumes

Major groundwater contamination sites within the OCWD Management Area include areas where contamination has migrated significantly beyond the contamination sources and threaten the water quality of the underlying groundwater. These plumes, shown in Figure 3-25 are in the process of being remediated.

The North Basin VOC plume area contains contaminated groundwater primarily in the Shallow Aquifer, which is generally less than 200 feet deep with some migration downward into the Principal Aquifer. OCWD is performing a remedial investigation/feasibility study (RI/FS) under the oversight of the U.S. EPA and working with regulatory agencies and stakeholders to evaluate and develop effective remedies to address the contamination under the National Contingency Plan process. The U.S. EPA is the lead agency for this North Basin Groundwater Protection Project (NBGPP).

The South Basin plume area contains VOCs and perchlorate. OCWD has collected data to assist with delineating the plumes. OCWD is performing an RI/FS in consultation with the Regional Water Board, Department of Toxic Substances Control, and stakeholders to evaluate and develop effective remedies to address the contamination under the National Contingency Plan process, designated as the South Basin Groundwater Protection Project (SBGPP).

The U.S. Navy is taking the lead in remediation of three groundwater contamination plumes of VOCs in the vicinity of the former El Toro Marine Corps Air Station (MCAS), former Tustin MCAS, and the Naval Weapons Station Seal Beach.

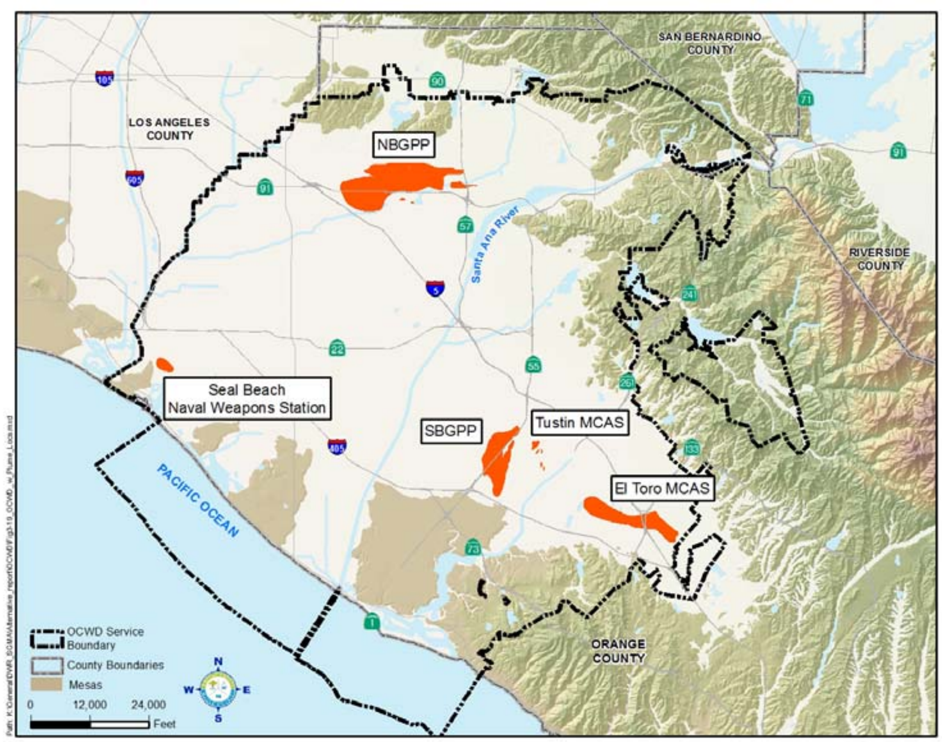


Figure 3-25: Groundwater Contamination Plume Locations

3.3.2 Coastal Gaps

In the coastal area of Orange County, the primary source of saline groundwater is seawater intrusion into the basin through permeable aquifer sediments underlying topographic lowlands or gaps between the erosional remnants or mesas of the Newport-Inglewood Uplift. The susceptible locations from north to south are the Alamitos, Sunset, Bolsa, and Talbert gaps as shown in Figure 3-26.

Alamitos Gap was formed primarily from the ancestral San Gabriel River which carved its way to the ocean as the surrounding hills were contemporaneously being uplifted. Similarly, Bolsa Gap and Talbert Gap were carved by two different paths of the ancestral Santa Ana River as the surrounding mesas were being uplifted by the Newport-Inglewood Fault.

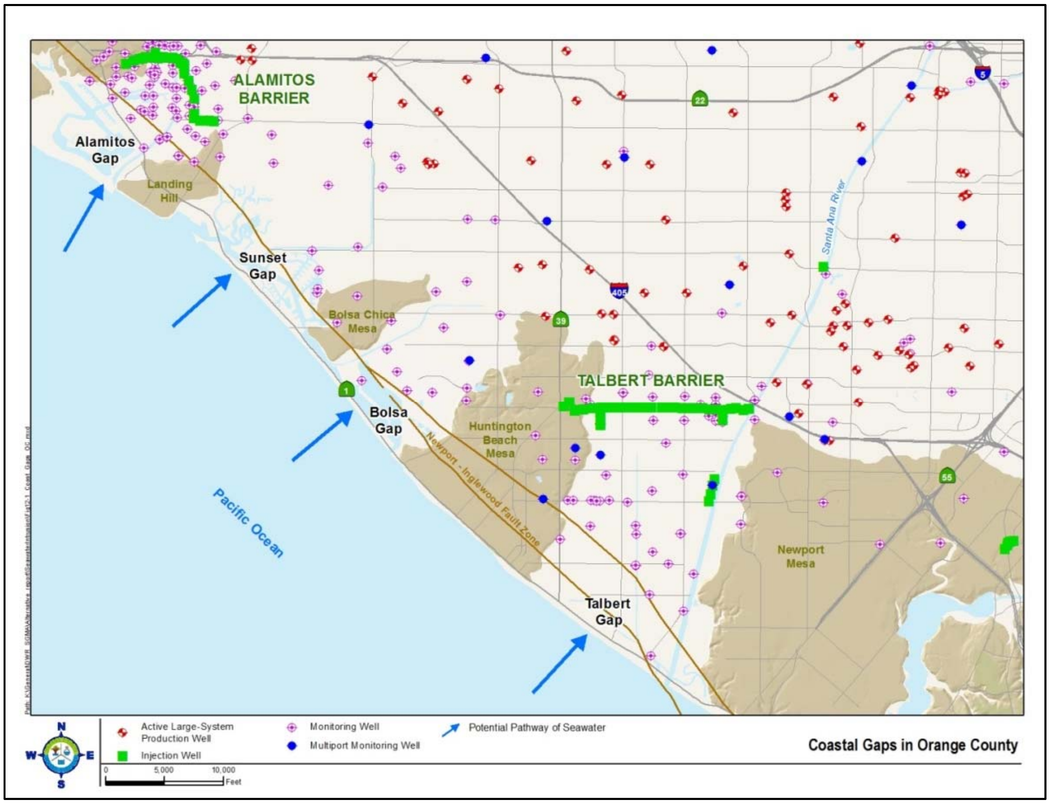


Figure 3-26: Orange County Coastal Gaps

Over Recent geologic time (within the last 12,000 years), the Santa Ana River meandered its way across what is now coastal Orange County reaching as far west as the San Gabriel River. These rivers deposited relatively coarse sands and gravels in their paths and were then subsequently buried with less permeable sediments as sea levels rose coming out of the last ice age. Therefore, in these three gaps, these relatively young river deposits formed permeable aquifers connecting to the Pacific Ocean and thus are the primary conduits for inland migration of seawater, namely the recent aquifer in Alamitos Gap, the Bolsa aquifer in Bolsa Gap, and the Talbert aquifer in Talbert Gap.

In the Alamitos and Talbert gaps, the permeable Recent and Talbert aquifers, respectively, have not been appreciably folded or offset by the Newport-Inglewood Fault Zone due to their geologically young age. Therefore, these shallow aquifers are relatively horizontal, continuous, and in direct hydraulic connection with the Pacific Ocean.

As compared to the Alamitos and Talbert gaps, the permeable Recent deposits forming the Bolsa aquifer in the Bolsa Gap are slightly older and thus are thought to be more offset by the Newport-Inglewood Fault Zone as evidenced by well logs and groundwater level and quality data. Groundwater quality trends (primarily chloride concentrations) from monitoring wells in Bolsa Gap indicate that the Newport-Inglewood Fault Zone restricts groundwater flow and thus impedes the inland migration of seawater.

In the Alamitos, Bolsa, and Talbert gaps, the shallow river-deposited aquifers are locally merged with deeper Upper Pleistocene aquifers, thus providing an avenue for seawater intrusion within the shallow aquifers to migrate vertically downward via these mergence zones into deeper aquifers tapped by production wells further inland.

Sunset Gap is not considered to be an erosional gap carved by a river but rather is a wider and more gradual topographic lowland resulting from a mild dip in the underlying strata. Therefore, Sunset Gap lacks a laterally extensive permeable shallow aquifer comprised of river deposits continuous to the ocean as in the other three gaps discussed above.

OCWD regularly reviews hydrogeologic data, including water quality data, to evaluate the extent of seawater intrusion. In 2016, OCWD documented an updated comprehensive evaluation of the extent of seawater intrusion along the Orange County coast within the OCWD Management Area. The Technical Memorandum, *Summary of Seawater Intrusion in Orange County* (OCWD, 2016a). This report contains detailed descriptions of coastal aquifers, monitoring networks and programs, operation of seawater intrusion barriers, barrier groundwater models, an evaluation of the current extent of seawater intrusion, and descriptions of future plans to protect the water quality of the groundwater basin.

3.3.3 Land Subsidence

In Orange County, subsidence in swampy low-lying coastal areas underlain by shallow organic peat deposits started as early as 1898 when development of these areas for agriculture resulted in excavation of unlined drainage ditches. The ditches drained the swamps and intercepted the shallow water table which was lowered sufficiently to allow the land to drain adequately for irrigated agriculture. When the shallow water table was lowered, it exposed the formerly-saturated peat deposits to oxygen that caused depletion and shrinkage of the peat due to oxidation (Fairchild and Wiebe, 1976).

Subsidence related to shallow peat deposits was associated with land development practices that occurred in Orange County in the late 1800s and early 1900s and, as such, is not something associated with or controlled by groundwater withdrawals in the basin. Another documented cause of subsidence in Orange County unrelated to groundwater basin utilization is oil extraction along the coast, particularly in Huntington Beach (Morton et al., 1976).

Subsidence due to changes in groundwater conditions in the Orange County groundwater basin is variable and does not show a pattern of widespread irreversible permanent lowering of the ground surface. Storage conditions in the groundwater basin were at historical lows in the mid-1950s, but since this time OCWD has operated the groundwater basin within a storage range above this historical low. There are reports that some subsidence may have occurred before OCWD began refilling the groundwater basin in the late 1950s (Morton, et al., 1976); however, the magnitude and scope of this subsidence is uncertain, and it is not clear if this subsidence was permanent. As such, there is no evidence of permanent, inelastic land subsidence in the OCWD Management Area (see Section 13) and future subsidence is not expected as long as OCWD continues to manage basin storage above the historic low observed in the late 1950s.

3.3.4 Groundwater/Surface Water Interactions and Groundwater Dependent Ecosystems

Frequent and destructive flooding of the Santa Ana River in Orange County was the impetus for construction of the Prado Dam in 1941. Prior to the construction of flood control facilities, the banks of the Santa Ana River naturally overflowed periodically and flooded broad areas of Orange County as seen in Figure 3-27. Coastal marshes were inundated during winter storms, and the mouth of the river moved both northward and southward of its present location. In the days before flood control, surface water naturally percolated into the groundwater basin, replenishing groundwater supplies.

Subsequent flood protection efforts included construction of levees along the river and concrete-lined bottoms along portions of the river. Flood risk was reduced, increased pumping of groundwater lowered water levels, and low-lying areas were filled in and/or equipped with drains, pumps and other flood control measures to allow for urban development. Since at least the 1950s, groundwater levels throughout the OCWD Management Area have been low enough that the rising and lowering of groundwater levels do not impact surface water flows or ecosystems.

Although it is outside the OCWD Management Area (within the Santa Ana Canyon Management Area described later), it is noted that from Prado Dam to Imperial Highway, the wide soft-bottomed Santa Ana River channel supports riparian habitats. Riparian habitat is dependent on river water released through Prado Dam, which is predominantly treated wastewater discharged in the upper watershed when storm flow is not present. In aggregate, this stretch is generally considered to be in equilibrium between surface water and groundwater based on available stream gage and groundwater level data, although some infiltration may occur due to minor groundwater pumping in the Santa Ana Canyon Management Area.

As the Santa Ana River enters the OCWD Management Area, from Imperial Highway to 17th Street in Santa Ana, there is minimal riparian habitat, and the river is a losing reach with engineered facilities to infiltrate surface water into groundwater basin. OCWD conducts recharge operations within the soft-bottomed river channel except for a portion of the river where the Riverview Golf Course occupies the river channel. The river levees are constructed of either rip-rap or concrete.

From 17th Street to near Adams Avenue in Costa Mesa, the river channel is concrete-lined for flood control with vertical to sloping concrete side walls and a concrete bottom as shown in Figure 3-38. From Adams Avenue to the coast, the channel has vertical concrete side walls or rip-rap for flood control and a soft bottom. Estuary conditions within the concrete channel exist at the mouth of the river where the ocean encroaches at high tide. The tidal prism extends from the ocean approximately three miles inland to the Adams Avenue Bridge.

There are no surface water bodies within the boundaries of the OCWD Management Area that are dependent on groundwater. Therefore, there are no groundwater-dependent ecosystems issues in the OCWD Management Area.

Some areas in the basin experience relatively high groundwater levels due to perched groundwater where shallow groundwater is impeded from flowing into deeper groundwater by a layer of low-permeable clay or silt, known as an aquitard. Except in very low-lying areas near sea level, the high groundwater is not close enough to the surface to support hydrophilic vegetation. OCWD carefully monitors water levels in the vicinity of the Talbert Seawater Barrier in order to maintain injection well rates to assure that groundwater levels do not rise to levels that could threaten urban infrastructure.

Figure 3-27: Santa Ana River in Orange County,1938
Courtesy of the Anaheim Public Library

Figure 3-28: Santa Ana River
View upstream from Talbert Avenue Bridge in Fountain Valley. The portion of the river here has both concrete levees and bottom.

SECTION 4 WATER BUDGET

OCWD developed a hydrologic budget (inflows and outflows) for the purpose of constructing a basin-wide groundwater flow model, (Basin Model) and for evaluating basin production capacity and recharge requirements. The key components of the budget include measured and unmeasured (estimated) recharge, groundwater production, and subsurface flows along the coast and across the Orange County/Los Angeles County line. Because the basin is not operated on an annual safe-yield basis, the net change in storage in any given year may be positive or negative; however, over the long-term, the basin is operated within the established operating range. The components of the water budget are described below. OCWD's water year (WY) begins on July 1 and ends on June 30.

4.1 WATER BUDGET COMPONENTS

4.1.1 Measured Recharge

Measured recharge consists of all water artificially recharged at OCWD's surface water recharge facilities and water injected in the Talbert and Alamitos Barriers. The majority of measured recharge occurs in the District's surface water system, which receives Santa Ana River baseflow and storm flow, GWRS recycled water, and imported water.

4.1.2 Unmeasured Recharge

Unmeasured recharge also referred to as "incidental recharge" accounts for a significant amount of the basin's recharge, particularly in wet periods. This includes recharge from precipitation, irrigation return flows, urban runoff, seawater inflow through the gaps as well as subsurface inflow at the basin margins along the Chino, Coyote, and San Joaquin hills and the Santa Ana Mountains, and beneath the Santa Ana River and Santiago Creek. Subsurface inflow beneath the Santa Ana River and Santiago Creek refers to groundwater that enters the basin at the mouth of Santa Ana Canyon and in the Santiago Creek drainage below Villa Park Dam. Estimated average subsurface inflow to the basin is shown in Figure 4-1.

OCWD has estimated total unmeasured recharge between 20,000 and 160,000 afy. Net unmeasured or incidental recharge is the amount of incidental recharge remaining in the basin after accounting for underflow losses to Los Angeles County. Under average hydrologic conditions, net incidental recharge averages 62,000 acre-feet per year. This average was substantiated during calibration of the Basin Model and is also consistent with the estimate of 58,000 afy reported by Hardt and Cordes (1971) as part of a USGS modeling study of the basin. Because unmeasured recharge is one of the least understood components of the basin's water budget, the error margin for any given year is likely in the range of 10,000 to 20,000 acre-feet. Since unmeasured recharge is well distributed throughout the basin, the physical significance (e.g., water level drawdown or mounding in any given area) of overestimating or underestimating the total recharge volume within this error margin is considered to be minor.

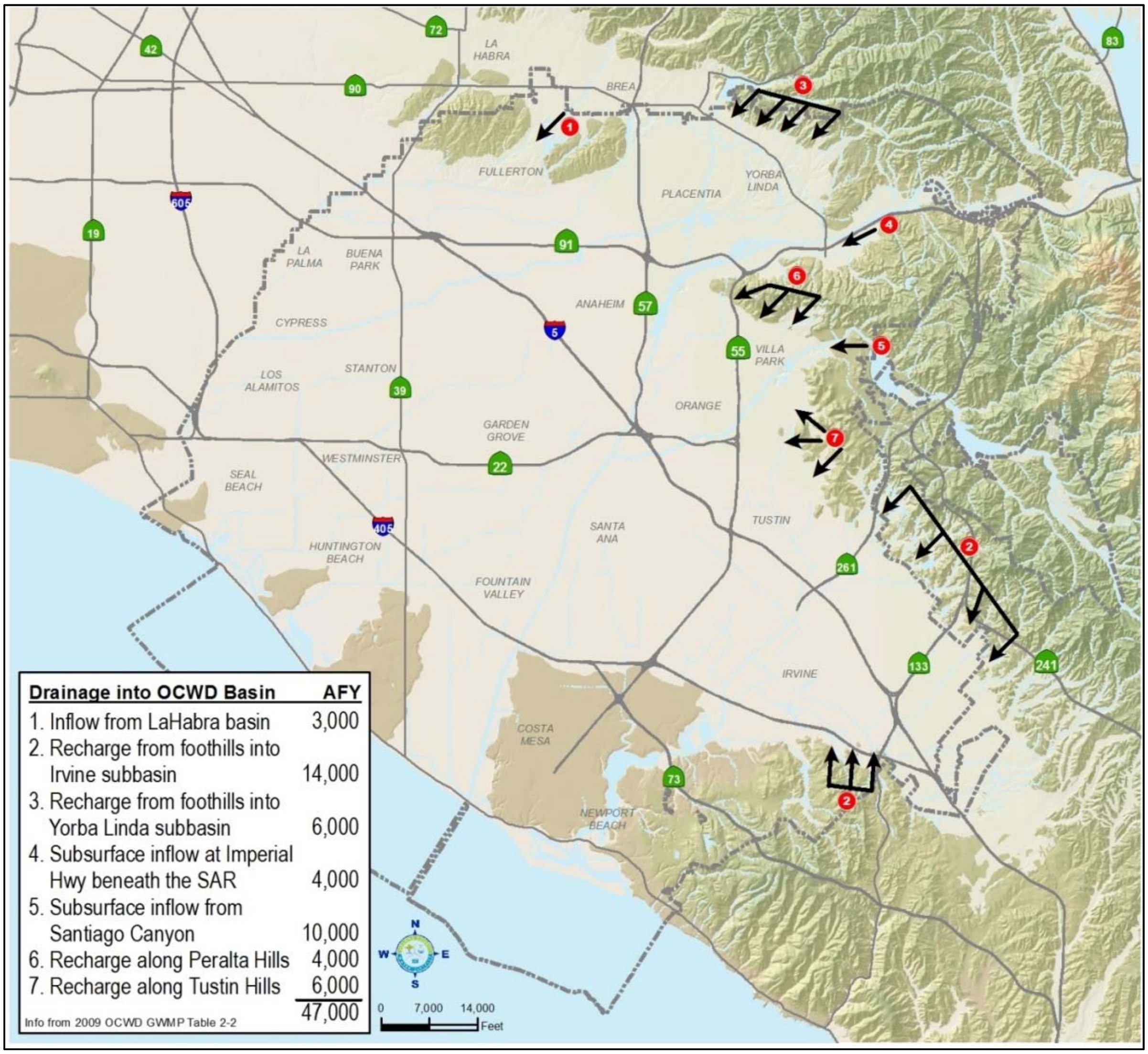


Figure 4-1: Estimated Subsurface Inflow

4.1.3 Groundwater Production

Entities that produce groundwater within the OCWD Management Area include major groundwater producers and small groundwater producers. Ninety-eight percent of groundwater production within Basin 8-1 occurs within the OCWD Management Area. The major groundwater producers include cities, water districts and water companies that account for approximately 97 percent of the total basin production. These 19 major producers operate approximately 200 large-system wells. Small groundwater producers include entities that typically produce less than 500 afy. These include small mutual water companies, industrial users, agricultural companies, golf courses, cemeteries, and private-well owners. Groundwater pumping for agricultural irrigation use accounts for less than one percent of total basin production.

4.1.4 Subsurface Outflow

Groundwater outflow from the basin across the Los Angeles County/Orange County line has been estimated to range from approximately 1,000 to 14,000 afy based on groundwater elevation gradients and aquifer transmissivity (DWR, 1967; McGillicuddy, 1989). The Water Replenishment District of Southern California also has estimated underflow from Orange County to Los Angeles County within the aforementioned range. Groundwater outflow cannot be directly measured and is accounted for in the basin water budget within the net unmeasured recharge described above.

Modeling by OCWD indicates that underflow to Los Angeles County increases by approximately 7,500 afy for every 100,000 acre-feet of increased groundwater in storage in Orange County, given the assumption that groundwater elevations in Los Angeles County remain constant (see Figure 4-2). With the exception of unknown amounts of semi-perched (near-surface) groundwater being intercepted and drained by submerged sewer trunk lines and unlined flood control channels along coastal portions of the basin, no other significant basin outflows are known to occur.

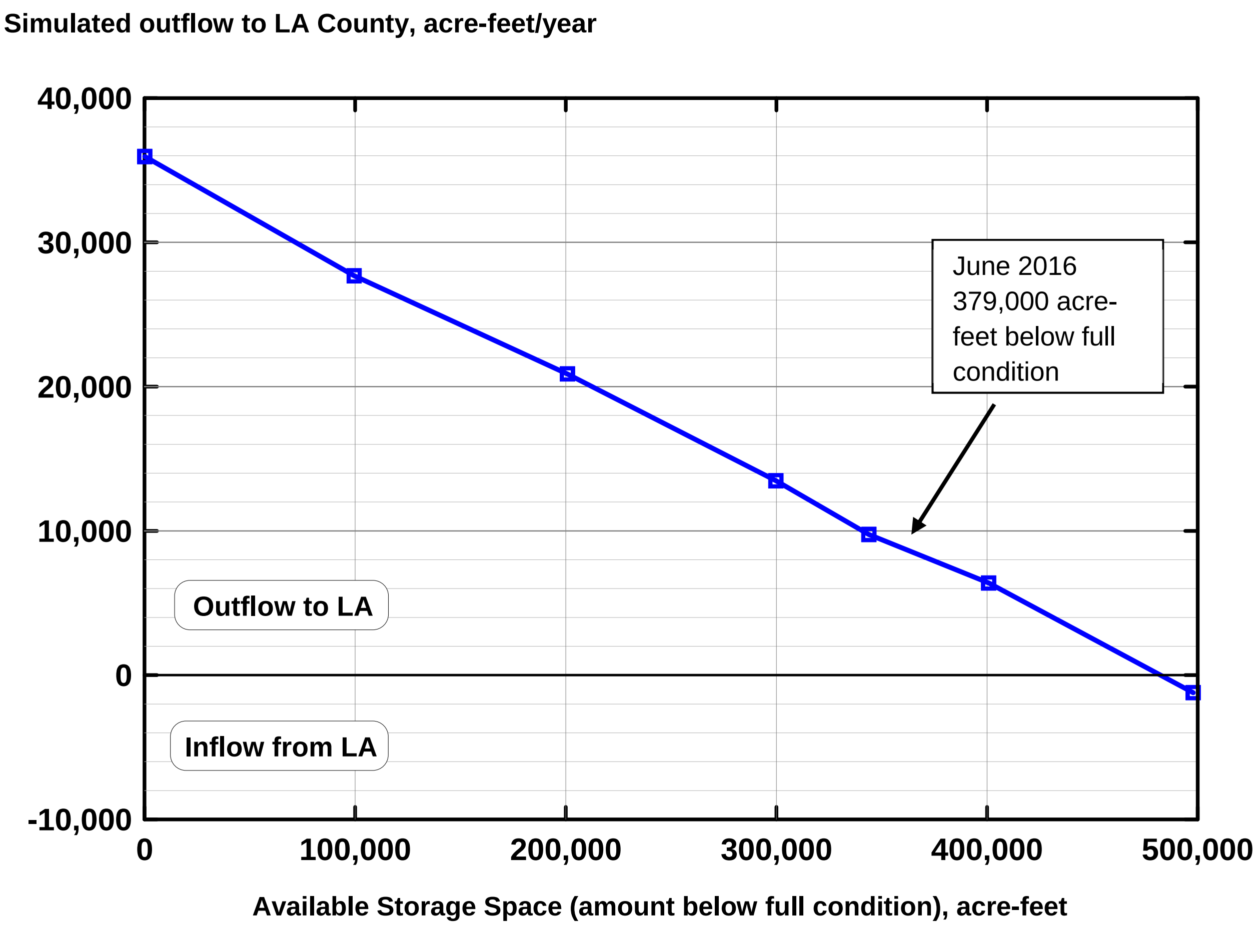


Figure 4-2: Relationship between Basin Storage and Estimated Outflow to Los Angeles County

4.1.5 Evaporation

The total wetted area of the District's recharge system is over 1,000 acres. OCWD estimates the evaporation from this system on a monthly basis. Generally, total evaporation is on the order of 2,000 acre-feet per year which is approximately one percent of the total volume recharged annually. The relatively minor impact of evaporation reflects moderate temperatures in the region and high percolation rates (1 to 10 feet per day).

4.2 WATER YEAR TYPE

As explained previously, OCWD manages groundwater pumping and basin storage over the long-term. Basin storage levels in comparison to wet and dry years from 1957 to present are shown in Figure 10-1. Typically, basin storage levels increase during wet periods and decrease during dry periods. Operating the basin within the operating range provides for maximum basin production while preventing significant and unreasonable undesirable results.

4.3 ESTIMATE OF SUSTAINABLE YIELD

Even though the groundwater basin contains an estimated 66 million acre-feet when full, OCWD operates the basin within an operating range of up to 500,000 acre-feet below full condition to protect against seawater intrusion, inelastic land subsidence, and other potential undesirable results. On a short-term basis, the basin can be operated at an even lower storage level in an emergency.

OCWD manages groundwater production and recharge to maintain groundwater storage levels within the established operating range. In this sense, the basin's sustainable yield can be defined as the volume of groundwater production that can be sustained while maintaining groundwater in storage within the operating range. Basin storage is determined on an annual basis by calculating the difference between groundwater production and recharge based on water year (July 1 to June 30).

In recent years (WY 2002-03 to 2014-15), annual groundwater production has ranged from 270,300 to 366,200 afy (shown in Figure 4-3). The average annual production for the past ten years (WY 2006-07 to 2015-16) was 310,000 afy. The long-term average annual production between WY 1965-666 and 2015-16 was 283,000 afy.

The sustainable yield of the basin is a function of the amount of groundwater recharge from OCWD's managed aquifer recharge program and natural recharge as a result of precipitation and percolation of irrigation flows.

OCWD seeks to maximize recharge in order to support the maximum levels of groundwater production. The increase in sustainable yield as a result of OCWD groundwater management can be illustrated by looking at long-term historical production data. Figure 4-3 shows the increase in annual groundwater production from approximately 150,000 afy in the mid-1950s to a high of 366,000 afy in WY 2007-08.

The process that determines a sustainable level of pumping on an annual basis considers the basin's operating range, basin storage conditions and the amount of available recharge water supplies.

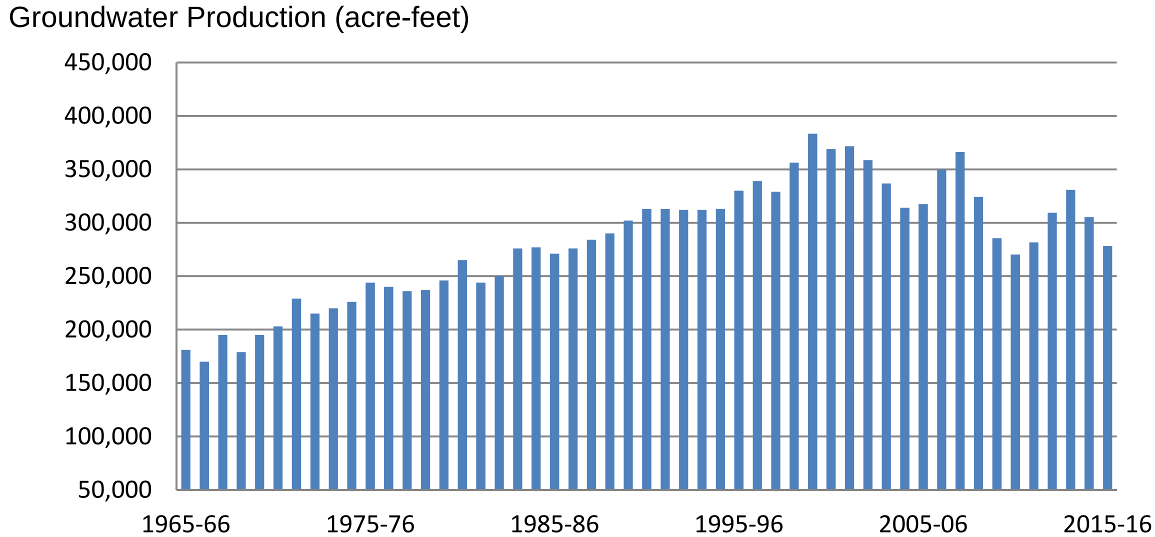


Figure 4-3: Groundwater Production, WY 1965-66 to WY 2015-16

4.4 WATER BUDGETS

Typical water budgets for dry years, average years and wet years as well as a future projected budget are presented in Tables 4-1 to 4-4. For the typical average year, total inflow and outflow are similar, indicating nearly balanced inflow and outflow, as shown in Table 4-1. During a dry year, measured and unmeasured recharge is lower compared with the average year. On the other hand, in a dry year water demands (including groundwater production) are usually higher due to outdoor irrigation. As shown in Table 4-2, the net result is a negative storage change, demonstrating how the groundwater basin serves as a storage reservoir to help meet demands during dry periods. During a wet year, measured and unmeasured recharge is greater compared to average year conditions. Water demands (hence, groundwater production) are often lower in a wet year due to decreased irrigation demands, and the resulting positive change in storage indicates how the basin reservoir is replenished, as shown in Table 4-3.

The average annual stormwater capture volume for the past ten years (WY 2006-07 to 2015-16) was approximately 44,000 acre-feet; however, this period's rainfall was 17% below the long-term average using San Bernardino precipitation data. The average year water budget (Table 4-1) assumed a stormwater capture volume of 52,000 acre-feet, which was based on a longer period (1989-2015) of rainfall and captured stormwater records.

The net estimated unmeasured or incidental recharge for the OCWD Management Area shown in Tables 4-1 through 4-4 include subsurface inflow from the South East, La Habra, and Santa Ana Canyon Management Areas.

Estimates of GWRS recharge volumes and Talbert Barrier injection volumes are based on actual GWRS production and recharge. These volumes do not fluctuate based on the average, dry and wet years. Alamitos Barrier injection volumes were based on long-term records and do not fluctuate significantly between average, wet, or dry years.

Table 4-4 is the projected future water budget under average hydrologic conditions. This projection considers several possible new sources of water supply: the final expansion of GWRS, recharging recycled water produced by a proposed MWD Regional Recycled Water Supply Program, and desalinated ocean water. The future projection accounts for these new water supplies as an increase in total inflow to the basin. The projected amount of groundwater production is increased in order to balance total inflow and outflow. In the case where one or more of the new water supplies is not available in the future, the amount of groundwater production would be reduced in order to create a balanced water budget.

Over the long-term, the basin must be maintained in an approximate balance to ensure the long-term viability of basin water supplies and to prevent the occurrence of undesirable results. In any particular year, water withdrawals may exceed water recharged as long as this is balanced by years when water recharged exceeds withdrawals. OCWD manages groundwater production and recharge to maintain groundwater storage levels within the established operating range as explained in detail in Section 10.

Table 4-1: Water Budget – Average Year

FLOW COMPONENT	Acre-feet
INFLOW	
Measured Recharge	
Santa Ana River baseflow	52,000
Santa Ana River stormflow	52,000
GWRS recharge in Forebay	73,000
Imported Water	65,000
Talbert Barrier injection	30,000
Alamitos Barrier injection in Orange County	2,000
Net Estimated Unmeasured or Incidental Recharge*	62,000
TOTAL INFLOW:	336,000
OUTFLOW	
Groundwater Production	320,000
TOTAL OUTFLOW:	320,000
CHANGE IN STORAGE:	+16,000

*subsurface outflow is included within net unmeasured recharge

Table 4-2: Water Budget – Dry Year

FLOW COMPONENT	Acre-feet
INFLOW	
Measured Recharge	
Santa Ana River baseflow	44,000
Santa Ana River stormflow	35,000
GWRS recharge in Forebay	73,000
Imported Water	50,000
Talbert Barrier injection	30,000
Alamitos Barrier injection in Orange County	2,000
Net Estimated Unmeasured or Incidental Recharge*	40,000
TOTAL INFLOW:	274,000
OUTFLOW	
Groundwater Production	330,000
TOTAL OUTFLOW:	330,000
CHANGE IN STORAGE:	-56,000

*subsurface outflow is included within net unmeasured recharge

Table 4-3: Water Budget – Wet Year

FLOW COMPONENT	Acre-feet
INFLOW	
Measured Recharge	
Santa Ana River baseflow	60,000
Santa Ana River stormflow	80,000
GWRS recharge in Forebay	73,000
Imported Water	65,000
Talbert Barrier injection	30,000
Alamitos Barrier injection in Orange County	2,000
Net Estimated Unmeasured or Incidental Recharge*	80,000
TOTAL INFLOW:	390,000
OUTFLOW	
Groundwater Production	305,000
TOTAL OUTFLOW:	305,000
CHANGE IN STORAGE:	+ 85,000

*subsurface outflow is included within net unmeasured recharge

Table 4-4: Water Budget – Future Projection (Average Rainfall)

FLOW COMPONENT	Acre-feet
INFLOW	
Measured Recharge	
Santa Ana River baseflow	52,000
Santa Ana River stormflow	52,000
GWRS recharge in Forebay	104,000
Imported Water/MWD IPR	65,000
Desalinated Ocean Water	53,000
Talbert Barrier injection	30,000
Alamitos Barrier injection in Orange County	2,000
Net Estimated Unmeasured or Incidental Recharge*	62,000
TOTAL INFLOW:	420,000
OUTFLOW	
Groundwater Production	420,000
TOTAL OUTFLOW:	420,000
CHANGE IN STORAGE:	0

*subsurface outflow is included within net unmeasured recharge

SECTION 5 WATER RESOURCE MONITORING PROGRAMS

5.1 OVERVIEW

Water resource monitoring programs can be categorized into groundwater, surface water, and recycled and imported water programs. These programs are summarized in Table 5-1 and described below.

Table 5-1: Summary of Monitoring Programs

MONITORING PROGRAM	PURPOSE	SCALE	FREQUENCY OF MONITORING
GROUNDWATER			
Groundwater Production	Manage basin storage; collect revenues based on production	All entities that pump groundwater	Producers (approx. 200 large capacity wells producing 97% of total production) track daily production rates and volumes; report totals to OCWD monthly. Others report semi-annually
Groundwater Elevation	Manage basin storage; prepare groundwater level contour maps; manage seawater intrusion barrier injection rates	1,000 individual measuring points	OCWD monitoring wells: all once a year (typically monthly); some measured by-weekly with some equipped with continuous monitoring equipment. Varying frequency for production wells, depending on local protocols
CA Statewide Groundwater Elevation Monitoring (CASGEM) Program	Compliance with state CASGEM program	96 key wells	Quarterly
Title 22 Water Quality Program	Compliance with CA SWRCB Division of Drinking Water, Title 22	All production wells regulated by Title 22	See schedule in Table 5-2

MONITORING PROGRAM	PURPOSE	SCALE	FREQUENCY OF MONITORING
	Monitoring for more than 100 regulated and unregulated chemicals at drinking water wells		
Groundwater Contamination Plumes	Monitor location of contamination plumes and levels of contamination	As needed	Depending on site-specific conditions
Seawater Intrusion	Monitor effectiveness of existing seawater intrusion barriers	425 monitoring and production wells	Semi-annually for all; selected wells monthly; some equipped with pressure transducers and data loggers for twice daily measurements Key parameters include chloride, TDS, electrical conductivity and bromide
SURFACE WATER			
Santa Ana River Monitoring Program	Annual review to affirm that OCWD recharge practices are protective of public health	22 surface water sites	Varying frequencies for general minerals, nutrients, metals, microbial, volatile and semi-volatile organic compounds, total organic halides, radioactivity, perchlorate, chlorate, NDMA, and chemicals of emerging concern.
Basin Monitoring Program Task Force program	Annual report preparation for compliance with Regional Water Board Basin Plan	Compilation of data from all monitoring programs	Collection of data on annual basis
Santa Ana River Watermaster Monitoring	Determine annual baseflow and stormflow and water quality at two locations to comply with judgment on Santa Ana River water rights	Basin-wide data collected by Watermaster parties in the watershed	Monitoring programs in watershed vary depending on individual agencies schedules
Prado Wetlands	Evaluate changes in	Daily flow in	Field parameters

MONITORING PROGRAM	PURPOSE	SCALE	FREQUENCY OF MONITORING
	water quality and effectiveness of wetlands treatment of surface water used for groundwater recharge	and out of wetlands	Biological, inorganic, and organic constituents
Emerging Constituents	Compliance with federal and state regulations	Watershed - wide	Federal or state programs; frequency determined by regulatory requirements
RECYCLED AND IMPORTED WATER			
Recycled Water	Monitor quality of water produced by GWRS	35 monitoring wells	GWRS monitoring wells: Quarterly for general minerals, metals, organics, and microbiological constituents; GWRS final product water: daily & weekly for specific parameters
Recycled Water	Monitor GWRS final product water		Daily or weekly for specific parameters
Imported Water	Monitor water quality of supply used to recharge groundwater basin		General minerals, nutrients, other selected constituents

5.2 GROUNDWATER MONITORING PROGRAMS

OCWD collects samples and analyzes water elevation and water quality data from approximately 400 District-owned monitoring wells (shown in Figure 5-1) and at over 250 privately-owned and publically-owned large and small system drinking water wells that are part of OCWD's Title 22 program, shown in Figure 5-2. OCWD also has access agreements to sample a number of non-District-owned monitoring wells and privately-owned irrigation, domestic and industrial wells, shown in Figure 5-3. Inactive wells are included in District monitoring programs when feasible. An inactive well is defined as a well that is not currently being routinely operated. The number and location of wells that are sampled change regularly as new wells come online and old ones are abandoned and destroyed.

The District collects, stores, and uses data from wells owned and sampled by other agencies. For example, data collected by the Water Replenishment District of Southern California from wells in Los Angeles County along the Orange County boundary are part of the network of wells evaluated to determine annual groundwater elevations and are used for basin modeling. Also included in OCWD's monitoring network are wells that are owned and operated by the U.S.

Navy for remediation of contamination plumes in the cities of Irvine, Seal Beach and Tustin, and wells that are related to operation of the Alamitos Barrier that are located in Los Angeles County. Los Angeles County wells are also used to model the Orange County groundwater basin as groundwater flow is unrestricted across the county line.

Wells sampled under various monitoring programs change in response to fluctuations in the number of available wells, basin conditions, observed water quality, and regulatory and non-regulatory requirements. A comprehensive list of all wells in OCWD's database can be found in Appendix A. This list includes well name, owner, type of well, casing sequence number, depth, screened interval, and aquifer zone monitored, when known.

In some cases well depth and screened intervals are listed on the database as unknown. OCWD maintains data on these wells when water quality or elevation data continues to be collected by the owner or operator. OCWD is able to use data from these wells in monitoring programs, for groundwater modeling, or for other basin programs. Wells on the list also include inactive wells when water quality or water elevation data continues to be collected or the data is utilized in one or more current basin programs. Groundwater elevation and monthly production data are used to quantify total basin pumping, evaluate seasonal groundwater level fluctuations and assess basin storage conditions.

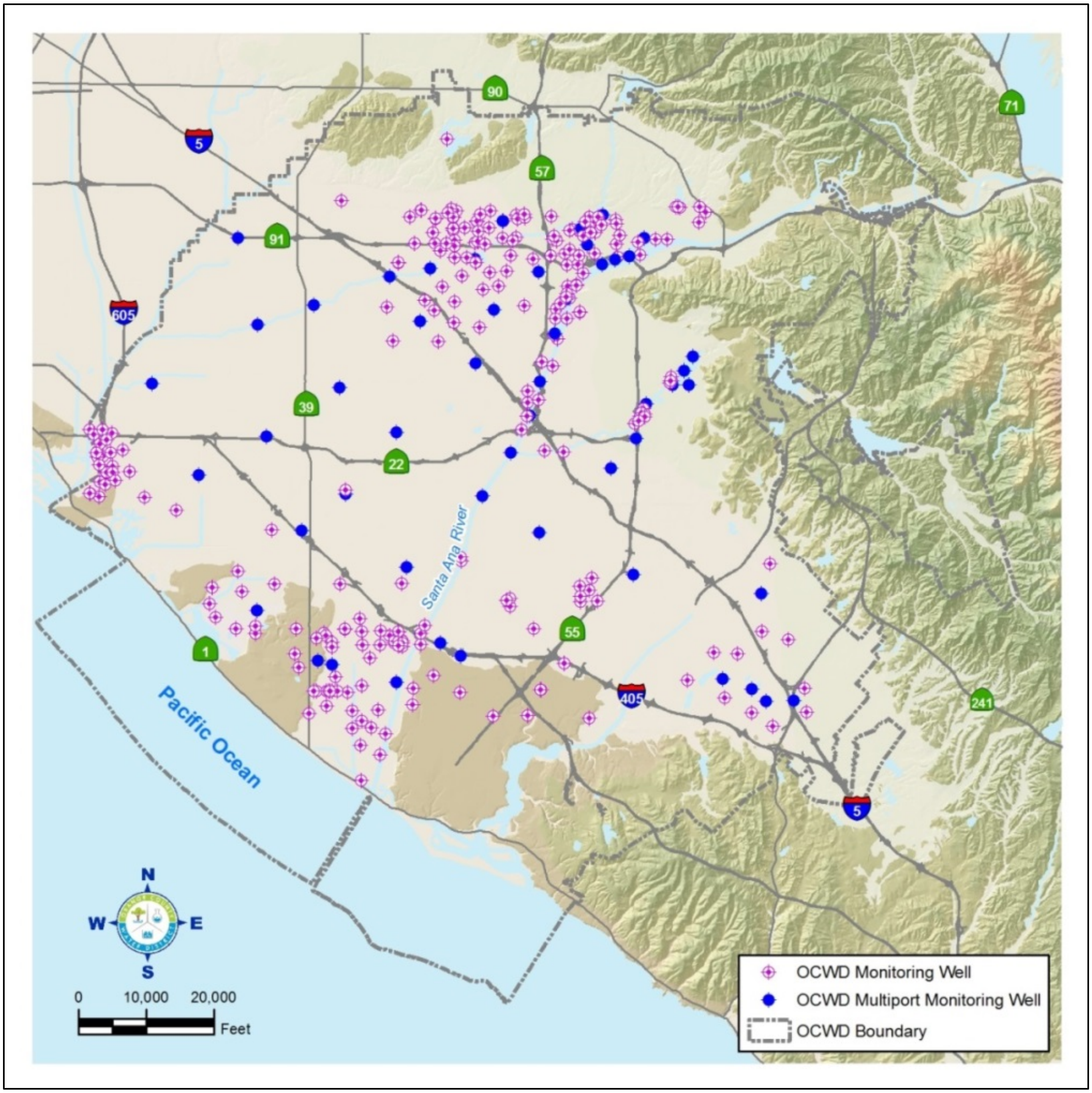


Figure 5-1: OCWD Monitoring Wells

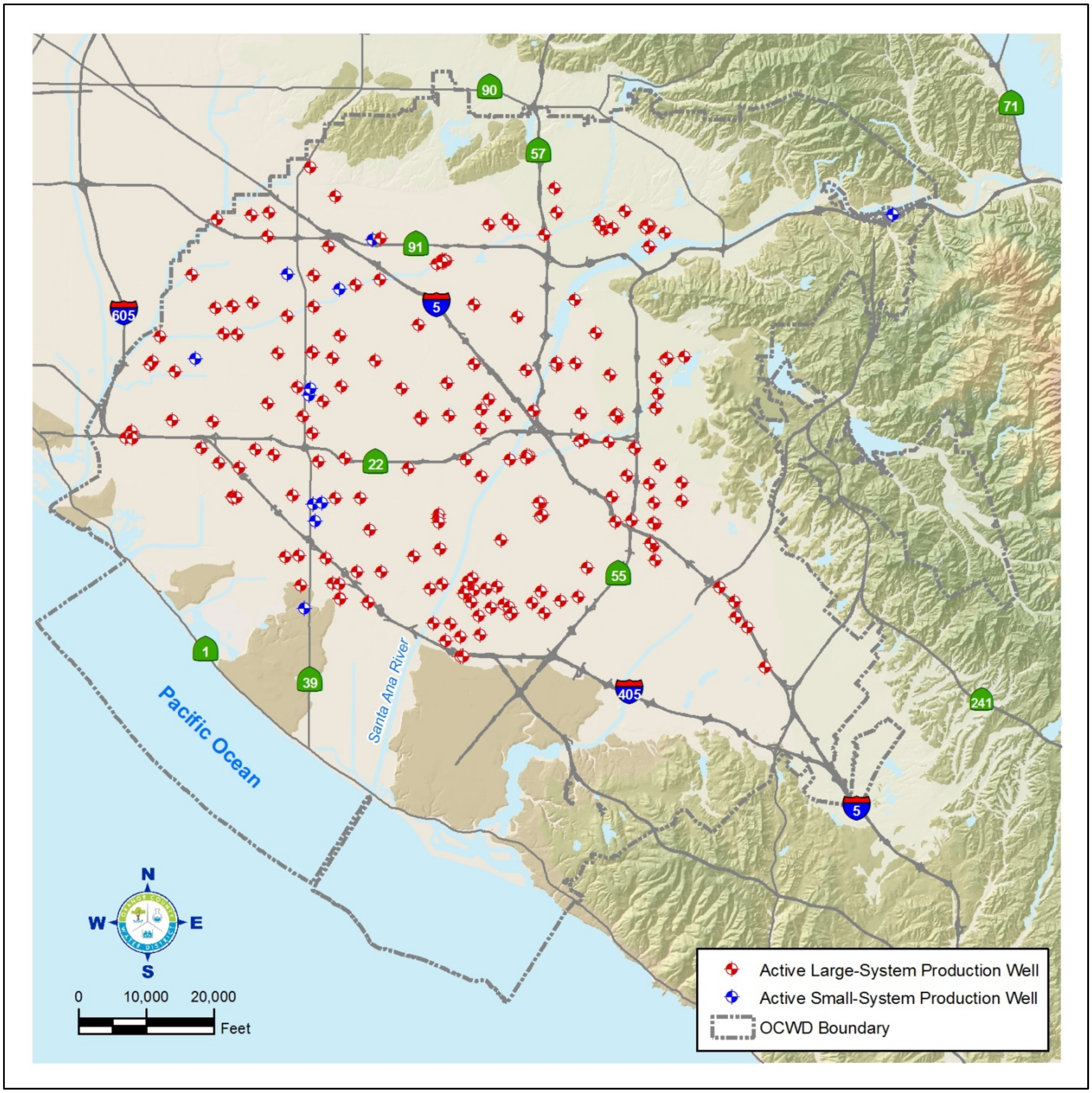


Figure 5-2: Large and Small System Drinking Water Wells in Title 22 Monitoring Program

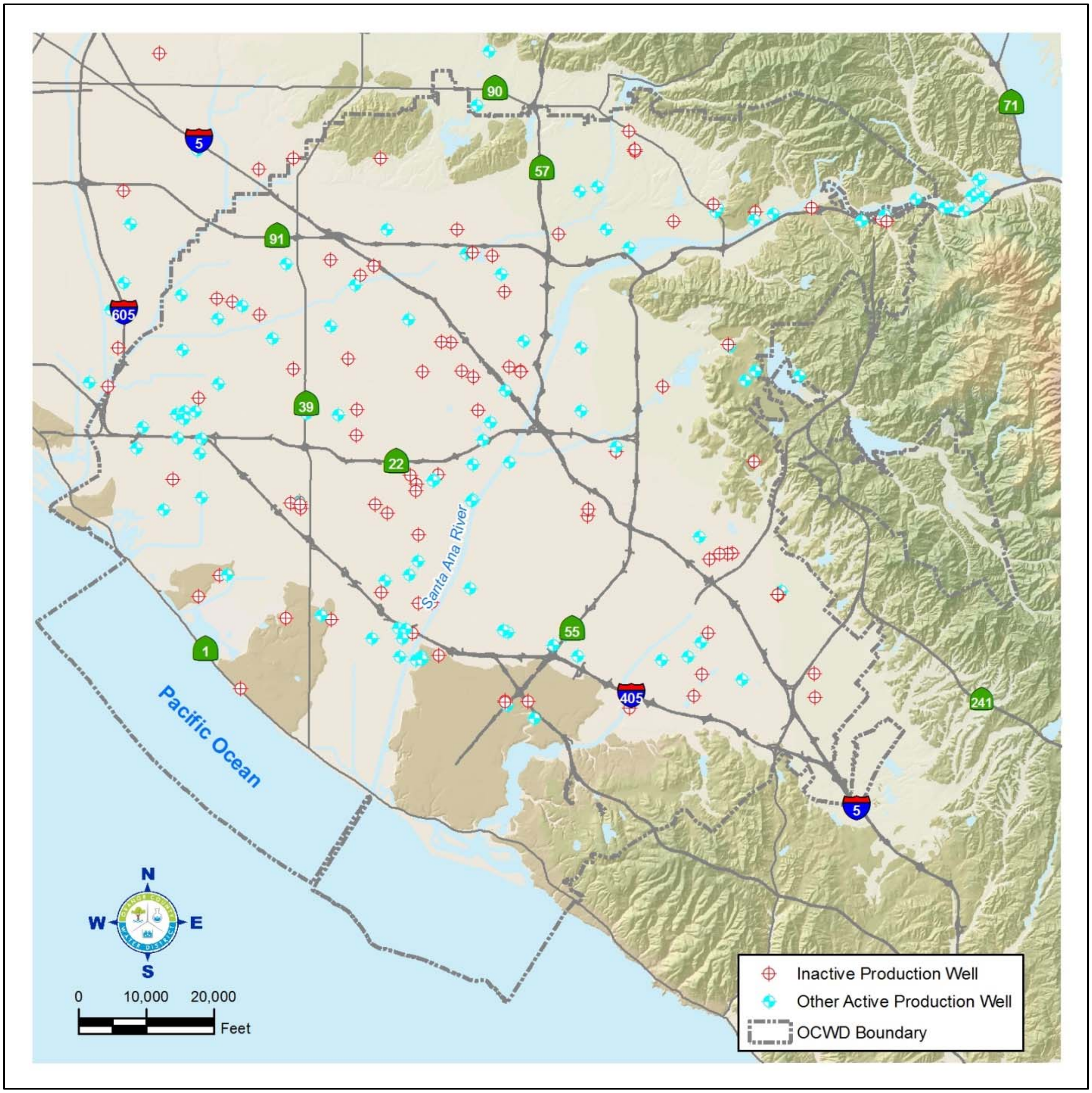


Figure 5-3: Private Domestic, Irrigation and Industrial Wells in OCWD Monitoring Program

5.2.1 Groundwater Production Monitoring

All entities that pump groundwater from the basin are required by the OCWD District Act to report production every six months and pay a Replenishment Assessment. Owners or operators of wells with discharge outlets of two inches in diameter or less and supply an area of no more than one acre pay an annual flat fee instead of the Replenishment Assessment and do not have to report their production.

Approximately 200 large-capacity production wells owned by 19 major water retail agencies account for ninety-seven percent of production. Large-capacity well owners report monthly groundwater production for each of their wells. The production volumes are verified by OCWD field staff. Production data are used to evaluate basin conditions, calculate and manage basin storage, run groundwater model scenarios, and collect revenues. Agricultural production accounts for a small amount of basin pumping. In 2015, irrigation production (including agriculture and nurseries) accounted for less than 2,000 acre-feet.

5.2.2 Groundwater Elevation Monitoring

Production and monitoring wells in the basin are measured for groundwater elevation at varying intervals, as explained below:

- Water elevation measurements are collected for every OCWD monitoring well at least once a year with most wells measured at least monthly;
- Monitoring of production wells is typically monthly but may vary depending on operational status, well maintenance, abandonment, new well construction, and related factors;
- Over 1,000 individual measuring points are monitored for water levels on a monthly or bi-monthly basis to evaluate short-term effects of pumping, recharge or injection operations; and
- Additional monitoring is done as needed in the vicinity of OCWD's recharge facilities, seawater barriers, and areas of special investigation where drawdown, water quality impacts or contamination are of concern.

Beginning in 2011, OCWD began reporting seasonal groundwater elevation measurements to DWR as part of the California Statewide Groundwater Elevation Monitoring (CASGEM) program. OCWD has been designated as the Monitoring Entity for the Orange County Groundwater Basin. Wells monitored under the CASGEM program are listed in Appendix A.

The monitoring well network developed for the CASGEM program and historical and proposed future groundwater elevation monitoring frequency provide a detailed and representative data set, both spatially and temporally. The initial network established in 2011 consisted of a total of 77 monitoring stations distributed laterally and vertically throughout the groundwater basin. Most of the wells are owned by OCWD and have detailed borehole geologic logs and downhole geophysical logs. Figures 5-4 to 5-6 present the monitoring well locations for each of the three aquifer systems. The CASGEM network includes wells within the La Habra-Brea and Santa Ana Canyon Management Areas.

Nearly all of the stations are discretely-screened monitoring wells, with the exceptions being inactive production wells. Many of the monitoring wells are of the "Westbay" or "multi-point" type whereby a single casing with multiple screened intervals is installed in a single borehole. Each screened interval (typically 10 feet long) is hydraulically isolated by permanently installed hydraulic packers inside the blank casing and annular seals outside the blank casing. With few unavoidable exceptions, the wells have known screened intervals, geologic logs, and typically more than 15 years of historical groundwater elevation data. The few wells with unknown screened intervals are the only known wells in their areas and are believed to provide representative groundwater elevation data based on historical measurements and their hydrogeologic setting. Wells in the network are sampled quarterly in order to monitor seasonal trends and amplitude. The quarterly measurements are typically completed within a one- to two-week period. Historical data from the wells within the La Habra-Brea and Santa Ana Canyon Management Areas indicate little seasonal variation in groundwater elevations. Measurements in these areas can be on a reduced scheduled as long as the levels show little variation.

Each monitoring station has been assigned a unique identification name. Most stations have also been assigned a State Well Number, but these are not recommended to be used for the purposes of CASGEM, because State Well Numbers were not assigned to each multi-depth station (or screened interval) and, therefore, are not unique.

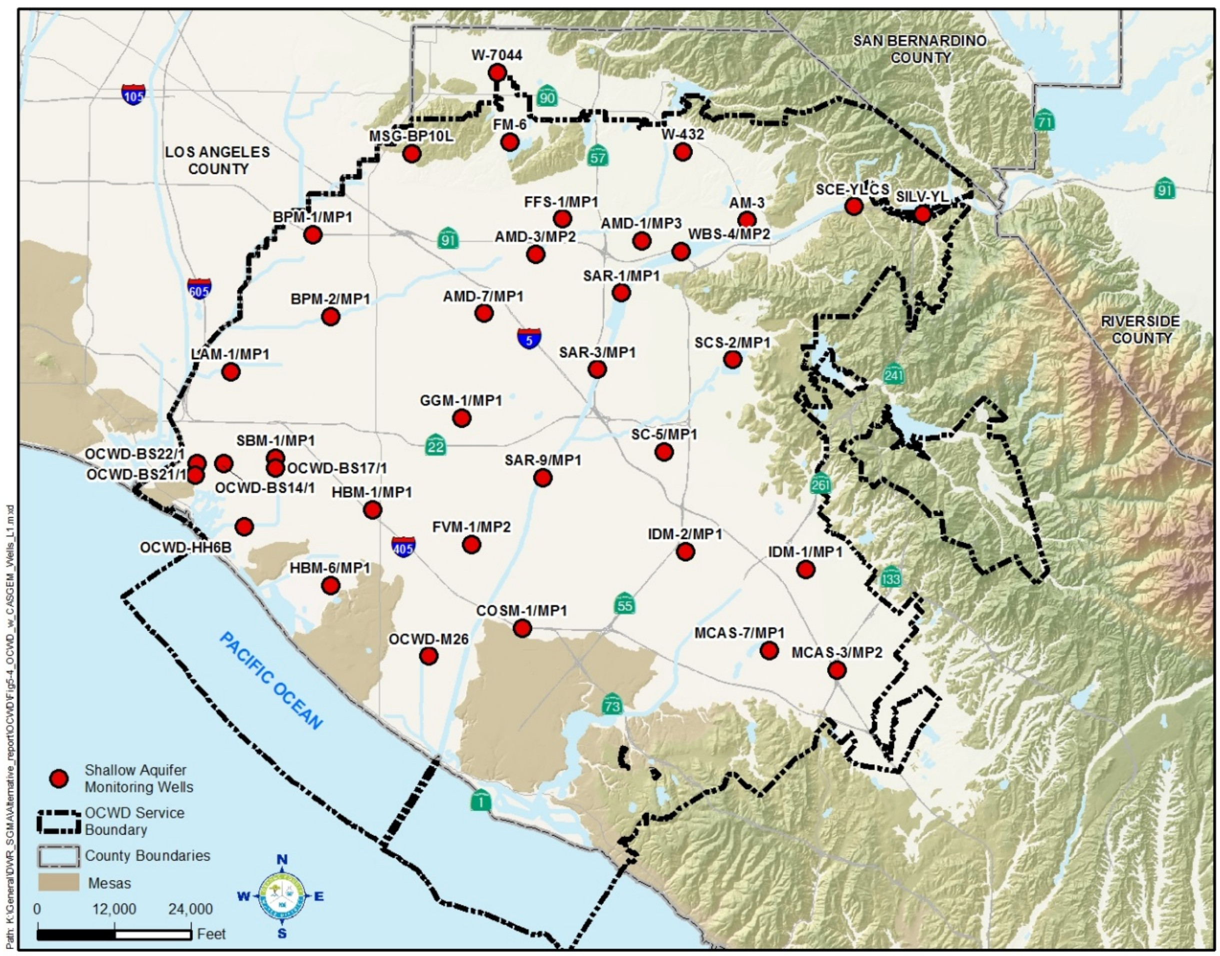


Figure 5-4: CASGEM Shallow Aquifer System Monitoring Well Network

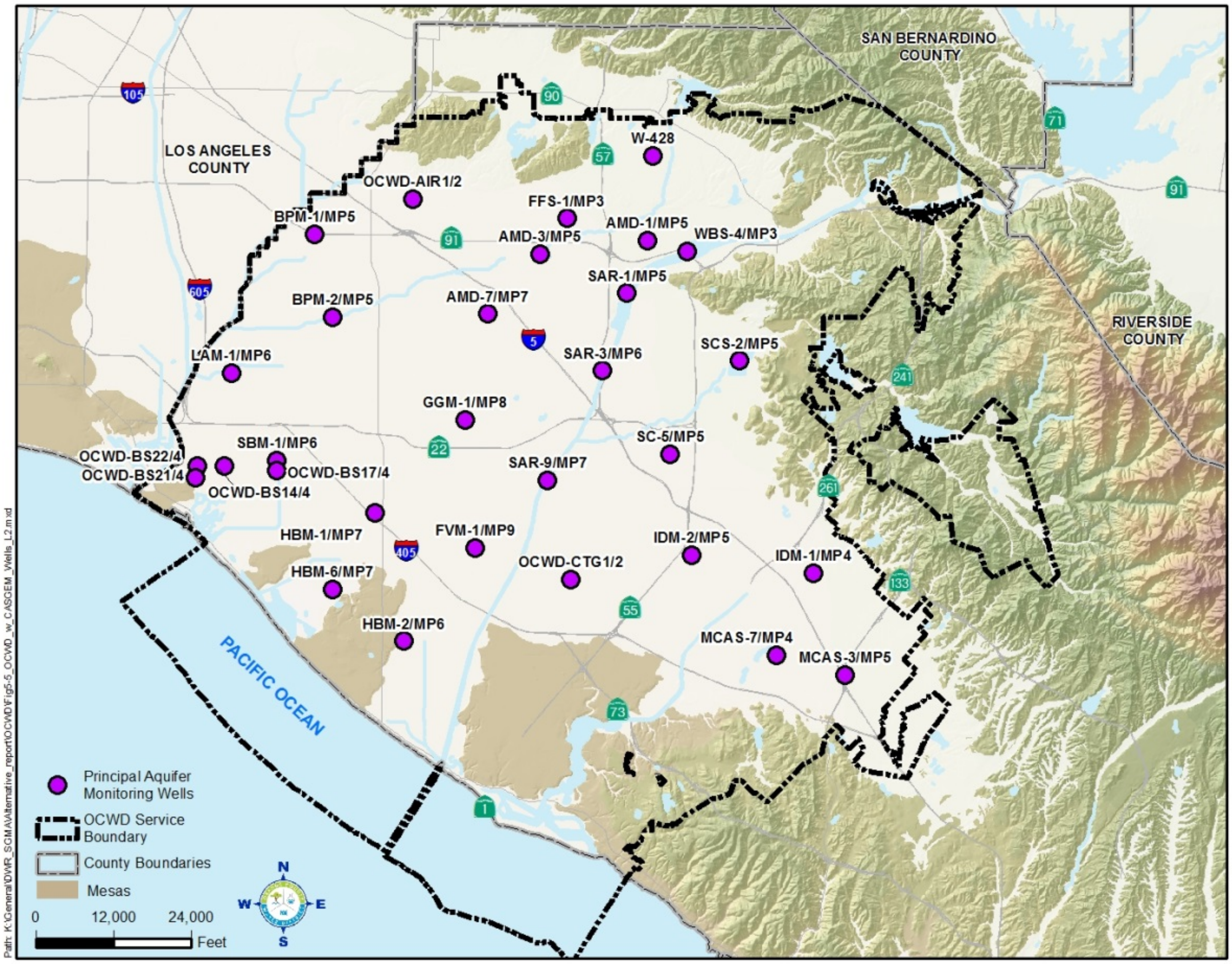


Figure 5-5: CASGEM Principal Aquifer System Monitoring Well Network

The locations of all of the monitoring network wells have been established through a global positioning system with a horizontal accuracy of ±3 feet after data post-processing. The location data are stored in the WRMS database using the projection of State Plane NAD83 California Zone 6, with latitude and longitude available to be reported in either decimal degrees or feet equivalent units.

Each monitoring station has an established reference point description and elevation referenced to the NAVD88 vertical datum. The reference point and ground surface elevations for most of the monitoring stations have been established to the nearest 0.01 foot by licensed surveyors, with elevations for the remaining stations estimated from topographic maps to the nearest foot (±10 feet estimated accuracy). The method of elevation determination for each station reference point is stored and reportable from the database. In the event a reference point elevation changes over time, e.g., a top of casing is raised or lowered, the WRMS database is designed to store historical reference point elevations such that reference point to water level measurements can be converted to an accurate, normalized groundwater elevation over time.

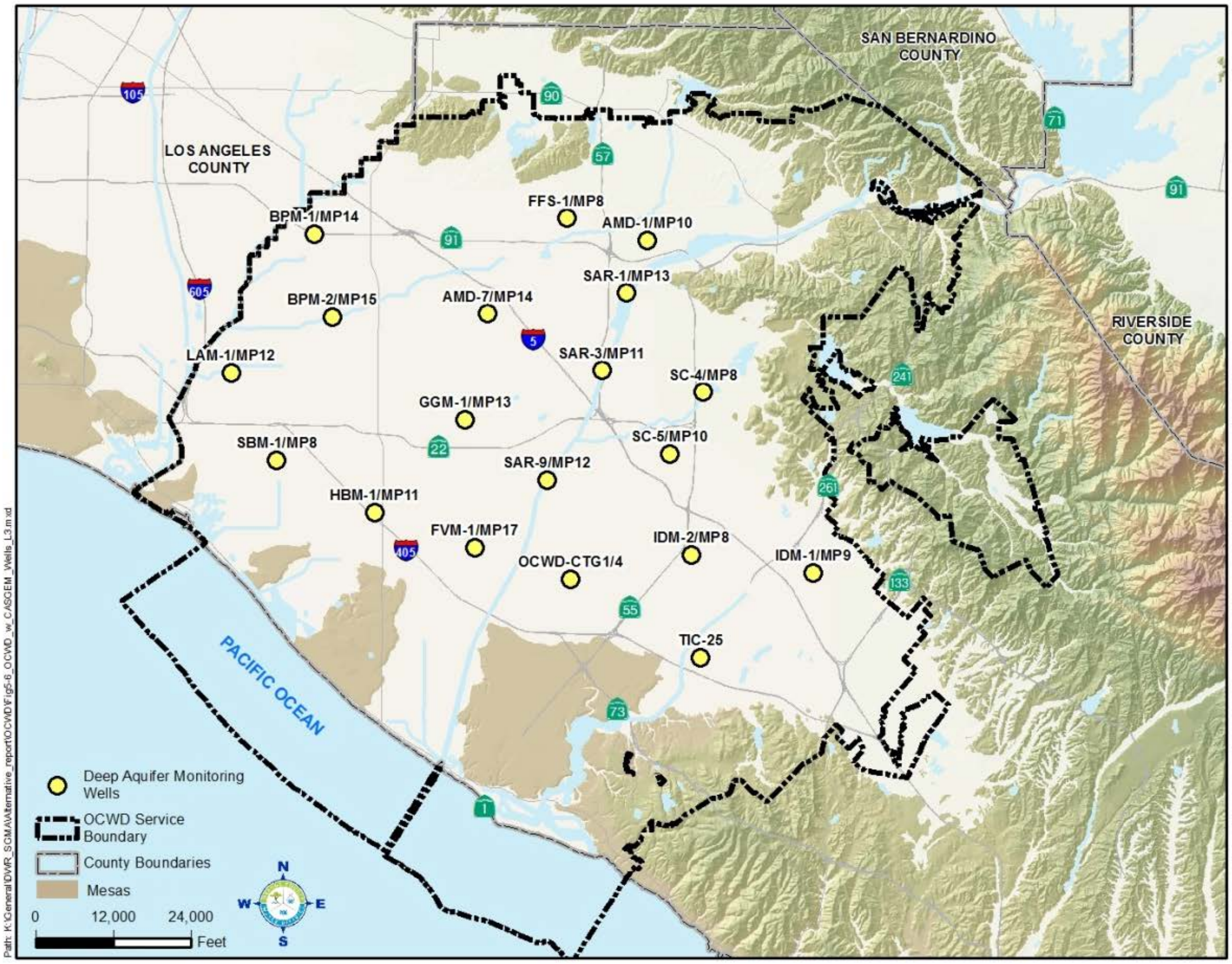


Figure 5-6: CASGEM Deep Aquifer System Monitoring Well Network

5.2.3 Groundwater Quality Monitoring

OCWD monitors water quality in production wells on behalf of the Groundwater Producers for compliance with state and federal drinking water regulations. Samples are analyzed for more than 100 regulated and unregulated chemicals at frequencies established by regulation as shown in Table 5-2. Over 425 monitoring and production wells are sampled semi-annually to assess water quality conditions during periods of lowest (winter) and peak production (summer).

The total number of water samples analyzed varies year-to-year due to regulatory requirements, conditions in the basin and applied research and/or special study demands. In 2015, over 15,000 samples were collected by the Water Quality Department and analyzed at OCWD's state-certified Water Quality Assurance Laboratory, of which 20% were for drinking water. OCWD developed specific programs to monitor the North Basin and South Basin plumes, shown in Figures 5-7 and 5-8.

Continual monitoring of groundwater near the coast is done to assess the effectiveness of the Alamitos and Talbert Barriers and track salinity levels in the Bolsa and Sunset Gaps. Key groundwater monitoring parameters used to determine the effectiveness of the barriers include water level elevations, chloride, TDS, electrical conductivity, and bromide. Groundwater elevation contour maps for the aquifers most susceptible to seawater intrusion are prepared to evaluate whether or not the freshwater mound developed by the barrier injection wells is sufficient to prevent the inland movement of saline water.

OCWD's extensive network of monitoring wells within the groundwater basin includes concentrated monitoring along the seawater barrier and near the recharge basins. GWRS-related monitoring wells in the vicinity of Kraemer, Miller, and Miraloma basins are used to measure water levels and to collect water quality samples. In addition to ensuring the protection of water quality, these wells have been used to determine travel times from recharge basins to production wells.

Permits regulating operation of GWRS require adherence to rigorous product water quality specifications, extensive groundwater monitoring, buffer zones near recharge operations, reporting requirements, and a detailed treatment plant operation, maintenance and monitoring program. GWRS product water is monitored daily, weekly, and quarterly for general minerals, metals, organics, and microbiological constituents. Focused research-type testing has been conducted on organic contaminants and selected microbial species.

Table 5-2: Monitoring of Regulated and Unregulated Chemicals in Production Wells

CA SWRCB Division of Drinking Water (DDW) Title 22 Drinking Water: Groundwater Source Monitoring Frequency - Regulated Chemicals		
Chemical Class	**Frequency**	**Monitoring Notes**
Inorganic - General Minerals	Once every 3 years	
Inorganic - Trace Metals	Once every 3 years	
Nitrate and nitrite	Annually	New wells sampled quarterly for 1st year
Detected ≥ 50% MCL	Quarterly	
Perchlorate		New wells sampled quarterly for 1st year
Detected ≥ DLR	Quarterly	State Detection limit = 4 ppb; OCWD RDL = 2.5 ppb
Non-detect at < DLR	Once every 3 years	
Volatile organic chemicals (VOC)	Annually	New wells sampled quarterly for 1st year
Detected VOC	Quarterly	
Synthetic organic chemicals (SOC)		New wells sampled quarterly for 1st year; if non-detect, susceptibility waiver for 3 years
Simazine	Once every 3 years	Must sample 2 consecutive quarters once every 3 years
Radiological		New wells sampled quarterly for 1st year (initial screening) to determine reduced monitoring frequency for each radionuclide
Detected at > 1/2 MCL to MCL	Once every 3 years	Per radionuclide
Detected at ≥ DLR ≤ 1/2 MCL	Once every 6 years	Per radionuclide
Non-detect at < DLR	Once every 9 years	Per radionuclide
EPA and DDW Unregulated Chemicals		
DDW : 4-Inorganic and 5-Organic chemicals	Two required GW samples: (1) Vulnerable period: May-Jun-Jul-Aug-Sep (2) 5 to 7 months before or after the sample collected in the vulnerable period. No further testing after completing the two required sampling events	Monitoring completed for existing wells in 2001-2003; new wells tested during 1st year of operation
EPA UCMR1 - List 1: 1-Inorganic and 10-Organic chemicals		UCMR1 program completed Jan 2001 - Dec 2003
EPA UCMR1 - List 2: 13-Organic chemicals		
EPA UCMR2 - List 1: 10 Organic chemicals		UCMR2 program completed Jan 2008 - Dec 2010
EPA UCMR2 - List 2: 15 Organic chemicals		
EPA UCMR3 List 1: 7-Inorganic and 14-Organic chemicals		All water utilities serving >10,000 people. Monitoring period: Jan 2013 - Dec 2015
EPA UCMR3 List 2: 7-Organic chemicals (Hormones)		All water utilities serving population >100,000 and EPA selected systems serving <100,000 population. Monitoring period: Jan 2013 - Dec 2015

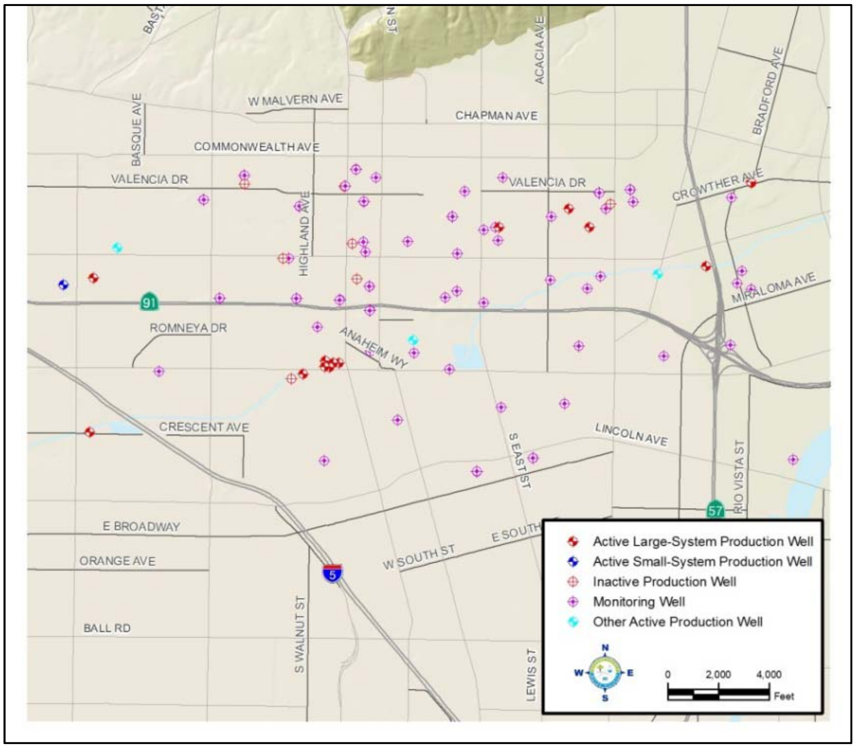


Figure 5-7: North Basin Monitoring Wells

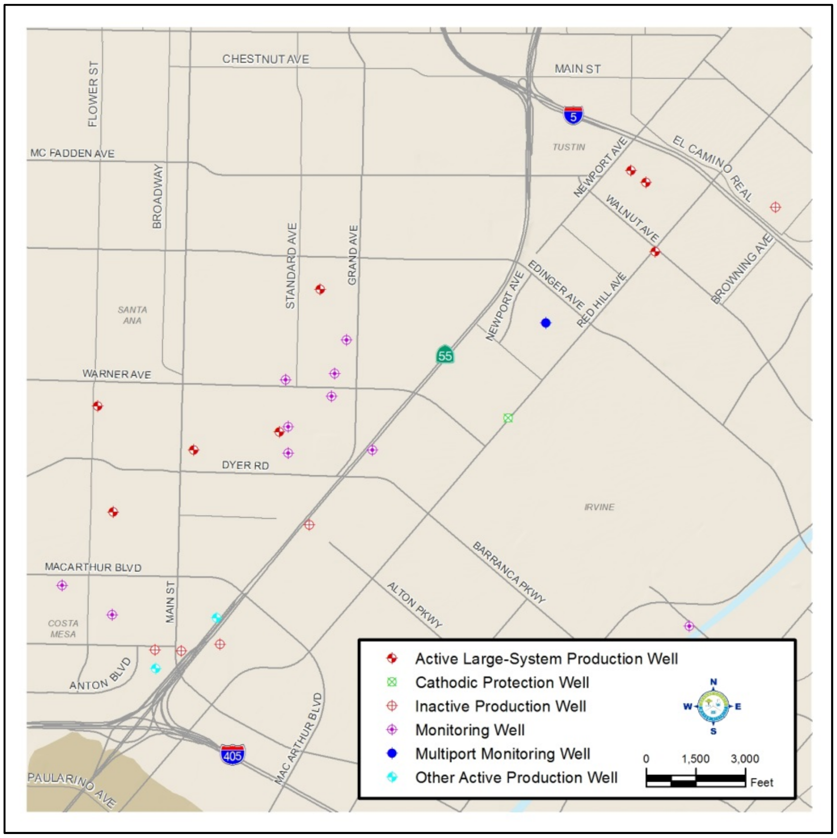


Figure 5-8: South Basin Monitoring Wells

5.2.4 Coastal Area Monitoring

OCWD operates and maintains a network of coastal area monitoring wells that provide water level and water quality data that allow staff to evaluate the performance of seawater intrusion barriers and to identify potential intrusion in coastal areas. The monitoring well network has been expanded and improved over time based on new information and a greater understanding of the basin hydrogeology.

In addition to obtaining groundwater level and quality data from the coastal monitoring well network, valuable geologic information is gained whenever a new well is drilled. Analysis of lithologic logs and geophysical logs produced during well drilling helps fill in data gaps and better define the structure of the underlying strata, such as the depth, thickness, and composition of the various aquifer zones susceptible to seawater intrusion. This geologic information, coupled with groundwater level and quality data, has led to an improved and refined conceptual model of Orange County coastal stratigraphy and characterization of seawater intrusion in the area.

Approximately 200 monitoring and production well sites are monitored for groundwater levels and quality within a 4- to 5- mile area from the coast, generally seaward or south of the 405 freeway, as shown in Figure 5-9. The monitoring wells are largely located in the coastal gaps as well as on the coastal mesas. The mesas are not impermeable features; rather, the marine deposition Pleistocene aquifers extend beneath the mesas to the basin production wells and provide potential avenues for seawater intrusion.

OCWD conducts the groundwater monitoring for the majority of the monitoring wells with the exception of the Alamitos Barrier monitoring wells. The Alamitos Seawater Intrusion Barrier is located along the border of Los Angeles and Orange counties and is jointly owned by OCWD and LACDPW. LACDPW operates, maintains, and samples Alamitos Barrier monitoring and injection wells, including those owned by OCWD located within Orange County. Through an interagency cooperative agreement dating to 1964, operational costs and data are shared between the two agencies with a joint report on the status of the barrier prepared on an annual basis.

Most of the monitoring wells shown in Figure 5-9 are owned by OCWD and are either single-point or nested. Single-point monitoring wells have one screened interval in one targeted aquifer zone, while nested wells have multiple (2 to 6) casings within the same borehole, with each casing screened in a separate aquifer zone at a discrete depth. A handful of OCWD monitoring wells in the coastal area are Westbay multi-port type, having only one well casing but with multiple monitoring ports each separated by inflatable packers. Therefore, although there are approximately 200 monitoring and production well sites in the coastal groundwater monitoring program, there are as many as 436 individual sampling points.

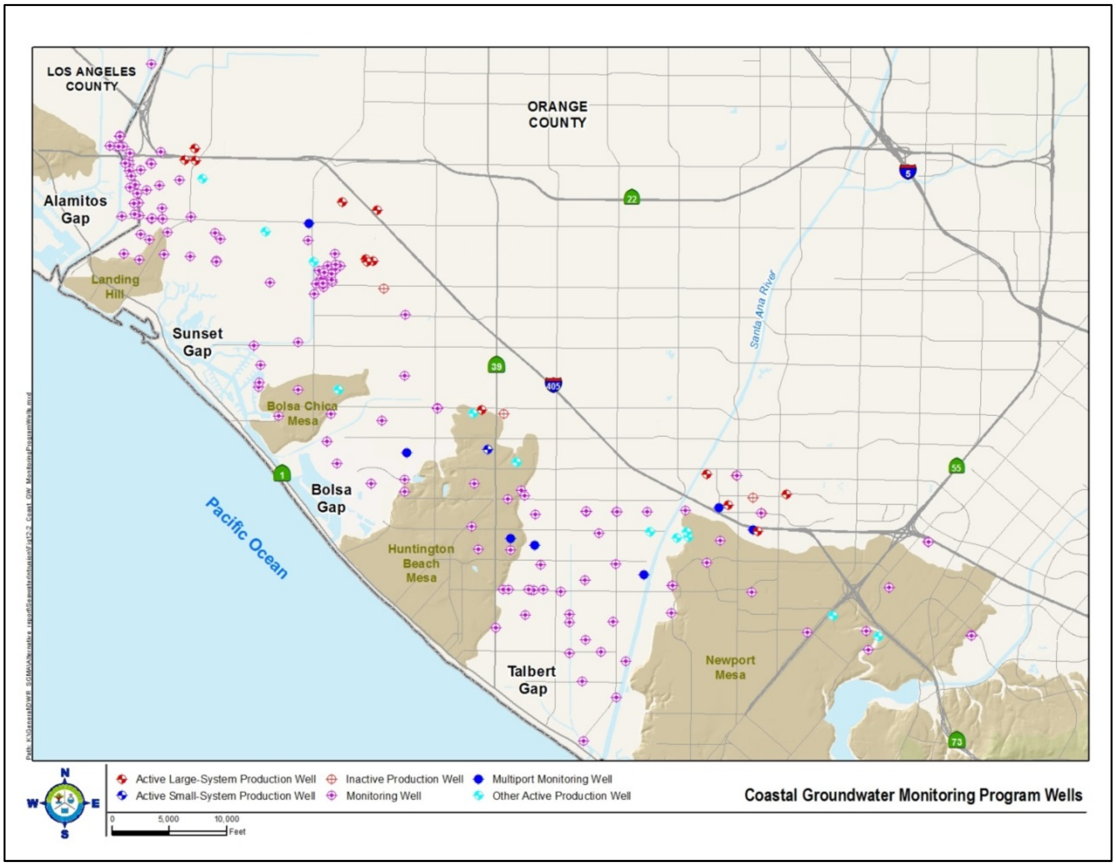


Figure 5-9: Seawater Intrusion Monitoring Wells

In addition to OCWD monitoring wells, there are a few privately owned monitoring wells and active municipal production wells included in OCWD's coastal monitoring program. For example, in Sunset Gap there are a few monitoring wells owned by The Boeing Company (Boeing) related to a shallow VOC plume in the area; Boeing monitors these wells twice a year (groundwater levels and VOCs), and OCWD obtains split samples with Boeing for seawater intrusion monitoring. The retail water agency production wells in the coastal monitoring program include three wells inland of the Alamitos Barrier (City of Seal Beach and Golden State Water Company) and three wells just inland of Sunset Gap (City of Huntington Beach). A complete list of all wells in the coastal groundwater monitoring program, along with their screened interval depths, can be found in Appendix A.

Groundwater levels are measured bi-monthly (every 2 months) at the majority of coastal monitoring wells, with many wells done monthly where seasonally changing gradients and protective elevations must be evaluated throughout the year to evaluate the potential for intrusion and the effectiveness of injection barrier operations at the Alamitos and Talbert barriers. In addition, several key coastal wells are also equipped with pressure transducers connected to automated data loggers that are downloaded regularly and record twice-daily groundwater level readings.

Nearly all of the coastal monitoring wells are sampled semi-annually (March and September) for key groundwater quality parameters to assess seawater intrusion and barrier operations. Some wells in the immediate vicinity of the injection barriers are sampled more frequently (e.g., quarterly) to track injection water pathways and travel times, per the permit requirements for the direct injection of purified recycled water. Key groundwater quality parameters analyzed for the coastal monitoring program include chloride, bromide, and electrical conductivity (EC), which is a surrogate for TDS. The EC is typically measured both in the field at the time of sampling and in the laboratory.

Dissolved chloride concentrations and EC are used both to track seawater intrusion and to trace the injection of purified recycled water at the barriers, especially the Talbert Barrier in which the injection supply consists of 100 percent recycled water having a much lower salinity signal than native fresh groundwater. Chloride is considered to be a good conservative intrinsic tracer since it is relatively unaffected by sorption- and chemical-, or biological reactions in the subsurface. Bromide concentrations in brackish groundwater samples are valuable to help determine the origin or source of intrusion by evaluating the chloride to bromide ratio. Chloride to bromide ratios in the range of 280-300 in brackish coastal samples suggest relatively young active intrusion from the ocean or water body connected to the ocean, whereas lower ratios may indicate intrusion from past oil brine disposal or an influence of very old connate water from the original marine depositional process when these coastal aquifers were first formed.

5.3 SURFACE WATER AND RECYCLED WATER MONITORING

Surface water from the Santa Ana River is a major source of recharge supply for the groundwater basin. As a result, the quality of the surface water has a significant influence on groundwater quality. Therefore, characterizing the quality of the river and its effect on the basin is necessary to verify the sustainability of continued use of river water for recharge and to safeguard a high-quality drinking water supply for Orange County. Several on-going programs monitor the condition of Santa Ana River water. OCWD monitoring sites along the river and its tributaries are shown in Figure 5-10.

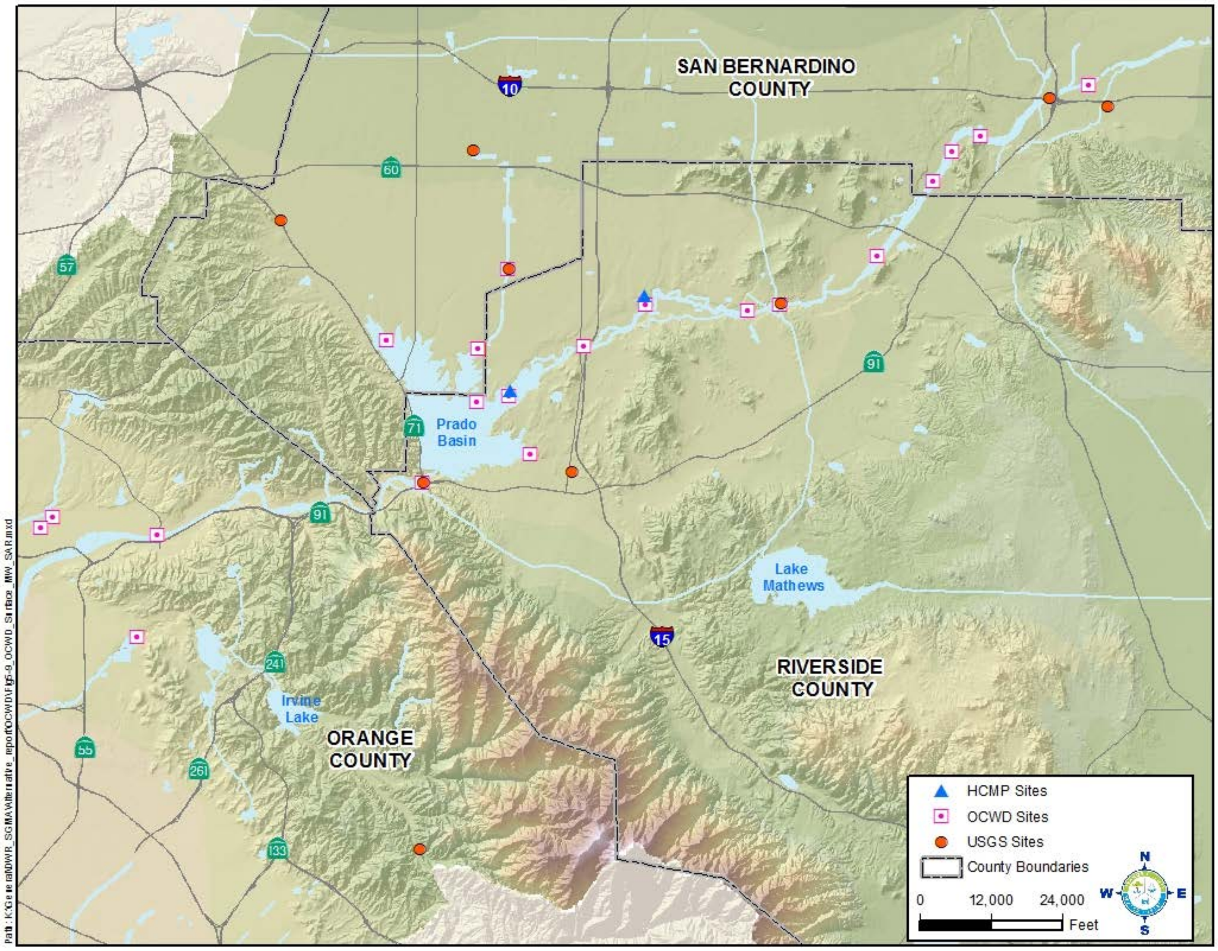


Figure 5-10: Surface Water Monitoring Locations

5.3.1 Surface Water Monitoring Programs

SARMON Monitoring

OCWD implements a comprehensive surface water and groundwater monitoring program, referred to as the Santa Ana River Monitoring (SARMON) Program. Monitoring activities include sites on the Santa Ana River, Anaheim Lake, Miraloma Basin, and Santiago Basin, as well as selected monitoring wells downgradient from the recharge basins to provide data on travel time, to assess water quality changes and ensure the continued safety of recharging Santa Ana River water into the groundwater basin.

On-going monthly surface water monitoring of the Santa Ana River is conducted at Imperial Highway near the diversion of the river to the off-river recharge basins and at a site below Prado Dam. Sampling frequencies for selected river sites and recharge basins are shown in Table 5-3.

Table 5-3: Surface Water Quality Sampling Frequency within Orange County
(A= annual, S= semi-annual, M = monthly, Q = quarterly)

CATEGORY	SAR Below Dam	SAR Imperial Hwy	Anaheim Lake	Miraloma Basin	Santiago Basins
General Minerals	M	M	Q	Q	M
Nutrients	M	M	Q	Q	M
Metals	Q	Q	Q	Q	Q
Microbial	M	M	Q	M	M
Volatile Organic Compounds (VOC)	Q	M	Q	Q	M
Semi-Volatile Organic Compounds	Q	Q	Q	Q	Q
Total Organic Halides (TOX)	M	M	Q	--	M
Radioactivity	Q	Q	Q	--	Q
Perchlorate	M	M	Q	Q	M
Chlorate	Q	M	Q	Q	M
NDMA Formation Potential (NDMA-FP)	--	S	--	--	--
Chemicals of Emerging Concern (CEC)*	Q	Q	Q	Q	Q

*Imperial Highway samples are tested for a full suite of CECs. The other sites are tested for a reduced list of analytes.

Basin Monitoring Program Annual Report of Santa Ana Water Quality

The Basin Monitoring Program Task Force (Task Force) monitors levels of Total Inorganic Nitrogen (TIN) and Total Dissolved Solids (TDS) in groundwater basins in the Santa Ana River Watershed. The Task Force is a group of 22 water and wastewater agencies in the watershed that conducts this work under the direction of the Regional Water Board. The Board requires that the Task Force prepare an annual report of the Santa Ana River water quality. Sampling locations used for this program include sites, shown in Figure 5-10, sampled by OCWD, USGS, and the Chino Basin Watermaster/Inland Empire Utilities Agency for the Hydrologic Control Monitoring Program (HCMP).

Santa Ana River Watermaster Monitoring

The Santa Ana River Watermaster produces an annual report in fulfillment of requirements of the Stipulated Judgment in the case of Orange County Water District v. City of Chino, et al., Case No. 117628-County of Orange, entered by the court on April 17, 1969. The Judgment settled water rights between entities in the Lower Area of the Santa Ana River Basin downstream of Prado Dam against those in the Upper Area tributary to Prado Dam. The court-appointed Watermaster Committee consists of representatives of the Orange County Water District representing the Lower Area and San Bernardino Municipal Water District, Western Municipal Water District, and the Inland Empire Utilities Agency, representing the Upper Area.

The Watermaster annually compiles the basin hydrologic and water quality data necessary to determine compliance with the provisions of the Judgment. The data include records of stream discharge (flow) and quality for the Santa Ana River at Prado Dam and at Riverside Narrows as well as discharges for most tributaries; flow and quality of non-tributary water entering the river; rainfall records at locations in or adjacent to the watershed; and other data that may be used to support the determinations of the Watermaster.

Data collected by the USGS at two gaging stations, “Santa Ana River below Prado” and “Santa Ana River at Metropolitan Water District Crossing” are used. Discharge data at both stations consists of computed daily mean discharges based on continuous recordings and daily maximum and minimum and mean values for EC measured as specific conductance and monthly measured values for total dissolved solids.

Stream gage data collected by the USGS at the following gaging stations are also used: Santa Ana River at E Street in San Bernardino, Chino Creek at Schaefer Avenue, Cucamonga Creek near Mira Loma, and Temescal Creek in the City of Corona. Precipitation data is collected at the USGS Gilbert Street Gage in San Bernardino and by OCWD in Orange County.

Emerging Constituents

OCWD participated in a watershed-wide Emerging Constituents Monitoring Program administered by the Santa Ana Watershed Project Authority. This group was formed in 2010 to characterize emerging constituents in 1) municipal wastewater effluents, 2) the Santa Ana River at various locations, and 3) imported water. Three years of testing (2011-2013) were completed as directed by the Regional Water Quality Control Board (R8-2009-0071). OCWD monitored two sites twice a year on the Santa Ana River for this program. Watershed-wide testing may be conducted in the future.

OCWD monitors two surface water sites monthly on the Santa Ana River and at groundwater monitoring wells downgradient of the recharge area. In addition, OCWD sampled for emerging constituents at the diversion into the Prado Wetlands once during the winter and fall and monthly from spring through summer as part of a focused research study.

For the GWRS, OCWD performs the emerging constituents monitoring required by its Regional Water Board permit and by the Amended Recycled Water Policy adopted by the State Water Resources Control Board in 2013. Samples are analyzed for pharmaceuticals, endocrine disruptors and other emerging constituents such as personal care products, food additives, pesticides and industrial chemicals.

Metropolitan Water District of Southern California Imported Water

Imported water purchased by OCWD from the Metropolitan Water District of Southern California (MWD) is monitored for general minerals, nutrients and other selected constituents. OCWD may also monitor metals, volatile organics and select semi-volatile organics (e.g., pesticides and herbicides). MWD performs its own comprehensive monitoring and provides data to the District upon request.

5.3.2 Recycled Water Monitoring

Performance of the GWRS is monitored on a routine basis. Annual GWRS reports are prepared by a diplomate of the American Academy of Environmental Engineering and an Independent Advisory Panel (IAP) to document ongoing scientific peer review. The IAP analyzes data in OCWD's Annual GWRS Report as well as water quality data collected throughout the groundwater basin. The IAP is appointed and administered by the National Water Research Institute to provide credible, objective review of all aspects of GWRS by scientific and engineering experts. In addition to formal written reports, the IAP also offers suggestions for enhancing monitoring of water quality, improving the efficiency of current GWRS technologies and evaluating future projects associated with the GWRS.

Use of GWRS water is regulated by the Regional Water Board and the Division of Drinking Water. Monitoring is performed at the WRD-owned Leo J. Vander Lans Advanced Water Treatment Facility that supplies recycled water to the Alamitos Seawater Barrier for injection.

To comply with the permit to operate the GWRS, groundwater samples are taken from 35 monitoring wells at nine sites to monitor GWRS water after percolation or injection. Samples are also taken from wells downgradient and along the groundwater flow path to collect data for long-term analysis of the effect of using GWRS supply for groundwater recharge. The location of these wells is shown in Figure 5-11. Monitoring frequencies are shown in Table 5-4.

Because of the low concentration of salts in GWRS water, OCWD initiated a Metals Mobilization Study to analyze for trace metals in selected wells near and downgradient of basins used for recharge of GWRS water. The GWRS Independent Advisory Panel recommended this study to evaluate the potential of GWRS water to alter existing groundwater geochemical equilibria, such as causing metals currently bound to aquifer sediments to be released when GWRS water mixes with an aquifer matrix that is in equilibrium with the ambient groundwater.

OCWD is investigating the feasibility of injecting 100 percent GWRS water directly into the Principal Aquifer in the central part of the basin. The Mid-Basin Injection Demonstration Project consists of a test injection well (MBI-1) along with seven nearby monitoring wells (SAR-10/1-4 and SAR-11/1-3) located approximately three miles north of the Talbert Barrier, along the GWRS pipeline at the Santa Ana River and Edinger Avenue in Santa Ana.

Ambient water quality conditions are monitored in the vicinity of the demonstration project to establish a water quality baseline to evaluate the potential of metals mobilization upon injection of GWRS water and to access any other water quality changes should they occur once injection of GWRS water at the site commences. Samples are analyzed for microbial, general minerals, trace metals, semi-volatile organic compounds, and radiological constituents. Data from this Mid-Basin Injection Demonstration Project will support the design and permitting of future additional wells in the basin.

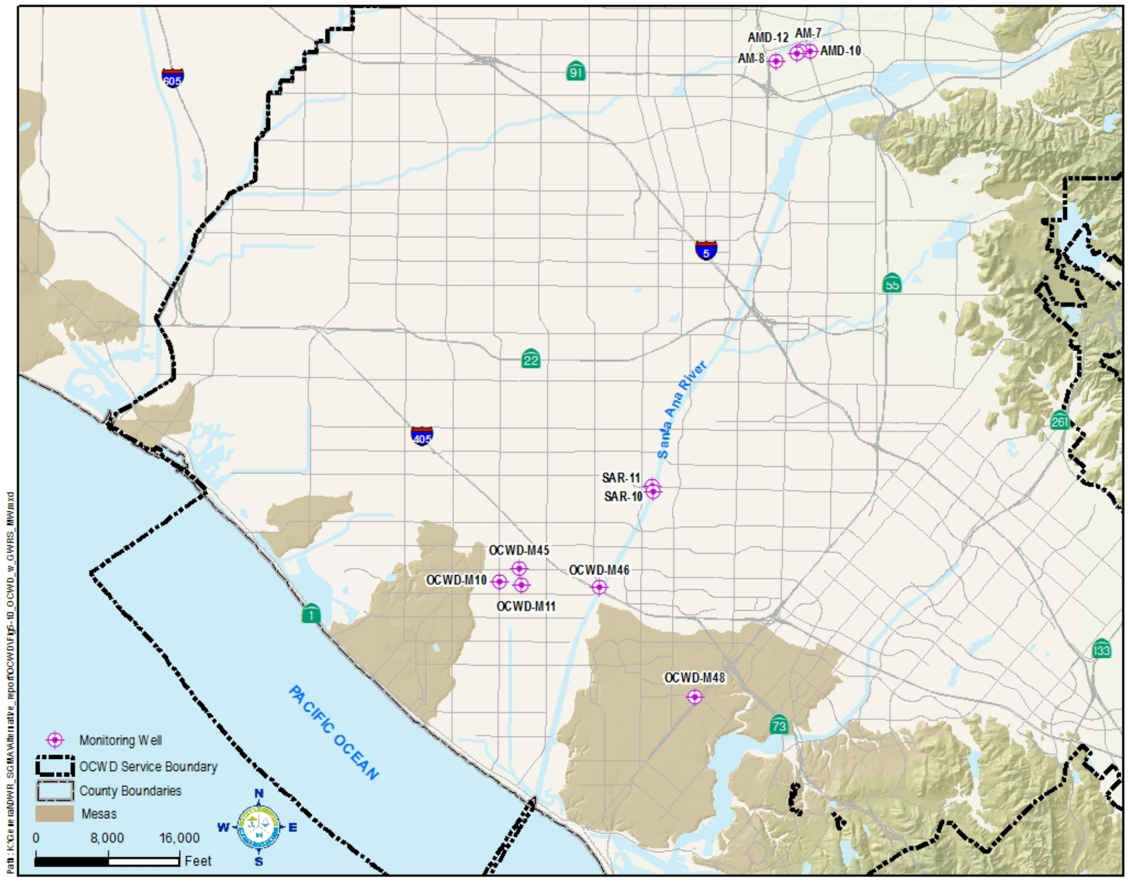


Figure 5-11: Recycled Water Monitoring Wells

Table 5-4: Groundwater Replenishment System Product Water Quality Monitoring

CATEGORY	TESTING FREQUENCY
General Minerals	monthly
Nitrogen Species (NO3, NO2, NH3, Org-N)	twice weekly
TDS	weekly
Metals	quarterly
Inorganic Chemicals	quarterly
Microbial	daily
Total Organic Carbon (TOC)	daily
Non-volatile Synthetic Organic Compounds (SOCs)	quarterly
Disinfection Byproducts	quarterly
Radioactivity	quarterly
Emerging Constituents	quarterly

SECTION 6 WATER RESOURCE MANAGEMENT PROGRAMS

6.1 LAND USE ELEMENTS RELATED TO BASIN MANAGEMENT

The OCWD Management Area is highly urbanized. Monitoring potential impacts from proposed new land uses and planning for future development are key management activities essential for sustainable management of the groundwater basin.

OCWD monitors, reviews and comments on local land use plans and environmental documents such as Environmental Impact Reports, Notices of Preparation, amendments to local General Plans and Specific Plans, proposed zoning changes, draft Water Quality Management Plans, and other land development plans. District staff also review draft National Pollution Discharge Elimination System and waste discharge permits issued by the Regional Water Board. The proposed projects and programs may have elements that could cause short- or long-term water quality impacts to source water used for groundwater replenishment or have the potential to degrade groundwater resources. Monitoring and reviewing waste discharge permits provides OCWD with insight on activities in the watershed that could affect water quality.

The majority of the basin's land area is located in a highly urbanized setting and requires tailored water supply protection strategies. Reviewing and commenting on stormwater permits and waste discharge permits adopted by the Regional Water Board for the portions of Orange, Riverside and San Bernardino counties that are within the Santa Ana River watershed are conducted by OCWD on a routine basis. These permits can affect the quality of water in the Santa Ana River and other water bodies, thereby impacting groundwater quality in the basin.

OCWD works with local agencies having oversight responsibilities on the handling, use and storage of hazardous materials; underground tank permitting; well abandonment programs; septic tank upgrades; and drainage issues. Participating in basin planning activities of the Regional Water Board and serving on technical advisory committees and task forces related to water quality are also valuable activities to protect water quality.

6.1.1 Summary of Plans Related to Basin Management

Municipal Stormwater Permit

The municipal separate storm sewer systems (MS4) permit (Order R-8-2009-0030) was adopted by the Regional Water Board with specific requirements for new development and significant redevelopment to manage stormwater on-site. Low impact development (LID) is a stormwater management strategy that emphasizes conservation and use of existing site features integrated with distributed stormwater controls. The strategy is designed to mimic natural hydrologic patterns of undeveloped sites as opposed to traditional stormwater management controls. LID includes both site design and structural measures used to manage stormwater on a particular development site.

The MS4 permit requires that any new development or significant re-development project consider groundwater conditions as part of the preparation of a Project Water Quality Management Plan (WQMP). The County of Orange prepared a Model WQMP to explain the requirements and types of analyses that are required in preparing a Conceptual/Preliminary or Project WQMP in compliance with the permit. A Technical Guidance Document (TGD) was prepared as a technical resource companion to the Model WQMP.

To assist municipalities in implementing the stormwater program, the county prepared detailed maps showing areas where infiltration potentially is feasible and areas where infiltration is likely to be infeasible due to soil conditions, high groundwater, potential for landslides, and groundwater contamination. These maps are included as Figure XVI.2 in Appendix XVI of the Technical Guidance Document that can be found at:
http://cms.ocgov.com/gov/pw/watersheds/documents/wqmp/default.asp

A permit condition requires that municipalities consult with the applicable groundwater management agency in reviewing on-site project plans that propose to infiltrate storm water on-site. As such, OCWD reviews these plans within OCWD boundaries to evaluate potential impacts to groundwater quality due to infiltration of stormwater at particular sites.

The TGD contains specific criteria to protect groundwater quality as part of local efforts to manage stormwater infiltration. The depth to seasonal high groundwater table beneath the project may preclude on-site infiltration of stormwater. In areas with known groundwater and soil contamination, infiltration may need to be avoided if it could contribute to the movement or dispersion of soil or groundwater contamination or adversely affect ongoing cleanup efforts. Potential for contamination due to infiltration is dependent on a number of factors including local hydrogeology and the chemical characteristics of the pollutants of concern. If infiltration is under consideration in areas where soil or groundwater pollutant mobilization is a concern, a site-specific analysis must be conducted to determine where infiltration-based BMPs can be used without adverse impacts.

Criteria for infiltration related to protection of groundwater quality include:

- Minimum separation between the ground surface and groundwater including guidance for calculating mounding potential
- Categorization of infiltration BMPs by relative risk of groundwater contamination
- Pollutant sources in the tributary watershed and pretreatment requirements
- Setbacks from known plumes and contaminated sites
- Guidelines for review by applicable groundwater management agencies

North Orange County Integrated Regional Water Management Plan

This plan was prepared by the County of Orange with the participation of a diverse group of stakeholders. The North Orange County planning area encompasses the Santa Ana River Watershed, the Lower San Gabriel River, Coyote Creek Watershed, and the Anaheim Bay-Huntington Harbour Watershed. The North Orange County Integrated Regional Watershed Management Plan was prepared in 2011 to maximize use of local water resources, to increase collaboration and to apply multiple water management strategies by implementing multi-purpose projects in the region. The plan was designed to help agencies, governments and community groups manage their water, wastewater and ecological resources and to identify potential projects to improve water quality, engage in long range water planning and obtain funding. OCWD participated in the preparation of this plan and submitted proposed projects to be considered as regional projects to augment local water supplies, protect groundwater quality and increase water supply reliability.

Central Orange County Integrated Regional and Coastal Watershed Management Plan

The Central Orange County plan was prepared in 2011 by the County of Orange and local stakeholders, including OCWD, to serve as a planning tool to effectively manage the region's water resources. The central area encompasses the entire Newport Bay Watershed and the northern portion of the adjacent Newport Coast Watershed that lies within the jurisdiction of the Santa Ana Regional Water Quality Control Board. The plan sets goals and objectives, identifies water resource projects, and discusses ways to integrate a proposed project with other projects.

One Water One Watershed (OWOW) 2.0

The Integrated Regional Watershed Management Plan for the Santa Ana Watershed is referred to as the OWOW 2.0 plan. Drafted by watershed stakeholders, including OCWD, under the direction of the Santa Ana Watershed Project Authority (SAWPA), this updated plan was adopted by the SAWPA Commission in 2014. The plan details the water resource related opportunities and constraints with the aim of developing proposed projects that provide a regional benefit, are integrated, and are proposed by more than one agency.

Municipal Water District of Orange County

Urban Water Management Plan

The Municipal Water District of Orange County (MWDOC) is a water wholesaler and regional planning agency serving 26 cities and water districts throughout Orange County, which includes OCWD's service area. MWDOC prepared its 2015 Regional Urban Water Management Plan to provide a comprehensive assessment of the region's water services, sources and supplies, including imported water, groundwater, surface water, recycled water, and wastewater. Findings and projections in the plan are used by OCWD and water retailers.

Orange County Reliability Study

The Orange County Reliability Study was prepared in 2016 to comprehensively evaluate current and future water supply and system reliability for Orange County. Water demands and supplies were evaluated for current and future conditions with a planning horizon from 2015 to 2040 using a simulation model developed for this study.

6.1.2 Land Use Development and Water Demands and Supply

Water demands within the OCWD Management Area for water year (WY) 2015-16 totaled approximately 364,000 acre-feet, which reflects the state-mandated water use reductions in response to the extended drought. Total demands include the use of groundwater, surface water from Santiago Creek and Irvine Lake, recycled water, and imported water. As shown in Figure 6-1, water demands between WY1989-90 and 2014-15 have fluctuated between approximately 413,000 afy to 515,000 afy.

Since its founding, OCWD has grown in area from 162,676 to 243,968 acres and has experienced an increase in population from approximately 120,000 to 2.4 million people. OCWD has employed groundwater management techniques to increase the annual yield from the basin including operating over 1,500 acres of infiltration basins. Annual groundwater production increased from approximately 150,000 acre-feet in the mid-1950s to a high of over 360,000 acre-feet in WY 2007-08. OCWD strives to maximize production from the basin through maximizing recharge of the groundwater basin. The groundwater basin is managed within the established operating range independently of total regional water demands as total water demands are met by a combination of groundwater and imported water.

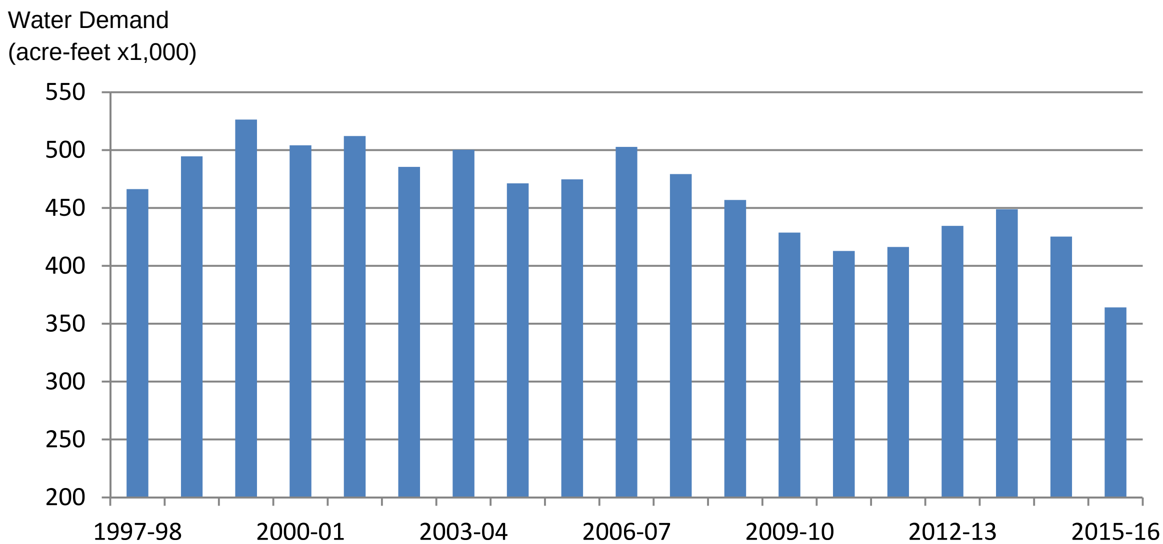


Figure 6-1: Historic Total Water Demands

6.1.3 Well Development, Management, and Closure

To comply with federal Safe Drinking Water Act requirements regarding the protection of drinking water sources, the California Department of Public Health (now the Division of Drinking Water) created the Drinking Water Source Assessment and Protection (DWSAP) program. Water suppliers must submit a DWSAP report as part of the drinking water well permitting process and have it approved before providing a new source of water from a new well. OCWD provides technical support to groundwater producers in the preparation of these reports.

This program requires all well owners to prepare a drinking water source assessment and establish a source water protection program for all new wells. The source water program must include: (1) a delineation of the land area to be protected, (2) the identification of all potential sources of contamination to the well, and (3) a description of management strategies aimed at preventing groundwater contamination.

Developing management strategies to prevent, reduce, or eliminate risks of groundwater contamination is one component of the multiple barrier protection of source water. Contingency planning is an essential component of a complete DWSAP and includes developing alternate water supplies for unexpected loss of each drinking water source, by man-made or catastrophic events.

Wells constructed by OCWD are built to prevent the migration of surface contamination into the subsurface. This is achieved through the placement of annular well seals and surface seals during construction. Also, seals are placed within the borehole annulus between aquifers to minimize the potential for flow between aquifers.

Well construction ordinances adopted and implemented by the Orange County Health Care Agency (OCHCA) and municipalities follow state well construction standards established to protect water quality under California Water Code Section 231. Cities within OCWD boundaries that have local well construction ordinances and manage well construction within their local jurisdictions include the cities of Anaheim, Fountain Valley, Buena Park, and Orange. To provide guidance and policy recommendations on these ordinances, the County of Orange established the Well Standards Advisory Board in the early 1970s. The five-member appointed Board includes OCWD's Chief Hydrogeologist. Recommendations of the Board are used by the OCHCA and municipalities to enforce well construction ordinances within their jurisdictions.

A well is considered abandoned when the owner has permanently discontinued its use or it is in such a condition that it can no longer be used for its intended purpose. This often occurs when wells have been forgotten by the owner, were not disclosed to a new property owner, or when the owner is unknown.

A properly destroyed and sealed well has been filled so that it cannot produce water or act as a vertical conduit for the movement of groundwater. In cases where a well is paved over or under a structure and can no longer be accessed it is considered destroyed but not properly sealed. Many of these wells may not be able to be properly closed due to overlying structures, landscaping or pavement. Some of them may pose a threat to water quality because they can be conduits for contaminant movement as well as physical hazards to humans and/or animals.

Information on the status of wells is kept within OCWD's Water Resource Management System data base. Records in this data base show 606 wells that have been destroyed and properly sealed, 217 destroyed wells with inadequate information to determine if properly sealed and 948 abandoned wells most of which have inadequate information to determine if the well is accessible or covered over.

OCWD supports and encourages efforts to properly destroy abandoned wells. As part of routine monitoring of the groundwater basin, OCWD will investigate on a case-by-case basis any location where data suggests that an abandoned well may be present and may be threatening water quality. When an abandoned well is found to be a significant threat to the quality of groundwater, OCWD will work with OCHCA and the well owner, when appropriate, to properly destroy the well.

The City of Anaheim has a well destruction policy and has an annual budget to destroy one or two wells per year. The funds are used when an abandoned well is determined to be a public nuisance or needs to be destroyed to allow development of the site. The city's well permit program requires all well owners to destroy their wells when they are no longer needed. When grant funding becomes available, the city uses the funds to destroy wells where a responsible party has not been determined and where the well was previously owned by a defunct water consortium.

6.2 GROUNDWATER QUALITY PROTECTION AND MANAGEMENT

6.2.1 OCWD Groundwater Quality Protection Policy

OCWD adopted the first Groundwater Quality Protection Policy in 1987 under statutory authority granted under Section 2 of the OCWD Act. A revised policy was adopted by the Board of Directors in 2014. The policy guides the actions of OCWD to:

- Maintain groundwater quality suitable for all existing and potential beneficial uses;
- Prevent degradation of groundwater quality and protect groundwater from contamination;
- Assist regulatory agencies in identifying sources of contamination to assure cleanup by the responsible parties;
- Support regulatory enforcement of investigation and cleanup requirements on responsible parties in accordance with law;
- Undertake investigation and cleanup projects as necessary to protect groundwater from contamination;
- Maintain consistency with the National Contingency Plan when seeking recovery of investigation and response costs;
- Negotiate with and engage in mediation with parties responsible for contamination when possible to resolve issues related to cleanup and abatement of contamination;

- Establish a Groundwater Contamination Cleanup Fund to hold proceeds received from settlement of lawsuits for each groundwater contamination case for which the District received moneys;
- Maintain surface water and groundwater quality monitoring programs and monitoring well network;
- Maintain the database system, geographic information system, and computer models to support water quality programs;
- Maintain an Emergency Response Fund to ensure adequate funds are available to contain and clean up catastrophic releases of chemicals or other substances that may contaminate surface water or groundwater;
- Coordinate with groundwater producer(s) impacted or threatened by any groundwater contamination and work to develop appropriate monitoring and remediation if necessary; and
- Encourage the beneficial use and appropriate treatment of poor-quality groundwater where the use of such groundwater will reduce the risk of impact to additional production wells, increase the operational yield of the basin and/or provide additional water quality improvements to the basin.

6.2.2 Salinity Management Programs

Increasing salinity in water supplies is a significant water quality problem in many parts of the southwestern United States and southern California. Programs to manage salinity within the OCWD Management Area are described in this section. These programs include both programs within the management area as well as those related to management of surface water in the upper watershed that affect the quality of water used by OCWD for groundwater replenishment. Seawater intrusion barrier programs are described in Section 6.5.

Coastal Pumping Transfer Program

The Coastal Pumping Transfer Program (CPTP) allows OCWD to manage salinity levels in the groundwater basin by encouraging the shifting of groundwater production from the coastal area to inland areas. The purpose of the CPTP is to encourage inland producers to pump more groundwater and coastal producers to pump less in order to raise coastal groundwater levels, which lessens the potential for seawater intrusion. Inland producers participate in this cooperative program to increase pumping and both inland and coastal producers are compensated so that it is a cost-neutral program for the groundwater producers.

Groundwater Replenishment System

The GWRS plant produces highly-treated recycled water to be used for groundwater recharge and to operate the Talbert Seawater Intrusion Barrier. The TDS of water produced by GWRS is approximately 50 mg/L. Recharging the groundwater basin with this water supply significantly improves the water quality of the basin.

Septic Systems

Another source of salinity in the basin originates from onsite wastewater treatment systems, commonly known as septic systems. There are an estimated 2,500 septic systems in operation within the OCWD Management Area. Septic systems operate by collecting wastewater in a holding tank and then allowing the liquid fraction to leach out into the underlying sediments where it becomes filtered and eventually becomes part of the groundwater supply. A properly maintained system can be effective at removing many contaminants from the wastewater but salts remain in the leachate. Septic systems are typically in older communities that were developed prior to the construction of sewer systems or located in an area some distance from existing sewers. The State Water Board and Regional Water Board regulate the siting of new septic systems to reduce the possibility of groundwater contamination. Within Orange County, water districts and local officials work to expand sewer systems in order to reduce the use of septic systems to the extent feasible and economical.

Nitrogen and Selenium Management Program

Selenium is a naturally-occurring micronutrient found in soils and groundwater in the Newport Bay watershed. Selenium is essential for reproductive health and immune system function in humans, fish and wildlife. However, selenium bio-accumulates in the food chain and can result in deformities, stunted growth, reduced hatching success, and suppression of immune systems in fish and wildlife.

Prior to urban development, in the western portion of the Irvine Subbasin was an area of shallow groundwater that contained an area known as the Swamp of the Frogs (Cienega de Las Ranas). Runoff from local foothills over several thousands of years accumulated selenium-rich deposits in the swamp. To make this region suitable for farming, drains and channels were constructed in the early 1900s. This mobilized selenium from sediments into the shallow groundwater drained by the channels that eventually discharge to Newport Bay.

The Nitrogen and Selenium Management Program was formed to develop and implement a work plan to address selenium and nitrate in the watershed. This stakeholder working group that includes the County of Orange, affected cities, environmental organizations, Irvine Ranch Water District, the Irvine Company and the Regional Water Board are implementing a long-term work plan. Management of selenium is difficult as there is no off-the-shelf treatment technology available.

Groundwater Desalters and the Inland Empire Brineline and Non-Reclaimable Waste Line

Several water treatment plants that are designed to remove salts from groundwater, commonly referred to as desalters, have been built in Orange, Riverside, and San Bernardino counties. These plants are effectively reducing the amount of salt buildup in the watershed. Managing salinity in the upper watershed is important to OCWD as this protects the water quality in the Santa Ana River that is used in Orange County for groundwater recharge. The Inland Empire Brine Line, formerly called the Santa Ana Regional Interceptor (SARI), built by SAWPA, has operated since 1975 to remove salt from the watershed by transporting industrial wastewater and brine produced by desalter operations directly to OCSD for treatment.

The other brine line in the upper watershed, the Non-Reclaimable Waste Line in the Chino Basin operated by the Inland Empire Utilities Agency (IEUA), segregates high TDS industrial wastewater and conveys this flow to Los Angeles County for treatment and disposal.

In Orange County, salinity management projects include groundwater desalters located in the cities of Tustin and Irvine that are pumping and treating high salinity groundwater. The saline groundwater in Tustin and Irvine is a combination of naturally occurring salts and impacts from past agricultural activities.

Basin Monitoring Program Task Force

In 1995, a task force of over 20 water and wastewater resource agencies and local governments, including OCWD, initiated a study to evaluate the impacts to groundwater quality of elevated levels of total inorganic nitrogen (TIN) and total dissolved solids (TDS) in the watershed. This study was completed and resulted in adoption in 2004 of amendments to the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan). This nearly 10-year effort involved collecting and analyzing data in 25 newly defined groundwater management zones in the watershed to recalculate nitrogen and TDS levels and to establish new water quality objectives.

One major challenge of this effort was developing the tools and collecting data to assess and monitor surface water and groundwater interactions. Although typically regulated and managed separately, stakeholders recognized that surface water and groundwater in the watershed are interconnected and as such protection of these resources would require a comprehensive program. Models were developed and data collected to enable an evaluation of the potential short-term and long-term impacts on water resources due to changes in land use, the quantity and quality of runoff, and point source discharges.

The Basin Plan charges the Task Force with implementing a watershed-wide TDS/Nitrogen management program. Task Force members agreed to fund and participate in a process to recalculate ambient water quality every three years in each of the 25 groundwater management zones and to compare water quality to the water quality objectives in order to measure compliance with the Basin Plan. The latest recalculation, the third since adoption of the amendment, was completed in 2014 (Wildermuth, 2014).

Salinity Management and Imported Water Recharge Workgroup

The Salinity Management and Imported Water Recharge Workgroup, in cooperation with the Regional Water Board, implements a cooperative agreement signed in 2008 by water agencies that use imported water for groundwater recharge. The objective of this effort is to evaluate and monitor the long-term impacts of recharging groundwater basins with imported water. The workgroup analyzes water quality data and estimates future conditions to evaluate the potential impact of recharging imported water. TDS and nitrate data are collected and analyzed to determine whether the intentional recharge of imported water may have adverse impacts on compliance with salinity objectives in the region.

Management of Nitrates

OCWD regularly monitors nitrate levels in groundwater and works with Groundwater Producers to treat individual wells when nitrate concentrations exceed safe levels. Construction of the Tustin Main Street Treatment Plant is an example of such an effort.

Within Orange County, nitrate (as N) levels in groundwater generally range from 4 to 7 mg/L in the Forebay area and from 1 to 4 mg/L in the Pressure area. One of OCWD's programs to reduce nitrate concentrations in groundwater is managing the nitrate concentration of water recharged in OCWD facilities. This includes managing the quality of surface water flowing to Orange County through Prado Dam. To reduce nitrate concentrations in Santa Ana River water, OCWD owns and operates an extensive system of wetlands in the Prado Basin.

The 465-acre Prado Constructed Wetlands, shown in Figure 6-2 are designed to remove nitrogen and other contaminants from the Santa Ana River before the water is diverted from the river in Orange County for recharge through OCWD's surface water recharge system. The majority of the baseflow (non-stormwater flow) in the Santa Ana River is comprised of treated wastewater. On an annual basis, about 50 percent of the SAR flow entering the Prado Basin is treated wastewater, but during summer months, treated wastewater can comprise more than 90 percent of the baseflow. OCWD diverts approximately half of the base flow of the Santa Ana River through the wetland ponds, which remove an estimated 15 to 40 tons of nitrate a month depending on the time of year. The wetlands are more effective from May through October when the water temperatures are warmer and daylight hours are longer. During summer months the wetlands reduce nitrate from nearly 10 mg/L to 1 to 2 mg/L.

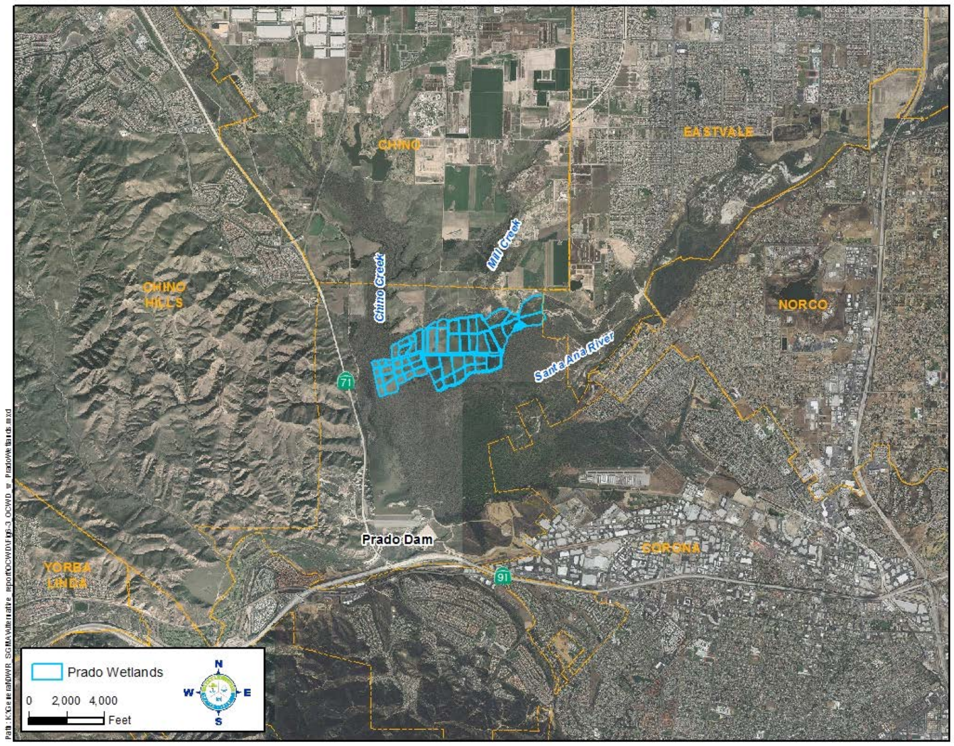


Figure 6-2: OCWD Prado Wetlands

6.2.3 Regulation and Management of Contaminants

A variety of federal, state, county and local agencies have jurisdiction over the regulation and management of hazardous substances and the remediation of contaminated groundwater supplies. OCWD does not have regulatory authority to require responsible parties to clean up pollutants that have contaminated groundwater. In some cases, OCWD has pursued legal action against entities that have contaminated the groundwater basin to recover OCWD's remediation costs or to compel those entities to implement remedies. OCWD also coordinates and cooperates with regulatory oversight agencies that investigate sources of contamination. OCWD efforts to assess the potential threat to public health and the environment from contamination in the Santa Ana River Watershed and within the County of Orange include:

- Reviewing ongoing groundwater cleanup site investigations and commenting on the findings, conclusions, and technical merits of progress reports;
- Providing knowledge and expertise to assess contaminated sites and evaluating the merits of proposed remedial activities; and
- Conducting third-party groundwater split samples at contaminated sites to assist regulatory agencies in evaluating progress of groundwater cleanup and/or providing confirmation data of the areal extent of contamination.

The following is a summary of the potential contaminants of greatest concern for basin water quality management.

Methyl Tertiary Butyl Ether (MTBE)

Methyl tertiary butyl ether (MTBE) is a synthetic, organic chemical that was added to gasoline to increase octane ratings during the phase-out of leaded gasoline. In the mid-1990s, the percentage of MTBE added to gasoline increased significantly to reduce air emissions. MTBE is a serious threat to groundwater quality as it sorbs weakly to soil and does not readily biodegrade. The greatest source of MTBE contamination comes from underground fuel tank releases. The State of California banned the use of the additive in 2004 in response to its widespread detection in groundwater throughout the state.

In 2003, OCWD filed suit against numerous oil and petroleum-related companies that produce, refine, distribute, market, and sell MTBE and other oxygenates. The suit seeks funding from these responsible parties to pay for the investigation, monitoring and removal of oxygenates from the basin.

Volatile Organic Compounds

Volatile organic compounds (VOCs) in groundwater come from a number of sources. From the late 1950s through early 1980s, VOCs were used for industrial degreasing in metals and electronics manufacturing. Other common sources include paint thinners and dry cleaning solvents. OCWD's comprehensive water quality monitoring programs include testing for a wide-range of potential VOC contaminants in order to discover incidents of groundwater contamination at the earliest possible stage.

N-Nitrosodimethylamine (NDMA)

N-Nitrosodimethylamine (NDMA) is a low molecular weight compound that can occur in wastewater after disinfection of water or wastewater via chlorination and/or chloramination. It is also found in food products such as cured meat, fish, beer, milk, and tobacco smoke. OCWD routinely monitors for NDMA in the groundwater and in water supplies used for recharge.

Dioxane

A suspected human carcinogen, 1,4-dioxane, is used as a solvent in various industrial processes such as the manufacture of adhesive products and membranes and may be present in consumer products such as detergents, cosmetics, pharmaceuticals, and food products.

Constituents of Emerging Concern

Constituents of emerging concern (CECs) are synthetic or naturally occurring substances that are not formally regulated in water supplies or wastewater discharges but can now be detected using very sensitive analytical techniques. One of the newest groups of constituents of emerging concern includes pharmaceuticals, personal care products and endocrine disruptors. Due to the potential impact of EDCs on water reclamation projects, OCWD prioritizes monitoring of these chemicals.

OCWD's state-certified laboratory is one of a few in the state that has a program to continuously develop capabilities to analyze for new compounds and works on developing low detection levels for chemicals likely to be targeted for future regulation or monitoring.

OCWD advocates the following general principles as water suppliers and regulators develop programs to protect public health and the environment from adverse effects of CECs:

- Monitoring should focus on constituents that pose the greatest risk.
- Constituents that are prevalent, persistent in the environment, and may occur in unsafe concentrations should be prioritized.
- Analytical methods to detect these constituents should be approved by the state or federal government.
- Studies to evaluate the potential risk to human health and the environment should be funded by the state or federal government.
- The state and federal government should encourage programs to educate the public on waste minimization and proper disposal of unused pharmaceuticals.

OCWD is committed to (1) track new compounds of concern; (2) research chemical occurrence and treatment; (3) communicate closely with the Division of Drinking Water on prioritizing investigation and guidance; (4) coordinate with Orange County Sanitation District, upper watershed wastewater dischargers and regulatory agencies to identify sources and reduce contaminant releases; and (5) inform the Groundwater Producers on emerging issues.

6.3 RECYCLED WATER PRODUCTION

6.3.1 Overview

The Groundwater Replenishment System (GWRS) is a joint project built by OCWD and the Orange County Sanitation District that began operating in 2008. Wastewater that otherwise would be discharged to the Pacific Ocean is purified using a three-step advanced process to produce high-quality water used to control seawater intrusion and recharge the groundwater basin. The GWRS produces up to 100 million gallons per day (mgd) of highly-treated recycled water. Plans are underway for expansion of GWRS to increase total capacity to 130 mgd. The system includes three major components (1) the Advanced Water Purification Facility (AWPF), (2) the Talbert Seawater Intrusion Barrier, and (3) recharge basins where GWRS water is percolated into the groundwater basin, schematically illustrated in Figure 6-3.

Secondary-treated wastewater is conveyed to OCWD from OCSD Plant No.1, located adjacent to OCWD's facilities in Fountain Valley. The water undergoes an advanced treatment process that includes microfiltration, reverse osmosis and advanced oxidation/disinfection with hydrogen peroxide and ultraviolet light exposure followed by de-carbonation and lime stabilization. The Full Advanced Treated water is used for groundwater recharge, to supply the Talbert Seawater Barrier and provide recycled water for three industrial/commercial users. On average, 34 percent of the water is injected in the Talbert Barrier and 66 percent is percolated in the recharge basins. Industrial and commercial uses include cooling water for the City of Anaheim's Canyon Power Plant, recycled water for the Anaheim Regional Transportation Intermodal Center, and hydrostatic testing of new secondary treatment basins at OCSD Plant No.1.

GWRS water is recharged in Kraemer, Miller and Miraloma basins, located in the city of Anaheim. Water is conveyed to these basins through a 13-mile pipeline in the west levee of the Santa Ana River through the cities of Fountain Valley, Santa Ana, Orange, and Anaheim and along the Carbon Canyon Diversion Channel. Five feet in diameter at its end point, this pipeline is capable of delivering over 80 million gallons of highly-treated recycled water to the basins each day.

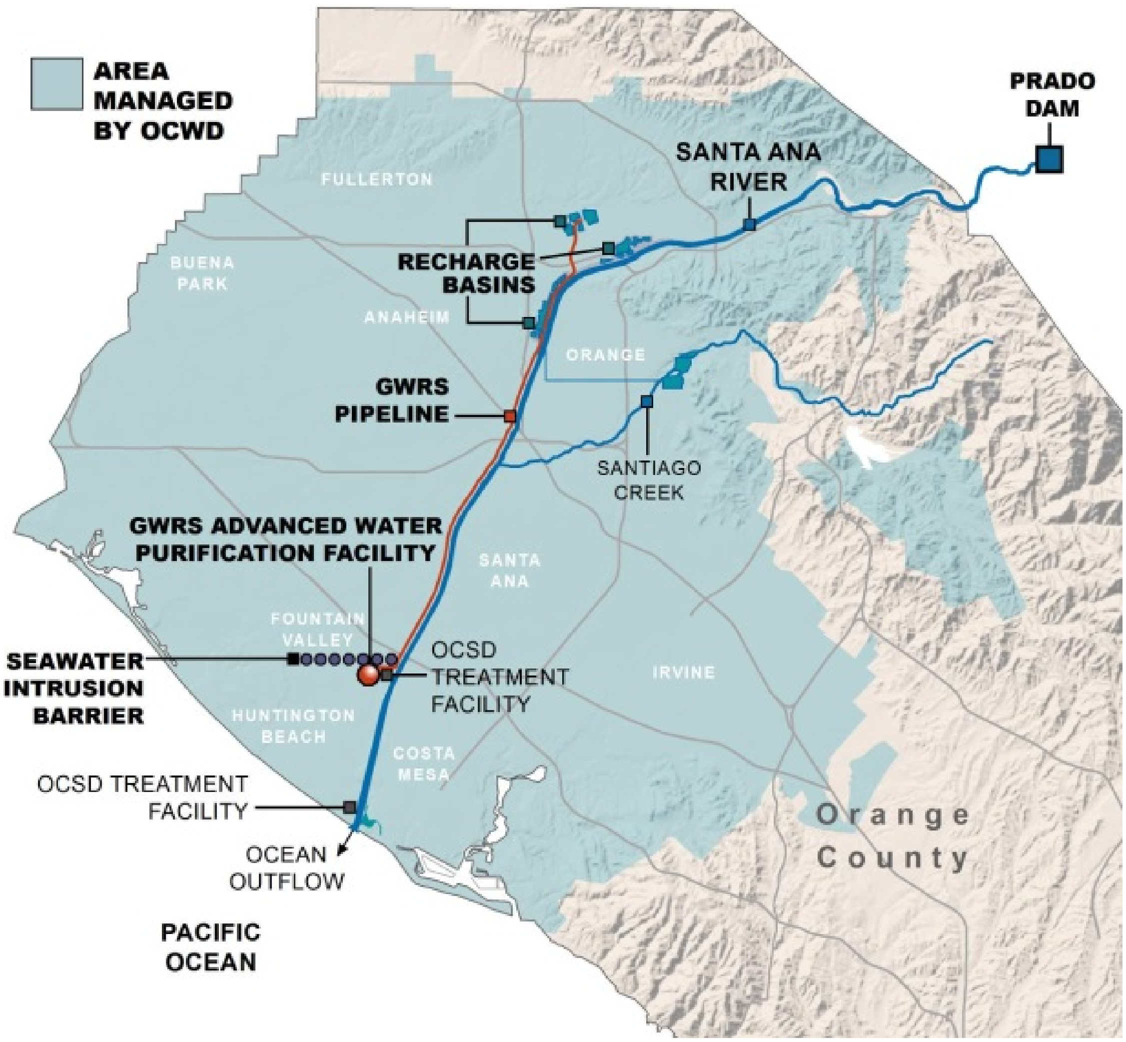


Figure 6-3: Groundwater Replenishment System

6.4 CONJUNCTIVE USE PROGRAMS

Recharge water sources include water from the Santa Ana River and tributaries, imported water, and recycled water supplied by the GWRS as well as incidental recharge from precipitation and subsurface inflow. OCWD owns over 1,500 acres of land on which there are 1,067 wetted acres of recharge facilities. These facilities are located in the Forebay of the groundwater basin adjacent to the Santa Ana River and Santiago Creek.

Managed aquifer recharge began in the 1930s, in response to declining water levels in the basin. OCWD began purchasing portions of the river channel, eventually acquiring six miles of the channel in Orange County, in order to maximize the recharge of Santa Ana River water to the basin.

Recharge of imported water began in 1949 when OCWD began purchasing Colorado River water from MWD. In 1958, OCWD purchased and excavated a 64-acre site one mile north of the Santa Ana River to create Anaheim Lake, OCWD's first recharge basin. Today OCWD operates a network of 25 facilities that recharge an average of over 230,000 afy.

6.4.1 Sources of Recharge Water Supplies

Water supplies used to recharge the groundwater basin are listed in Table 6-1. Figure 6-4 shows the historical recharge by source from 1936 to 2016. Table 6-2 shows the average annual recharge by source between WY 2006-07 and 2015-16.

Santa Ana River

Water from the Santa Ana River is a primary source of water used to recharge the groundwater basin. OCWD diverts river water into recharge facilities where the water percolates into the groundwater basin. Recharge facilities are capable of recharging all of the baseflow. Both the Santa Ana River baseflow and storm flow vary from year to year as shown in Figure 6-5. Recent trends show a decline in baseflow, which may be a result of increased recycling, drought conditions, and declining per capita water use in the upper watershed. The volume of storm water that can be recharged into the basin is highlight dependent on the amount and timing of precipitation in the upper watershed, which is highly variable, as shown in Figure 6-6. OCWD has water rights to all storm flows that reach Prado Dam. When storm flows exceed the capacity of the diversion facilities, river water reaches the ocean and this portion is lost as a water supply.

Santiago Creek

Santiago Creek is the primary drainage for the northwest portion of the Santa Ana Mountains and ultimately drains into the Santa Ana River. OCWD captures and recharges water in Santiago Creek that flows into the Santiago Recharge Basins. During dry periods, the Santiago basins are used to recharge Santa Ana River flows which are pumped to the basins.

Table 6-1: Sources of Recharge Water Supplies

SUPPLY SOURCES AND DESCRIPTION			RECHARGE LOCATION
Santa Ana River	Base Flow	Perennial flows from the upper watershed in Santa Ana River; predominately treated wastewater discharges	Santa Ana River, recharge basins, and Santiago Creek
	Storm Flow	Precipitation from upper watershed flowing in Santa Ana River through Prado Dam	Santa Ana River, recharge basins, and Santiago Creek
Santiago Creek	Storm Flow / Santa Ana River	Storm flows in Santiago Creek and Santa Ana River water pumped from Burris Basin via Santiago Pipeline	Santiago Creek, Santa Ana River, recharge basins
Incidental Recharge	Precipitation and subsurface inflow	Precipitation and runoff from Orange County foothills, subsurface inflow from basin boundaries	Basin-wide
Recycled Water	Groundwater Replenishment System	Advanced treated wastewater produced at GWRS plant in Fountain Valley	Injected into Talbert Barrier; recharged in Kraemer, Miller, and Miraloma basins
	Water Replenishment District of Southern CA	Water purified at the Leo J. Vander Lans Treatment Facility in Long Beach	Injected into Alamitos Barrier
Imported Water	Untreated	State Water Project and Colorado River Aqueduct	Various recharge basins
	Treated	State Water Project and Colorado River Aqueduct treated at MWD Diemer Water Treatment Plant	Injected into Talbert and Alamitos Barriers

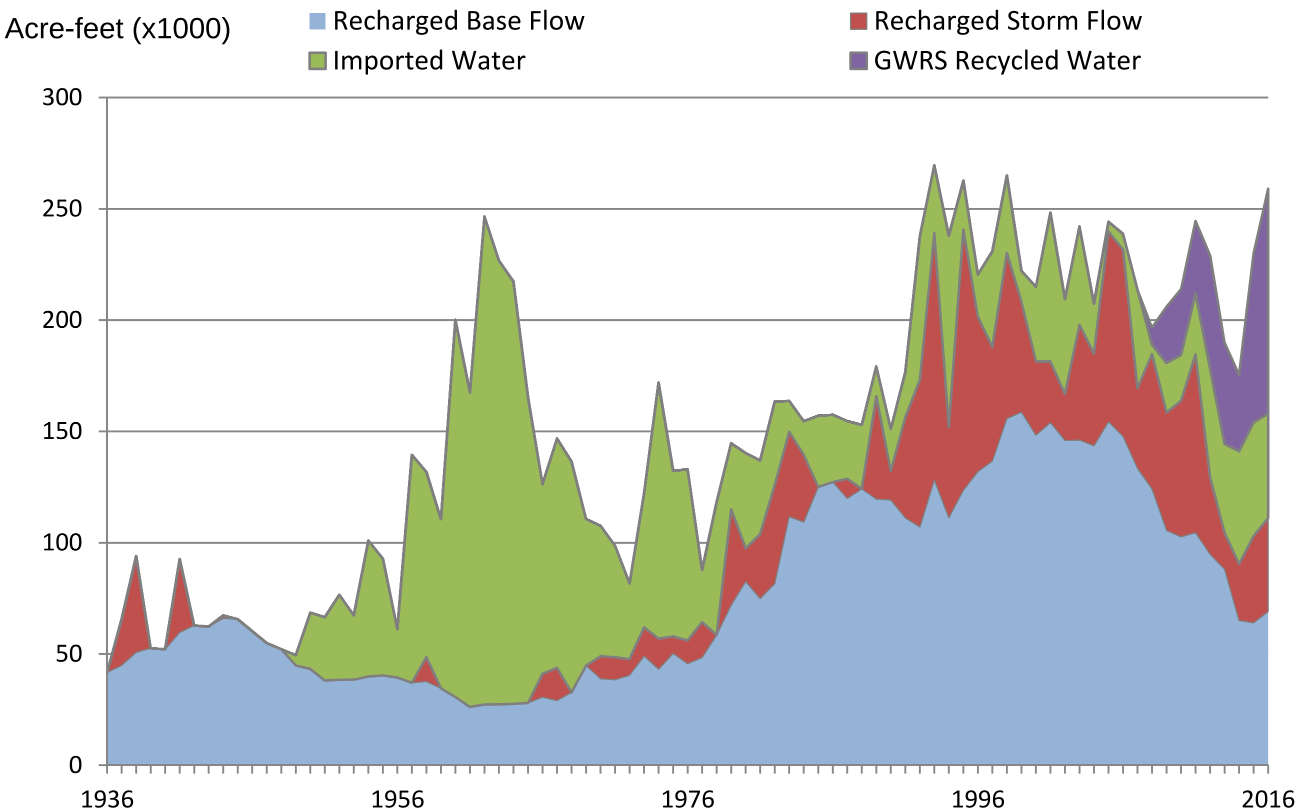


Figure 6-4**:** Historical Recharge in Surface Water Recharge System

Table 6-2: Annual Recharge by Source, Water Year 2006-07 to 2015-16 (acre-feet)

Water year	Santa Ana River Base Flow	Santa Ana River Storm Flow	Recycled Water	Imported Water	In-Lieu	Incidental Recharge	Total
2006-07	133,000	39,000	400	111,000	37,000	14,000	334,400
2007-08	122,000	61,000	18,000	15,000	0	46,000	262,000
2008-09	106,000	52,000	55,000	33,000	0	68,000	334,000
2009-10	103,000	59,000	67,000	22,000	0	83,000	332,000
2010-11	104,000	78,000	67,000	36,000	10,000	94,000	389,000
2011-12	95,000	32,000	72,000	90,000	31,000	27,000	347,000
2012-13	85,000	18,000	73,000	41,000	0	20,000	237,000

Water year	Santa Ana River Base Flow	Santa Ana River Storm Flow	Recycled Water	Imported Water	In-Lieu	Incidental Recharge	Total
2013-14	65,000	25,000	66,000	53,000	0	32,000	241,000
2014-15	63,000	39,000	76,000	51,000	0	50,000	279,000
2015-16	69,000	42,000	101,000	47,000	0	42,000	259,000
Average	95,000	45,000	60,000	50,000	8,000	48,000	304,000
Average %	31%	15%	19%	16%	3%	16%	100%

Notes: (1) "Storm Water" includes total storm flow recharged in both the Santa Ana River and Santiago Creek, a tributary of the Santa Ana River (2) "Imported water" includes water used for Alamitos and Talbert Barriers, water purchased by and recharged by OCWD, MWD CUP supply and MWD CUP in lieu supply recharged in the Forebay.

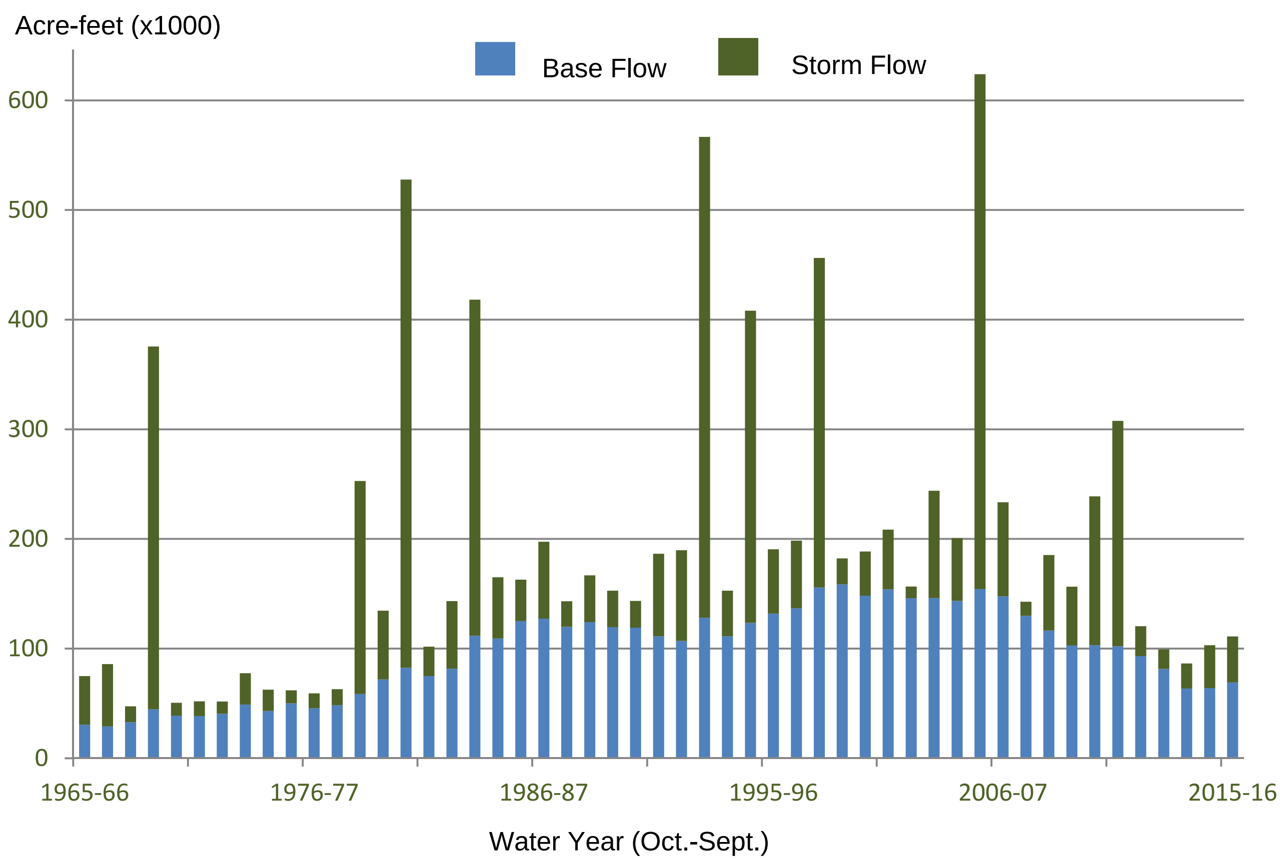


Figure 6-5: Annual Base and Storm Flow in the Santa Ana River at Prado Dam
Source: Santa Ana River Watermaster, 2014

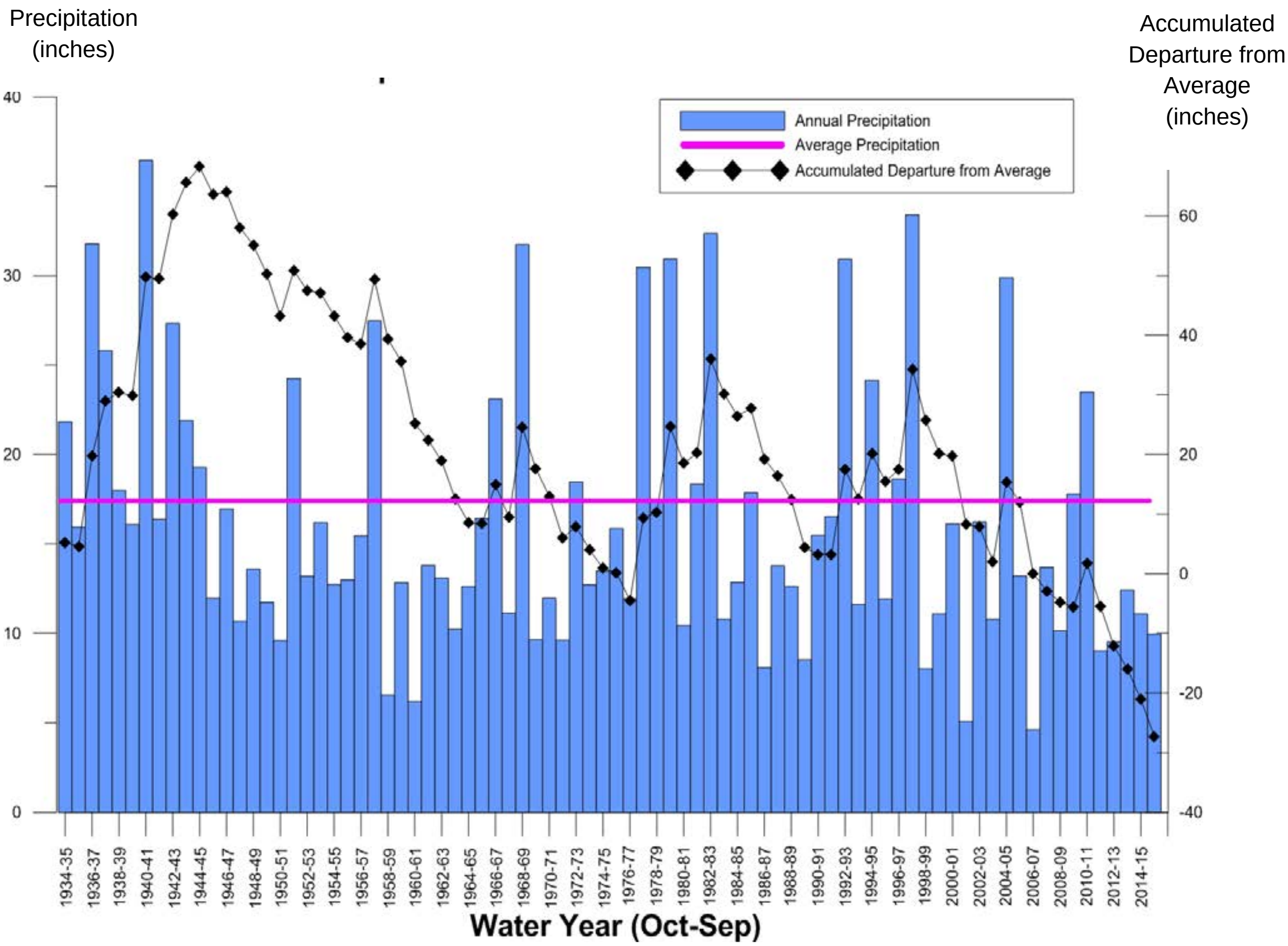


Figure 6-6: Precipitation at San Bernardino, Water Year (Oct.-Sept.) 1934-35 to 2015-16

Incidental Recharge

Also discussed in Section 4.1, l incidental recharge is comprised of subsurface inflow from the local hills and mountains, infiltration of precipitation and irrigation water, recharge in small flood control channels, and groundwater underflow to and from Los Angeles County and the ocean. Since the amount of incidental recharge cannot be directly measured, it is also referred to as unmeasured recharge. Each year, an estimate is made of the amount of net incidental recharge based on OCWD's annual groundwater storage calculation. In general, since the Central Basin in Los Angeles County is usually operated at a lower level than the Orange County basin, there is usually a net flow of water out of the Orange County basin to the Central Basin. This outflow is subtracted from the total incidental recharge to get the net incidental recharge to the basin, which is the value reported in this document. Figure 6-7 shows the amount of net incidental recharge from WY 2000-01 to 2013-14. Note the correlation between amount of precipitation and net incidental recharge.

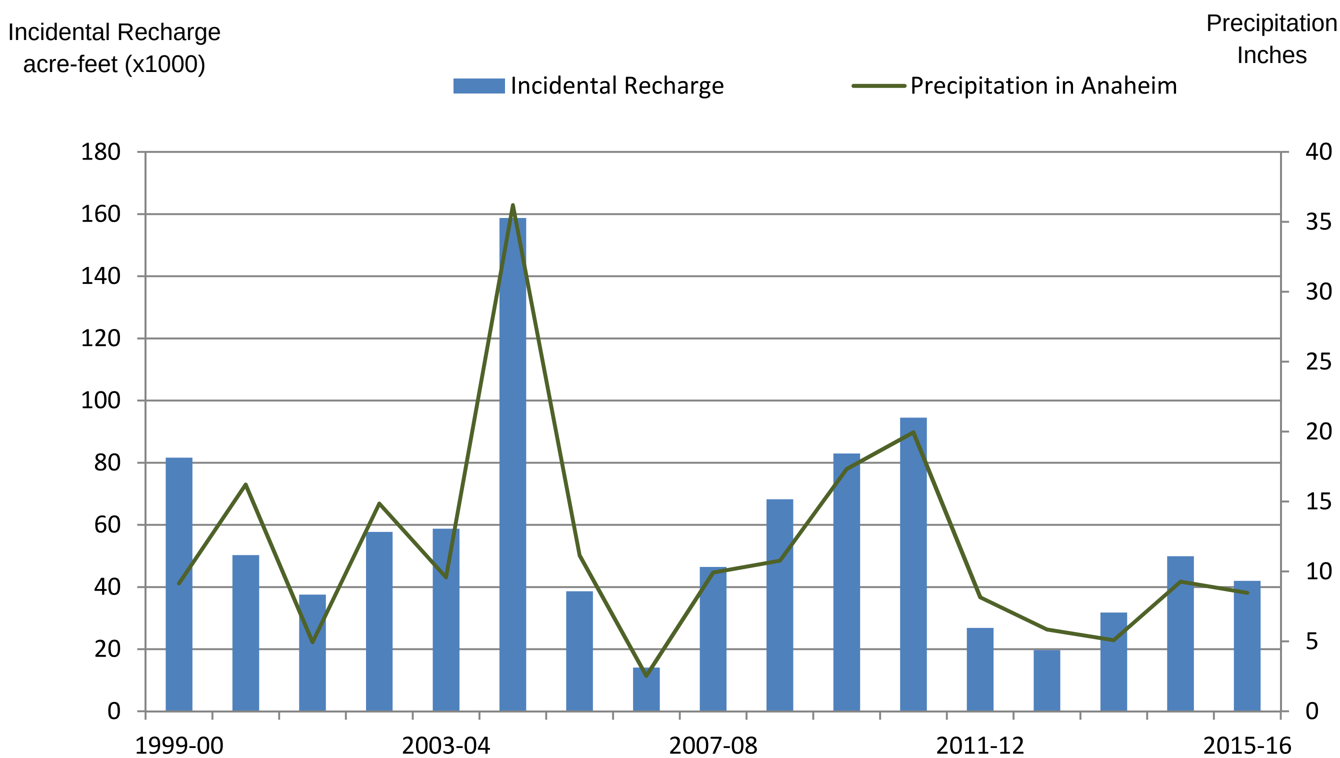


Figure 6-7: Net Incidental Recharge and Precipitation, WY 1999-00 to WY 2015-16

Recycled Water

The basin receives two sources of recycled water for recharge, the GWRS and the Leo J. Vander Lans Treatment Facility that supplies water to the Alamitos Seawater Barrier. Only a portion of the water recharged in the Alamitos Barrier recharges the Orange County Groundwater Basin with the remainder recharging the Central Basin in Los Angeles County.

Imported Water

OCWD purchases imported water for recharge from the Municipal Water District of Orange County (MWDOC), which is a member agency of MWD. Untreated imported water can be delivered to the surface water recharge system in multiple locations, including Anaheim Lake (OC-28/28A), Santa Ana River (OC-11), Irvine Lake (OC-13A), and San Antonio Creek near the City of Upland (OC-59). These locations are shown in Figure 6-8. Connections OC-28, OC-11 and OC-13 supply OCWD with Colorado River Aqueduct water. Connection OC-59 supplies OCWD with State Water Project water, and OC-28A supplies OCWD with a variable blend of water from these two sources.

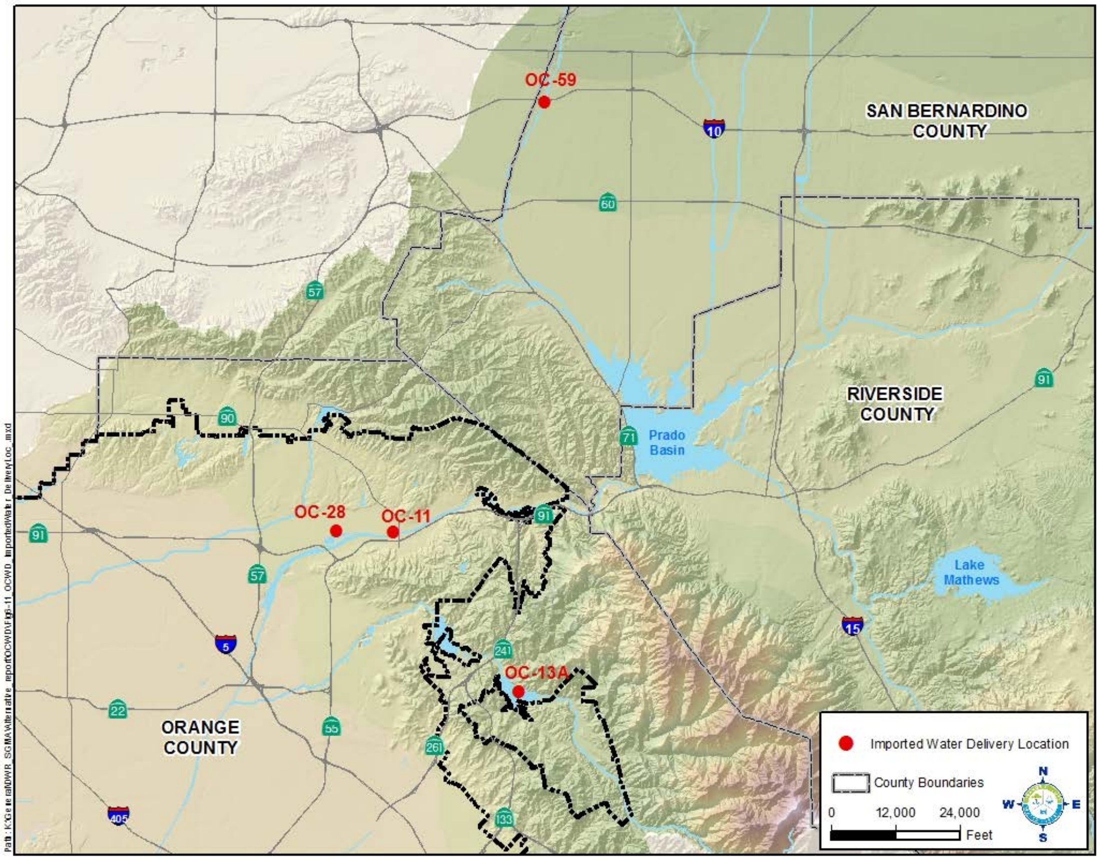


Figure 6-8: Locations of Imported Water Deliveries

6.4.2 Surface Water Recharge Facilities

OCWD's surface water recharge system is comprised of 24 facilities covering over 1,000 wetted acres and a total storage capacity of approximately 26,000 acre-feet. The locations of these facilities are shown in Figure 6-9. OCWD carefully tracks the amount of water being recharged in each facility on a daily basis.

Three full-time hydrographers control and monitor the recharge system. These hydrographers and other OCWD staff prepare a monthly *Water Resources Summary Report*, which lists the source and volume for each recharge water supply, provides an estimate of the amount of water percolated in each recharge basin, documents total groundwater production from the basin, and estimates the change in groundwater storage. The report also estimates the amount of incidental recharge, evaporation and losses to the ocean – essentially a monthly water budget accounting. The monthly figures are compiled to determine yearly recharge and production totals and used in the year-end determination of groundwater storage change.

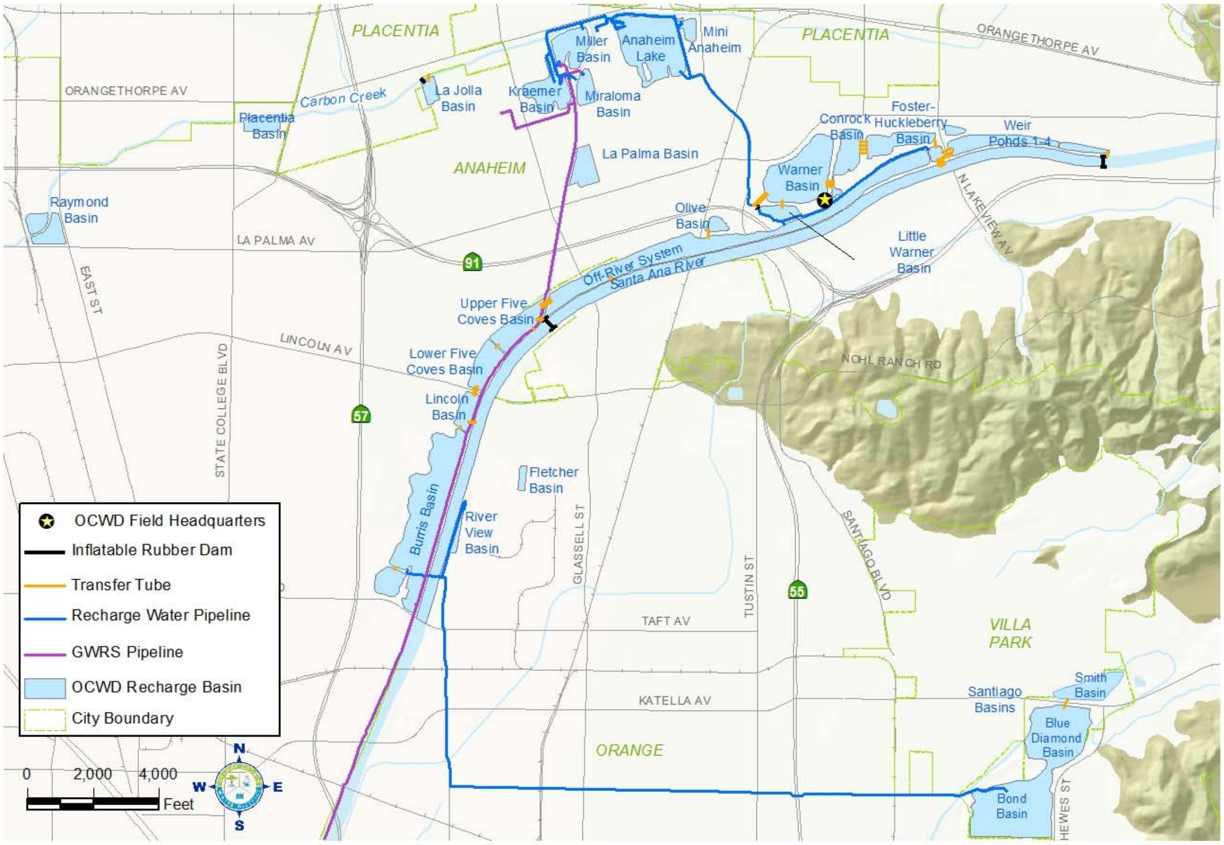


Figure 6-9: OCWD Surface Water Recharge Facilities

6.5 MANAGEMENT OF SEAWATER INTRUSION

In the coastal area of Orange County, the primary source of saline groundwater is seawater intrusion into the groundwater basin through permeable sediments underlying topographic lowlands or gaps between the erosional remnants or mesas of the Newport-Inglewood Uplift. The susceptible locations are the Talbert, Bolsa, Sunset, and Alamitos gaps as shown previously in Figure 3-26.

Seawater intrusion in the Talbert Gap area began as early as the 1920s as the previously flowing artesian conditions within the shallow Talbert aquifer were gradually lowered until groundwater levels declined below sea level due to unrestricted agricultural pumping. By the 1930s and 1940s, seawater had advanced more than one mile inland within the Talbert Gap, forcing the closure of municipal supply wells owned and operated by the cities of Newport Beach and Laguna Beach due to elevated salinity.

Seawater intrusion became a critical problem in the 1950s. Overdraft of the basin caused water levels to drop as much as 40 feet below sea level. By the mid-1960s seawater had intruded nearly four miles inland within the Talbert Gap. Intrusion was also observed in the Alamitos Gap area along the Orange County/Los Angeles County border. During the 1950s and 1960s seawater intrusion investigations in coastal Orange County were conducted by the USGS, DWR and OCWD to define the nature and extent of the problem. During this time, OCWD slowed seawater intrusion by filling the basin with imported Colorado River water in the Anaheim Forebay area, thus reducing the overdraft throughout the basin and raising coastal groundwater levels (DWR, 1966).

Largely based on the 1966 DWR study, OCWD constructed the initial Talbert Seawater Intrusion Barrier in 1975 with 23 injection well sites. In 1965, a line of injection wells was constructed across the Alamitos Gap to form a subsurface freshwater hydraulic barrier. The Alamitos and Talbert barriers control seawater intrusion in their respective gaps by injecting fresh water into a series of multi-depth wells targeting each individual aquifer zone that is susceptible to seawater intrusion. The pressure mound resulting from this injection minimizes seawater intrusion through these gaps into the basin.

Both the Alamitos and Talbert barriers have been expanded and improved periodically and have allowed the basin to be operated more flexibly as a storage reservoir with an operating range of 500,000 acre-feet below full condition.

In July 2014, the OCWD Board of Directors adopted a Seawater Intrusion Prevention Policy that contained the following tenets:

- Prevent degradation of the quality of the groundwater basin from seawater intrusion.
- Effectively operate and evaluate the performance of the seawater barrier facilities.
- Adequately identify and track trends in seawater intrusion in susceptible coastal areas and evaluate and act upon this information, as needed, to protect the groundwater basin.

6.5.1 Talbert Seawater Intrusion Barrier

The Talbert Barrier consists of 36 injection well sites, shown in Figure 3-26, with the primary alignment along Ellis Avenue approximately four miles inland from the ocean. Barrier injection raises groundwater levels in the immediate vicinity and thus creates a groundwater mound that acts as a hydraulic barrier to seawater that would otherwise migrate inland toward areas of groundwater production.

From 1975 until 2008, a blend of deep well water, imported water and recycled water from the former Water Factory 21 was injected into the barrier. In 2008, GWRS recycled water became the primary supply used for the injection wells, with a small and intermittent portion of the supply from potable imported water delivered via the City of Huntington Beach at the OC-44 turnout and potable water delivered by the City of Fountain Valley (a blend of groundwater and imported water). Since approval by the Regional Water Board in 2009, OCWD uses recycled water for all of the injection well supply at the Talbert Barrier.

Prior to GWRS, barrier capacity averaged approximately 15 MGD but now averages approximately 30 MGD with a typical seasonal range of 20 to nearly 40 MGD. The approximately doubled injection capacity was necessary to prevent seawater intrusion as groundwater production increased and was made possible by construction of additional injection wells and pipelines, superior water quality (100% purified recycled water), and improved barrier operations, such as more frequent back-washing and rehabilitation. Barrier injection rates are adjusted based on overall basin storage conditions and seasonally varying coastal water levels. Therefore, injection is typically lower in the winter months and higher in the summer when increased coastal production causes lower coastal groundwater levels. Approximately 85 to 90 percent of barrier injection is typically targeted into the shallow and intermediate aquifer zones for seawater intrusion control on an annual basis, while the other 10 to 15 percent goes into the deeper Main aquifer zone primarily for basin replenishment. Based on the much steeper hydraulic gradient inland toward pumping depressions (relative to that toward the coast), OCWD estimates that approximately 95 percent of the water injected at the Talbert Barrier flows inland to replenish the basin, with the remainder ultimately flowing to the ocean as subsurface outflow.

6.5.2 Alamitos Seawater Intrusion Barrier

The Alamitos Barrier Project was initially constructed in 1964 and went into operation in 1965 to create a freshwater pressure ridge to prevent seawater intrusion from migrating through the Alamitos Gap into the Central Basin of Los Angeles County and the Orange County groundwater basin. The barrier alignment straddles the Los Angeles-Orange County border and spans approximately 1.8 miles across the Alamitos Gap from Bixby Ranch Hill in the City of Long Beach to the vicinity of Landing Hill in the City of Seal Beach.

Under the terms of the 1964 Agreement for Cooperative Implementation of the Alamitos Barrier Project (1964 Agreement), the barrier facilities are co-owned by OCWD and the Los Angeles County Flood Control District (LACFCD, a division of LACDPW) and currently include 41 injection wells and 220 active monitoring wells as shown in Figure 3-26. The barrier is operated and maintained by LACDPW under the direction of the Alamitos Barrier Joint Management Committee (JMC), whose membership includes OCWD, LACDPW, Water Replenishment District of Southern California (WRD), City of Long Beach, and Golden State Water Company.

The barrier has been incrementally expanded over time to include the construction of additional injection and monitoring wells. Since the initial 14 injection wells were constructed in 1964, an additional 27 injection wells have been installed over seven phases of well construction.

Similar to the Talbert Barrier, the Alamitos Barrier consists of both nested and cluster-type injection wells screened discretely in each aquifer zone in order to control the injection rate and injection pressure into each targeted aquifer zone independently since each aquifer zone has different physical characteristics and groundwater levels. In addition, there are a couple “dual-point” injection wells that consist of only one well casing but two different screened interval depths separated inside the well by an inflatable packer and two separate injection drop pipes.

SECTION 7 NOTICE AND COMMUNICATION

7.1 DESCRIPTION OF GROUNDWATER USERS

The local agencies that produce the majority of the groundwater from the basin are listed in Table 7-1 with geographic boundaries shown in Figure 3-3. OCWD meets monthly with 19 major water retail agencies, referred to as the Groundwater Producers, to discuss and evaluate basin management issues and proposed projects and work cooperatively among the agencies in the OCWD Management Area.

Table 7-1: Major Groundwater Producers

CITIES		
Anaheim	Huntington Beach	Santa Ana
Buena Park	La Palma	Seal Beach
Fountain Valley	Newport Beach	Tustin
Fullerton	Orange	Westminster
Garden Grove		
WATER DISTRICTS AND WATER COMPANIES		
East Orange County Water District	Mesa Water District	
Golden State Water Company	Serrano Water District	
Irvine Ranch Water District	Yorba Linda Water District	

The monthly meeting with OCWD staff and the Groundwater Producers provides a forum for the Groundwater Producers to provide their input to OCWD on important issues such as:

- Setting the Basin Production Percentage (BPP) each year;
- Reviewing the merits of proposed capital improvement projects;
- Purchasing imported water to recharge the groundwater basin;
- Reviewing water quality data and regulations;
- Maintaining and monitoring basin water quality; and
- Budgeting, replenishment assessment and considering other important policy decisions.

7.2 PUBLIC PARTICIPATION

With passage of the Sustainable Groundwater Management Act (SGMA) in 2014, OCWD began discussing with Groundwater Producers and other stakeholders the potential impacts of this new law and options for compliance within Basin 8-1 and the OCWD Management Area. OCWD held discussions with Groundwater Producers and published articles concerning SGMA in the *Hydrospectives* newsletter, described below in this section. These forums provided opportunities for discussions about SGMA, the option for OCWD to become a Groundwater Sustainability Agency and prepare a Groundwater Sustainability Plan (GSP), and the option to develop an Alternative to a GSP. These discussions included conducting meetings with affected agencies and local and county government representatives in areas within the boundaries of Basin 8-1 both inside and outside of the service area of OCWD. A joint decision was made to proceed with preparation of this Basin 8-1 Alternative for submittal to DWR in compliance with SGMA.

In 2015, stakeholders within the OCWD Management Area participated in the preparation and completion of an update to the OCWD Groundwater Management Plan. This was the fifth update of OCWD's first Groundwater Management Plan adopted in 1989, under authority granted by the OCWD Act. In preparing each of these plan updates, OCWD presented groundwater basin conditions, the status of water supply monitoring, management of recharge operations, operation of seawater intrusion barriers and coastal water quality monitoring, water quality protection programs, and natural resource and collaborative watershed programs. The Groundwater Management plans were prepared to evaluate basin conditions and to document the continuing long-term sustainable management of the groundwater basin, and provided the foundation for the preparation of the Basin 8-1 Alternative. Preparation and adoption of the Groundwater Management plans included a public participation component with public notices, newsletter articles, posting on the OCWD website, and meetings with Groundwater Producers (see OCWD Groundwater Management Plan 2015 Update, Appendix A).

The draft Basin 8-1 Alternative, including the OCWD Management Area section, was posted on OCWD's website on November 4, 2016, for public review and comment. Additional public notification of the opportunity to review and comment on the draft document was provided through an article in OCWD's *Hydrospectives* newsletter. The OCWD Board of Directors was presented a draft version of the Basin 8-1 Alternative on November 9, 2016.

7.3 COMMUNICATION PLAN

Proactive community outreach and public education are central to OCWD. OCWD is dedicated to the creation, promotion and management of water education and conservation programs throughout Orange County. Each year, staff members give more than 70 offsite presentations to community leaders and citizens, conduct nearly 200 onsite presentations and tours of OCWD facilities, and take an active part in community events. The goal of OCWD's water-use efficiency and education programs, local water briefings, and outreach to organizations is to draw attention to state and local water needs and current issues, teach useful and simple ways to reduce water consumption and respect this natural resource, and encourage local citizens to make life-long commitments to conserving water. The components that comprise OCWD's water-use efficiency, outreach and public education events and programs are described in this section.

Children's Water Education Festival

The Children's Water Education Festival is the largest event of its kind in the nation, serving approximately 7,000 elementary school students annually. Thanks to more than 400 volunteers and the support of the Disneyland Resort, the National Water Research Institute and OCWD's Groundwater Guardian Team, the Festival celebrated its 20th anniversary in March 2016. The two-day Festival teaches children about water and the environment through hands-on educational activities. Topics include water resources, watersheds, wildlife and natural habitats, biology, chemistry and recycling at this unique event. Since inception, more than 110,000 students have attended.

O.C. Water Hero Program

The O.C. Water Hero Program was designed to make water conservation fun while helping children and parents develop effective water-use efficiency habits that will last a lifetime. When children sign up to commit to saving 20 gallons of water per day, they will enjoy videos, games, trivia, and other incentives they can access via the website and smartphone applications. The purpose of the O.C. Water Hero Program is to raise awareness of the need to conserve water and motivate county residents to reduce their water consumption by 20 gallons per day, per person. Since its inception in 2007, nearly 20,000 Water Heroes and Superheroes have enrolled in the program. In 2015, OCWD revamped the program to upgrade the technology platform in order to increase participation.

Groundwater Guardian

OCWD was recognized by The Groundwater Foundation as a Groundwater Guardian member in 1996, thereafter forming the OCWD Groundwater Guardian Team. This program is designed to empower local citizens and communities to take voluntary steps toward protecting groundwater resources. The OCWD Groundwater Guardian Team primarily supports the Children's Water Education Festival.

Social Media

Social media is a unique opportunity to provide information directly to people interested in OCWD and the topics associated with the organization. Through vehicles such as Facebook, Twitter, YouTube, Instagram and others, OCWD posts information of immediate importance, as well as joins the conversation on trending topics. OCWD engages in social media several times during a given week, primarily to followers of its Facebook and Twitter accounts.

OC Water Summit

The annual OC Water Summit teaches individuals, business, and community and civic leaders where our water comes from, and provides information about the water supply crisis and water quality challenges we face. The event, held annually since 2008, educates the public on what temporary measures are in place to address these issues as well as possible solutions to water reliability and preserving the Bay-Delta Region, California's main source of water. A collaborative effort between businesses, water agencies and local governments, the OC Water Summit provides a platform for individuals in the community to work with water utilities and legislators on creating and implementing solutions that will see Orange County through future water challenges. Topics for each Summit are determined according to the topical water issues each year. This event is hosted in conjunction with the Municipal Water District of Orange County and the Disneyland Resort.

Groundwater Adventure Tour

Nearly 150 guests attend the Groundwater Adventure Tour that takes place each fall. The annual event highlights OCWD operations that include the Groundwater Replenishment System, the Advanced Water Quality Assurance Laboratory, Recharge Operations, and Prado Wetlands. The day's activities are designed to provide an inside look at Orange County's water supply, as well as provide a better understanding of groundwater recharge operations.

Tour attendees include staff from cities, offices of elected officials, water districts, universities, state and county agencies, students, chambers of commerce members, service club members, and other stakeholders. Information is presented to attendees in a variety of formats including speeches, tours, video and question and answer sessions. OCWD executive management and supporting staff share their knowledge and facilitate activities throughout the day.

Website

The Public Affairs Department hosts the OCWD website, www.ocwd.com, to provide information on an array of subjects about OCWD, its board, facilities, and its programs. It includes access to important documents and forms providing transparency and public access. In 2015, OCWD merged the website with a separate site that was dedicated to information about the Groundwater Replenishment System, www.gwrsystem.com . The website helps to engage the citizens of north and central Orange County and water-related agencies to learn more about OCWD's operations.

Hydrospectives Newsletter

The *Hydrospectives* newsletter is a monthly OCWD publication with a circulation of approximately 5,700 subscribers from the water industry, government officials and agencies, OCWD staff, and the general public. It reflects the progress and decisions of OCWD, its achievements and influences and information pertinent to the groundwater industry in north and central Orange County. Each month, it offers a variety of subjects that include a message from the board president, important contributions from departments and staff, global and regional news, and celebrations and accomplishments of which OCWD is a part.

Media Coverage/Exposure

OCWD facilities and programs have been featured in thousands of print and broadcast stories, both mainstream and trade press, locally, nationally and internationally. OCWD and the Groundwater Replenishment System have been featured in National Geographic magazine, Wall Street Journal and on the 60 Minutes television program. They have also been featured in several documentaries including “Tapped – The Movie;” “Ecopolis” and “How Stuff Works” for *Discovery TV*; “Urban Evolution: The Story of Pure Water” for London’s Institution of Engineering & Technology; “America’s Infrastructure Report Card- Water” (ASCE 2009); in an episode of “Off Limits” for the *Travel Channel*; and referenced in the documentary titled “Last Call at the Oasis.”

Facility Tours and Speakers Bureau

OCWD receives hundreds of requests each year to provide tours and briefings for visitors from local colleges, water agencies, the surrounding community, and international organizations. Through its active speaker’s bureau program, OCWD also receives requests for representatives to go out to the community and speak to numerous organizations and schools, as well as at local, national and international conferences.

Since the GWRS came online in January 2008, more than 24,000 visitors have toured the facility. During FY 2013-14, OCWD conducted 198 public tours of the GWRS plant and the Advanced Water Quality Laboratory with a total of 3,432 participants.

Public Tours

Since the GWRS came on-line in January 2008, more than 24,000 visitors have toured the facility. During FY 2013-14, OCWD conducted 198 public tours of the GWRS plant and the Advanced Water Quality Laboratory with a total of 3,432 participants. Tour groups included 10 local high schools and 20 colleges and universities. In addition to many groups from throughout the United States, OCWD hosted tours from China, Korea, Japan, Saudi Arabia, Thailand, Australia, Switzerland, and Russia.

SECTION 8 SUSTAINABLE BASIN MANAGEMENT

8.1 SUSTAINABILITY GOAL

The sustainability goal for the OCWD Management Area is as follows:

> Continue to manage the groundwater basin to prevent basin conditions that would lead to significant and unreasonable undesirable results as defined by California Water Code Section 10721 (x).

Existing monitoring and management programs in place today enable OCWD to sustainably manage the groundwater basin. Since its founding in 1933, OCWD has developed a managed aquifer recharge program, constructed hundreds of monitoring wells, developed water quality monitoring programs, constructed a large surface water recharge system, installed seawater intrusion barriers, and managed the volume of groundwater production through a scientifically-based understanding of the basin's sustainable yield and the use of financial incentives. Continued successful protection of the groundwater basin requires that OCWD's management of the basin be able to adapt to changing conditions affecting the groundwater basin. The following sections describe the sustainable basin management for each of the undesirable results as defined in the California Water Code, Section 10721(x).

SECTION 9 SUSTAINABLE MANAGEMENT RELATED TO GROUNDWATER LEVELS

9.1 HISTORY/SUMMARY

OCWD manages the basin for long-term sustainability by maximizing recharge of the basin and managing basin production within sustainable levels. This section will discuss the relationship between groundwater elevations and sustainable groundwater management.

Groundwater elevations over the last twenty years exhibit short-term changes and long-term (multi-year) trends see Figures 3-11 through 3-14). Short-term elevation changes typically reflect seasonal variations in pumping and recharge, while multi-year trends reflect the effects of extended periods of above- or below-average precipitation and/or availability of imported water.

Groundwater elevation is monitored at over 1,000 individual measuring points, including the key wells designated under the California Statewide Groundwater Elevation Monitoring (CASGEM) program. OCWD was designated the Monitoring Entity for the Orange County groundwater basin under the CASGEM program. As such, OCWD designated key wells distributed laterally and vertically throughout the basin for the purpose of monitoring water elevations over the long-term.

In general, groundwater elevations in the Shallow Aquifer system show less amplitude than those in the underlying Principal and Deep Aquifer systems due to the higher degree of pumping and confinement of the Principal and Deep Aquifer systems. Because approximately 95 percent of all production occurs from wells screened within the Principal Aquifer system, groundwater elevations within this system are typically lower than those in the overlying Shallow Aquifer system and, in some areas, the underlying Deep Aquifer system. Vertical hydraulic gradients created by pumping and recharge drive groundwater into the Principal Aquifer system from the overlying Shallow Aquifer system and, to a lesser extent, from the Deep Aquifer system.

Long-term data demonstrates that groundwater elevations in the basin have exhibited multi-year cyclical patterns and have not experienced chronic lowering due to OCWD's management approach of maintaining basin storage within the established operating range. As a result, the undesirable effect of "chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply" is not occurring in the OCWD Management Area and is not expected to occur in the future as OCWD continues to manage the basin as described in this Basin 8-1 Alternative.

9.2 MONITORING OF GROUNDWATER LEVELS FOR SUSTAINABILITY

As explained in Section 3.2, OCWD monitors water levels at over 1,000 individual measuring points on a monthly or bi-monthly basis to evaluate the effects of pumping, recharge or injection operations. Additional monitoring is conducted as needed in the vicinity of OCWD's recharge facilities, seawater barriers and areas of special investigation where drawdown, water quality impacts or contaminants are of concern.

Groundwater elevation contour maps for the Shallow, Principal and Deep Aquifers are prepared annually and are scanned and digitized into OCWD's GIS database. The changes in groundwater elevations for the three aquifers are also calculated on an annual basis. The contoured water level changes for each of the three aquifers for June 2015 to June 2016 are shown in Figures 9-1, 9-2 and 9-3.

9.3 MANAGEMENT OF GROUNDWATER LEVELS FOR SUSTAINABILITY

For each of the three major aquifer systems, GIS mapping is used to multiply the water level changes by a grid of aquifer storage coefficients from OCWD's calibrated groundwater flow model. This results in a storage change volume for each of the three aquifer layers which are totaled to provide a net annual storage change for the basin. Thus, measurements of groundwater elevations are ultimately used to calculate total basin storage levels each year.

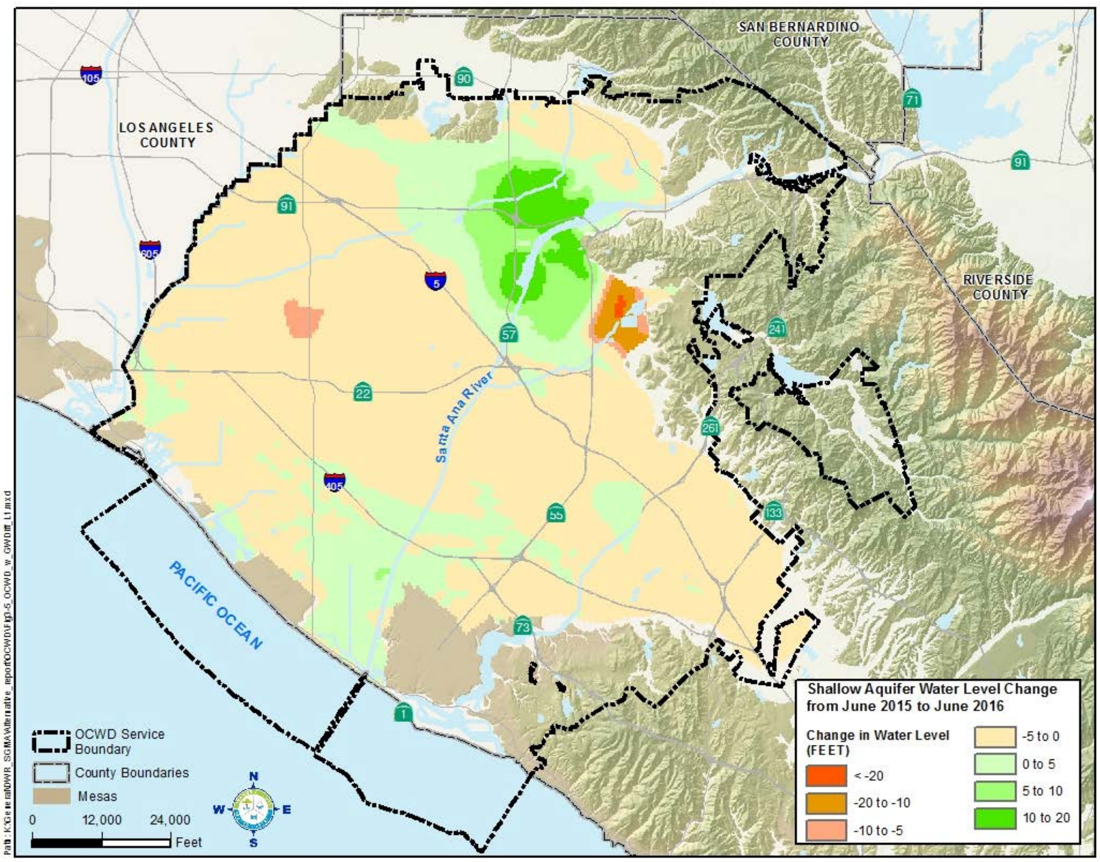


Figure 9-1: Shallow Aquifer Water Level Change, June 2015 to June 2016

In determining the operating range for groundwater storage levels, OCWD considered the potential negative impacts that could occur due to unreasonable and chronic lowering of groundwater elevations. These potential negative impacts include increased costs for groundwater producers to pump groundwater, decreased yield in production wells, increased risk of land subsidence, and increased risk of seawater intrusion.

Monitoring and management of groundwater elevations in the OCWD Management Area is most important in the coastal areas in order to protect groundwater basin water quality from seawater intrusion. Management programs that enable long-term sustainable basin management related to groundwater elevations in the coastal areas include the Coastal Pumping Transfer Program and operation of the Alamitos and Talbert Seawater Intrusion Barriers.

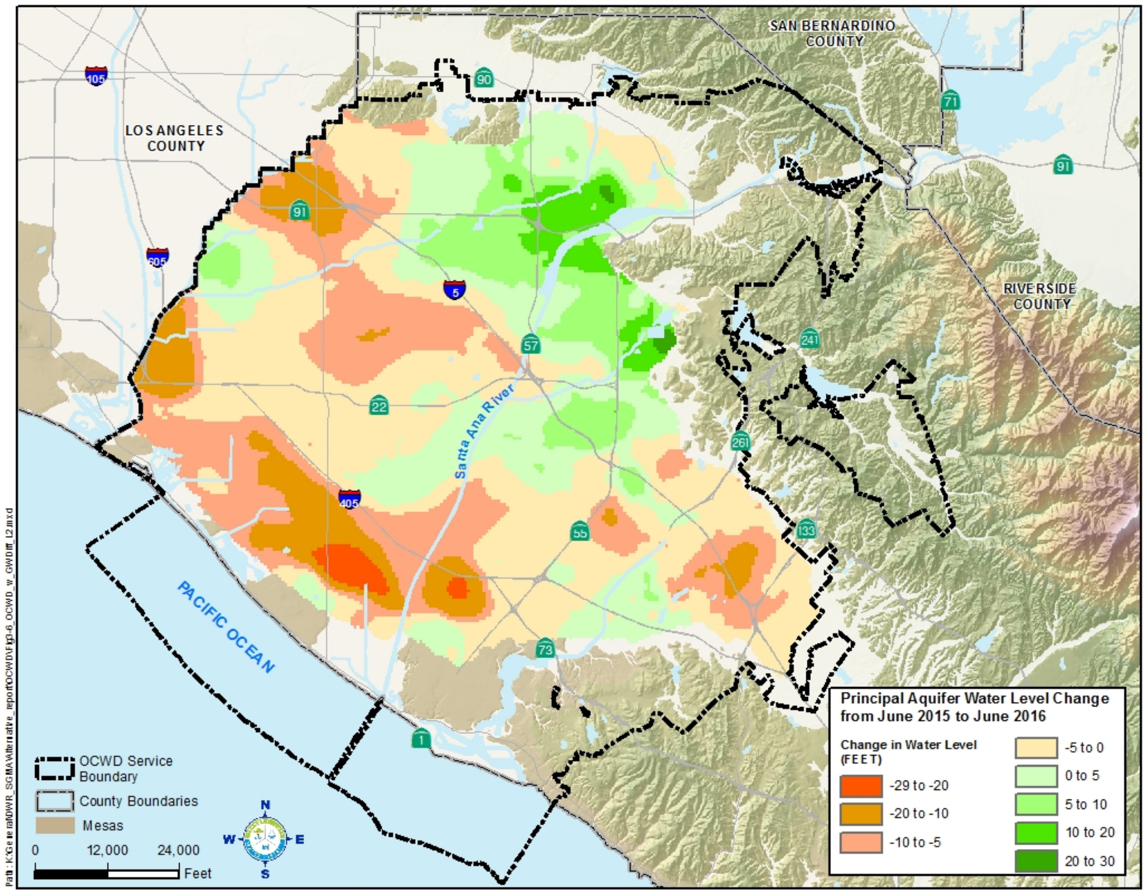


Figure 9-2: Principal Aquifer Water Level Change, June 2015 to June 2016

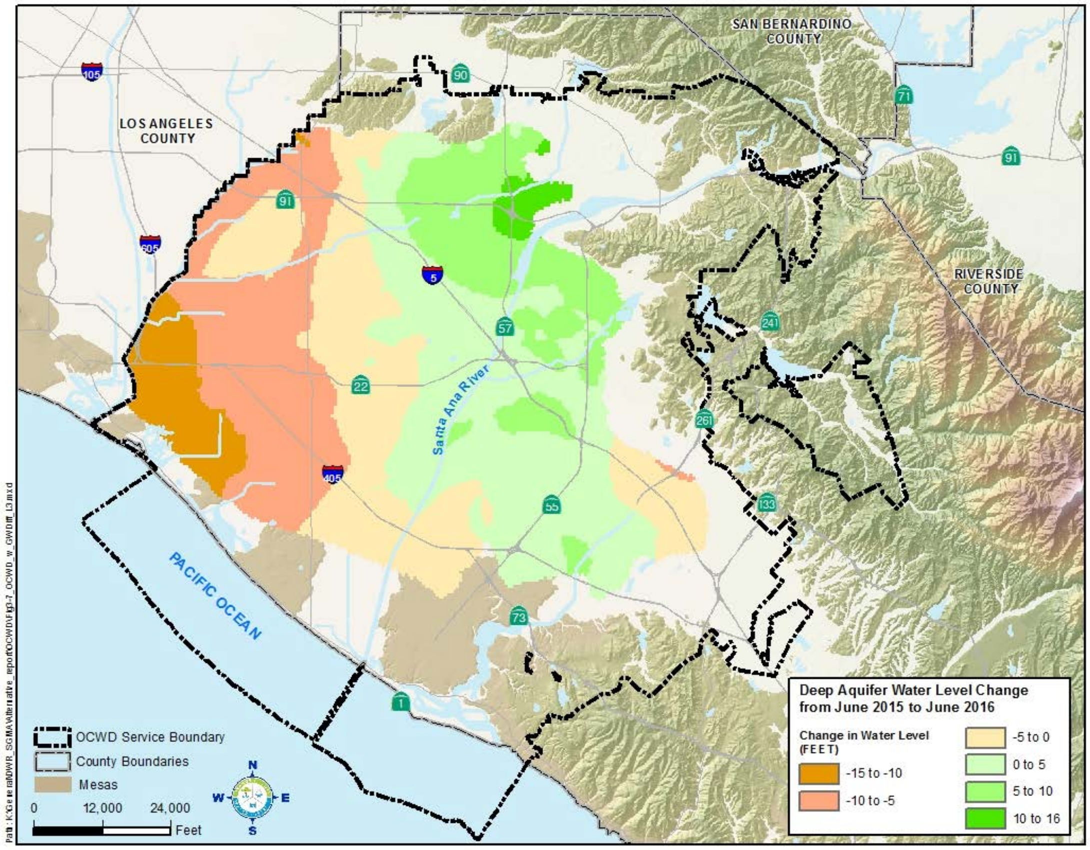


Figure 9-3: Deep Aquifer Water Level Change, June 2015 to June 2016

9.4 DEFINITION OF SIGNIFICANT AND UNREASONABLE LOWERING OF GROUNDWATER LEVELS

OCWD closely monitors groundwater levels in the three major aquifer systems (Shallow, Principal and Deep) for a number of purposes including determination of groundwater storage within the basin. OCWD uses groundwater storage conditions to manage the basin sustainably by keeping storage levels within an operating range up to 500,000 acre-feet below full condition. Significant and unreasonable reduction of groundwater in storage could occur in the event that the volume of groundwater in storage fell below the 500,000 acre-feet below full condition for an extended period of time. If OCWD were to consider an operating range below 500,000 acre-feet from full condition, additional analysis and monitoring would be needed.

9.5 DETERMINATION OF MINIMUM THRESHOLD

The minimum threshold for significant and unreasonable reduction in groundwater levels is reached when the storage volume of the groundwater basin falls below the operating range of up to 500,000 acre-feet below full condition for an extended period of time.

SECTION 10 SUSTAINABLE MANAGEMENT RELATED TO BASIN STORAGE

10.1 HISTORY

Within the Orange County Groundwater Basin, there is an estimated 66 million acre-feet of water in storage (OCWD, 2007). In spite of the large amount of stored water, there is a comparatively narrow operating range within which the basin can be safely operated.

The operating range of the basin is considered to be the maximum allowable storage range over the long-term without incurring detrimental impacts. The upper limit of the operating range is defined by the full basin condition. Although it may be physically possible to fill the basin higher than this full condition, it could lead to detrimental impacts such as percolation reductions in recharge facilities and increased risk of shallow groundwater seepage in low-lying coastal areas.

The lower limit of the operating range is considered to be 500,000 acre-feet below full condition. Although it may be considered to be acceptable to allow the basin to decline below 500,000 acre-feet below full condition for brief periods due to severe drought conditions and lack of imported water for basin recharge, it is not considered to be an acceptable management practice to intentionally manage the basin for sustained periods at this lower limit for the following reasons:

- Increased risk of seawater intrusion
- Increased risk of land subsidence
- Depletion of water in storage available for future drought conditions
- Some wells potentially becoming inoperable due to lower groundwater levels
- Increased costs to pump groundwater for groundwater users
- Increased potential for upwelling of amber-colored groundwater from the Deep Aquifer

It is important to note that detrimental impacts do not suddenly happen when storage levels fall to 500,000 or more acre-feet below full condition; rather, they occur incrementally, or the potential for their occurrence grows as the basin declines to lower levels. OCWD has used the basin model computer simulations to evaluate the potential for detrimental impacts if storage were to fall to 700,000 acre-fee from full. Basin model runs at 700,000 acre-feet below full condition indicates the potential for increased seawater intrusion and considerably more production wells being impacted by low pumping levels. Thus, a reduction of up to 700,000 acre-feet of groundwater in storage is only considered acceptable during an extreme emergency, such as a disruption in imported water supplies due to an earthquake. Negative or adverse impacts that are considered when establishing the operating range include chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the long-term, increased seawater intrusion, significant and unreasonable land subsidence that substantially interferes with surface land uses, and increased pumping costs.

The current policy of maintaining a groundwater storage level of up to 500,000 acre-feet below full was established based on completion of a comprehensive hydrogeological study of the basin in 2007 (OCWD, 2007).

The basin's storage level is quantified based on a benchmark defined as the full basin condition. Although the groundwater basin rarely reaches the full basin condition, basin storage has fluctuated within the operating range for many decades. OCWD manages groundwater pumping such that it is sustainable over the long term; however, in any given year pumping may exceed recharge or vice versa. Thus, the amount of groundwater stored in or withdrawn from the basin varies from year to year and often goes through multi-year cycles of emptying and filling, which typically correlates with state-wide and/or local precipitation patterns.

Each year OCWD calculates the volume of groundwater storage change from a theoretical "full" benchmark condition based on a calculation using changes in groundwater elevations in each of the three major aquifer systems and aquifer storage coefficients. This calculation is checked against an annual water budget that accounts for all production, measured recharge, and estimated unmeasured recharge. The amount of available or unfilled storage from the theoretical full condition from WY 1958-59 to WY 2015-16 is shown in Figure 10-1.

Available storage below
full condition

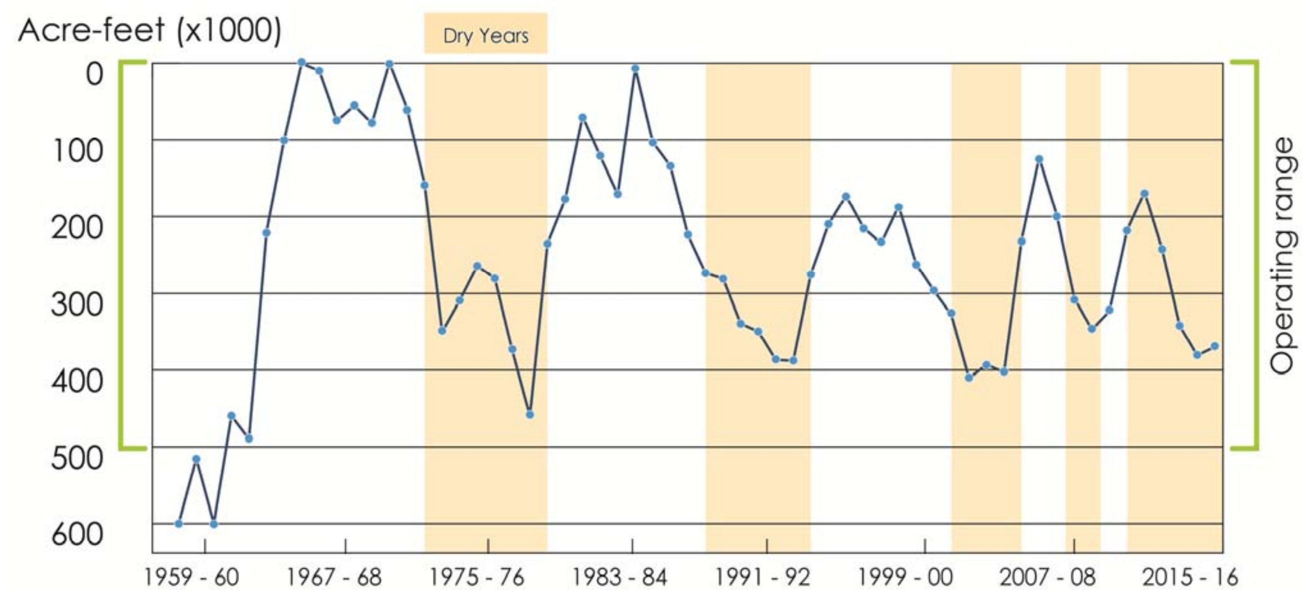


Figure 10-1: Basin Storage Levels WY 1958-59 to WY 2015-16

Maintaining the basin storage condition on a long-term basis within this operating range allows for long-term sustainable management of the basin without experiencing undesirable effects. Short-term excursions from the operating range due to extreme drought or other factors are not expected to cause adverse impacts but would need to be monitored closely and be of limited duration. In the California Water Plan Update 2013 this manner of groundwater basin management is described as follows:

> "Change in groundwater storage is the difference in stored groundwater volume between two time periods…However, declining storage over a period characterized by average hydrologic conditions does not necessarily mean that the basin is being managed unsustainably or is subject to conditions of overdraft. Utilization of groundwater in storage during years of diminishing surface water supply, followed by active recharge of the aquifer when surface water or other alternative supplies become available, is a recognized and acceptable approach to conjunctive water management." (CWP, p. SC-77)

10.2 CALCULATION OF GROUNDWATER STORAGE LEVELS

The estimated historical minimum storage level of 500,000 to 700,000 acre-feet below full condition occurred in 1956-57 (DWR, 1967; OCWD, 2003). Since this time, the basin storage fluctuated within the operating range reaching a full condition in 1969 and 1983.

OCWD uses two methods to calculate the storage condition of the basin: (1) water budget method and (2) three-layer storage change method. The water budget method is simply an accounting of the inflows to the basin and outflows. This data is collected and compiled on a monthly basis. Estimates of unmeasured or incidental recharge are used based on a statistical relationship between historical local precipitation and calculated unmeasured recharge. Unmeasured recharge is trued up at the end of the year with the final reports of inflows and outflows and basin storage change (based on groundwater level changes). This method produces a monthly estimate of the change in groundwater storage and allows for real-time decision making with respect to managing the basin.

In 2007, OCWD instituted a new three-layer change in storage method for calculating the amount of groundwater in storage (OCWD, 2007). The three-layer method involves creating groundwater elevation contour maps for each of the three aquifer layers (Shallow, Principal and Deep aquifers) for conditions at the end of June of each year. Prior to this time, groundwater storage was determined based on a single groundwater elevation map that was essentially a composite of the Shallow and Principal aquifers.

The need for this revised method was driven by the record-setting wet year of 2004-05, in which water levels throughout the basin approached a near-full condition. An analysis of the amount of groundwater in storage compared to the estimate using a one-layer change in storage method showed a discrepancy of 150,000 acre-feet. The discrepancy of 150,000 acre-feet in two different calculations indicated that the current condition could not be properly rectified back to the prior 1969 benchmark. This brought to light three important discoveries:

- The one-layer storage change calculation contained considerable uncertainty that when cumulatively added over tens of years led to a large discrepancy in the level of water in storage relative to 1969.

- Water level conditions in 1969 no longer represented a full basin, particularly because of changes in pumping and recharge conditions.
- A more accurate storage change calculation should be based on water level changes and storage coefficients for each of the three major aquifer systems, as was now made possible given OCWD's mature groundwater monitoring well network.

In February 2007, OCWD adopted an updated approach to defining the full basin condition and calculating storage changes. This updated approach included:

- A new full-basin groundwater level based on the following prescribed conditions:
  - Observed historical high water levels
  - Present-day pumping and recharge conditions
  - Protection from seawater intrusion
  - Minimal potential for mounding at or near recharge basins
- Calculation of the amount of groundwater in storage in each of the three major aquifer systems.

This method involves annually contouring water levels for each aquifer system annually and digitizing them and storing them in OCWD's GIS database. The previous year's water levels are subtracted from the current water levels to calculate change in water levels. Water level change contour maps are prepared for each of the three aquifer layers. For each of the three aquifers, the GIS data are used to multiply the water level changes by a grid of aquifer storage coefficients from OCWD's calibrated groundwater flow model. This results in a storage change volume for each of the three aquifers which are totaled to provide a net annual storage change for the basin. In cases where there is a calculation discrepancy between the storage changes estimated by the two methods, the unmeasured recharge value (previously estimated based on local rainfall) is adjusted to eliminate the difference.

A more detailed description of the full basin storage determination and three-layer methodology is presented in OCWD's *Report on Evaluation of Orange County Groundwater Basin Storage and Operational Strategy* (OCWD, 2007) and can be found in Appendix D of the *OCWD Groundwater Management Plan 2015 Update* (OCWD, 2015).

10.3 SUSTAINABLE MANAGEMENT PROGRAMS

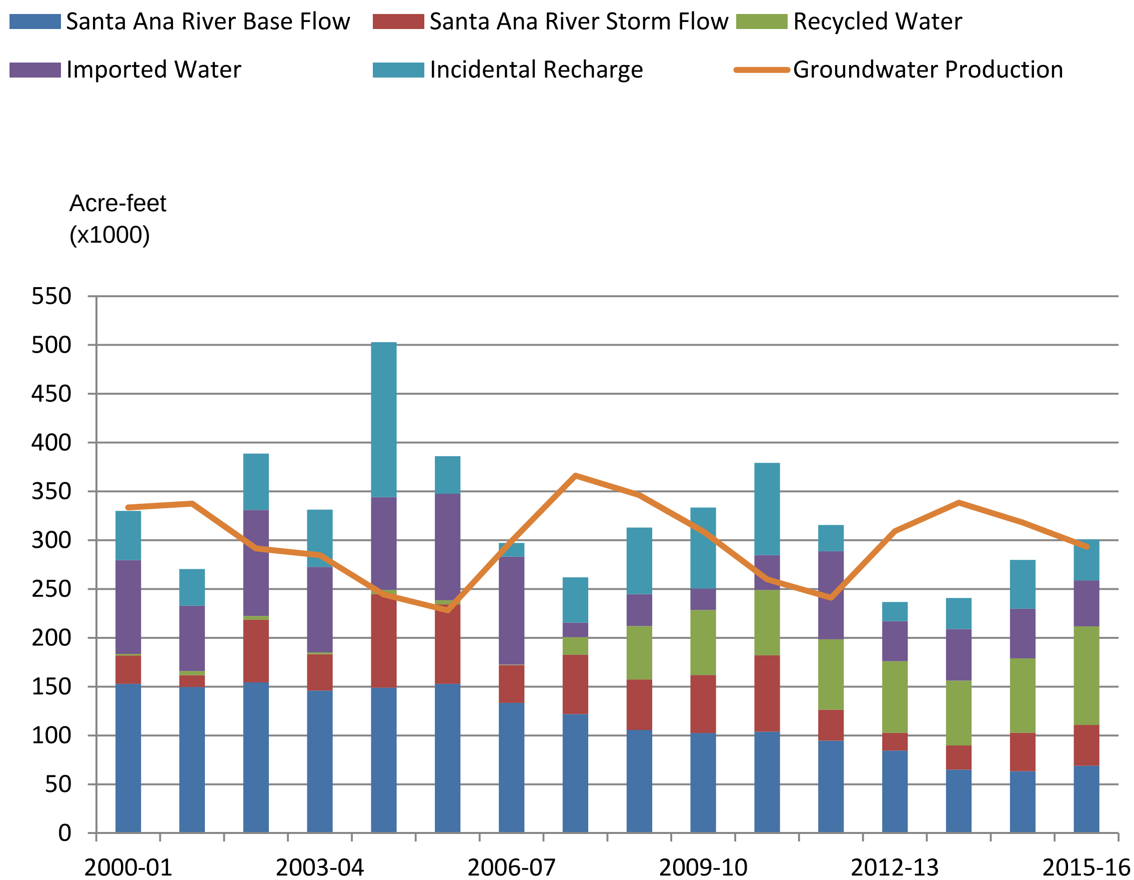
10.3.1 Basin Operating Range

Each year OCWD assesses current basin storage and projected water supply availability as factors in its determination of setting the Basin Production Percentage for the following year, as described in Section 10.3.3. If basin storage approaches or falls within the lower end of the established operating range, issues that are evaluated when considering the management of the basin include the current status of seawater intrusion protective measures, monitoring of ground surface elevations to assess the risk of land subsidence, inflow of amber-colored water or poor quality groundwater into the Principal Aquifer from underlying or overlying aquifers, and the number of shallow production wells that would become affected by lower groundwater levels. On the other hand, when operating the basin near the higher end of the storage range, considerations include the potential to increase the Basin Production Percentage, purchase less imported replenishment water, and the potential for more groundwater outflow to Los Angeles County.

OCWD does not directly limit pumping from the groundwater basin. Instead, basin storage and total pumping are managed by using the Basin Production Percentage and pumping assessments to apply financial incentives to encourage groundwater producers to pump an aggregate amount of water that is sustainable over the long- term. The process that determines a sustainable level of pumping considers the basin's operating range, basin storage conditions, water demands, the amount of recharge water available to OCWD, and other factors. The basin is managed to avoid groundwater storage levels declining to levels that could result in long-term significant negative or adverse impacts.

10.3.2 Balancing Production and Recharge

Over the long-term, the basin must be maintained in an approximate balance to ensure the long-term viability of basin water supplies. In one particular year, water withdrawals may exceed water recharged as long as over the course of a number of years this is balanced by years where water recharged exceeds withdrawals. Levels of total basin production and total water recharged since WY 2000-01 are shown in Figure 10-2.



Notes: (1) "Imported Water" includes water purchased by OCWD for recharge and water recharged under both the MWD Conjunctive Use Program (CUP) and the in-lieu program. (2) "Production" includes water produced from the basin by groundwater producers and under the MWD CUP program.

Figure 10-2: Basin Production and Recharge Sources, WY 2000-01 to WY 2015-16

10.3.3 Managing Basin Pumping

The primary mechanisms used by OCWD to manage pumping are the Basin Production Percentage (BPP) and the Basin Equity Assessment (BEA). The ability to assess the BPP and the BEA were provided to OCWD through an amendment to the OCWD Act in 1969. Section 31.5 of the OCWD Act empowers the Board to annually establish the BPP, defined as:

> "…the ratio that all water to be produced from groundwater supplies with the district bears to all water to be produced by persons and operators within the District from supplemental sources and from groundwater within the District during the ensuing water year."

In other words, the BPP is a percentage of each Producer's water supply (supplemental and groundwater sources) that comes from groundwater pumped from the basin. The BPP is set uniformly for all Groundwater Producers. Groundwater production at or below the BPP is assessed the Replenishment Assessment (RA). Any production above the BPP is charged the RA plus the Basin Equity Assessment (BEA). The BEA is set by the Board and is presently calculated so that the cost of groundwater production above the BPP is equivalent to the cost of purchasing imported potable supplies. This approach serves to discourage, but not eliminate, production above the BPP. In practice, Groundwater Producers rarely pump in excess of the BPP as doing so triggers a requirement to pay the BEA, thereby eliminating any cost savings that a pumper might obtain by pumping an amount in excess of the BPP. Collection of the BEA provides funds for OCWD to purchase additional replenishment water (where determined appropriate by OCWD). If necessary, the BEA can be increased to even further to discourage production above the BPP.

The BPP is set after evaluating groundwater storage conditions, availability of recharge water supplies and basin management objectives. OCWD's goal is to set the BPP as high as possible to allow Groundwater Producers to sustainably maximize pumping and reduce their overall water supply cost.

To change the BPP, the Board of Directors must hold a public hearing. Raising or lowering the BPP allows OCWD to manage the amount of pumping from the basin. The BPP is lowered when basin conditions necessitate a decrease in pumping. A lower BPP results in the need for Groundwater Producers to purchase additional, more expensive imported water.

Methodology for Setting the Basin Production Percentage

To determine the initial estimated BPP for a given year, the amount of water available for basin recharge in the coming year is estimated. The supplies of recharge water that are estimated are:

- Santa Ana River stormflow
- Natural incidental recharge
- Santa Ana River baseflow
- Highly purified recycled water produced by the GWRS
- "Supplemental" supplies such as imported water originating outside of the Santa Ana River Watershed
- Recycled water purchased by OCWD for operation of the Alamitos Seawater Barrier

Water demands by the Groundwater Producers are also estimated, as this factors into the BPP formula. Expected water quality pumping above the BPP refers to the authorization for a Groundwater Producer to pump above the BPP (with an exempted or reduced BEA) in order to address a localized water quality issue.

BPP Policy

The Board of Directors has several policy considerations that may be considered as the BPP is determined at least annually. For example, the Groundwater Producers generally prefer that the BPP be changed gradually (generally not more than five percent from one year to the next).

In some situations, for example, the Board may need to consider lowering the BPP more than five percent, such as in response to relatively low groundwater storage levels.

In 2013, the Board of Directors adopted a policy to work toward achieving and maintaining a 75% BPP. Principles of this policy include:

- OCWD sets a goal for achieving a stable 75% BPP, while maintaining the same process of setting the BPP on an annual basis, with the BPP set in April of each year after holding a public hearing and based upon the public hearing testimony, presented data and reports provided at that time.
- OCWD must sustainably manage the groundwater basin for future generations. If future conditions warrant, the BPP will be reduced.
- Projects and programs to achieve the 75% BPP goal will be individually reviewed and assessed for their economic viability. Economical projects and programs that could support a BPP above 75% also would be considered.

The groundwater basin's storage levels would be managed to support the 75% BPP policy. As long as the storage levels remain between 100,000 and 300,000 acre-feet from full, there would be a presumption that the BPP would not be decreased. Table 10-1 shows the management actions to be used to guide OCWD in setting the BPP. As the BPP is annually set in April for the following fiscal year (but may be changed throughout the year), the projected change in basin storage would be estimated for the end of that fiscal year (as of June 30), given various assumptions of basin pumping, inflows and outflows.

Table 10-1: Management Actions based on Change in Groundwater Storage

Available Storage Space (amount below full basin condition)	Basin Management Actions to Consider
Less than 100,000 acre-feet	Raise BPP
100,000 to 300,000 acre-feet	Maintain and/or raise BPP towards 75% goal
300,000 to 350,000 acre-feet	Seek additional supplies to refill basin and/or lower the BPP
Greater than 350,000 acre-feet	Seek additional supplies to refill basin & lower the BPP

Maintaining some available storage space in the basin allows for maximizing surface water recharge when such supplies are available, especially in relatively wet years. By keeping the basin relatively full during wet years and for as long as possible in years with near-normal recharge, the maximum amount of groundwater could be maintained in storage for future drought conditions. During dry hydrologic years when less water would be available for recharge, the BPP could need to be lowered to maintain groundwater storage levels.

At the beginning of 2015, OCWD committed to purchase 650,000 acre-feet of imported water to recharge the basin over a ten-year time period. This amount of imported water for recharge into the basin will help maintain the BPP and assist in managing the basin storage level within the operating range. OCWD works to maintain a Water Reserve Fund to purchase imported water from MWD. Each year, a specific amount of money is budgeted to purchase imported water and, if water is not available from MWD, the funds are carried over to the next year in the Water Reserve Fund.

Basin Production Limitation

Another management tool that enables OCWD to sustainably manage the basin is the Basin Production Limitation. Section 31.5(g)(7) of the OCWD Act authorizes limitations on production and the setting of surcharges when those limits are exceeded. This provision can be used when it is necessary to shift pumping from one area of the basin to another. An example of this is the Coastal Pumping Transfer Program, which shifts pumping from the coastal area to inland to minimize seawater intrusion, when necessary.

10.3.4 Supply Management Strategies

One of OCWD's basin management objectives is to maximize groundwater recharge. This is achieved through increasing the efficiency of and expanding OCWD's recharge facilities and the supply of recharge water. Construction and operation of the GWRS has provided a substantial increase in supply of water available to recharge the basin. Additional OCWD supply management programs include developing increased stormwater capture programs behind Prado Dam in cooperation with the U.S. Army Corps of Engineers, encouraging and participating in water conservation efforts, and working with MWD and the Municipal Water District of Orange County in developing and conducting other supply augmentation projects and strategies.

Conjunctive Use and Water Transfers

By agreement with OCWD, MWD established a Conjunctive Use Project (CUP) in the OCWD Management Area by purchasing the right to use up to 66,000 acre-feet of storage space in the groundwater basin until 2028. OCWD used the funds provided by MWD to improve basin management facilities including the construction of eight new production wells for water retail agencies and new injection wells for the Talbert Barrier. Under the agreement, MWD may request that stored water be extracted up to a maximum of 22,000 acre-feet each year.

OCWD reviews opportunities for additional conjunctive use projects that would store water in the basin and potentially in other groundwater basins. Additionally, OCWD reviews opportunities for water transfers that could provide additional sources of recharge water. Such projects are evaluated carefully with respect to their impact on available storage, reliability and cost effectiveness.

10.3.5 Water Demands

Water demands within the OCWD Management Area for WY 2014-15 totaled approximately 425,000 acre-feet. Total demand includes the use of groundwater, surface water from Santiago

Creek and Irvine Lake, recycled water, and imported water. As shown in Figure 6-1, water demands between WY1989-90 and 2014-15 have ranged between approximately 413,000 and 515,000 afy.

Projected Water Demands

OCWD estimated future water demands within the OCWD Management Area to be 447,000 afy in 2035. This is an average of two numbers: (1) a summation of the 19 major Groundwater Producers individually-estimated future water demands provided in their 2015 Urban Water Management Plans, which totaled 459,000 afy; and (2) the Municipal Water District of Orange County's Water Supply Reliability Study estimate of 435,000 afy (MWDOC, 2016). Population within OCWD's service area is projected to increase from the current 2.38 million to 2.54 million by 2035.

Drought Management

During a drought, flexibility to manage pumping from the basin becomes increasingly important. The OCWD Management Area typically experiences a decline in the supply of recharge water (local supply of Santa Ana River water and net incidental recharge) of up to 55,000 afy or more during drought.

Provided that the basin has available water in storage within the established operating range, this stored water provides a valuable water supply asset during drought conditions. Ensuring that the basin can provide a buffer against drought conditions requires:

- Maintaining sufficient water in storage that can be pumped out in time of need; and
- Possessing a plan to recover basin storage following the drought, including having a reserve account with sufficient funds to purchase replenishment water.

A sufficient supply of stored groundwater provides a safe and reliable buffer to manage for drought periods. If the basin, for example, has an available storage level of 150,000 acre-feet and can be drawn down to 500,000 acre-feet without irreparable seawater intrusion, a supply of 350,000 acre-feet is available for increased production. In a hypothetical five-year drought, an additional 70,000 afy may be produced from the basin for five years without jeopardizing the long-term health of the basin. In addition to reducing pumping when the basin is at lower storage levels, planning for refilling the basin is important. Approaches for refilling the basin are described in Table 10-2.

10.4 DEFINITION OF SIGNIFICANT AND UNREASONABLE REDUCTION OF GROUNDWATER STORAGE

OCWD manages the groundwater basin to maintain groundwater storage levels within an operating range of up to 500,000 acre-feet below the full condition. Significant and unreasonable reduction of groundwater in storage would occur when the volume of groundwater in storage fell below the 500,000 acre-feet below full condition for an extended period of time. If

OCWD were to consider an operating range below 500,000 acre-feet additional analysis and monitoring would be needed.

10.5 DETERMINATION OF MINIMUM THRESHOLDS

The minimum threshold for significant and unreasonable reduction in groundwater in storage is reached when the storage volume of the groundwater basin falls below the operating range of up to 500,000 acre-feet below full condition for an extended period of time

Table 10-2: Approaches to Refilling the Basin

APPROACH	DISCUSSION
Decrease Total Water Demands	• Increase water conservation and water-use efficiency measures
Decrease BPP	• Allows groundwater levels to recover rapidly • Decreases revenue to the OCWD • Increases water cost for producers • Does not require additional recharge facilities • Dependent upon other sources of water (e.g., imported water) being available to substitute for reduced groundwater pumping
Increase Recharge	• Dependent on increased supply of recharge water • Replenishment could be in the form of in-lieu water (additional imported water delivered to Producers instead of groundwater pumping) • Water transfers and exchanges could be utilized to provide the increased supply of recharge water • May be dependent on building and maintaining excess recharge capacity (which may be under-utilized in non-drought years)
Combination of the Above	• A combination of the approaches provides flexibility and a range of options for refilling the basin

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SECTION 11 SUSTAINABLE MANAGEMENT RELATED TO WATER QUALITY

OCWD has extensive monitoring and management programs in place to protect the groundwater basin from significant and unreasonable degradation of water quality including migration of contaminant plumes that impair water supplies. These programs are described in previous sections. This section describes sustainable basin management related to the water quality programs and projects instituted to prevent degradation of water quality and to remediate water quality problems in the OCWD Management Area.

11.1 SALINITY MANAGEMENT

Management of salt and nitrate concentrations in groundwater is important to maintaining the long-term sustainable use of groundwater supplies. OCWD's programs to manage water quality include monitoring, remediation of contaminated groundwater, and recharging high-quality recycled water. OCWD also operates the Prado Wetlands to remove nitrate from Santa Ana River (SAR) water that is recharged into the groundwater basin. These efforts help provide high-quality groundwater to water users in Orange County.

In July 2016, OCWD completed an evaluation of future TDS and nitrate concentrations in the OCWD Management Area (OCWD, 2016b). This involved using a model to evaluate the effects of different basin management scenarios on TDS and nitrate concentrations over the next 30 years. The report was prepared to meet regulatory requirements of the Regional Water Board as part of the watershed-wide salt and nutrient management plan.

Data and information used for this analysis included:

- Quantity and quality of water recharged through surface recharge facilities;
- Quantity and quality of water recharged through seawater injection barriers;
- Quantity and quality of unmeasured recharge, such as percolation of irrigation water into the groundwater basin;
- Measurements of groundwater pumping; and
- Estimates of groundwater outflow from the Orange County Management Zone.

Data from a variety of sources, included:

- OCWD measurements of the quantities of water recharged at surface recharge facilities;
- OCWD measurements of the quantities of water recharged at the Talbert Seawater Barrier;
- OCWD measurements of water quality for water recharged at surface recharge facilities and the Talbert Seawater Barrier;

- Los Angeles County Department of Public Works measurements of the quantities of water recharged at the Alamitos Seawater Barrier;
- Water Replenishment District of Southern California measurements of water quality for the Alamitos Seawater Barrier;
- MWD measurements of water quality for imported water purchased by OCWD; and
- OCWD measurements of water quality for imported water purchased from MWD by OCWD.

The quantity and quality of water recharged in the model are shown in Table 11-1.

Table 11-1: Example Projected Future Salt Inflows

Source of Water Recharge	Volume (acre-feet)	TDS Conc. (mg/L)	Mass (tons)
Deep percolation of precipitation*	6,500	100	900
Percolation of applied water*	9,000	1,900	23,200
Subsurface inflow*	37,500	1,177	59,200
SAR baseflow	52,000	700	49,200
SAR stormflow	50,000	200	13,600
Recycled water (Forebay & Talbert Barrier)	103,000	60	8,400
Alamitos Barrier	2,500	350	1,200
MWD imported water	65,000	650	57,300
Total	325,500	479	213,000

*Component of unmeasured recharge

The model was used to predict the ambient water quality of the basin for TDS using nine scenarios with differing volumes of recharge water sources. Sources of water recharge volume and TDS concentrations in Table 11-1 were used as the base case. Eight additional scenarios were chosen to represent potential future portfolios of available water sources.

For the modeled scenarios, the ambient concentration of TDS in the groundwater basin was predicted in 30 years to be between 565 and 588 mg/L. In all cases the long-term flow-weighted concentration of TDS of inflow to the groundwater basin was projected to be below the current ambient concentration of 610 mg/L. The model predicts a gradual decrease in the TDS concentration in the groundwater basin over time. Based on the current ambient TDS concentration of 610 mg/L and the projected inflow TDS of 479 mg/L in Table 11-1, the average mass of TDS pumped from the OCWD Management Zone is projected to surpass the total mass of TDS inflow.

With regards to nitrate, the approach used to estimate future nitrate concentrations was similar to the approached used for TDS projections. The nitrate (as nitrogen, or nitrate-N) concentration for each inflow component was estimated using available data. Table 11-2 summarizes the inflow terms and their nitrate-N concentrations.

The flow-weighted average nitrate-N concentration for all inflows to the management zone is 2.1 mg/L. The initial concentration was set at 2.9 mg/L (based on the current ambient concentration for the most recent 20-year period). Since the inflow concentration is less than the initial concentration, the estimated future nitrate-N concentration gradually decreases.

The model was used to predict the ambient water quality of the basin for nitrate-N using three scenarios with differing volumes of recharge water sources. The concentration of 2.1 mg/L for nitrate-N in inflows is below the water quality objective of 3.4 mg/L nitrate-N. The results indicate a gradual decrease in the nitrate concentration over the long-term. Based on the current ambient nitrate-N concentration of 2.9 mg/L and the projected inflow nitrate-N of 2.1 mg/L, the average mass of nitrate pumped from the OCWD Management Zone is projected to surpass the total mass of nitrate inflow.

Table 11-2: Example Projected Future Nitrate-N Inflows to OCWD Management Area

Inflow	Volume (Acre-Feet)	Nitrate-N Conc.(mg/L)	Mass (tons)
Deep percolation of precipitation*	6,500	1	9
Percolation of applied water*	9,000	10	122
SAR baseflow	52,000	4.5	318
SAR stormflow	50,000	0.9	61
Imported water recharge	65,000	0.6	53
Recycled water recharge (Forebay & Talbert Barrier)	103,000	1.7	238
Subsurface inflow*	37,500	3.5	178
Alamitos Barrier	2,500	2	7
Total	325,500	2.1	986

*component of unmeasured recharge

11.2 GROUNDWATER QUALITY IMPROVEMENT PROJECTS

This section describes specific projects that improve groundwater quality by removing TDS, nitrate, VOCs and other constituents. The location of these projects is shown in Figure 11-1.

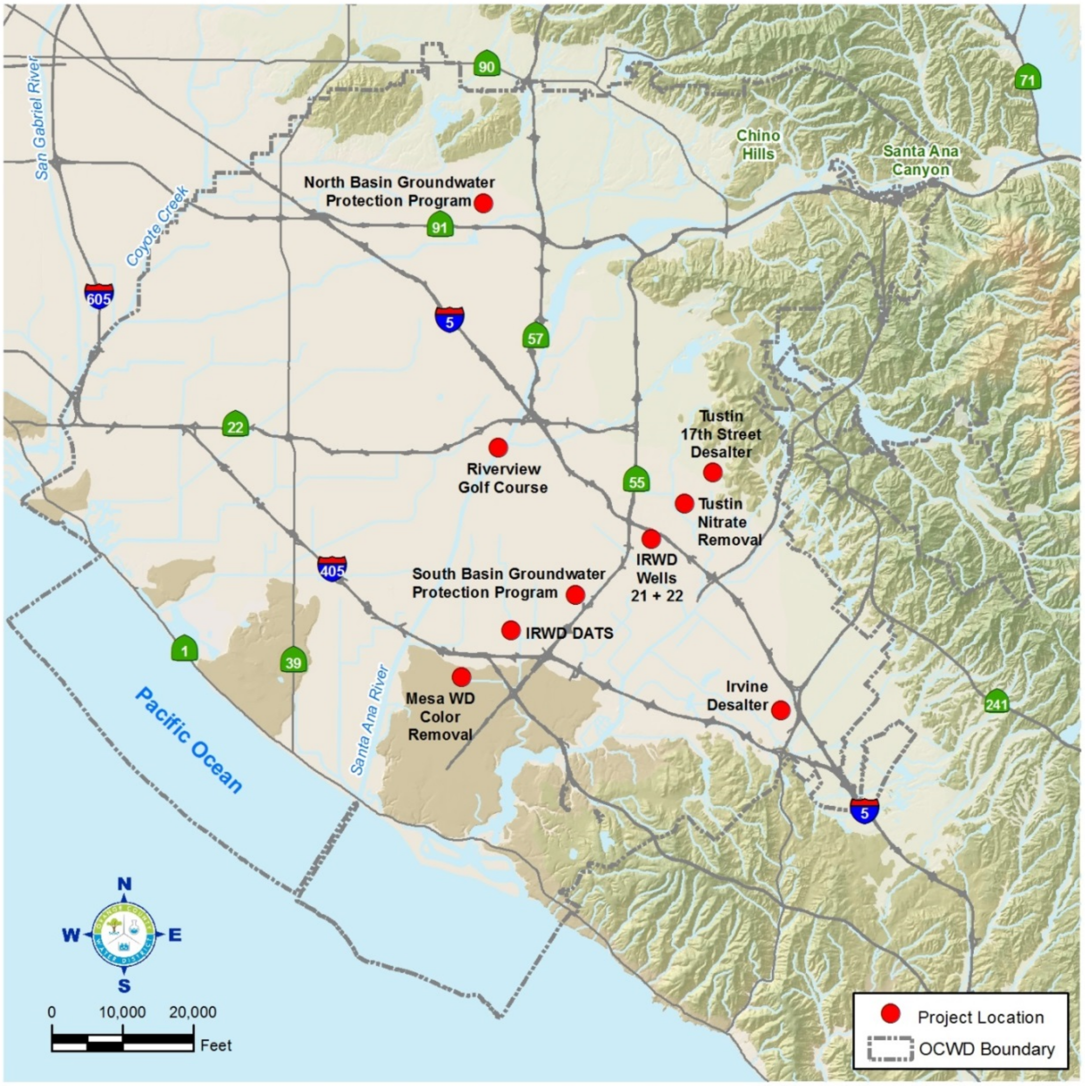


Figure 11-1: Water Quality Improvement Projects and Programs

North Basin Groundwater Protection Program

The U.S. Environmental Protection Agency (USEPA) is taking the lead to remediate a VOC plume in the North Basin area of the groundwater basin as shown in Figure 11-2. Groundwater contamination is primarily found in the Shallow Aquifer, which is generally less than 200 feet deep; however, VOC-impacted groundwater has migrated downward into the Principal Aquifer tapped by production wells. The contamination continues to migrate both laterally and vertically threatening downgradient production wells operated by the cities of Fullerton and Anaheim and other agencies. OCWD is conducting a remedial investigation/feasibility study under USEPA oversight to evaluate and develop effective remedies to address the contamination under the National Contingency Plan (NCP) process.

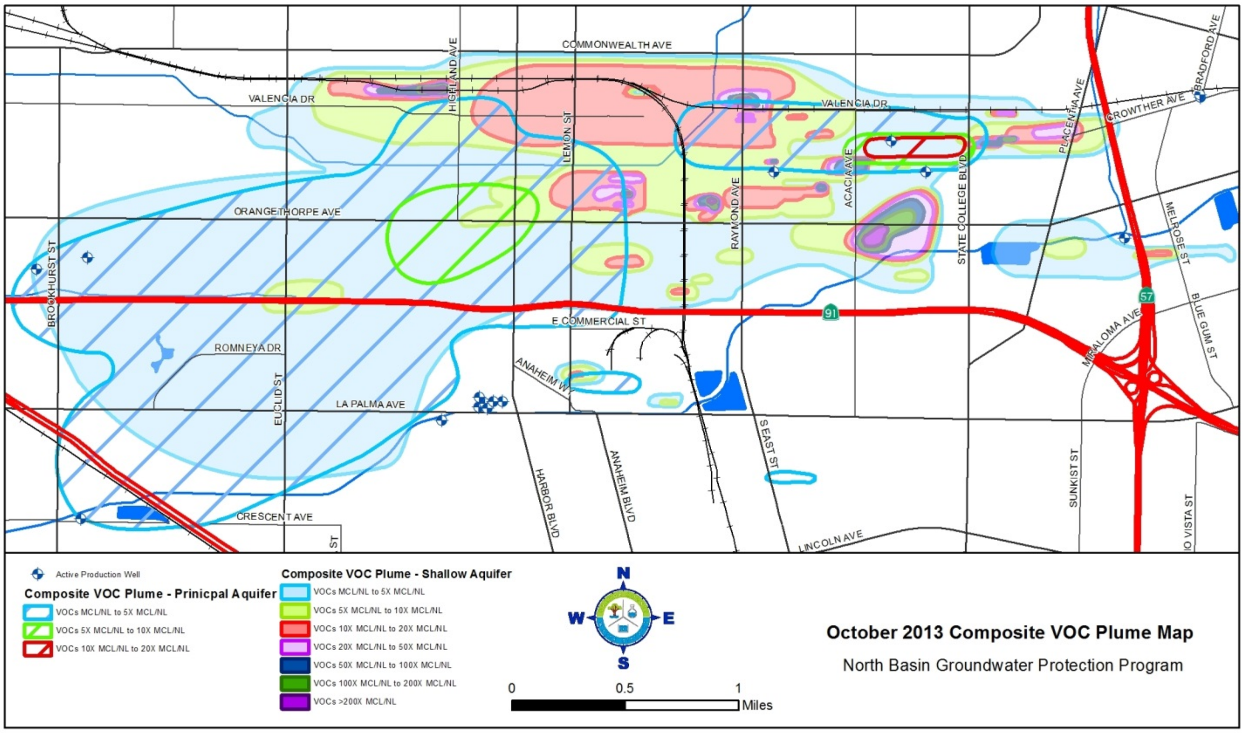


Figure 11-2: North Basin Groundwater Protection Program Plume

South Basin Groundwater Protection Program

Groundwater contaminated with VOCs and perchlorate in the South Basin area of the groundwater basin is shown in Figure 11-3. The extent of groundwater contamination has been investigated, contamination plumes have been delineated, and the remedial program is being developed in cooperation with regulatory agencies and stakeholders following the NCP process.

Elevated concentrations of perchloroethylene (PCE), TCE, and perchlorate were detected in Irvine Ranch Water District's Well No. 3, located in Santa Ana. OCWD is currently working with the Regional Water Board and the California Department of Toxic Substances Control to require aggressive cleanup actions at nearby sites that are sources of the contamination.

MTBE Remediation

In 2003, OCWD filed suit against numerous oil and petroleum-related companies that produce, refine, distribute, market, and sell MTBE and other oxygenates. The suit seeks funding from these responsible parties to pay for the investigation, monitoring and removal of oxygenates from the basin.

Treatment technologies used to remove MTBE from groundwater include granular activated carbon or advanced oxidation. Depending upon site-specific requirements, a treatment train of two or more technologies in series may be appropriate (i.e., use one technology to remove the bulk of MTBE and a follow-up technology to polish the effluent water stream).

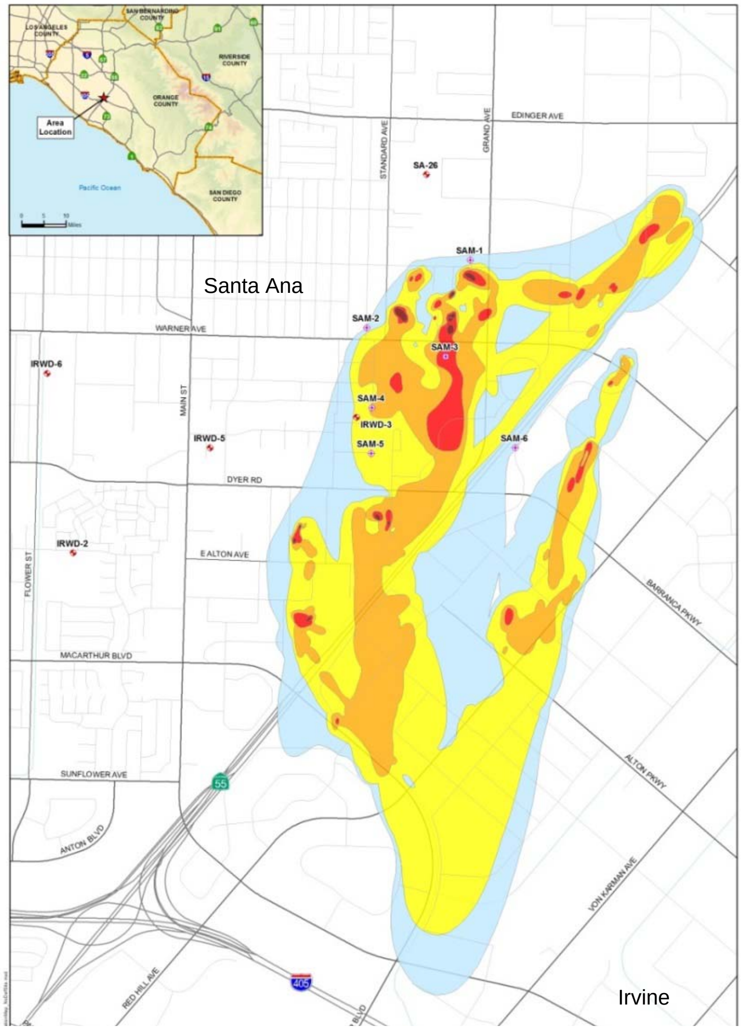


Figure 11-3: South Basin Groundwater Protection Program Plume

Irvine Desalter

The Irvine Desalter was built in response to elevated TDS and nitrate and the discovery in 1985 of VOCs beneath the former El Toro Marine Air Corps Station and the central area of Irvine. A plume of TCE migrated off base and threatened the groundwater basin. Irvine Ranch Water District and OCWD cooperated with the U.S. Department of Navy in building production wells, pipelines and two treatment plants, both of which are now owned and managed by Irvine Ranch Water District. The two plants remove VOCs by air-stripping and vapor-phase carbon adsorption with the treated water used for irrigation and recycled water purposes. A third plant treats groundwater outside the plume to remove excess nitrate and TDS concentrations using reverse osmosis (RO) membranes for drinking water purposes. Combined production of the Irvine Desalter wells is approximately 8,000 afy. OCWD provides a financial subsidy to IRWD in the form of a BEA exemption to help offset the treatment costs.

Tustin Desalters

Tustin's Main Street Treatment Plant has operated since 1989 to reduce nitrate levels from the groundwater produced by Tustin's Main Street Wells Nos. 3 and 4. The groundwater undergoes either RO or ion exchange treatment. The RO membranes and ion exchange units operate in a parallel treatment train. Approximately 1 mgd is bypassed and blended with the treatment plant product water to produce up to 2 mgd or 2,000 afy.

The Tustin Seventeenth Street Desalter began operation in 1996 to reduce high nitrate and TDS concentrations from the groundwater pumped by Tustin's Seventeenth Street Wells Nos. 2 and 4 and Tustin's Newport Well. The desalter utilizes two RO membrane trains to treat the groundwater. The treatment capacity of each RO train is 1 mgd. Approximately 1 mgd is bypassed and blended with the RO product water to produce up to 3 mgd or 3,000 afy. OCWD provides a financial subsidy to the City of Tustin in the form of a BEA exemption to help offset the treatment costs.

River View Golf Course

VOC contamination, originating from an up-gradient source, was discovered in a well owned by the City of Orange in the last 1980s. The well was subsequently closed. After an investigation by OCWD, it was determined that an existing irrigation well operated by River View Golf Course, located in the City of Santa Ana would help to contain and remove the VOC contamination. OCWD provides a financial incentive to keep the golf course well in operation to remove VOC contamination from the basin.

Irvine Ranch Water District Wells 21 and 22

Water produced by IRWD Wells 21 and 22 contain nitrate (as N) at levels exceeding the primary MCL of 10 mg/L. TDS concentrations range from 650-740 mg/L, which is above the secondary MCL of 500 mg/L. Because of the elevated nitrate, TDS, and hardness concentrations, IRWD constructed a RO treatment facility to reduce concentrations in the water before conveying to the potable supply distribution system. Operation of the treatment facility provides 6,300 afy of drinking water and benefits the groundwater basin by reducing the spread of impaired groundwater to other portions of the basin. OCWD provides a financial subsidy to IRWD in the form of a BEA exemption to help offset the treatment costs.

Amber-Colored Groundwater

Amber-colored water is found in the Deep Aquifer (600 to 2,000 feet below ground surface). Natural organic material from ancient buried plant and wood material gives the water an amber tint and a sulfur odor. Although this water is of high quality, its color and odor produce negative aesthetic qualities that require treatment before use as drinking water.

Two facilities currently treat colored groundwater in Orange County. In 2001, Mesa Water District opened its Colored Water Treatment Facility (CWTF) capable of treating 5.8 mgd. This facility was replaced in 2012 by the 8.6-mgd Mesa Water Reliability Facility that uses nanofiltration membranes to remove color. OCWD provides a financial subsidy to Mesa Water District in the form of a BEA exemption to help offset the treatment costs. The second facility is the Deep Aquifer Treatment System (DATS), a treatment facility operated by the IRWD since 2002 that uses nano-filtration membranes. This facility purifies 7.4 mgd of amber- colored water.

BEA Exemption for Water Quality Improvement Projects

In some cases, OCWD encourages the pumping of groundwater that does not meet drinking water standards in order to protect water quality. This is achieved by using a financial incentive called the Basin Equity Assessment (BEA) Exemption. The benefits to the basin include promoting beneficial uses of poor-quality groundwater and reducing or preventing the spread of poor-quality groundwater into non-degraded aquifer zones.

OCWD uses a partial or total exemption of the BEA to compensate a qualified participating agency or Groundwater Producer for the costs of treating poor-quality groundwater. These costs typically include capital, interest and operations and maintenance (O&M) costs for the treatment facilities.

Using this approach, OCWD has exempted all or a portion of the BEA for pumping and treating groundwater for removal of nitrates, TDS, VOCs, and other contaminants. Water quality improvement projects that currently are receiving BEA exemptions are listed in Table 11-3.

Table 11-3 Summary of BEA Exemption Projects

Project Name	Project Description	BEA Exemption Approved	Production above BPP (afy)	OCWD BEA Subsidy
Irvine Desalter	Remove nitrates, TDS, and VOCs	2001	10,000	Exemption
Tustin Desalter	Remove nitrates and TDS	1998	3,500	Exemption
Tustin Nitrate Removal	Remove nitrates	1998	1,000	Exemption
River View Golf Course	Remove VOCs	1998	350	$50/af BEA reduction
Mesa WD Colored Water Removal	Remove color	2000	8,700	Exemption
IRWD Wells 21 and 22	Remove nitrates	2012	7,000	Exemption

11.3 DEFINITION OF SIGNIFICANT AND UNREASONABLE DEGRADATION OF WATER QUALITY

There are three elements that must be considered when evaluating the impact of groundwater quality degradation.

The first element is considering the causal nexus between groundwater management activities and groundwater quality. For example, groundwater contamination due to improper handling of toxic materials impacts groundwater quality; however, this water quality degradation is not caused by groundwater management activities.

The second element is the beneficial uses of the groundwater and water quality regulations, such as MCLs and other potable water quality requirements.

The third element that must be considered is the volume of groundwater impacted by groundwater quality degradation. If small volumes are negatively affected that do not materially affect the use of the aquifer or basin for its existing beneficial uses, then this would not represent a significant and unreasonable degradation of water quality. However, if the impacted volume grows, then it could reach a level that it becomes significant and unreasonable.

When considering all three elements, “significant and unreasonable degradation of water quality” is defined as degradation of groundwater quality attributable to groundwater production or recharge practices in the OCWD Management Area and to the extent that a significant volume of groundwater becomes unusable for its designated beneficial uses.

11.4 DETERMINATION OF MINIMUM THRESHOLDS

The minimum thresholds for groundwater quality are exceedances of MCLs or other applicable regulatory limits that are directly attributable to groundwater management actions in the OCWD Management Area that prevents the use of groundwater for its designated beneficial uses.

SECTION 12 SUSTAINABLE MANAGEMENT RELATED TO SEAWATER INTRUSION

In the coastal area of the Orange County groundwater basin, the primary source of saline groundwater is seawater intrusion through permeable aquifer sediments underlying topographic lowlands or gaps between the erosional remnants or mesas of the Newport-Inglewood Uplift. The susceptible locations from north to south are the Alamitos, Sunset, Bolsa, and Talbert gaps as shown in Figure 3-26.

OCWD's policy regarding control of seawater intrusion is implemented through a comprehensive program that includes operating seawater intrusion barriers, monitoring and evaluating barrier performance, monitoring and evaluating susceptible coastal areas, and coastal groundwater management. These programs, described below, enable OCWD to sustainably manage groundwater conditions in the basin in order to prevent significant and unreasonable seawater intrusion.

12.1 TALBERT GAP

The Talbert Gap, also referred to as the Santa Ana Gap, is shown in Figure 12-1. Figure 12-2 shows a geologic cross-section through the Talbert Gap and the 2015 chloride concentrations within the various aquifers dissected by this cross-section alignment. The furthest seaward mergence zone between the Talbert and Lambda aquifers in the vicinity of Adams Avenue is a primary pathway by which seawater can potentially migrate inland and downward within the Talbert Gap. The chloride concentrations shown on this cross-section are updated annually to determine if intrusion is worsening or being pushed seaward with the information published in the GWRS Annual Report (OCWD, 2016c).

OCWD monitoring well M26 is strategically located seaward of the barrier in the Talbert-Lambda aquifer mergence zone in the middle of the Talbert Gap and is screened within the merged Talbert and Lambda aquifers (see Figure 12-3). Therefore, M26 is a key monitoring well for evaluating barrier injection requirements versus seawater intrusion potential and is used to assess whether protective groundwater elevations are being achieved in the Talbert Gap to prevent seawater intrusion. At the location of well M26, the protective groundwater elevation is approximately 3.5 feet above mean sea level (msl), as explained below.

The protective groundwater elevation is based on the Ghyben-Herzberg relation (Ghyben, 1888; Herzberg, 1901; Freeze and Cherry, 1979, pp. 375-376), which takes into account the depth of the Talbert aquifer at a given location along with the density difference between saline and fresh groundwater. Using this relation, for every 40 feet that the bottom of the aquifer is below sea level, there should be about one foot of head of fresh water above sea level to overcome the density effect of seawater. In the case of well M26, the bottom of the merged Talbert-Lambda aquifer is approximately 140 feet below sea level. Therefore, the fresh water head (protective elevation) should be approximately 140 feet divided by 40 which equals 3.5 feet above sea level. Achieving this protective elevation at well M26 is OCWD's goal to prevent brackish water in the Talbert aquifer from migrating down into the Lambda aquifer that is tapped by inland production wells.

Figure 12-3 shows the historical inter-relationship between coastal groundwater production, Talbert Barrier injection, and groundwater elevations at well M26 over the last 10 years. The largest annual decline in groundwater elevations at well M26 occurred in 2007, from a winter high of approximately 4 ft msl down to a low in the fall of approximately -18 ft msl. This 22-foot decline was primarily due to the unusually large amount of groundwater production that year (historical maximum) combined with an unusually low amount of barrier injection; barrier injection supply was limited to the imported water MWD OC-44 connection during this transition period after Interim Water Factor 21 (IWF-21) was decommissioned and prior to commencement of GWRS operations.

With the commencement of GWRS purified recycled water injection in January 2008 and the contemporaneous startup of 8 new injection well sites, the Talbert Barrier injection volume was essentially doubled from previous years, causing groundwater elevations at well M26 to steadily rise over a two-year period to reach protective elevations. Since 2010, groundwater elevations at well M26 have consistently been maintained at or above protective elevations with the exception of brief periods related to GWRS shutdowns. To date, the longest shutdown occurred in June 2014 (26 days) related to GWRS Initial Expansion construction activities. Most other shutdowns have been one day or less.

Operationally, when groundwater elevations at well M26 rise above 6 ft msl, barrier injection is incrementally reduced by 1 to 2 mgd to prevent additional groundwater elevation increases (ground surface elevation at well M26 is approximately 8 ft msl). Conversely, when groundwater elevations at well M26 drop below 3 ft msl (protective elevation), then barrier injection is incrementally increased by 1 to 2 MGD until groundwater elevations again stabilize within the desired 3 to 6 ft msl range. When groundwater levels drop below mean sea level at M26, like after prolonged barrier shutdowns as occurred in June 2014, subsequent barrier injection is then maximized and prioritized into the shallow and intermediate depth aquifer zones susceptible to seawater intrusion in order to get back to protective elevations as quickly as possible. For more detailed information on the operation of the Talbert Seawater Barrier, see *GWRS 2015 Annual Report* prepared for the Regional Water Board, June 17, 2016.

Since 2010, a seaward gradient has been predominantly maintained in the Talbert aquifer seaward of the barrier within the Talbert Gap. Under these conditions, brackish groundwater that had migrated inland in previous years has slowly begun to migrate back towards the ocean as evidenced by recent declines in chloride concentrations at well M26 and other monitoring wells seaward of the barrier.

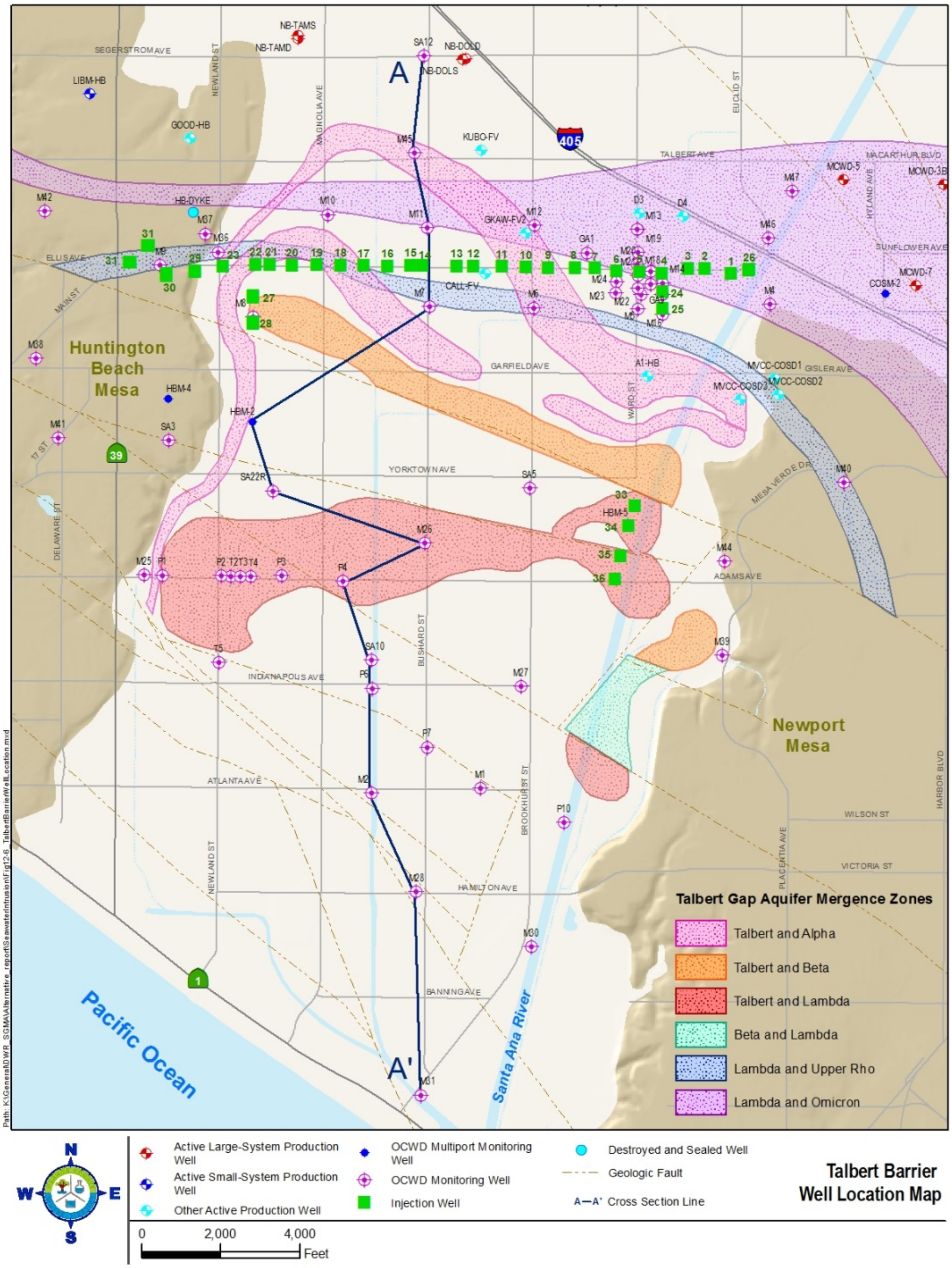


Figure 12-1: Talbert Gap – Seawater Intrusion Barrier and Cross-Section Location

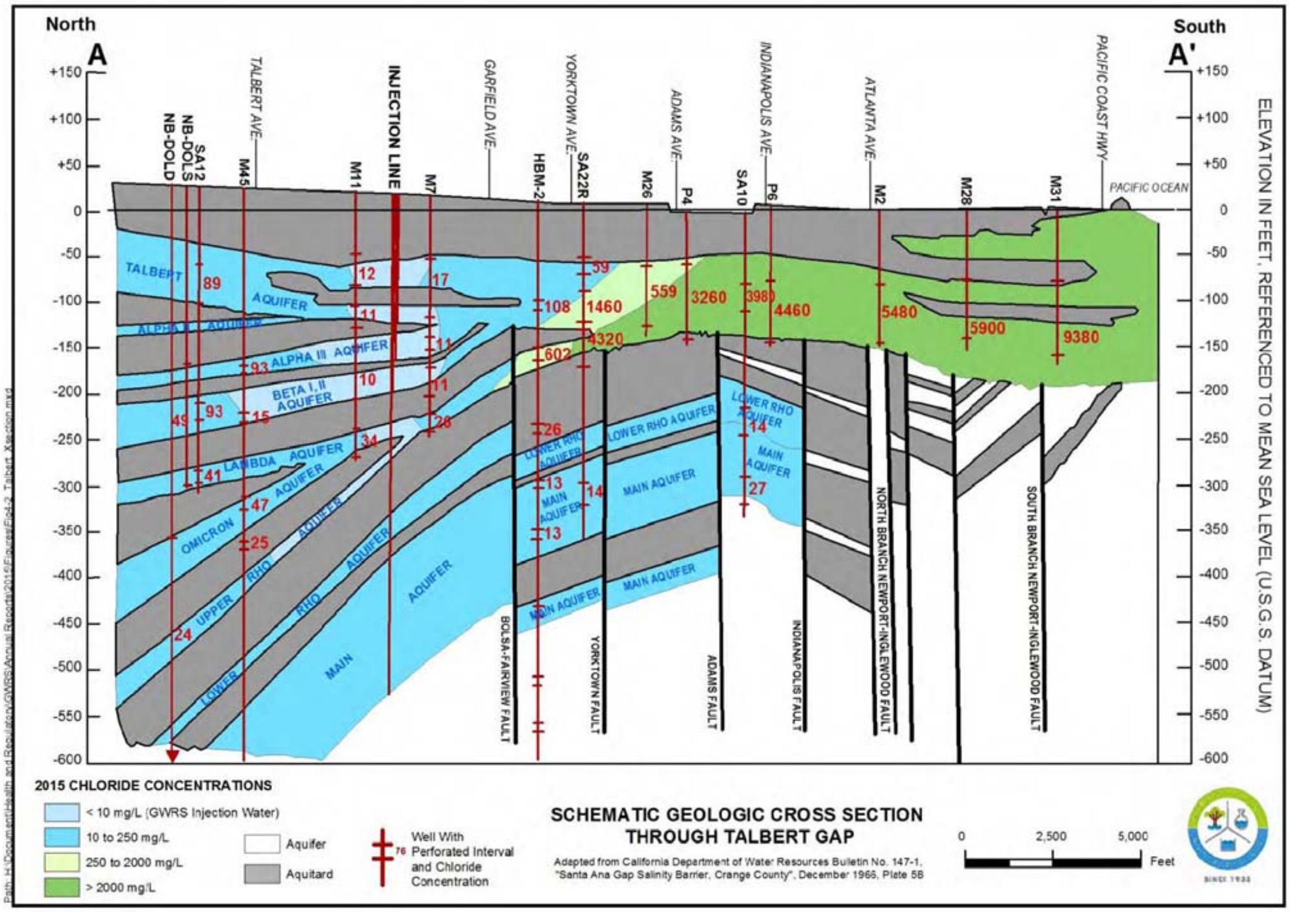
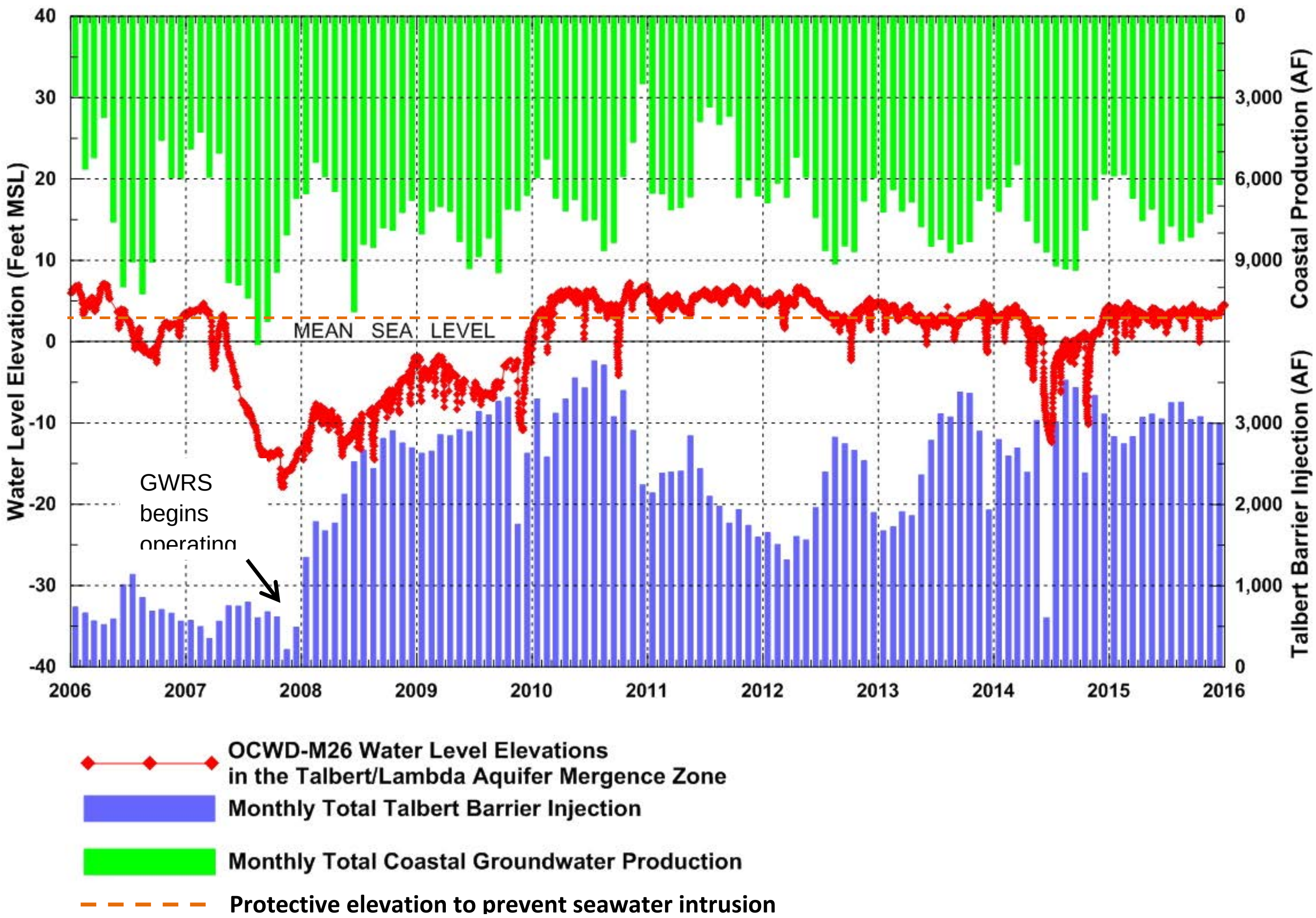


Figure 12-2: Geologic Cross-Section through Talbert Gap Showing 2015 Chloride Concentrations

Figure 12-4 shows the 250 mg/L chloride concentration contour for the selected years of 1993, 1998, 2008, and 2016 in the Talbert and Bolsa gaps and adjacent mesas. The 250 mg/L chloride contour is used to delineate the inland extent of intrusion because this is above ambient (non-intruded) groundwater quality and is equal to the secondary drinking water standard. Native fresh groundwater in this area typically has a chloride concentration well below 100 mg/L, while the GWRS injection supply has a chloride concentration of approximately 10 mg/L. During the 1990s prior to any barrier expansion, the 250 mg/L chloride contour progressed inland. From 1998-2008, intrusion was held at bay without appreciably worsening as five new injection well sites came online. Since 2008 when eight new injection well sites came online along with the GWRS, the 250 mg/L chloride contour has been pushed slightly seaward primarily due to doubling barrier injection and other basin management practices. The Coastal Pumping Transfer Program and Coastal In-Lieu Program reduced coastal groundwater production by either shifting it inland or purchasing imported water in lieu of groundwater, thus helping to raise coastal groundwater levels.



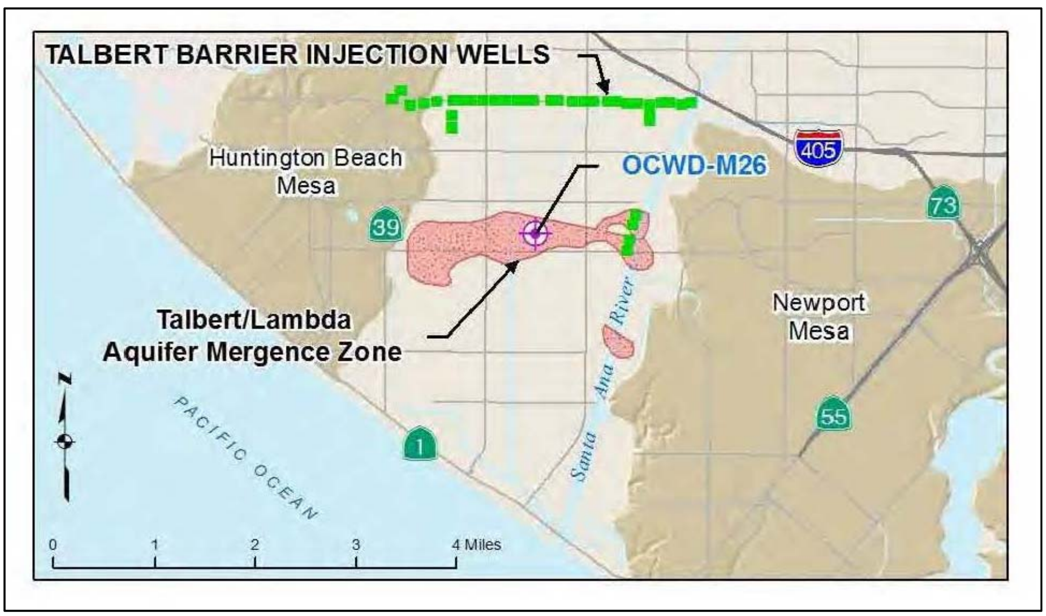


Figure 12-3: Key Well OCWD-M26 Groundwater Levels, Talbert Barrier Injection, and Coastal Pumping

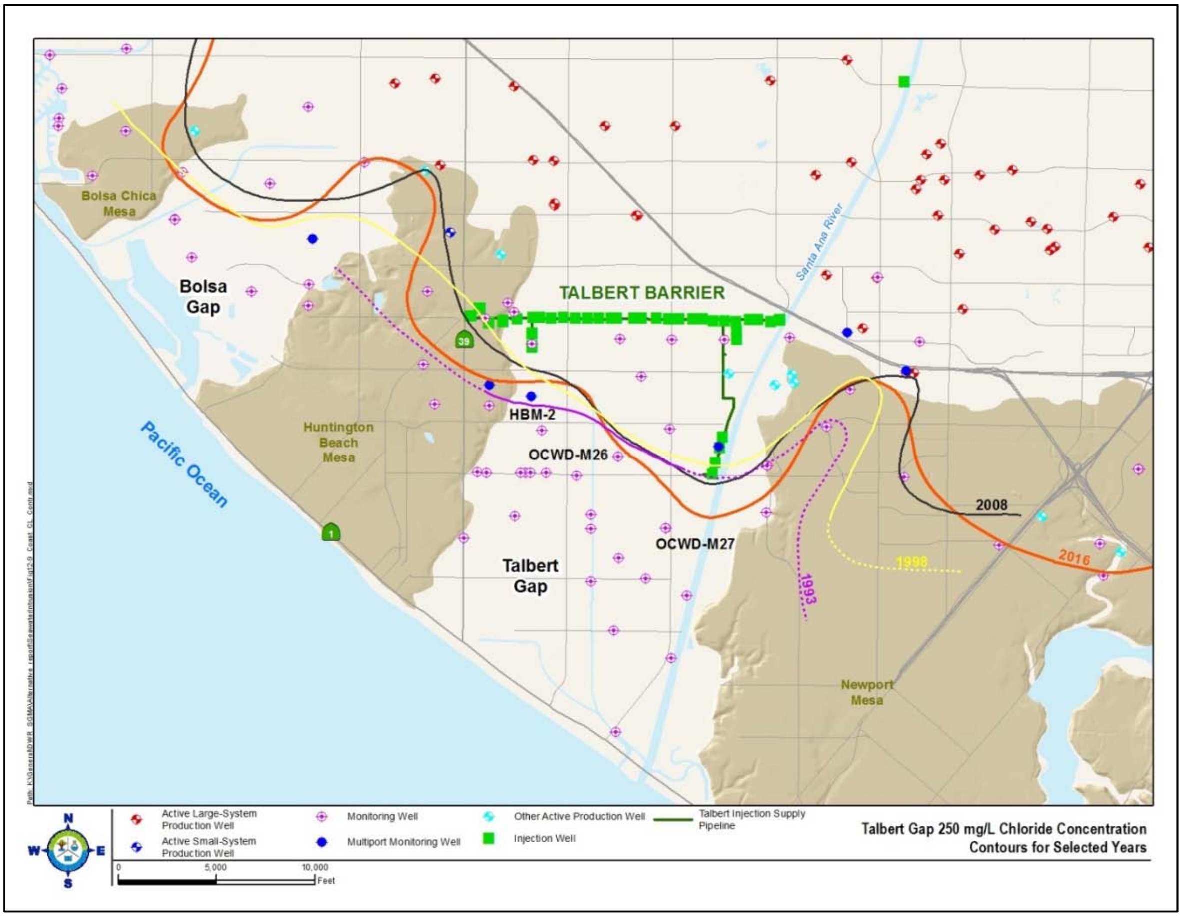


Figure 12-4: Talbert Gap 250 mg/L Chloride Concentration Contours for Selected Years

In addition to chloride contour maps, OCWD prepares and reviews chloride concentration time series graphs at individual wells to identify and evaluate trends in specific aquifer zones. Seaward of the barrier at coastal monitoring wells with elevated salinity, chloride concentrations tend to be inversely related to groundwater elevations. When groundwater elevations decline significantly below mean sea level in the area of the intrusion front, chloride concentrations generally increase and seawater intrusion moves inland. Conversely, when groundwater elevations rise and are sustained above mean sea level, chloride concentrations decrease and intrusion is pushed seaward.

12.1.1 Talbert Barrier Groundwater Model

A numerical groundwater flow model of the Talbert Barrier and surrounding vicinity (Talbert Model) was originally developed by Camp, Dresser & McKee, Inc. (CDM; now CDM Smith) in 1999-2000 with oversight from OCWD. The original Talbert Model was a seven-layer transient model developed as part of the initial planning for the GWRS to evaluate the expansion needs of the existing Talbert Barrier (CDM, 2000). In 2003, the Talbert Model was refined to 13 layers by explicitly modeling the intervening aquitards between the aquifer zones so that the model would be suitable for solute transport simulations in addition to groundwater flow.

The Talbert Model area covers approximately 85 square miles and uses the MODFLOW code (Harbaugh and McDonald, 1996) with 13 vertical layers and 509,000 grid cells (uniform grid with 250 feet x 250 feet horizontal grid cell dimensions). The model layering generally follows the conceptual model of aquifers, aquitards, and mergence zones developed by DWR (1966) with some refinements in the stratigraphy by OCWD based on newer data.

The Talbert Model was calibrated under transient conditions over the nine-year period 1990-99 and provided a sufficient match to observed historical groundwater levels. Along the ocean boundary a constant head condition was employed, whereas time-varying specified head conditions were used along the three inland boundaries based on observed groundwater levels at monitoring wells near those boundaries.

In addition to helping to guide the planning, location, and hydraulic effectiveness of the supplemental injection wells for the Talbert Barrier during pre-GWRS planning activities, the Talbert Model was also used to estimate the general groundwater flow paths and subsurface residence time of barrier injection water by using the USGS particle tracking code MODPATH (Pollack, 1994). This modeling work provided the basis for delineating a recycled water retention buffer area surrounding the Talbert Barrier at a distance of 2,000 feet and one-year travel distance. No new drinking water production wells are allowed within this buffer area, as required by the original California Department of Public Health requirements contained within the original permit to operate GWRS (RWQCB, 2004; OCWD, 2005).

12.2 ALAMITOS GAP

As explained earlier, the Alamitos Barrier Project was initially constructed in 1964 and became operational in 1965 to manage seawater intrusion in the Alamitos Gap. The barrier has been expanded over time to include the construction of additional injection and monitoring wells.

The 41 existing injection wells, shown in Figure 12-5, are screened in several Upper Pleistocene-aged aquifers, referred to locally as the C, B, A and I aquifer zones. The underlying Main and Sunnyside (Lower Main) aquifers are not considered to be susceptible to intrusion due to being offset by the Newport-Inglewood Fault Zone (locally referred to as the Seal Beach Fault) and are not hydraulically merged with either the Recent or the overlying C, B, A, and I aquifers, as shown in Figure 12-6. Consequently, none of the Alamitos Barrier injection wells extend into the Main or Sunnyside aquifers.

The Recent aquifer in Alamitos Gap is age correlative with the Talbert aquifer in Talbert Gap. However, the Recent aquifer in Alamitos Gap is considerably thinner (approximately 40 feet thick) and somewhat finer grained than the more transmissive Talbert aquifer. Since there are no production wells screened in the Recent aquifer and it is generally of poor quality, none of the Alamitos Barrier injection wells are screened in the Recent aquifer.

Similar to the Talbert Barrier, the Alamitos Barrier consists of both nested and cluster-type injection wells screened discretely in each aquifer in order to control the injection rate and injection pressure into each targeted aquifer independently since each aquifer has different physical characteristics and groundwater levels. In addition, there are two “dual-point” injection wells that consist of only one well casing but two different screened interval depths separated inside the well by an inflatable packer and two separate injection drop pipes.

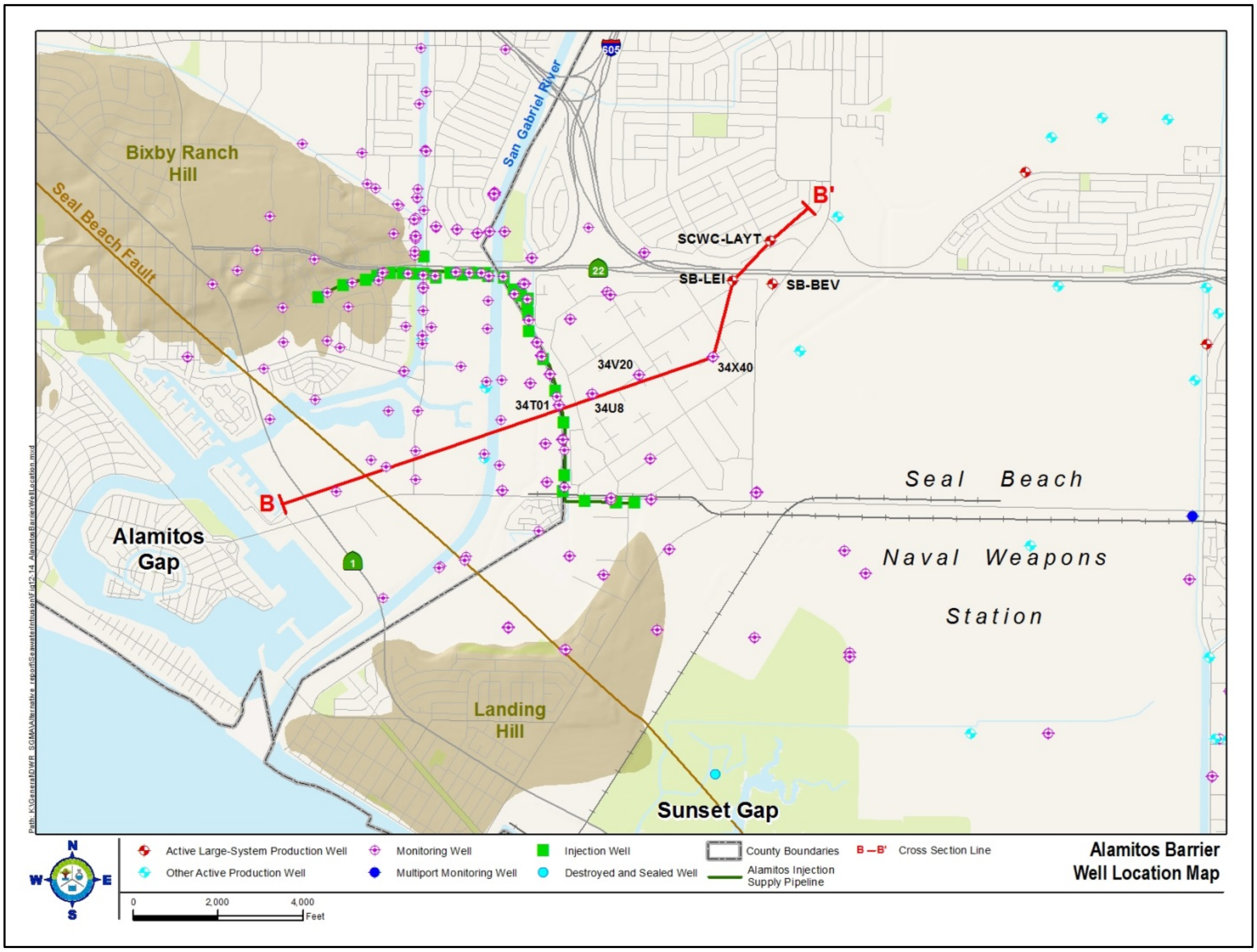


Figure 12-5: Alamitos Barrier

The pathways for intrusion in Alamitos Gap are similar to the Talbert Gap. As previously discussed, the Recent aquifer is connected to the Pacific Ocean. Once seawater migrates inland within the Recent aquifer past the Seal Beach Fault, the brackish water can then migrate downward into the C, B, A, and I aquifers via areas of hydraulic mergence with the Recent aquifer where the intervening low-permeability aquitards are absent. Similar to the Talbert Gap, these susceptible Pleistocene aquifers were warped upward by the Newport-Inglewood Fault Zone and then during Recent geologic time were eroded away and subsequently overlain by the Recent aquifer river deposits. Although similar in structure to the Talbert Gap, the Alamitos Gap aquifers are typically shallower, thinner, and finer grained.

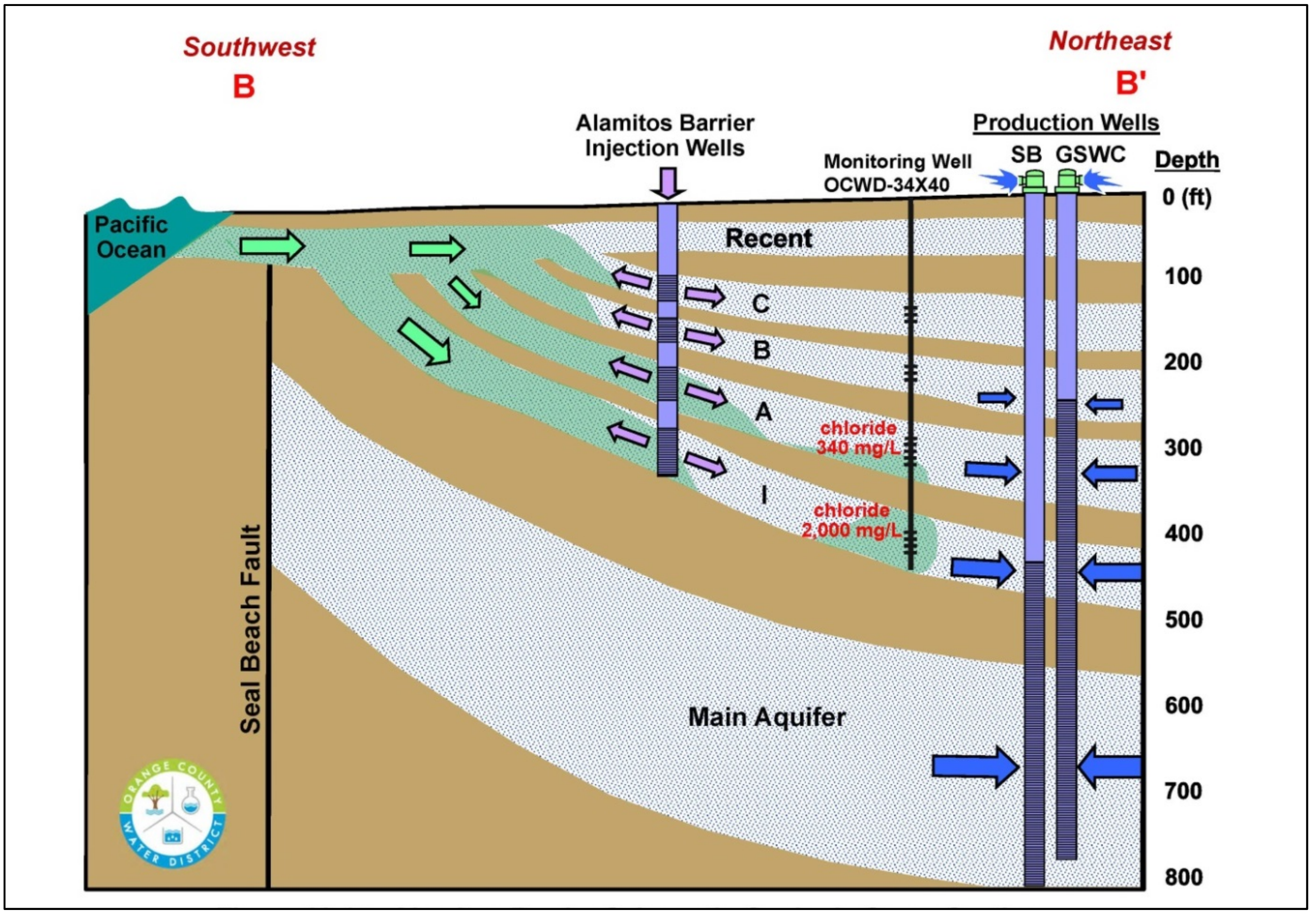


Figure 12-6: Alamitos Barrier Schematic Geologic Cross-Section

In 2008, OCWD identified data gaps where seawater intrusion was suspected but unconfirmed. Staff installed four monitoring wells in 2009 at three sites downgradient of the Orange County portion of the Alamitos Barrier. Analysis of groundwater elevations and chloride concentrations from the existing and new monitoring wells in the area confirmed that pockets of elevated chloride concentrations above the secondary drinking water standard (250 mg/L) had migrated inland of the barrier within Orange County. Potential causes of elevated salinity pulses include insufficient injection well spacing, injection well clogging (low injection rates), and injection wells being offline for extended periods for maintenance and repairs.

The aquifers susceptible to intrusion are generally thinner and finer-grained than their counterparts in Talbert Gap. Therefore, per-well injection capacity is relatively low and thus requires more injection wells and denser spacing to achieve sufficient injection for creating a continuous pressure ridge that achieves protective elevations. Annual Alamitos Barrier injection is typically about 6,000 AF spread over 40 injection well points. In comparison, annual Talbert Barrier injection is typically about 36,000 AF spread over 103 injection well points, resulting in more than double the amount of average injection per well point than Alamitos Barrier.

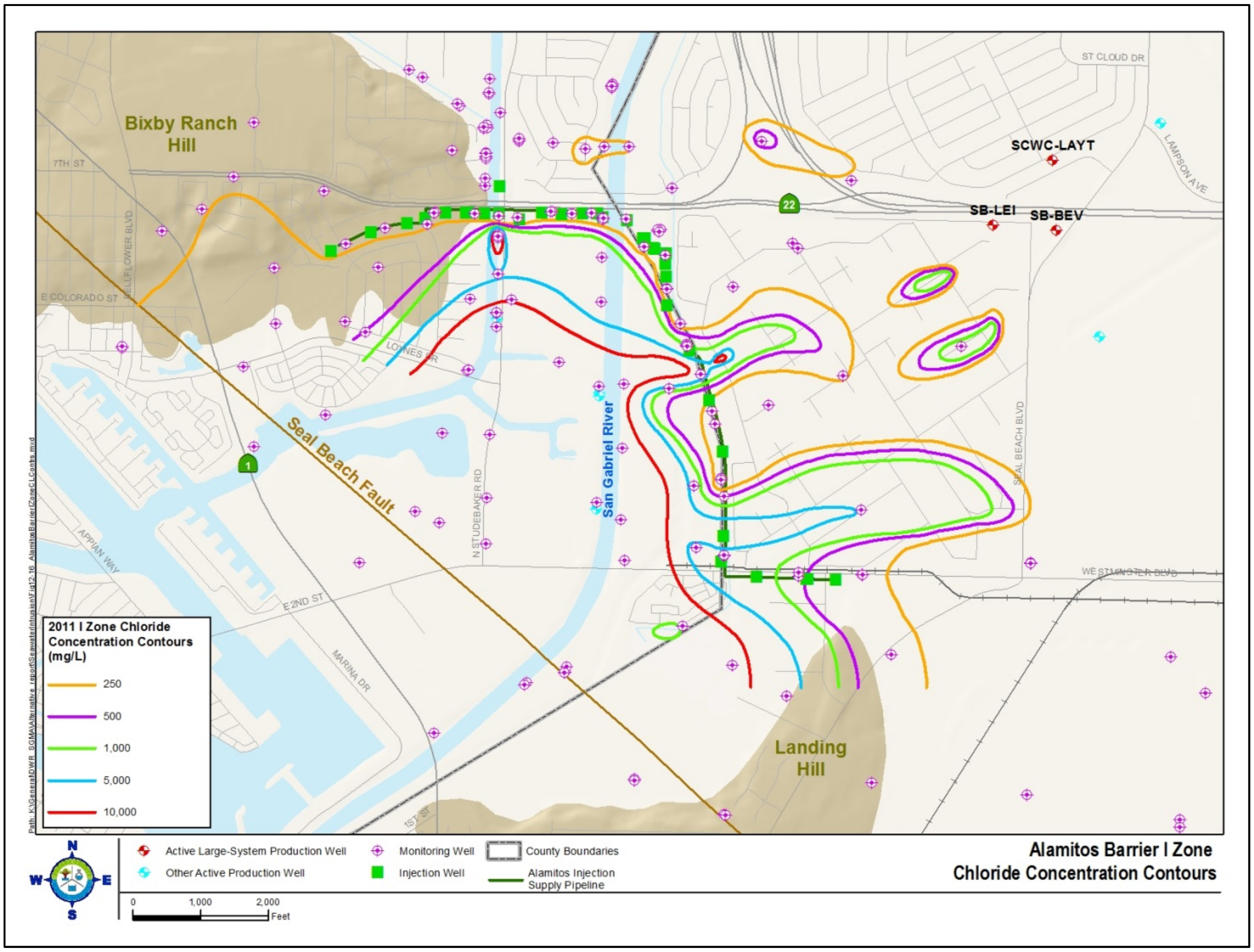


Figure 12-7: Alamitos Barrier I Zone Chloride Concentration Contours

In an effort to control the identified breaches through the barrier and to address barrier deficiencies along the north-south reach where injection well spacing is too large and injection well capacity too small, OCWD developed the Alamitos Barrier Improvement Project consisting of:

- 17 injection wells at eight locations to augment injection capacity along the north-south reach of the barrier
- Four nested monitoring wells to enhance the inter-nodal monitoring network at and near the barrier
- Two piezometers to monitor shallow (semi-perched) groundwater

With a project budget of $15 million, drilling and construction of the wells began in 2016. Once constructed, the new monitoring and injection wells will be operated and maintained by LACDPW along with the existing barrier facilities (OCWD, 2013).

12.2.1 Alamitos Barrier Groundwater Model

A transient groundwater flow and solute transport model of the Alamitos Barrier area was developed and calibrated in 2010 by Intera, Inc. with oversight and cost sharing from OCWD, LACDPW, and Water Replenishment District of Southern California. The model was developed to provide a useful tool to evaluate the existing barrier's effectiveness, determine barrier expansion requirements, evaluate migration of saline intrusion as well as migration of recycled injection water towards production wells for regulatory purposes, and optimize existing barrier operations.

The Alamitos Barrier Model (ABM) has 13 layers, each corresponding to an individual aquifer or aquitard and uses the MODFLOW-2000 code (Harbaugh et al., 2000). The ABM has a uniform grid consisting of 100-ft x 100-ft square grid cells with varying vertical thickness based on the stratigraphy defined in the conceptual model, which was largely based on Callison et al. (1991) in the immediate vicinity of the barrier and OCWD geologic interpretations at monitoring and production wells in the outlying area of the model domain. The 100-ft grid cell size ensures that nearly every monitoring and injection well occupies its own grid cell. The ABM was calibrated to match observed historical groundwater level and chloride (salinity) conditions over the period 1999-2009 (Intera, 2010).

Findings from predictive scenarios simulated with the calibrated model confirmed that new injection wells along the north-south barrier alignment were needed to augment injection capacity in areas where breaches are occurring, and to raise the average groundwater levels to protective elevations. The ABM was also used to determine the number, locations, and approximate flow rates of additional injection wells needed to control seawater intrusion along the north-south reach of the barrier. These findings culminated in the Alamitos Barrier Improvement Project currently under construction, as described above.

Results from the ABM scenarios indicated that approximately 10,400 AFY of total barrier injection may be needed during low-basin conditions to entirely prevent seawater intrusion on both the Los Angeles and Orange County sides of the barrier, including the aforementioned intrusion eastward south of the existing barrier into Sunset Gap. This modeled injection amount represents almost twice the typical historical injection of 6,000 AFY and at least preliminarily confirmed the potential need for a future barrier extension south to the Seal Beach Fault to help protect Sunset Gap.

Upon completion of the current Alamitos Barrier Improvement Project, groundwater elevations and chloride concentrations resulting from the newly expanded barrier will be closely monitored for at least one full year prior to determining potential southerly barrier extension requirements that would trigger the need for an additional injection supply source and new barrier pipeline.

12.3 SUNSET GAP

Sunset Gap has historically been considered to be a much lesser seawater intrusion threat compared to the Talbert and Alamitos Gaps. Recent monitoring data, however, indicate that seawater intrusion is occurring in Sunset Gap, as shown schematically in Figure 12-8.

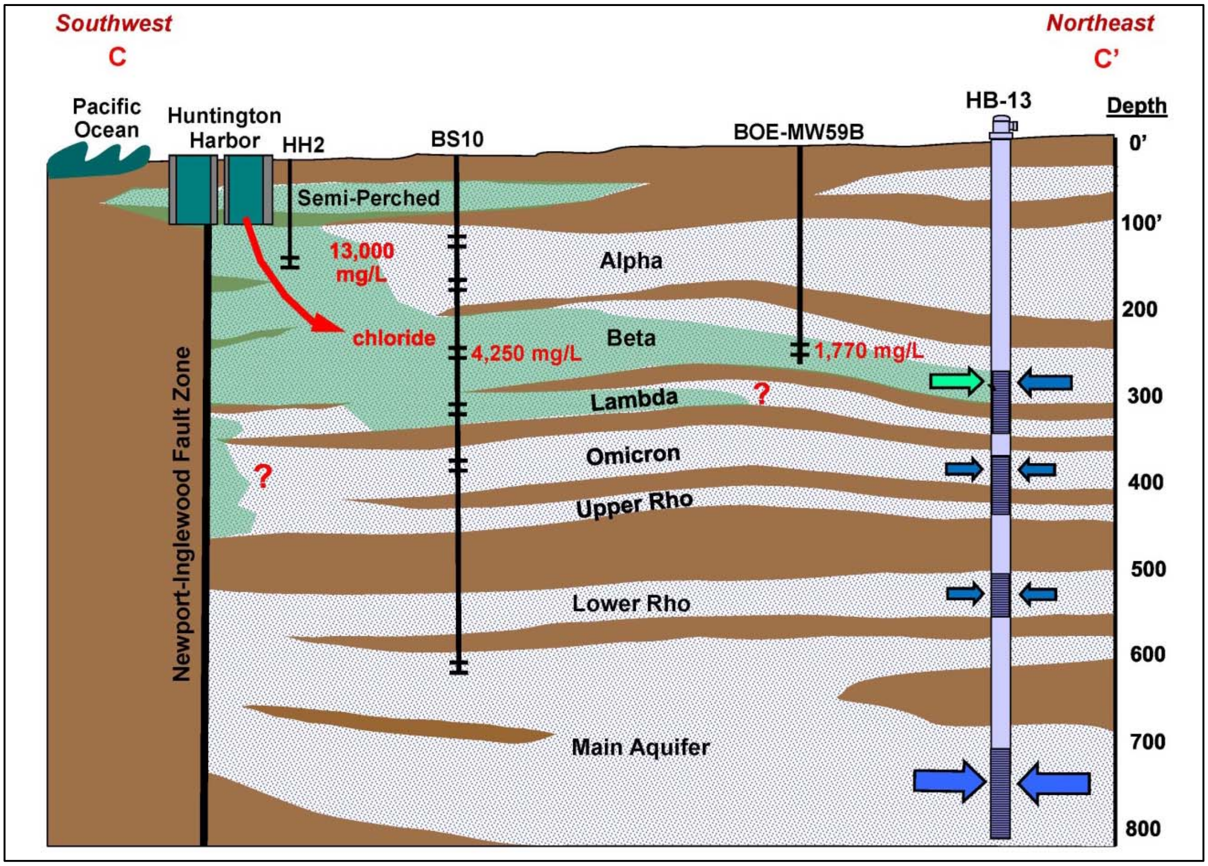


Figure 12-8: Schematic Geologic Cross-Section from Huntington Harbor through Sunset Gap

Three potential source areas appear likely:

- Intrusion from Alamitos Gap south of Alamitos Barrier moving in an easterly direction;
- Intrusion moving north-northeasterly from the Huntington Harbor Marina where dredged canals may have breached through the shallow aquitard overlying the shallow-most potable aquifer; and
- Lateral leakage across the Newport/Inglewood Fault Zone (Seal Beach Fault) in the Landing Hill area in one or more of the Upper Pleistocene aquifers.

In the southeast portion of Sunset Gap, dredging associated with construction of the boat canals in Huntington Harbor during the 1960s was the subject of several studies at that time regarding the potential for causing saline intrusion. Conclusions of these studies were inconsistent and inconclusive. Studies done by the USGS (1966) and DWR (1968) found that seawater intrusion into the semi-perched aquifer (generally the uppermost 50 feet) associated with the harbor development was occurring, but this was considered to be of little to no significance due to the lack of beneficial use of this near-surface water bearing zone.

Approximately 10 years after construction of Huntington Harbor, chloride concentrations began to rise during the mid-1970s at OCWD monitoring well HH2 screened in the shallow-most Pleistocene Alpha aquifer at a depth of 85-95 ft bgs and located just inland of the Bolsa-Fairview Fault in the Huntington Harbor area. The Bolsa-Fairview Fault is the farthest inland branch of the Newport-Inglewood Fault Zone in the area. Chloride concentrations at this well rose steadily over time to very brackish levels today, suggesting an inland gradient and active pathway for inland intrusion.

In 2004, elevated chloride concentrations ranging from 300 to 800 mg/L were first discovered at two monitoring wells owned by the Boeing Corporation (BOE-MW16 and BOE-MW17) screened in the Beta aquifer. OCWD commissioned a geophysical survey in 2010 at the Seal Beach Naval Weapons Station to delineate the extent and depth of intrusion and to help guide the number and location of proposed monitoring wells necessary to sufficiently define the extent of intrusion.

Based on groundwater elevation contours (see Figure 12-9), the elevated salinity plume is not expected to migrate farther inland past wells HB-4, HB-7, and HB-13 since the pumping from these three wells appears to create a local depression and because of the lack of other large system production wells within this vicinity. Only two City of Westminster production wells (WM-125 and WM-RES2) are located within one mile of these three Huntington Beach wells and based on the gradient direction do not appear to be threatened so long as the three Huntington Beach wells remain active.

One large system production well (HB-12) was shut down and destroyed due impacts from advancing intrusion in Sunset Gap. Since 2012, OCWD has constructed seven of nine planned multi-depth monitoring wells to depths up to 1,000 feet in Sunset Gap to better define the source areas, pathways, and overall inland extent of seawater intrusion in that area as the first step towards identifying feasible remedies.

12.3.1 Planned Modeling to Evaluate Sunset Gap Alternatives

Existing data are sufficient to warrant timely evaluation and planning of potential project alternatives to address the intrusion in Sunset Gap. To accomplish this, the existing Alamitos Barrier groundwater model (ABM) is currently being expanded to cover the entire Sunset Gap area and beyond. In addition to expanding the model domain, model layering and aquifer parameters (e.g., hydraulic conductivity) is being refined using data from the new OCWD monitoring wells, which were constructed after completion of the original ABM. Once the model expansion is completed and recalibrated, various predictive model scenarios will be simulated to analyze the effects of potential remedial alternatives.

Potential short-term remedies to evaluate would likely include:

- Reduce coastal pumping in this area and/or shift pumping inland via the Coastal Pumping Transfer or Coastal In-Lieu programs;
- Brackish extraction wells upgradient of Huntington Beach production wells; and
- Equip wells HB-4, HB-7, and HB-13 with liners or packers to prevent production from the uppermost Beta aquifer screened interval.

Potential long-term remedies to evaluate would likely include:

- Southerly extension of Alamitos Barrier to the Seal Beach Fault;
- Sunset Gap injection barrier along the eastern edge of the SBNWS (Bolsa Chica Rd.);
- Combination injection/extraction barrier in Sunset Gap; and
- Physical barrier along Edinger Avenue just north of Huntington Harbor.

The expanded model will be used to evaluate these alternatives as to the number of wells, locations, injection/extraction requirements, and the resulting groundwater elevations and chloride concentrations after several years of simulated operation. In addition, during model development and calibration, areas still lacking sufficient data would be identified for potential locations of additional monitoring wells.

In conjunction with the groundwater modeling activities, engineering feasibility studies would be necessary for the proposed alternatives, such as to determine a reliable water supply for the proposed Alamitos Barrier southerly extension and/or an entirely new Sunset Gap injection barrier. Other potential injection supplies include deep colored water from the Lower Main aquifer, which is not considered to be susceptible to intrusion, and treated brackish water.

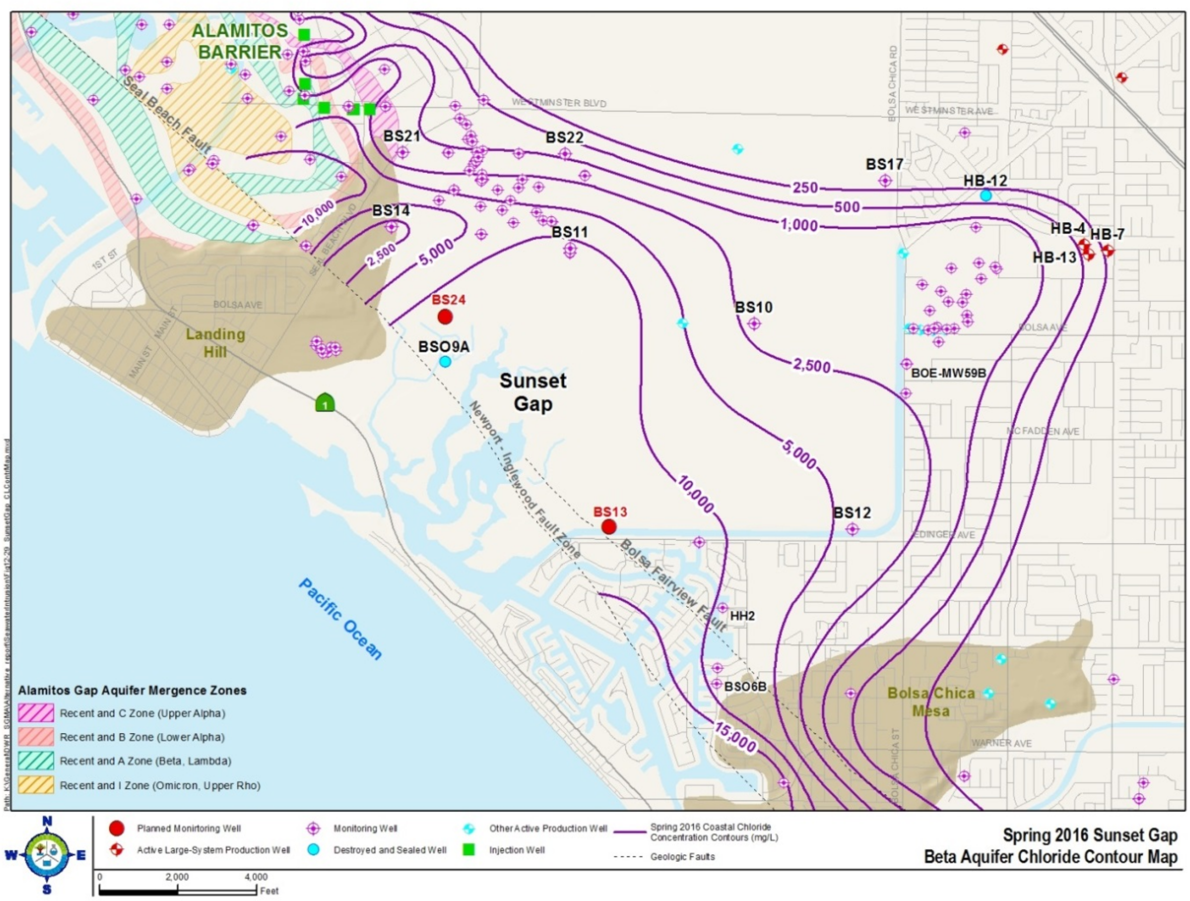


Figure 12-9: Sunset Gap Chloride Contours

12.4 BOLSA GAP

In the Bolsa Gap, seawater intrusion extends approximately 1.3 miles inland from the Pacific Ocean. The highest chloride concentrations in Bolsa Gap have remained seaward of the Bolsa-Fairview Fault, which is the farthest inland branch of the Newport-Inglewood Fault Zone in that area. Therefore, it appears that saline groundwater is largely restricted from migrating inland across these faults within the Bolsa aquifer under normal basin conditions, as the Bolsa aquifer zones of mergence with the underlying Pleistocene aquifers are all inland of the Bolsa-Fairview Fault. An area of slightly elevated salinity has existed beneath the Huntington Beach Mesa for many years and is thought to be due to past disposal practices of oil field brines in the early 1900s rather than active seawater intrusion from the ocean. This area of saline groundwater is being pushed westerly into Bolsa Gap due to increased injection at the west end of the Talbert Barrier but is not expected to be a threat to any active production wells or groundwater resources.

12.5 NEWPORT MESA

Chloride concentrations in the Beta/Lambda aquifers in the Newport Mesa area have either remained stable or decreased over the last 10 years even though groundwater elevations have typically been below sea level in these two aquifers in this area. Main aquifer chloride concentrations in this area have either decreased or have remained relatively stable for the last 10 years. A proposed extension of the Talbert Barrier eastward along Adams Avenue onto the Newport Mesa has been preliminarily evaluated and modeled by OCWD staff using the Talbert Model. Such a project would serve to provide assurance against any future intrusion in the Beta/Lambda and Main aquifers under lower basin conditions and would thus protect production wells owned by Mesa Water District in addition to replenishing the basin. Based on the stability of chloride concentrations in the Newport Mesa, there is no need to advance this project at this time.

In 2014, OCWD constructed four new multi-depth monitoring wells (M51, M52, M53, MRSH) farther east on the Newport Mesa whose locations are shown on Figure 12-10. These four well sites are now a part of OCWD's coastal monitoring program for both groundwater levels and seawater intrusion sampling. The East Newport Mesa area was previously a data gap in which the aquifer stratigraphy and groundwater flow patterns were not well understood.

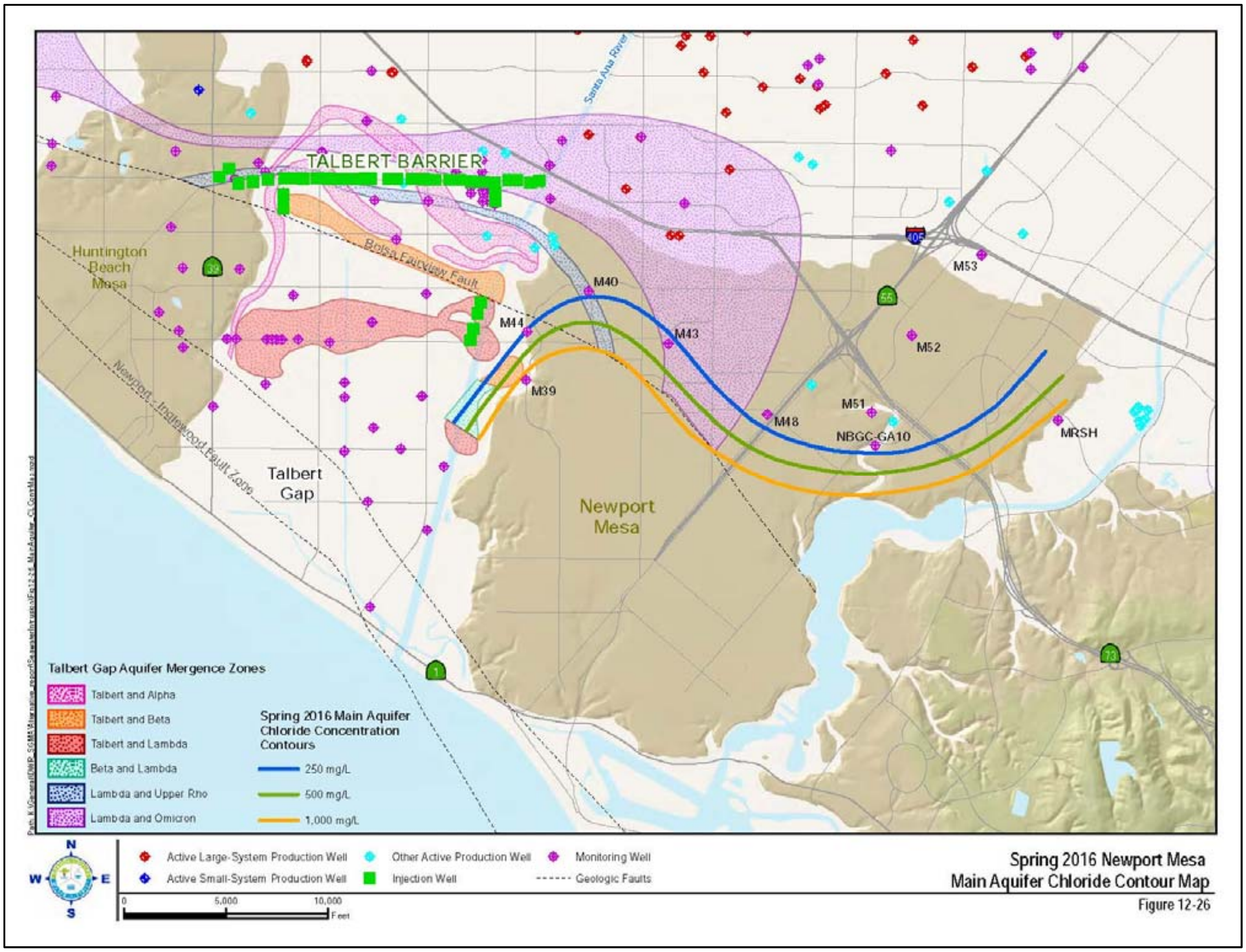


Figure 12-10: Newport Mesa Chloride Contours

12.6 IMPLEMENTATION OF SEAWATER INTRUSION PREVENTION POLICY

Implementation of OCWD's seawater intrusion prevention policy, described in Section 6.5, is summarized below. These programs enable OCWD to continue sustainably managing the groundwater basin to prevent significant and unreasonable seawater intrusion.

12.6.1 Effective Barrier Operations

The effective operation of the Talbert and Alamitos barriers is critical to the protection of the basin aquifers from seawater intrusion. This program includes, but is not limited to, the following activities:

1. Injection of sufficient water quantities combined with other basin management programs, such that protective groundwater elevations are established and maintained, where applicable, based on local hydrogeologic characteristics.
2. Regular maintenance of injection facilities to provide sufficient injection quantities. Such maintenance includes backwashing, redevelopment, and replacement (if necessary) of injection wells and operational fitness checks/repairs of flow meters, pressure reducing valves, and telemetry equipment.
3. Regular communications and coordination between operations, hydrogeology, and engineering staff on barrier operations and activities.
4. Annual reporting on barrier facilities status and operations. The report will include recommendations, as necessary, for barrier improvements to achieve policy objectives.

12.6.2 Barrier Performance Monitoring and Evaluation

Monitoring and evaluating barrier performance provides the basis on which to determine if the barriers are preventing seawater intrusion from occurring. This program consists of the following activities:

1. Semi-annual sampling and testing of designated monitoring wells in the vicinity of the seawater barriers. Testing will include parameters such as total dissolved solids, chloride, and electrical conductivity as indicators of seawater intrusion. Wells will be designated to provide adequate spatial coverage, particularly near likely seawater pathways and near the interface between seawater and freshwater.
2. Quarterly water level measurements at designated monitoring wells in the vicinity of the seawater barriers. More frequent measurements will be collected as needed at key locations.
3. Installation of monitoring wells in areas where it is determined that data gaps exist near the seawater barriers that may allow seawater intrusion to go undetected or would otherwise significantly impede the ability to assess barrier performance.
4. Annual evaluation and reporting of barrier performance based on surrounding groundwater level and quality data.

12.6.3 Susceptible Coastal Area Monitoring and Evaluation

This program addresses the assessment and ongoing monitoring of the coastal gaps and other areas that are not currently protected from seawater intrusion by the Talbert and Alamitos barriers. These areas include the Bolsa and Sunset gaps and adjacent mesas. This program includes the following activities:

1. Semi-annual sampling and testing of designated monitoring wells. Testing includes parameters such as total dissolved solids, chloride, and electrical conductivity as indicators

of seawater intrusion. Wells have been designated to provide adequate spatial coverage, particularly near likely seawater pathways.

2. Quarterly water level measurements at designated monitoring wells. More frequent measurements will be collected as needed at key locations.
3. Installation of monitoring wells in areas where it is determined that data gaps exist that may allow seawater intrusion to go undetected or would significantly impede the ability to understand the location of and trends in seawater intrusion.
4. Annual evaluation and reporting of the coastal area monitoring program, including recommendations, as needed, for further investigation or other potential actions to address seawater intrusion.

12.6.4 Coastal Groundwater Management

In addition to operating the seawater barriers, OCWD has implemented other basin management activities to lessen the potential for seawater intrusion. These activities have included the Coastal Pumping Transfer Program, Coastal In-Lieu Program, and maintaining basin storage levels within the operating range. Each of these activities shall continue to be considered and implemented as deemed necessary along with other potential actions to complement and enhance the OCWD seawater prevention program.

12.7 DEFINITION OF SIGNIFICANT AND UNREASONABLE SEAWATER INTRUSION

As explained above, OCWD conducts comprehensive programs to protect the groundwater basin from the undesirable effect of significant and unreasonable seawater intrusion. Seawater intrusion in the OCWD Management Area would be considered significant and unreasonable if a significant and continuing reduction in usable storage volume in the groundwater basin occurs as a result of increased salinity due to seawater intrusion.

12.8 DETERMINATION OF MINIMUM THRESHOLDS

The minimum threshold for seawater intrusion that defines an undesirable result is (1) the shutdown of active large system production wells due to seawater-derived salinity, and (2) continuing loss of a significant amount of basin storage due to seawater-derived salinity.

SECTION 13 SUSTAINABLE MANAGEMENT RELATED TO LAND SUBSIDENCE

Management of the groundwater basin by maintaining storage levels within OCWD's established operating range has prevented significant and unreasonable land subsidence that substantially interferes with surface uses. Within the OCWD Management Area there is no evidence of continuing irreversible land subsidence, nor is there evidence that land subsidence has interfered with surface uses. Therefore, the undesirable result of "significant and unreasonable land subsidence that substantially interferes with surface uses" is not present and is not anticipated to occur in the OCWD Management Area in the future

Subsidence due to changes in groundwater conditions in the Orange County groundwater basin is variable and does not show a pattern of irreversible permanent lowering of the ground surface. Some subsidence may have occurred before OCWD began refilling the groundwater basin in the late 1950s after storage conditions reached a historic low (Morton, et al., 1976); however, the magnitude and scope of this subsidence is uncertain and it is not clear if this subsidence was permanent. Since this time OCWD has operated the groundwater basin within the established operating range.

More recent data show a consistent pattern of the ground surface rising and falling in tandem with groundwater levels and overall changes in basin groundwater storage. This is referred to as elastic subsidence. Interferometric Synthetic Aperture Radar (InSAR) data collected from satellites and data collected by the Orange County Surveyor (Surveyor) show that ground surface elevations in Orange County both rise and fall in response to groundwater recharge and withdrawals. InSAR data during the period 1993-1999 shows temporary seasonal land surface changes of up to 4.3 inches (total seasonal amplitude from high to low) in the Los Angeles-Orange County area and a net decline of approximately 0.5 inch/year near Santa Ana over the period 1993 to 1999, which happened to coincide with a period of a net decrease in groundwater storage in the basin (Bawden, 2001; 2003).

The Surveyor's office maintains more than 1,500 elevation benchmarks throughout Orange County. Periodically, the Surveyor resurveys the benchmarks to detect changes in elevation. The Surveyor maintains the survey records and makes them available to the public (http://ocpublicworks.com/survey/services/ocrtn) and provides the data to OCWD upon request. The Surveyor also maintains an Orange County Real Time Network (OCRTN) that consists of continuously operating GPS reference stations that monitor horizontal and vertical movement throughout Orange County. Figure 13-1 shows the locations of the GPS stations in Orange County.

Based on real time GPS data, the BLSA and SACY sites show the greatest range of elevation change of any of the sites in Orange County. Ground surface elevation changes at these sites from 2002 to 2014 correlate well with changes in groundwater storage, as shown on Figure 13-2. Note that this period of time includes a very wet period (2004-06) when basin groundwater storage increased significantly and a dry period (2010-2014) when basin groundwater storage decreased significantly.

In reviewing the available sources of data, it is clear that depending on the time period selected, the ground surface is rising, falling, or remaining stable. GPS data collected by the Surveyor over the past 12 years (2002-14) show that the ground surface fluctuations appear to be completely elastic, reversible, and well correlated with fluctuations in groundwater levels. These data indicate that there has not been any permanent, irreversible subsidence of the ground surface over the past 12 years.

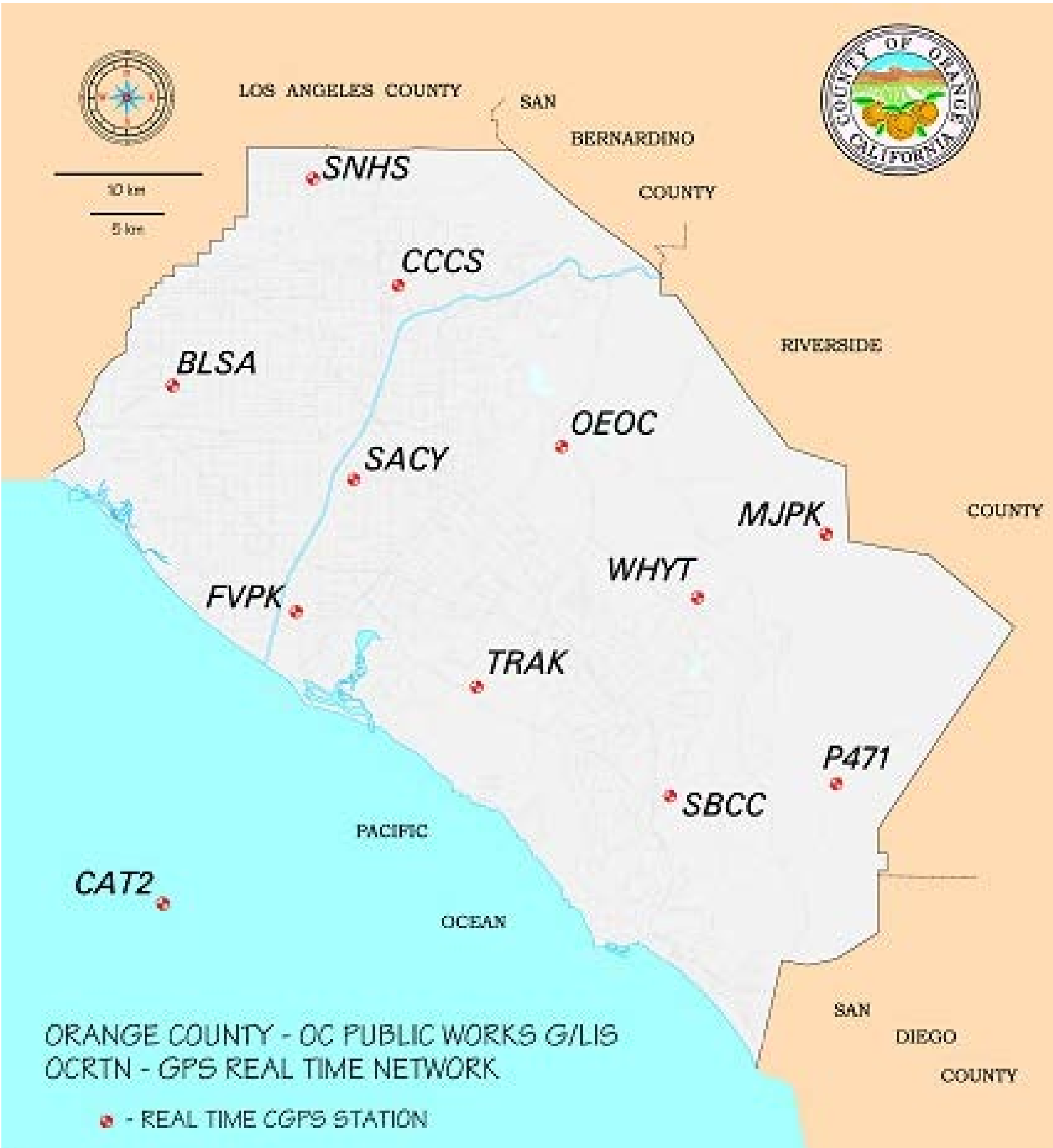


Figure 13-1: Orange County Public Works GPS Real Time Network

Finally, there is little potential for future widespread permanent, irreversible subsidence given OCWD's commitment to sustainable groundwater management and policy of maintaining groundwater storage levels within a specified operating range. Nevertheless, OCWD annually reviews Surveyor data to evaluate ground surface fluctuations within OCWD's service area. If irreversible subsidence was found to occur in a localized area in relation to groundwater pumping patterns or groundwater storage conditions, OCWD would coordinate with local officials to investigate and develop an approach to address the subsidence. This could include OCWD managing the basin at higher groundwater storage levels.

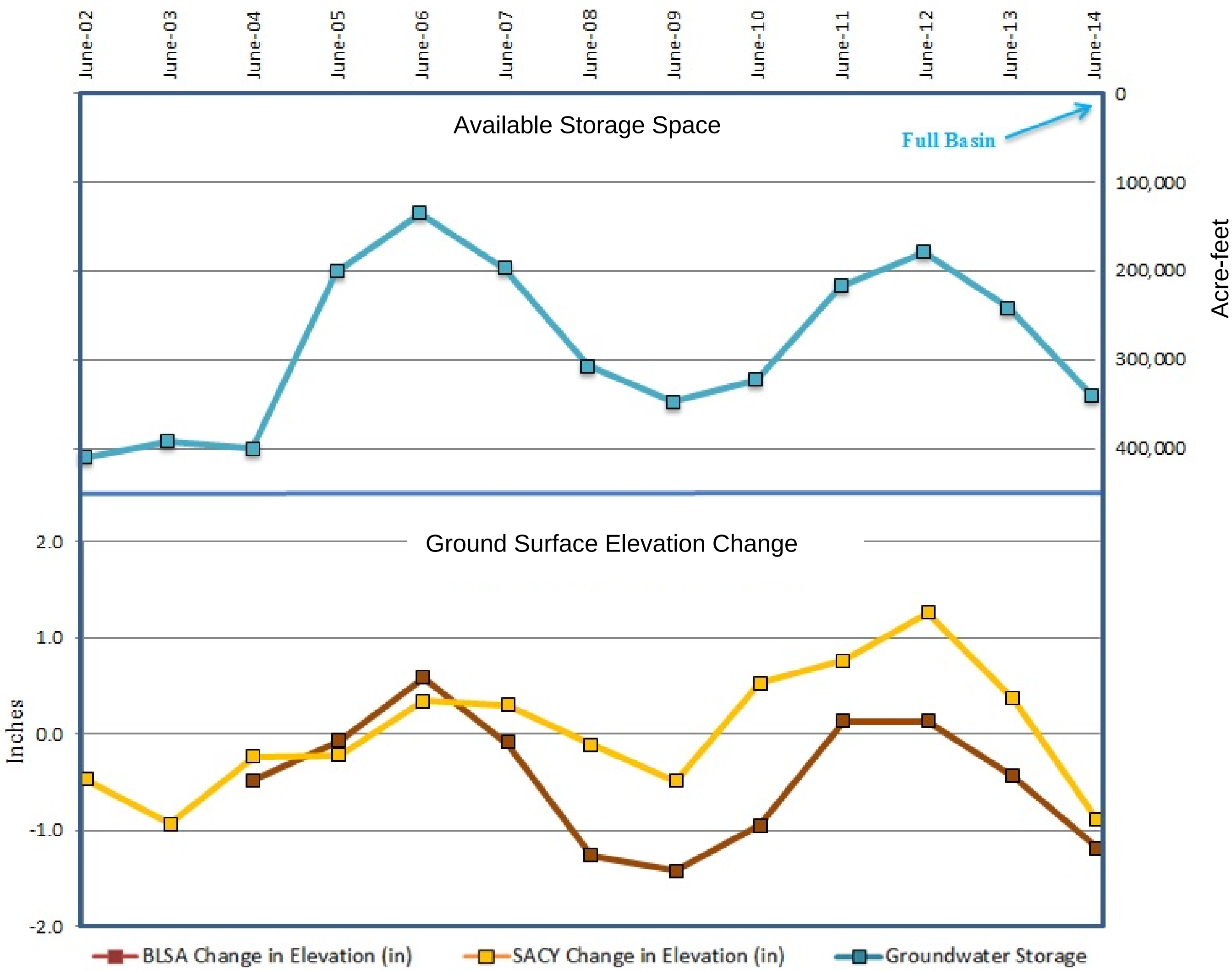


Figure 13-2: Available Groundwater Basin Storage and Ground Surface Elevation Change, 2002-2014

13.1 DEFINITION OF SIGNIFICANT AND UNREASONABLE LAND SUBSIDENCE THAT SUBSTANTIALLY INTERFERES WITH SURFACE USES

As stated above, data indicates that there is no inelastic land subsidence within the OCWD Management Area due to changes in groundwater elevation or groundwater storage levels. Land subsidence would be considered to be significant and unreasonable if ground surface elevation changes as measured by Orange County Public Works are determined to be inelastic over a significant period of time, these elevation changes are attributed to declines in groundwater storage, and these changes are likely to significantly interfere with surface uses.

13.2 DETERMINATION OF MINIMUM THRESHOLDS

The minimum threshold for land subsidence that defines an undesirable result is a sustained lowering of ground surface elevation that is attributable to lowering of groundwater storage in the basin and is likely to significantly interfere with surface uses.

SECTION 14 SUSTAINABLE MANAGEMENT RELATED TO GROUNDWATER DEPLETIONS IMPACTING SURFACE WATER

There are no surface water bodies within the OCWD Management Area that are interconnected and dependent on groundwater basin conditions. Therefore, the undesirable result of "depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water due to groundwater conditions occurring throughout the basin" is not present and in the future is not anticipated to occur in the OCWD Management Area due to OCWD's management programs.

14.1 SANTA ANA RIVER

The Santa Ana River in Orange County flows through a highly urbanized environment. Flood protection infrastructure has constrained the flow of the river with engineered levees along most of its course.

From Imperial Highway to 17th Street in Santa Ana (Figure 14-1 and 14-2), the river is a losing reach with surface water percolating into groundwater. OCWD conducts recharge operations within the soft-bottomed river channel except for a portion of the river where the Riverview Golf Course occupies the river channel. The river levees are constructed of either rip-rap or concrete. The river bed is utilized for groundwater recharge. OCWD diverts surface water flows into recharge basins at Imperial Highway and at another diversion point farther downstream. Nearly all the water that remains in the river during non-storm conditions percolates into the groundwater basin upstream of 17th Street.

When the groundwater basin is in a nearly full condition, groundwater levels in the Shallow Aquifer in this area are generally 20 feet to greater than 60 feet below ground surface. When groundwater storage levels are in the lower portion of the operating range, groundwater levels in the Shallow Aquifer are even further below ground surface. Data indicate that this reach of the river has historically been a losing reach that was frequently dry during summer months. There is no evidence that changes in groundwater levels have had an impact on flows in the Santa Ana River from Imperial Highway to 17th Street in Santa Ana.

From 17th Street to near Adams Avenue in Costa Mesa (Figure 3-28), the river channel is concrete-lined for flood control with sloping or vertical concrete side levees and a concrete bottom. The flood control infrastructure in this section of the Santa Ana River creates a barrier between surface water and underlying groundwater.

From Adams Avenue to the coast, the channel has concrete side walls or rip-rap for flood control and a soft bottom. The river here is brackish as it is subject to tidal influences. Estuary conditions within the concrete or rip-rap channel exist at the mouth of the river where the ocean encroaches at high tide. The tidal prism extends from the ocean to approximately the Adams Avenue Bridge.

Figure 14-1: View of Santa Ana River (left) with OCWD recharge facilities (right). An inflatable rubber dam that crosses the river here enables OCWD to divert some river flows into basins for percolation.

Figure 14-2: Santa Ana River, looking upstream in the vicinity of Ball Road. Here the river, with side levees and a soft bottom, is typically dry during non-storm conditions.

14.2 SANTIAGO CREEK

Santiago Creek is a major tributary of the Santa Ana River. The creek is the primary drainage for the northwest portion of the Santa Ana Mountains. Under natural conditions, the creek is ephemeral, with dry conditions predominant during most of the year (Figures 14-3 and 14-4). Water from the creek is impounded by Santiago Dam and Villa Park Dam. Downstream of the Villa Park Dam, OCWD conducts groundwater recharge operations. OCWD manages infiltration of stormwater in Santiago Basins and releases water into the creek at rates that maximize percolation in the creek bed. Recharge occurs in the basins as well as downstream in the creek from the basins to Hart Park in the city of Orange. OCWD also conveys water via a pipeline from the recharge facilities along the Santa Ana River for percolation in the Santiago recharge facilities. This supply is a combination of Santa Ana River flow and imported water. During most of the year, there is more flow in the creek due to OCWD recharge operations than would be under natural conditions. Data indicates that Santiago Creek naturally loses flow through percolation into the groundwater and that groundwater levels have no impact on creek flows due to the vadose zone being tens of feet thick in this area.

Figure 14-3: Santiago Creek,view upstream in the vicinity of Hart Park in Orange

Figure 14-4: Santiago Creek, view upstream from Tustin Avenue in Orange

SECTION 15 PROTOCOLS FOR MODIFYING MONITORING PROGRAMS

Protocols that trigger a change in a monitoring program include:

- a recommendation by the GWRS Independent Advisory Panel for resampling or increased monitoring of a particular constituent of concern;
- a recommendation by the Independent Advisory Panel that reviews OCWD use of Santa Ana River water for groundwater recharge and related water quality;
- a change in regulation or anticipation of a change in regulation;
- a constituent in a sample approaches or exceeds a regulatory water quality limit or Maximum Contaminant Level, notification level, or first-time detection of a constituent;
- the computer program built by OCWD to validate water quality data prior to transfer to the WRMS data base flags a variation in historical data that may indicate a statistically significant change in water quality;
- analysis of water quality trends conducted by water quality, hydrogeology, or recycled water production staff indicate a need to change monitoring; or
- OCWD initiates a special study, such as quantifying the removal of contaminants using treatment wetlands or testing the infiltration rate of a proposed new recharge basins.

SECTION 16 EVALUATION OF POTENTIAL PROJECTS

16.1 FACILITIES IMPROVEMENT PROJECTS AND STUDIES

OCWD regularly evaluates potential projects and conducts studies to improve the existing facilities and build new facilities, such as:

- Increasing the capacity to transfer water from one basin to another;
- Reconfiguring a basin to improve infiltration rates;
- Evaluating potential sites for new recharge facilities such as existing flood control facilities;
- Developing new water supply sources such as water recycling and increasing stormwater capture; and
- Developing remediation plans to protect basin water quality.

16.2 LONG-TERM FACILITIES PLANS

The Long-Term Facilities Plan (LTFP) is a strategic planning tool which identifies potential projects that advance the mission of OCWD. The key purpose in preparing the LTFP is to identify the most important and effective potential projects so that available resources can be focused appropriately. Preparation of the LTFP helps OCWD prioritize its efforts to those potential projects that should be further developed. Plan development includes consideration of current and projected water demands, current water supplies available for groundwater recharge, and estimated costs and benefits of potential projects.

The Long-Term Facilities Plan 2014 Update evaluated 65 potential projects grouped by project type (water supply, basin management, recharge facilities, operational improvements, and operational efficiency). Each project was reviewed and evaluated by OCWD staff with regards to its economic and technical feasibility. Benefits of projects were evaluated based on the following:

- Increase supply of recharge water;
- Increase recharge capacity and efficiency of recharge facilities;
- Cleanup of contaminated groundwater;
- Protection of groundwater quality; and
- Control of seawater intrusion.

Seventeen of the 65 projects were selected for additional focused study. For these projects more detailed cost estimates were prepared along with an analysis of the project's feasibility, potential constraints, and estimated timeline for construction. Groundwater recharge projects were evaluated using the Recharge Facilities Model, described in the following section.

16.3 RECHARGE STUDIES AND EVALUATIONS

OCWD has an ongoing program to continually assess potential enhancements to existing recharge facilities, evaluate new recharge methods and analyze potential new recharge facilities. The planning and implementation horizon for recharge facilities varies from a near term horizon of 5 to 10 years for development of specific projects to 50-year projections of the future availability of recharge water supplies, as described below.

Recharge Enhancement Working Group

The Recharge Enhancement Working Group is comprised of OCWD staff from multiple departments that works to maximize the efficiency of existing recharge facilities and evaluate new concepts to increase recharge capacity. Proposed projects under investigation are continually evolving as needs and conditions change. Potential projects/concepts considered include reconfiguration of existing basins, operational improvements to increase flexibility in the management of the basins, alternative basin cleaning methods, potential sites for new basins, and control of sediment concentrations.

Computer Model of Recharge Facilities

One of the challenges OCWD faces in determining the value of improving existing recharge facilities, storing more water at Prado Dam and purchasing new recharge facilities is estimating the amount of additional water that could be recharged due to a potential project. Given the complexity and interconnectivity of the recharge system, a model was needed to isolate the impacts of various proposed projects in order to determine the increased recharge potential due to a specific project.

OCWD developed the Recharge Facilities Model, which is a computer model of the recharge system that simulates Prado Dam operations, Santa Ana River flow and each recharge facility. This model is primarily a planning tool that is used to evaluate various conditions including estimating recharge benefits if new recharge facilities are constructed, existing facilities are improved, increased storage is achieved at Prado Dam, or baseflow changes occur in the Santa Ana River. The model can be operated by OCWD staff from a desktop computer using a graphical user interface.

The Recharge Facilities Model was completed in 2009 with the assistance of CH2M HILL and is based on GoldSim software, which is a general simulation software solution for dynamically modeling complex systems in business, engineering and science http://www.goldsim.com/Home/) (CH2M HILL, 2009).

Key features of the Recharge Facilities Model include:

- Ability to simulate different surface water inflow scenarios (e.g., high base flow, low base flow, etc.)
- Inflatable rubber dam operations (e.g., diversion rates, deflation/inflation)

- Conveyance capacity of system (e.g., pipeline and pumping capacities)
- Basin recharge capacities
- Reductions in basin capacities caused by clogging
- Maintenance thresholds that cause basins to be taken out of service and cleaned
- Different Prado Dam conservation pool elevations and release rates
- Different sedimentation levels behind Prado Dam
- Ability to add imported water to system when excess capacity is available

Output from the model includes:

- Amount of water recharged in each facility, storage at Prado Dam, release rates from Prado Dam, storage in each facility, etc.;
- Amount of water that could not be recharged and water losses to the ocean;
- Optimal amount of cleaning operations;
- Available (unused) recharge capacity; and
- Amount of imported water that can be recharged using unused capacity.

The RFM is flexible and allows for the development and simulation of a wide array of different scenarios. Examples of how the model has been used to evaluate potential recharge projects include:

- Estimate of the additional amount of water available for recharge if the water conservation pool behind Prado Dam is raised to 505 ft msl year round
- Estimate of the impact of the recent trend toward decreasing base flows in the Santa Ana River.
- Estimate of how much imported water could be purchased using unused system capacity.

16.3.1 Future Santa Ana River Flow Projections

OCWD prepares projections and works with other agencies to prepare projections of future Santa Ana River flows. Previous summaries are discussed in OCWD's Groundwater Management Plan (OCWD, 2015). The most recent projection is discussed below.

In 2014, projections of future Santa Ana River flows were developed for OCWD and the Army Corps to evaluate the feasibility of increasing the volume of water that can be stored behind Prado Dam (WEI, 2014). An existing model developed by Wildermuth Environmental, Inc. (WEI) called the Waste Load Allocation Model (WLAM), was used to estimate non-discharge inputs contributing to river flows. The WLAM is a hydrologic simulation tool of the Santa Ana River watershed tributary to Prado Dam and was developed for the Santa Ana Watershed

Project Authority (SAWPA) by WEI (2010). WEI began development of the WLAM for SAWPA in 1994 and has improved it over time to support numerous water resources investigations.

The WLAM uses historic rainfall and stream flow along the model boundaries for the 50-year period from 1950 to 1999. The model also accounts for the contribution of rising groundwater to Santa Ana River flows. The volume of rising groundwater has decreased in recent years due to lower groundwater levels in the southern portion of the Chino Groundwater Basin. Groundwater levels in this area are expected to remain low as this is part of the basin management strategy to reduce the migration of poor quality groundwater into the Santa Ana River.

Estimated future discharges of water from wastewater treatment plants to the Santa Ana River are expected to decline due to conservation and increased recycling. This, along with reductions in rising groundwater, means that projected Santa Ana River base flows reaching Prado Dam are significantly lower than what occurred from the early 1990s to 2005.

As a result of this work, OCWD developed three Santa Ana River base flow projections:

1. High Base Flow Condition: 101,700 afy
2. Medium Base Flow Condition: 52,400 afy
3. Low Base Flow Condition: 36,000 afy

Per the 1969 Stipulated Judgment in the case of Orange County Water District v. City of Chino, et al., Case No. 117628-County of Orange, a minimum annual Santa Ana River base flow of 42,000 afy is required to reach Prado Dam. However, a system of credits in the judgment allows the Santa Ana River base flow to be as low as 34,000 afy until the credits are exhausted. Given the large credit that exists due to many years of base flow exceeding 42,000 afy, the minimum flow of 34,000 afy could be in place for many decades. Even though the minimum allowable base flow is 34,000 afy, the annual base flow simulated was 36,000 afy for the low base flow condition due to minor variations in rising groundwater produced by the WLAM.

In developing estimates of future Santa Ana River storm flows arriving at Prado Dam, land use conditions in the WLAM were reviewed. For future conditions, SCAG 2005 land use data was modified to represent future (2071) land uses. The assumptions made in modifying the 2005 land use data were: (1) already developed urban areas and surrounding mountain areas were assumed not to change; (2) dairy, poultry, intensive livestock, as well as land use classified as “other agriculture” were assumed to be developed; and, (3) vacant and undeveloped areas were also assumed to be developed by 2071. In addition, all new developed land use in 2071 was assumed to be high density residential. This analysis resulted in an increase in high density residential area of approximately 71 square miles, a decrease dairy, poultry, horse ranch, etc. areas by approximately 11 square miles, and a decrease in undeveloped areas by approximately 59 square miles.

The increased runoff generated by future land uses is offset by plans for storm water harvesting by upstream agencies. Plans were identified for future storm water harvesting from Seven Oaks Dam, diversions from the Santa Ana River and its tributaries, and on-site infiltration that would be required by the Municipal Separate Storm Sewer System (MS4) permit. To develop the lowest flow condition possible, it was assumed that projects that have reached the environmental review stage would be constructed. As a result, the average annual storm flow arriving at Prado Dam is reduced by 27,360 afy (WEI, 2014).

Future estimates of Santa Ana River storm flow arriving at Prado Dam are presented in Table 16-1. The three Santa Ana River base flow conditions were combined with the estimated storm flow arriving at Prado Dam to develop three inflow conditions as summarized in Table 16-2.

Table 16-1**:** Estimated Future Santa Ana River Storm Flow Arriving at Prado Dam

STORM FLOW RUNOFF CONDITION	Average Storm Flow to Prado Basin (afy)
Current Land Uses	118,000
Future (2071) Land Uses	125,970
Future (2071) Land Uses, Maximum Storm Water Harvesting	98,610

Table 16-2: Santa Ana River Flow Conditions and Estimated Average Inflow to Prado Dam

CONDITION	DESCRIPTION	Santa Ana River Flow to Prado (afy)		Total Average Flow (afy)
		Average Base Flow	Average Storm Flow	
High	High Base Flow, Current Land Uses	101,700	118,000	219,700
Medium	Medium Base Flow, Future (2071) Land Uses	52,400	125,970	178,370
Low	Low Base Flow, Future (2071) Land Uses, Maximum Storm Water Harvesting	36,000	98,610	134,610

Sixteen potential recharge projects were evaluated using the Recharge Facilities Model (RFM) as part of the preparation of OCWD's Long-Term Facilities Plan 2014 Update. Key assumptions used in the RFM are as follows:

1. The Prado Dam conservation pool is operating at 505 feet year round. Work to raise the flood season pool from 498 to 505 feet is ongoing and is expected to be completed and implemented in the next few years.
2. All GWRS water conveyed to Anaheim, including flows from the final expansion of GWRS, will be recharged in Miraloma Basin and La Palma Basin. This assumption frees up the capacity of the remainder of the recharge system for Santa Ana River flows and imported water.

The approach to modeling each project was to compare the total system recharge with and without the project for each flow condition. For example, total system recharge was modeled for the high flow condition with and without a project. The difference in the recharge obtained for the entire system comparing the two runs defined the benefit of the project being modeled. This was then repeated for the medium and low flow conditions. Table 16-3 shows the additional yield produced by each potential project for the high, medium, and low flow conditions.

The RFM was also used to evaluate the loss of storm flow capture that will result as sediment continues to accumulate in the Prado Basin. Based on the historical rate of sediment accumulation of approximately 350 acre-feet per year, the storage within the conservation pool is projected to fill up within the next 50 years. If the conservation pool becomes filled with sediment, the eventual loss of storm water available for recharge will range from 30,000 to 38,000 acre-feet per year.

Table 16-3: Annual Yield of Potential Surface Water Recharge System Projects based on Recharge Facilities Model

PROJECT NAME	Santa Ana River Flow Condition (afy)		
	High	Medium	Low
Desilting Santa Ana River Flows	10	390	10
Enhanced Recharge in Santiago Creek at Grijalva Park	10	10	85
Subsurface Collection and Recharge System in Off-River and Five Coves	610	730	150
Enhanced Recharge in Santa Ana River Between Five Coves/Lincoln Ave.	10	220	20
Enhanced Recharge in Santa Ana River Below Ball Road	730	600	230
Recharge in Lower Santiago Creek	270	150	90
Five Coves Bypass Pipeline	130	10	10
Five Coves Bypass Pipeline with Lincoln Basin Rehabilitation	710	490	100
Placentia Basin Improvements	75	170	260
Raymond Basin Improvements	40	230	350
River View Basin Expansion	10	100	10
Additional Warner to Anaheim Lake Pipeline	10	10	30
Lakeview Pipeline	10	10	10
Warner System Modifications	210	250	10
Anaheim Lake Re-contouring	10	125	10

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APPENDIX A

List of Wells in OCWD Monitoring Network

List of Wells in OCWD Monitoring Programs

KEY

Aquifer Zone: S=Shallow Aquifer, P=Principal Aquifer, D= Deep Aquifer

Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
ABC-KISCH	ABC SCHOOL DIST.	0		0	0	Inactive Production		2
ABC-MESCH	ABC SCHOOL DIST.	0		0	0	Other Active Production		2
ABC-TETZL	ABC SCHOOL DIST.	0		0	0	Other Active Production		2
W-5470	ABC SCHOOL DIST.	282		190	240	Inactive Production		2
ACP-I03	AC PRODUCTIONUCTS	460		370	450	Injection		4
ACP-P01	AC PRODUCTIONUCTS	200		90	140	Inactive Production		2,3
ACP-P02	AC PRODUCTIONUCTS	190		100	180	Other Active Production		2
AVCC-P	ALTA VISTA COUNTRY CLUB	438		0	0	Other Active Production		2,3
AVCC-P2	ALTA VISTA COUNTRY CLUB	803		210	770	Other Active Production	P	2,3
A-14	ANAHEIM	450		309	425	Inactive Production	P	2,8
A-36	ANAHEIM	818		651	796	Inactive Production	P	2,7
A-39	ANAHEIM	1493		540	1280	Active Large Production	P	2,7
A-40	ANAHEIM	1308		505	1220	Active Large Production	P	2,7
A-41	ANAHEIM	1532		437	1450	Active Large Production	P	2,7
A-42	ANAHEIM	1260		430	1180	Active Large Production	P	2,7
A-43	ANAHEIM	1400		530	1210	Active Large Production	P	2,7
A-44	ANAHEIM	1155		450	1130	Active Large Production	P	2,7
A-45	ANAHEIM	1430		455	1410	Active Large Production	P	2,7
A-46	ANAHEIM	1565		599	1529	Active Large Production	P	2,7
A-47	ANAHEIM	1500		482	1375	Active Large Production	P	2,7,8
A-48	ANAHEIM	1450		932	1344	Active Large Production	P	2,7
A-49	ANAHEIM	1498		580	1450	Active Large Production	P	2,7,8
A-51	ANAHEIM	1310		525	965	Active Large Production	P	2,7
A-52	ANAHEIM	1210		570	1066	Active Large Production	P	2,7
A-53	ANAHEIM	1350		945	1270	Active Large Production	P	2,7
A-54	ANAHEIM	0		680	1480	Active Large Production	P	2,7
A-55	ANAHEIM	1340		370	1300	Active Large Production	P	2,7
A-56	ANAHEIM	1600		725	1300	Active Large Production	P	2,7
A-58	ANAHEIM	1218		400	930	Inactive Production		2,7
ADEV-AM1	ANAHEIM	157		110	150	Monitoring		1
A-DMGC	ANAHEIM	500		430	482	Other Active Production	P	2,3
A-YARD-MW1	ANAHEIM	112		85	109	Monitoring		1
A-YARD-MW2	ANAHEIM	111		86	110	Monitoring		1
W-15896	ANAHEIM MOTEL, LIMITED	200		0	0	Inactive Production		2,3
ANGE-O	ANGELICA HEALTHCARE SERVICES	670		186	639	Other Active Production		2,3
AET-RMW10	ARCO/TOSCO/EQUIVA	129		127	128	Monitoring		1
AET-RMW14	ARCO/TOSCO/EQUIVA	197		195	196	Monitoring		1
AET-RMW15	ARCO/TOSCO/EQUIVA	142		140	141	Monitoring		1
AET-RMW16	ARCO/TOSCO/EQUIVA	200		189	190	Monitoring		1
AET-RMW17	ARCO/TOSCO/EQUIVA	218		217	218	Monitoring		1
AET-RMW2	ARCO/TOSCO/EQUIVA	199		196	197	Monitoring		1
AET-RMW20	ARCO/TOSCO/EQUIVA	100		98	99	Monitoring		1
AET-RMW23	ARCO/TOSCO/EQUIVA	124		119	120	Monitoring		1
AET-RMW3	ARCO/TOSCO/EQUIVA	200		194	195	Monitoring		1
AET-RMW5	ARCO/TOSCO/EQUIVA	200		195	196	Monitoring		1
AET-RMW6	ARCO/TOSCO/EQUIVA	184		116	117	Monitoring		1
AET-RMW7	ARCO/TOSCO/EQUIVA	113		108	109	Monitoring		1
AET-RMW8	ARCO/TOSCO/EQUIVA	98		94	95	Monitoring		1
AET-RMW9	ARCO/TOSCO/EQUIVA	112		107	108	Monitoring		1
ARMD-LA3	ARMED FORCES RESERVE CENTER	965		333	363	Inactive Production		2
ARMD-LARA	ARMED FORCES RESERVE CENTER	0		0	0	Inactive Production		2
AR-PUMP	ARTESIA	217		0	0	Other Active Production		2,3
W-14107	ARTESIA ICE CO.	51		0	0	Inactive Production		2,3
ARCO-FBH11	ATLANTIC RICHFIELD CO.	62		50	62	Monitoring		1
ARCO-FBH12	ATLANTIC RICHFIELD CO.	75		55	75	Monitoring		1
ARCO-FBH14	ATLANTIC RICHFIELD CO.	75		0	0	Monitoring		1
ARCO-FBH17	ATLANTIC RICHFIELD CO.	140		124	139	Monitoring		1
ARCO-FBH5	ATLANTIC RICHFIELD CO.	75		0	0	Monitoring		1
ARCO-FBH6	ATLANTIC RICHFIELD CO.	80		48	80	Monitoring		1
ARCO-T2209	ATLANTIC RICHFIELD CO.	150		82	143	Injection		4
BF-BF1	BELLFLOWER	1200		574	1160	Active Large Production		2
PEER-17	BELLFLOWER MUNICIPAL WATER CO.	1030		610	1012	Active Small Production		2
PEER-2	BELLFLOWER MUNICIPAL WATER CO.	204		162	177	Active Large Production		2
PEER-7	BELLFLOWER MUNICIPAL WATER CO.	108		0	0	Active Small Production		2
PEER-8	BELLFLOWER MUNICIPAL WATER CO.	174		113	153	Other Active Production		2
FUJI-FV	BERUMEN FARMS	170		0	0	Other Active Production		2,3
FUJI-WM	BERUMEN FARMS	150		0	0	Inactive Production		2,3

List of Wells in OCWD Monitoring Programs

KEY

Aquifer Zone: S=Shallow Aquifer, P=Principal Aquifer, D= Deep Aquifer

Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
BOE-EW101	BOEING CO.	77		57	77	Other Active Production	S	2
BOE-EW102	BOEING CO.	87		62	82	Other Active Production	S	2
BOE-EW103	BOEING CO.	85		63	83	Other Active Production	S	2
BOE-EW104	BOEING CO.	83		57	82	Other Active Production	S	2
BOE-MW16	BOEING CO.	297		260	280	Monitoring		1,6
BOE-MW17	BOEING CO.	298		255	275	Monitoring		1,6
BOE-MW19A	BOEING CO.	173		153	173	Monitoring		1,6
BOE-MW20S	BOEING CO.	84		59	80	Monitoring	S	1
BOE-MW21S	BOEING CO.	81		59	79	Monitoring	S	1
BOE-MW27A	BOEING CO.	172		139	159	Monitoring		1,6
BOE-MW31S	BOEING CO.	92		78	88	Monitoring	S	1
BOE-MW34	BOEING CO.	278		252	267	Monitoring		1,6
BOE-MW37A	BOEING CO.	172		135	165	Monitoring		1,6
BOE-MW38A	BOEING CO.	170		135	165	Monitoring		1,6
BOE-MW41A	BOEING CO.	177		149	169	Monitoring		1,6
BOE-MW42A	BOEING CO.	173		140	170	Monitoring		1,6
BOE-MW57A	BOEING CO.	172		150	170	Monitoring		1,6
BOE-MW58A	BOEING CO.	175		150	170	Monitoring		1,6
BOE-MW59B	BOEING CO.	268		240	250	Monitoring		1,6
BOE-MW60A	BOEING CO.	172		150	170	Monitoring		1,6
BOE-MW61A	BOEING CO.	172		150	170	Monitoring		1,6
BOE-MW72A	BOEING CO.	132		112	127	Monitoring		1,6
BOE-MW73A	BOEING CO.	137		113	133	Monitoring		1,6
BOE-MW75	BOEING CO.	227		202	222	Monitoring		1,6
BOE-MW95A	BOEING CO.	172		135	165	Monitoring		1,6
BOE-MW96A	BOEING CO.	175		150	170	Monitoring		1,6
BOE-MW97A	BOEING CO.	215		170	175	Monitoring		1,6
BOE-MW98A	BOEING CO.	215		169	174	Monitoring		1,6
BOE-MW99A	BOEING CO.	210		146	166	Monitoring		1,6
BOTT-C	BOTT TRACT MUTUAL WATER CO.	150		0	0	Other Active Production		2,3
LB-NLB10	BOY SCOUTS OF AMERICA	378		357	374	Monitoring		1
BR-1	BREA	500		78	115	Other Active Production		2,3
BROS-WM	BRORS OF ST.PATRICK	106		98	105	Other Active Production		2
BP-BALL	BUENA PARK	890		260	870	Active Large Production	P	2,7
BP-BOIS	BUENA PARK	1505		475	1355	Active Large Production	P	2,7
BP-CABA	BUENA PARK	1430		250	1010	Active Large Production	P	2,7
BP-FREE	BUENA PARK	1000		260	1000	Active Large Production	P	2,7
BP-HOLD	BUENA PARK	1020		250	1000	Active Large Production	P	2,7
BP-KNOT	BUENA PARK	1020		260	1000	Active Large Production	P	2,7
BP-LIND	BUENA PARK	1410		470	1221	Active Large Production	P	2,7
BP-SM	BUENA PARK	1038		308	1038	Active Large Production	P	2,7
OCWD-BGO10	CA STATE LANDS COMMISSION	110		80	100	Monitoring		1
SLC-MW1	CA STATE LANDS COMMISSION	25		5	25	Monitoring		1
SLC-MW10	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW11	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW12	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW13	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW14	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW15	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW16	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW2	CA STATE LANDS COMMISSION	25		5	25	Monitoring		1
SLC-MW3	CA STATE LANDS COMMISSION	25		5	25	Monitoring		1
SLC-MW4	CA STATE LANDS COMMISSION	25		5	25	Monitoring		1
SLC-MW5	CA STATE LANDS COMMISSION	25		5	25	Monitoring		1
SLC-MW6	CA STATE LANDS COMMISSION	25		5	25	Monitoring		1
SLC-MW7	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW8	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-MW9	CA STATE LANDS COMMISSION	32		10	30	Monitoring		1
SLC-P10	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P11	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P13	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P14	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P15	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P16	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
SLC-P17	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
SLC-P18	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
SLC-P19	CA STATE LANDS COMMISSION	40		5	20	Monitoring		1

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
SLC-P20	CA STATE LANDS COMMISSION	25		5	10	Monitoring		1
SLC-P21	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P22	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
SLC-P23	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P24	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P25	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
SLC-P26	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
SLC-P27	CA STATE LANDS COMMISSION	40		5	20	Monitoring		1
SLC-P29	CA STATE LANDS COMMISSION	25		6	21	Monitoring		1
SLC-P30	CA STATE LANDS COMMISSION	46		22	37	Monitoring		1
SLC-P31	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
SLC-P32	CA STATE LANDS COMMISSION	25		8	23	Monitoring		1
SLC-P33	CA STATE LANDS COMMISSION	40		6	21	Monitoring		1
SLC-P34	CA STATE LANDS COMMISSION	40		6	21	Monitoring		1
SLC-P35	CA STATE LANDS COMMISSION	40		7	22	Monitoring		1
SLC-P36	CA STATE LANDS COMMISSION	40		6	21	Monitoring		1
SLC-P4	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
SLC-P5	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P6	CA STATE LANDS COMMISSION	25		5	15	Monitoring		1
SLC-P9	CA STATE LANDS COMMISSION	25		5	20	Monitoring		1
CIFM-CH	CA. INSTITUE FOR MEN - CHINO	239		122	226	Other Active Production		2
CIFM-CH1A	CA. INSTITUE FOR MEN - CHINO	529		0	0	Other Active Production		2
CSF-1	CA. STATE UNIV., FULLERTON	842		130	726	Multiport Monitoring	S/P/D	1
FPRK-YLE	CANYON RV PARK	98		60	84	Active Small Production	S	2,7
FPRK-YLW	CANYON RV PARK	98		48	80	Active Small Production	S	2,7
CARD-O	CARDINAL MANAGEMENT	70		0	0	Other Active Production		2,3
MKSSN-A	CCDA WATERS, LLC	800		635	755	Other Active Production		2,3
CE-C1	CERRITOS	1035		295	976	Active Large Production		2
CE-C2	CERRITOS	1050		280	980	Active Large Production		2
CE-C4	CERRITOS	1030		305	955	Active Large Production		2
CHEV-HBP4	CHEVRON U.S.A. - LA HABRA	680		490	640	Inactive Production		2,3
CHEV-NOR4	CHEVRON U.S.A. - LA HABRA	1023		990	1005	Inactive Production		2,3
W-18110	CHEVRON U.S.A.-HUNTINGTON BCH.	116		85	115	Monitoring		1
PLMP-YL	CITY OIL CORP	77		0	0	Inactive Production		2,3
CCOL-C	COMMUNITY COLLEGE DIST.	395		365	395	Other Active Production		2,3
COMM-LP	COMMUNITY WATER ASSOC.	0		0	0	Inactive Production		2
CNXT-NBEI1	CONEXANT SYSTEMS, INC.	100		60	100	Inactive Production		2
CNXT-NBEI2	CONEXANT SYSTEMS, INC.	100		60	100	Inactive Production		2
CNXT-NBEI3	CONEXANT SYSTEMS, INC.	100		60	100	Inactive Production		2
CNXT-NBEI4A	CONEXANT SYSTEMS, INC.	104		65	100	Inactive Production		2
CNXT-NBES1	CONEXANT SYSTEMS, INC.	43		22	42	Inactive Production		2
CNXT-NBES2	CONEXANT SYSTEMS, INC.	45		21	41	Inactive Production		2
CNXT-NBES3A	CONEXANT SYSTEMS, INC.	46		24	44	Inactive Production		2
CNXT-NBES4B	CONEXANT SYSTEMS, INC.	47		23	43	Inactive Production		2
CNXT-NBES5A	CONEXANT SYSTEMS, INC.	42		20	40	Inactive Production		2
CNXT-NBES6	CONEXANT SYSTEMS, INC.	45		25	40	Inactive Production		2
CNXT-NBI17	CONEXANT SYSTEMS, INC.	105		0	0	Injection		4
CNXT-NBMW27	CONEXANT SYSTEMS, INC.	40		10	40	Monitoring		1
CNXT-NBMW28	CONEXANT SYSTEMS, INC.	82		60	82	Monitoring		1
CNXT-NBMW29	CONEXANT SYSTEMS, INC.	42		21	40	Monitoring		1
CNXT-NBMW30	CONEXANT SYSTEMS, INC.	42		21	42	Monitoring		1
CNXT-NBRI1	CONEXANT SYSTEMS, INC.	105		77	102	Injection		4
CNXT-NBRI2	CONEXANT SYSTEMS, INC.	115		75	110	Injection		4
CNXT-NBRI3	CONEXANT SYSTEMS, INC.	122		75	115	Injection		4
CNXT-NBRI4	CONEXANT SYSTEMS, INC.	97		0	0	Injection		4
CO-16	CORONA	850		415	755	Active Large Production		2
CMW-CO	CORONITA MUTUAL WATER CO.	270		126	234	Other Active Production		2
MCWD-GC	COSTA MESA	225		195	215	Monitoring		1,6
W-3799	COSTA MESA SCHOOL DIST.	297		0	0	Inactive Production		2,3
CCC-LA1	COTTONWOOD CHRISTIAN CENTER	340		140	310	Other Active Production		2
MRCF-GG	CROSBY WATER SYSTEM	240		0	0	Other Active Production		2
MBF-FM2	CT STORAGE - FULLERTON, LLC	135		110	134	Monitoring		1,8
MBF-FM3	CT STORAGE - FULLERTON, LLC	135		110	134	Monitoring		1,8
FJC-LAK2	CYPRESS GC LLC/CYPRESS GOLF CL	620		300	570	Other Active Production	P	2,3
W-18698	DEGUSSA FLAVOR & FRUIT SYSTEMS	90		70	90	Monitoring		1
OCWD-BS103	DEPT. OF WATER RESOURCES	484		184	205	Monitoring	S	1,6
OCWD-BS105	DEPT. OF WATER RESOURCES	394		150	197	Monitoring	S	1,6

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
OCWD-BS106	DEPT. OF WATER RESOURCES	556		213	255	Monitoring	S	1,6
OCWD-BS107	DEPT. OF WATER RESOURCES	738		398	441	Monitoring		1,6
OCWD-BS111	DEPT. OF WATER RESOURCES	483		184	205	Monitoring		1,6
OCWD-BSO1A	DEPT. OF WATER RESOURCES	500		245	335	Monitoring		1
OCWD-BSO1B	DEPT. OF WATER RESOURCES	500		80	104	Monitoring		1
OCWD-BSO4	DEPT. OF WATER RESOURCES	700		268	498	Monitoring		1
OCWD-BSO6A	DEPT. OF WATER RESOURCES	150		85	135	Monitoring		1,6
OCWD-BSO6B	DEPT. OF WATER RESOURCES	305		235	295	Monitoring		1,6
OCWD-BSO9A	DEPT. OF WATER RESOURCES	445		195	285	Monitoring	S	1,6
OCWD-BSO9B	DEPT. OF WATER RESOURCES	624		520	615	Monitoring	P	1,6
OCWD-BSO9C	DEPT. OF WATER RESOURCES	450		340	435	Monitoring		1,6
OCWD-SA10	DEPT. OF WATER RESOURCES	483		300	330	Monitoring	S/P	1,6
OCWD-SA12	DEPT. OF WATER RESOURCES	715		305	325	Monitoring	S	1
OCWD-SA3	DEPT. OF WATER RESOURCES	401		100	160	Monitoring	S	1,6
OCWD-SA5	DEPT. OF WATER RESOURCES	401		273	312	Monitoring	P	1,6
DICE-SA2	DIAMONITORINGD ICE CORP	1003		330	990	Inactive Production		2,3
SSPG-O	DS WATERS OF AMERICA, INC.	270		250	270	Inactive Production		2
EOCW-E	EAST ORANGE COUNTY WATER DIST.	504		324	450	Active Large Production	P	2,7
EOCW-W	EAST ORANGE COUNTY WATER DIST.	800		315	450	Active Large Production	P	2,7
LKVG-YL	EASTLAKE VILLAGE HOA	124		50	124	Other Active Production		2,3
ESWA-4	EASTSIDE WATER ASSOC.	560		240	520	Active Small Production		2,7
EDGW-SA	EDINGER WATER ASSOC.	308		0	0	Inactive Production		2
EMA-FVRI	ENVIRONMENTAL MGMT AGENCY	0		0	0	Other Active Production		2,3
ALEN-GG	EUCHARISTIC MISSIONARIES	252		0	0	Other Active Production		2
SAKH-A	F S NURSERY	383		0	0	Other Active Production		2,3
FAIR-SA	FAIRHAVEN MEMORIAL PARK	427		0	0	Inactive Production		2,3
FAIR-SA3	FAIRHAVEN MEMORIAL PARK	520		250	500	Other Active Production		2,3
FAA-LA1	FEDERAL AVAIATION ADMIN.	0		0	0	Other Active Production		2,3
FLWN-CQ2	FOREST LAWN	590		160	560	Other Active Production		2,3
FV-10	FOUNTAIN VALLEY	1100		460	980	Active Large Production	P	2,7
FV-11	FOUNTAIN VALLEY	1027		440	950	Active Large Production	P	2,7
FV-12	FOUNTAIN VALLEY	1230		340	1070	Active Large Production	P	2,7
FV-6	FOUNTAIN VALLEY	1150		370	1110	Active Large Production	P	2,7
FV-8	FOUNTAIN VALLEY	920		312	844	Active Large Production	P	2,7
FV-9	FOUNTAIN VALLEY	1114		415	1070	Active Large Production	P	2,7
W-3791	FOUNTAIN VALLEY	0		0	0	Inactive Production		2
F-10	FULLERTON	1350		460	1290	Active Large Production	P	2,7,8
F-3A	FULLERTON	1295		580	1280	Active Large Production	P	2,7,8
F-4	FULLERTON	415		315	405	Active Large Production	P	2,7,8
F-5	FULLERTON	440		350	400	Active Large Production	P	2,7,8
F-6	FULLERTON	430		340	401	Active Large Production	P	2,7,8
F-7	FULLERTON	434		300	410	Active Large Production	P	2,7,8
F-8	FULLERTON	458		324	402	Active Large Production	P	2,7,8
F-AIRP	FULLERTON	1135		435	1080	Active Large Production	P	2,7
F-CHRI2	FULLERTON	1350		520	1330	Active Large Production	P	2,7,8
F-COYO2	FULLERTON	1517		309	919	Inactive Production	P	2
F-KIM1A	FULLERTON	1243		500	1225	Active Large Production	P	2,7,8
F-KIM2	FULLERTON	652		320	626	Active Large Production	P	2,7,8
GG-16	GARDEN GROVE	1000		304	864	Active Large Production	P	2,7
GG-19	GARDEN GROVE	942		818	892	Active Large Production	P	2,7
GG-20	GARDEN GROVE	960		360	912	Active Large Production	P	2,7
GG-21	GARDEN GROVE	1187		428	1080	Active Large Production	P	2,7
GG-22	GARDEN GROVE	1040		416	1020	Active Large Production	P	2,7
GG-23	GARDEN GROVE	860		474	835	Active Large Production	P	2,7
GG-25	GARDEN GROVE	987		442	850	Active Large Production	P	2,7
GG-26	GARDEN GROVE	1120		470	1060	Active Large Production	P	2,7
GG-27	GARDEN GROVE	1215		520	1160	Active Large Production	P	2,7
GG-28	GARDEN GROVE	328		130	240	Active Large Production	S	2,7
GG-29	GARDEN GROVE	1140		465	1110	Active Large Production	P	2,7
GG-30	GARDEN GROVE	1205		390	1146	Active Large Production	P	2,7
GG-31	GARDEN GROVE	1462		739	1373	Active Large Production	P	2,7
WWGC-SAK3	GARDEN GROVE	206		149	170	Other Active Production	S	2,3
WWGC-SAK4	GARDEN GROVE	272		150	249	Other Active Production		2,3
W-15829	GARDEN GROVE UNIF. SCH. DIST.	209		0	0	Inactive Production		2,3
W-4220	GENERAL SERVICE ADMIN.	900		264	887	Inactive Production		2
W-4224	GENERAL SERVICE ADMIN.	602		378	438	Inactive Production		2,3
W-4226	GENERAL SERVICE ADMIN.	586		271	372	Inactive Production		2,3

List of Wells in OCWD Monitoring Programs

KEY

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Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
W-4856	GENERAL SERVICE ADMIN.	804		247	427	Inactive Production		2
GSWC-HGC6	GOLDEN STATE WATER CO - LA	1295		180	1170	Active Large Production		2
SCWC-ARR1	GOLDEN STATE WATER CO - LA	1026		919	965	Active Small Production		2
SCWC-HGC3	GOLDEN STATE WATER CO - LA	860		110	852	Inactive Production		2
SCWC-HGC4	GOLDEN STATE WATER CO - LA	861		110	856	Inactive Production		2
SCWC-HGCAR	GOLDEN STATE WATER CO - LA	570		121	327	Inactive Production		2
SCWC-HGJ4	GOLDEN STATE WATER CO - LA	890		530	710	Active Large Production		2
SCWC-LKHAW	GOLDEN STATE WATER CO - LA	822		200	796	Active Large Production		2
SCWC-LKMA	GOLDEN STATE WATER CO - LA	885		215	830	Active Large Production		2
SCWC-NWDAC1	GOLDEN STATE WATER CO - LA	380		0	0	Other Active Production		2
SCWC-NWIMP1	GOLDEN STATE WATER CO - LA	0		0	0	Other Active Production		2
SCWC-NWIMP2	GOLDEN STATE WATER CO - LA	399		0	0	Other Active Production		2
SCWC-NWIMP3	GOLDEN STATE WATER CO - LA	890		0	890	Other Active Production		2
W-17720	GOLDEN STATE WATER CO - LA	0		0	0	Other Active Production		2
GSWC-POR1	GOLDEN STATE WATER CO - OC	1129		350	895	Active Large Production	P	2,7
GSWC-SCL5	GOLDEN STATE WATER CO - OC	1416		700	1000	Active Large Production	P	2,7
RHWC-E	GOLDEN STATE WATER CO - OC	945		410	920	Active Large Production	P	2,7
RHWC-W2	GOLDEN STATE WATER CO - OC	954		474	753	Active Large Production	P	2,7
SCWC-CBAL	GOLDEN STATE WATER CO - OC	990		200	770	Active Large Production	P	2,7
SCWC-CSC	GOLDEN STATE WATER CO - OC	600		526	556	Active Large Production	P	2,7
SCWC-CVV	GOLDEN STATE WATER CO - OC	670		524	645	Active Large Production	P	2,7
SCWC-CVV2	GOLDEN STATE WATER CO - OC	1010		480	981	Active Large Production	P	2,7
SCWC-LABL2	GOLDEN STATE WATER CO - OC	708		460	690	Active Large Production	P	2,7
SCWC-LAC3	GOLDEN STATE WATER CO - OC	632		346	593	Active Large Production	P	2,7
SCWC-LAFL	GOLDEN STATE WATER CO - OC	720		300	680	Active Large Production	P	2,7
SCWC-LAHO	GOLDEN STATE WATER CO - OC	520		386	486	Active Large Production	P	2,7
SCWC-LAYT	GOLDEN STATE WATER CO - OC	812		250	800	Active Large Production	P	2,6,7
SCWC-PBF3	GOLDEN STATE WATER CO - OC	496		220	475	Active Large Production	P	2,7,8
SCWC-PBF4	GOLDEN STATE WATER CO - OC	550		275	520	Active Large Production	P	2,7,8
SCWC-PLJ2	GOLDEN STATE WATER CO - OC	505		402	492	Active Large Production	P	2,7,8
SCWC-PRU	GOLDEN STATE WATER CO - OC	837		430	790	Active Large Production	P	2,7
SCWC-SBCH	GOLDEN STATE WATER CO - OC	600		200	570	Active Large Production	P	2,7
SCWC-SCL4	GOLDEN STATE WATER CO - OC	530		294	488	Active Large Production	P	2,7
SCWC-SDAL	GOLDEN STATE WATER CO - OC	562		500	542	Active Large Production	P	2,7
SCWC-SLON	GOLDEN STATE WATER CO - OC	778		0	0	Active Large Production	P	2,7
SCWC-SORG	GOLDEN STATE WATER CO - OC	302		242	286	Active Large Production	P	2,7
SCWC-SSHR	GOLDEN STATE WATER CO - OC	618		520	580	Active Large Production	P	2,7
SCWC-SSYC	GOLDEN STATE WATER CO - OC	568		500	546	Active Large Production	P	2,7
SCWC-YLCO2	GOLDEN STATE WATER CO - OC	504		100	480	Inactive Production		2
GWRC-SFS8	GOLDEN WEST REFINING CO.	0		0	0	Other Active Production		2
GOOD-HB	GOOD SHEPHERD CEMETERY	244		180	218	Other Active Production		2,3,6
ETCH-AL2	GOODWIN MUTUAL WATER CO.	200		85	185	Inactive Production	S	2,3
GRV-RSIR	GREEN RIVER VILLIAGE	85		50	82	Other Active Production		2,3
HALD-BP	HALDOR PLACE MUTUAL WATER	265		0	0	Inactive Production		2
HMEM-COS	HARBOR LAWN MEMORIAL PARK	280		190	200	Monitoring		1,6
HOLY-A	HOLY CROSS CEMETERY	365		334	364	Other Active Production	P	2,3
HOUS-F	HOUSTON AVE. WATER	156		0	0	Other Active Production		2
W-14801	HUGHES AIRCRAFT CO.	155		135	155	Monitoring		1
W-14803	HUGHES AIRCRAFT CO.	165		144	164	Monitoring		1
HB-1	HUNTINGTON BEACH	306		258	297	Inactive Production		2,6
HB-10	HUNTINGTON BEACH	1000		232	942	Active Large Production	P	2,7
HB-12	HUNTINGTON BEACH	807		265	740	Inactive Production		2,6
HB-13	HUNTINGTON BEACH	860		280	810	Active Large Production	P	2,6,7
HB-3A	HUNTINGTON BEACH	738		370	640	Active Large Production	P	2,6,7
HB-4	HUNTINGTON BEACH	826		252	804	Active Large Production	P	2,6,7
HB-5	HUNTINGTON BEACH	830		223	800	Active Large Production	P	2,7
HB-6	HUNTINGTON BEACH	876		246	810	Active Large Production	P	2,7
HB-7	HUNTINGTON BEACH	930		263	879	Active Large Production	P	2,6,7
HB-8	HUNTINGTON BEACH	1172		256	704	Inactive Production	P	2
HB-9	HUNTINGTON BEACH	1010		556	996	Active Large Production	P	2,7
HB-MEA2	HUNTINGTON BEACH	537		480	510	Or Active Production	P	2,3
W-15104	HUNTINGTON BEACH CO.	130		90	125	Inactive Production		2
W-15819	HUNTINGTON BEACH CO.	181		0	0	Inactive Production		2
W-15821	HUNTINGTON BEACH CO.	155		0	0	Inactive Production		2
W-15823	HUNTINGTON BEACH CO.	123		0	0	Inactive Production		2
HUNT-P13	HUNTINGTON CONDO ASSOC.	9		0	9	Monitoring		1
HUNT-P14	HUNTINGTON CONDO ASSOC.	10		0	10	Monitoring		1

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
HUNT-P7	HUNTINGTON CONDO ASSOC.	19		4	20	Monitoring		1
OCWD-HH2	HUNTINGTON HARBOUR CORP	150		130	140	Monitoring	S	1,6
OCWD-HH3	HUNTINGTON HARBOUR CORP	150		133	143	Monitoring	S	1,6
OCWD-HH4	HUNTINGTON HARBOUR CORP	145		130	140	Monitoring	S	1,6
OCWD-HH5	HUNTINGTON HARBOUR CORP	138		102	112	Monitoring	S	1,6
OCWD-HH6A	HUNTINGTON HARBOUR CORP	55		40	50	Monitoring		1,6
OCWD-HH6B	HUNTINGTON HARBOUR CORP	110		90	100	Monitoring	S	1,6,10
OCWD-HH6C	HUNTINGTON HARBOUR CORP	202		170	180	Monitoring		1,6
HYNS-S1	HYNES ESTATES, INC.	250		0	0	Active Small Production		2,7
HYNS-S2	HYNES ESTATES, INC.	182		162	182	Active Small Production	S	2,7
IWMD-LVM2	INTERGRATED WASTE MGMT. DIST.	248		223	243	Monitoring		1
IWMD-LVM3	INTERGRATED WASTE MGMT. DIST.	253		223	253	Monitoring		1
IWMD-LVM4	INTERGRATED WASTE MGMT. DIST.	247		206	246	Monitoring		1
IWMD-RPM3	INTERGRATED WASTE MGMT. DIST.	101		76	101	Monitoring		1
IWMD-RPM5	INTERGRATED WASTE MGMT. DIST.	102		70	100	Monitoring		1
TIC-108	IRVINE CO.	1045		200	960	Inactive Production	P	2,3
TIC-194	IRVINE CO.	822		562	726	Monitoring	P/D	1,9
TIC-25	IRVINE CO.	790		666	760	Monitoring	P/D	1,10
TIC-50	IRVINE CO.	1488		475	1070	Monitoring		1
TIC-61	IRVINE CO.	762		240	695	Inactive Production	P	2,3
TIC-80	IRVINE CO.	1553		415	1300	Monitoring		1
TIC-99	IRVINE CO.	692		346	650	Monitoring	P	1
W-285	IRVINE CO.	93		37	84	Inactive Production		2,3
ET-1	IRVINE RANCH WATER DIST.	520		220	490	Other Active Production	P	2,3
ET-2	IRVINE RANCH WATER DIST.	1120		280	1080	Other Active Production	P	2,3
IRWD-1	IRVINE RANCH WATER DIST.	2020		410	860	Active Large Production	P	2,7
IRWD-10	IRVINE RANCH WATER DIST.	1040		419	940	Active Large Production	P	2,7
IRWD-107R	IRVINE RANCH WATER DIST.	1060		275	1000	Active Large Production	P	2,7
IRWD-11	IRVINE RANCH WATER DIST.	1300		410	870	Active Large Production	P	2,7
IRWD-110	IRVINE RANCH WATER DIST.	1070		555	1015	Active Large Production	P	2,7
IRWD-115R	IRVINE RANCH WATER DIST.	1136		290	1080	Active Large Production		2,7
IRWD-12	IRVINE RANCH WATER DIST.	1424		580	1040	Active Large Production	P	2,7
IRWD-13	IRVINE RANCH WATER DIST.	1170		410	980	Active Large Production	P	2,7
IRWD-14	IRVINE RANCH WATER DIST.	1015		470	970	Active Large Production	P	2,7
IRWD-15	IRVINE RANCH WATER DIST.	1085		470	990	Active Large Production	P	2,7
IRWD-16	IRVINE RANCH WATER DIST.	1010		406	807	Active Large Production	P	2,7
IRWD-17	IRVINE RANCH WATER DIST.	1019		504	960	Active Large Production	P	2,7
IRWD-18	IRVINE RANCH WATER DIST.	1120		390	1080	Active Large Production	P	2,7
IRWD-2	IRVINE RANCH WATER DIST.	1450		385	855	Active Large Production	P	2,7,9
IRWD-21	IRVINE RANCH WATER DIST.	1223		290	970	Active Large Production	P	2,7,9
IRWD-22	IRVINE RANCH WATER DIST.	1220		300	970	Active Large Production	P	2,7,9
IRWD-3	IRVINE RANCH WATER DIST.	1309		484	1250	Active Large Production	P	2,7,9
IRWD-4	IRVINE RANCH WATER DIST.	1146		440	910	Active Large Production	P	2,7
IRWD-5	IRVINE RANCH WATER DIST.	1075		554	1028	Active Large Production	P	2,7,9
IRWD-52	IRVINE RANCH WATER DIST.	1400		635	1290	Inactive Production		2,7,9
IRWD-6	IRVINE RANCH WATER DIST.	1175		499	1124	Active Large Production	P	2,7,9
IRWD-7	IRVINE RANCH WATER DIST.	2731		359	660	Active Large Production	P	2,7
IRWD-72	IRVINE RANCH WATER DIST.	1192		254	1151	Other Active Production	P	2,3
IRWD-76	IRVINE RANCH WATER DIST.	1055		450	900	Active Large Production	P	2,7
IRWD-77	IRVINE RANCH WATER DIST.	1000		330	980	Active Large Production	P	2,7
IRWD-78R	IRVINE RANCH WATER DIST.	1010		250	730	Other Active Production	P	2,3
IRWD-98	IRVINE RANCH WATER DIST.	355		115	343	Inactive Production	P	2,3
IRWD-C8	IRVINE RANCH WATER DIST.	2065		1080	1982	Active Large Production	D	2,7
IRWD-C9	IRVINE RANCH WATER DIST.	2106		1055	1930	Active Large Production	D	2,7
IRWD-LA1	IRVINE RANCH WATER DIST.	800		200	790	Inactive Production		2
IRWD-LA3	IRVINE RANCH WATER DIST.	800		0	0	Inactive Production		2
IRWD-LA4	IRVINE RANCH WATER DIST.	810		350	790	Inactive Production		2
IRWD-LA5	IRVINE RANCH WATER DIST.	820		350	780	Inactive Production		2
IRWD-LA7	IRVINE RANCH WATER DIST.	1000		430	980	Inactive Production		2
IRWD-LF2	IRVINE RANCH WATER DIST.	808		280	640	Active Large Production		2
IRWD-MICH10	IRVINE RANCH WATER DIST.	0		0	0	Other Active Production		2
IRWD-MICH2	IRVINE RANCH WATER DIST.	0		30	50	Other Active Production		2
IRWD-MICH3	IRVINE RANCH WATER DIST.	0		30	50	Other Active Production		2
IRWD-MICH4	IRVINE RANCH WATER DIST.	0		17	67	Other Active Production		2
IRWD-MICH5	IRVINE RANCH WATER DIST.	0		17	67	Other Active Production		2
IRWD-MICH6	IRVINE RANCH WATER DIST.	0		40	70	Other Active Production		2
IRWD-MICH7	IRVINE RANCH WATER DIST.	0		40	70	Other Active Production		2

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IRWD-MICH8	IRVINE RANCH WATER DIST.	0		40	70	Other Active Production		2
IRWD-MICH9	IRVINE RANCH WATER DIST.	0		17	67	Other Active Production		2
IRWD-OPA1	IRVINE RANCH WATER DIST.	1000		390	750	Inactive Production		2,7
TIC-106	IRVINE RANCH WATER DIST.	725		405	715	Other Active Production	P	2,3
TIC-109	IRVINE RANCH WATER DIST.	1145		240	1120	Inactive Production	P	2,3
TIC-112	IRVINE RANCH WATER DIST.	1141		240	1100	Inactive Production	P	2,3
TIC-114	IRVINE RANCH WATER DIST.	1000		300	960	Inactive Production	P	2,3
TIC-55	IRVINE RANCH WATER DIST.	746		300	497	Inactive Production		2,3
TIC-82	IRVINE RANCH WATER DIST.	1145		410	1002	Monitoring	P	1
W-14556	IRVINE RANCH WATER DIST.	0		17	67	Inactive Production		2
ITO-LA	ITO-OZAWA FARMS	860		70	710	Other Active Production		2,3
ITO-LAG3	ITO-OZAWA FARMS	800		170	780	Other Active Production		2,3
JLAW-HB	JANUARY & ELLIS LAW	135		0	0	Inactive Production		2
SAKI-FV	JKS-SF, LLC	450		304	438	Inactive Production		2,3
SULY-OA1	JMI PROPERTIES/SANTIAGO PRTNRS	120		0	0	Other Active Production		2,3
SULY-OA4	JMI PROPERTIES/SANTIAGO PRTNRS	130		0	0	Inactive Production	S	2,3
JWC-NWLEF	JUNIOR WATER CO.	480		416	426	Other Active Production		2
JWC-NWTAD	JUNIOR WATER CO.	614		361	587	Other Active Production		2
W-15825	KAREN STREET WATER CO.	100		0	0	Inactive Production		2
GKAW-FV2	KAWAGUCHI ENTERPRISES û LP	125		120	125	Other Active Production		2
MKAW-FV	KAWAGUCHI ENTERPRISES û LP	225		185	225	Other Active Production	S	2
KAYO-GG	KAYANO FARMS	0		0	0	Inactive Production		2,3
GARD-A	KINDRED COMMUNITY CHURCH	35		0	0	Other Active Production		2,3
KINGK-CE2	KING KELLY MARMILADE CO. INC.	0		0	0	Other Active Production		2
W-18116	KLEINFELDER & ASSOCIATES	250		238	248	Monitoring		1
W-18118	KLEINFELDER & ASSOCIATES	187		176	186	Monitoring		1
W-18120	KLEINFELDER & ASSOCIATES	255		243	253	Monitoring		1
KNOT-BP	KNOTT'S BERRY FARM	447		0	0	Other Active Production		2,3
KNOT-BPBS	KNOTT'S BERRY FARM	730		430	630	Active Small Production	P	2,7
W-14871	KOLL REAL ESTATE	600		0	0	Inactive Production		2,3
LH-2A	LA HABRA	1000		460	950	Active Large Production		2
LH-FS192	LA HABRA	1403		880	1210	Inactive Production		2,10
LH-LBPW	LA HABRA	1000		544	870	Active Large Production		2
LH-PPW	LA HABRA	1290		770	990	Inactive Production		2
LMP-MW	LA HABRA HEIGHTS WATER CO.	593		540	560	Monitoring		1
HALL-O	LA LINDA LLC	280		0	0	Inactive Production		2
LP-CITY	LA PALMA	1516		290	1415	Active Large Production	P	2,7
LP-WALK	LA PALMA	1020		489	919	Active Large Production	P	2,7
LMA-I	LAKES MASTER ASSOC.	0		0	0	Other Active Production		2,3
LW-10	LAKEWOOD	1148		448	471	Active Large Production		2
LW-13A	LAKEWOOD	1120		620	940	Active Large Production		2
LW-15A	LAKEWOOD	1050		470	1030	Active Large Production		2
LW-17	LAKEWOOD	1134		1064	1121	Active Large Production		2
LW-18	LAKEWOOD	1108		1041	1069	Active Large Production		2
LW-22	LAKEWOOD	1500		440	1060	Active Large Production		2
LW-27	LAKEWOOD	990		490	950	Active Large Production		2
LW-2A	LAKEWOOD	656		612	637	Active Large Production		2
LW-4	LAKEWOOD	716		367	388	Active Large Production		2
LW-6	LAKEWOOD	602		224	306	Other Active Production		2,3
LW-8	LAKEWOOD	405		352	380	Active Small Production		2
W-17351	LAKEWOOD	0		0	0	Inactive Production		2
LWPC-LWP1	LAKEWOOD WATER & POWER CO.	870		488	835	Other Active Production		2
LIBM-HB	LIBERTY PARK WATER ASSOC.	160		0	0	Active Small Production		2,6,7
LMC-EW1	LOCKHEED MARTIN CORP.	62		40	60	Other Active Production		2
LMC-EW2	LOCKHEED MARTIN CORP.	62		40	60	Other Active Production		2
LMC-EW3	LOCKHEED MARTIN CORP.	90		58	78	Other Active Production		2
LB-1017	LONG BEACH	875		140	540	Other Active Production		2,3
LB-1017B	LONG BEACH	675		0	0	Monitoring		1
LB-AL13	LONG BEACH	1030		559	902	Active Large Production		2
LB-AL8	LONG BEACH	982		515	978	Active Large Production		2
LB-AL9	LONG BEACH	1152		804	1130	Active Large Production		2
LB-AN201	LONG BEACH	854		507	838	Active Large Production		2
LB-AN204	LONG BEACH	1186		1124	1146	Other Active Production		2,3
LB-AN206	LONG BEACH	1170		300	471	Inactive Production		2
LB-AN26	LONG BEACH	610		364	590	Inactive Production		2
LB-CIT10	LONG BEACH	1020		300	988	Active Large Production		2
LB-CIT7A	LONG BEACH	950		300	898	Active Large Production		2

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
LB-CIT8	LONG BEACH	1516		310	1039	Active Small Production		2
LB-CIT9	LONG BEACH	850		300	808	Active Large Production		2
LB-COM10	LONG BEACH	900		540	685	Active Large Production		2
LB-COM13	LONG BEACH	1634		310	1539	Active Large Production		2
LB-COM14	LONG BEACH	1110		302	1072	Active Large Production		2
LB-COM15	LONG BEACH	1120		303	1008	Active Large Production		2
LB-COM16	LONG BEACH	1023		300	988	Active Large Production		2
LB-COM17	LONG BEACH	1030		300	988	Active Large Production		2
LB-COM18	LONG BEACH	0		303	988	Active Large Production		2
LB-COM19	LONG BEACH	1700		605	1640	Active Large Production		2
LB-COM20	LONG BEACH	1500		602	1240	Active Large Production		2
LB-COM21	LONG BEACH	1691		640	1370	Active Large Production		2
LB-COM22	LONG BEACH	1512		490	1160	Active Large Production		2
LB-COM23	LONG BEACH	1513		480	1020	Active Large Production		2
LB-COM24	LONG BEACH	1500		540	1411	Active Large Production		2
LB-COM25	LONG BEACH	1508		540	900	Active Large Production		2
LB-COM6A	LONG BEACH	1012		412	980	Monitoring		1
LB-DEV1	LONG BEACH	1017		959	1017	Active Large Production		2
LB-DEV2	LONG BEACH	684		390	684	Inactive Production		2
LB-DEV4	LONG BEACH	1004		400	972	Inactive Production		2
LB-DEV5	LONG BEACH	1016		267	990	Active Large Production		2
LB-DEV9	LONG BEACH	1030		260	1030	Active Large Production		2
LB-NLB11	LONG BEACH	2000		412	1431	Active Large Production		2
LB-NLB12	LONG BEACH	1058		300	1000	Active Large Production		2
LB-NLB4	LONG BEACH	1160		972	1142	Active Large Production		2
LB-NLB8	LONG BEACH	1180		1050	1100	Active Large Production		2
LB-NLB9	LONG BEACH	800		445	720	Active Large Production		2
LB-WIL1A	LONG BEACH	1370		272	1351	Active Large Production		2
LB-WS1A	LONG BEACH	1100		272	1078	Active Large Production		2
W-11412	LONG BEACH	639		458	630	Inactive Production		2,3
W-11460	LONG BEACH	994		0	0	Inactive Production		2
LART-CR2	LOS ALAMITOS RACE TRACT	0		0	0	Active Small Production		2,7
LAC-32LP8X	LOS ANGELES COUNTY	120		105	115	Monitoring		1
LAC-32LP8Z	LOS ANGELES COUNTY	945		325	335	Monitoring		1
LAC-32S9	LOS ANGELES COUNTY	885		189	199	Monitoring		1
LAC-32TP25	LOS ANGELES COUNTY	945		252	262	Monitoring		1
LAC-32U15	LOS ANGELES COUNTY	141		117	133	Monitoring		1
LAC-32V22	LOS ANGELES COUNTY	151		120	135	Monitoring		1
LAC-32VP10	LOS ANGELES COUNTY	210		145	180	Monitoring		1
LAC-32X11	LOS ANGELES COUNTY	196		135	165	Monitoring		1
LAC-32YP43	LOS ANGELES COUNTY	55		42	52	Monitoring		1
LAC-32ZP5	LOS ANGELES COUNTY	155		93	133	Monitoring		1
LAC-33D01	LOS ANGELES COUNTY	453		215	275	Monitoring		1
LAC-33D24	LOS ANGELES COUNTY	750		315	325	Monitoring		1
LAC-33DP22	LOS ANGELES COUNTY	825		210	220	Monitoring		1
LAC-33G	LOS ANGELES COUNTY	119		43	103	Injection		4
LAC-33G36	LOS ANGELES COUNTY	525		338	348	Monitoring		1
LAC-33G9	LOS ANGELES COUNTY	147		120	140	Monitoring		1
LAC-33GJ	LOS ANGELES COUNTY	140		52	115	Monitoring		1
LAC-33HP13	LOS ANGELES COUNTY	123		88	103	Monitoring		1
LAC-33J	LOS ANGELES COUNTY	134		66	126	Injection		4
LAC-33JL	LOS ANGELES COUNTY	147		52	137	Monitoring		1
LAC-33KP42	LOS ANGELES COUNTY	86		63	73	Monitoring		1
LAC-33L	LOS ANGELES COUNTY	144		56	136	Injection		4
LAC-33L23	LOS ANGELES COUNTY	405		349	359	Monitoring		1
LAC-33L30	LOS ANGELES COUNTY	73		50	65	Monitoring		1
LAC-33N	LOS ANGELES COUNTY	164		58	148	Injection		4
LAC-33N21	LOS ANGELES COUNTY	497		460	485	Monitoring		1
LAC-33NQ	LOS ANGELES COUNTY	177		60	160	Monitoring		1
LAC-33Q	LOS ANGELES COUNTY	174		69	164	Injection		4
LAC-33Q1	LOS ANGELES COUNTY	58		28	44	Injection		4
LAC-33Q15V	LOS ANGELES COUNTY	232		210	220	Monitoring		1
LAC-33Q15W	LOS ANGELES COUNTY	296		273	283	Monitoring		1
LAC-33Q15X	LOS ANGELES COUNTY	390		346	356	Monitoring		1
LAC-33Q9	LOS ANGELES COUNTY	223		115	145	Monitoring		1
LAC-33S	LOS ANGELES COUNTY	207		73	194	Injection		4
LAC-33S1	LOS ANGELES COUNTY	63		25	45	Injection		4

List of Wells in OCWD Monitoring Programs

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
LAC-33S18U	LOS ANGELES COUNTY	101		73	83	Monitoring		1
LAC-33S18V	LOS ANGELES COUNTY	295		231	241	Monitoring		1
LAC-33S18W	LOS ANGELES COUNTY	300		273	283	Monitoring		1
LAC-33S18X	LOS ANGELES COUNTY	405		357	367	Monitoring		1
LAC-33S20	LOS ANGELES COUNTY	514		476	486	Monitoring		1
LAC-33S40	LOS ANGELES COUNTY	527		477	507	Monitoring		1
LAC-33S43	LOS ANGELES COUNTY	615		341	362	Monitoring		1
LAC-33S52	LOS ANGELES COUNTY	393		290	350	Monitoring		1
LAC-33ST	LOS ANGELES COUNTY	195		140	185	Monitoring		1
LAC-33T	LOS ANGELES COUNTY	214		89	199	Injection		4
LAC-33T125	LOS ANGELES COUNTY	487		426	466	Monitoring		1
LAC-33T13U	LOS ANGELES COUNTY	87		63	73	Monitoring		1
LAC-33T13V	LOS ANGELES COUNTY	237		210	220	Monitoring		1
LAC-33T13W	LOS ANGELES COUNTY	294		273	283	Monitoring		1
LAC-33T13X	LOS ANGELES COUNTY	405		336	346	Monitoring		1
LAC-33T15	LOS ANGELES COUNTY	420		341	351	Monitoring		1
LAC-33T29U	LOS ANGELES COUNTY	83		63	73	Monitoring		1
LAC-33T29X	LOS ANGELES COUNTY	405		357	367	Monitoring		1
LAC-33T29Z	LOS ANGELES COUNTY	1926		664	705	Monitoring		1
LAC-33T3	LOS ANGELES COUNTY	141		45	90	Monitoring		1
LAC-33T4	LOS ANGELES COUNTY	330		281	306	Monitoring		1
LAC-33T9U	LOS ANGELES COUNTY	50		25	40	Monitoring		1
LAC-33T9V	LOS ANGELES COUNTY	190		133	158	Monitoring		1
LAC-33T9W	LOS ANGELES COUNTY	200		179	189	Monitoring		1
LAC-33T9X	LOS ANGELES COUNTY	885		273	283	Monitoring		1
LAC-33T9Y	LOS ANGELES COUNTY	400		378	388	Monitoring		1
LAC-33TP13U	LOS ANGELES COUNTY	79		46	66	Monitoring		1
LAC-33TP24U	LOS ANGELES COUNTY	55		30	43	Monitoring		1
LAC-33TP24Y	LOS ANGELES COUNTY	109		63	88	Monitoring		1
LAC-33U	LOS ANGELES COUNTY	254		98	238	Injection		4
LAC-33U11V	LOS ANGELES COUNTY	210		194	204	Monitoring		1
LAC-33U11W	LOS ANGELES COUNTY	295		273	283	Monitoring		1
LAC-33U11X	LOS ANGELES COUNTY	405		357	367	Monitoring		1
LAC-33U3	LOS ANGELES COUNTY	143		70	125	Injection		4
LAC-33UP05	LOS ANGELES COUNTY	83		63	73	Monitoring		1
LAC-33UP34	LOS ANGELES COUNTY	61		53	60	Monitoring		1
LAC-33UP3X	LOS ANGELES COUNTY	120		94	105	Monitoring		1
LAC-33UP3Y	LOS ANGELES COUNTY	169		151	161	Monitoring		1
LAC-33UP3Z	LOS ANGELES COUNTY	1720		378	399	Monitoring		1
LAC-33UV	LOS ANGELES COUNTY	308		213	262	Monitoring		1
LAC-33V	LOS ANGELES COUNTY	294		119	269	Injection		4
LAC-33VP14U1	LOS ANGELES COUNTY	27		23	27	Monitoring		1
LAC-33VP14U2	LOS ANGELES COUNTY	84		79	83	Monitoring		1
LAC-33VP14U3	LOS ANGELES COUNTY	50		40	50	Monitoring		1
LAC-33VP15P	LOS ANGELES COUNTY	100		57	82	Other Active Production		2
LAC-33VP22Z1	LOS ANGELES COUNTY	150		127	137	Monitoring		1
LAC-33VP22Z2	LOS ANGELES COUNTY	780		255	265	Monitoring		1
LAC-33VP46	LOS ANGELES COUNTY	80		61	71	Monitoring		1
LAC-33VP8	LOS ANGELES COUNTY	163		105	145	Monitoring		1
LAC-33W	LOS ANGELES COUNTY	420		120	390	Injection		4
LAC-33W11	LOS ANGELES COUNTY	508		427	482	Monitoring		1,6
LAC-33W54	LOS ANGELES COUNTY	83		40	70	Monitoring		1
LAC-33WP14	LOS ANGELES COUNTY	108		57	87	Monitoring		1
LAC-33WP17	LOS ANGELES COUNTY	78		45	65	Monitoring		1
LAC-33WX	LOS ANGELES COUNTY	448		379	423	Monitoring		1
LAC-33WXU	LOS ANGELES COUNTY	74		45	60	Monitoring		1
LAC-33X	LOS ANGELES COUNTY	452		170	430	Injection		4
LAC-33X10	LOS ANGELES COUNTY	517		425	475	Monitoring		1,6
LAC-33X20U	LOS ANGELES COUNTY	110		85	95	Monitoring		1,6
LAC-33X20W	LOS ANGELES COUNTY	325		294	304	Monitoring		1,6
LAC-33X20X	LOS ANGELES COUNTY	415		377	387	Monitoring		1,6
LAC-33X20Y	LOS ANGELES COUNTY	645		483	493	Monitoring		1,6
LAC-33XY	LOS ANGELES COUNTY	475		409	451	Monitoring		1
LAC-33Y	LOS ANGELES COUNTY	475		218	457	Injection		4
LAC-33Y10	LOS ANGELES COUNTY	125		75	115	Monitoring		1,6
LAC-33Y42U	LOS ANGELES COUNTY	105		89	95	Monitoring		1,6
LAC-33Y42X	LOS ANGELES COUNTY	660		362	372	Monitoring		1,6

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
LAC-33YP35	LOS ANGELES COUNTY	103		73	83	Monitoring		1
LAC-33YZ	LOS ANGELES COUNTY	467		408	451	Monitoring		1
LAC-33Z	LOS ANGELES COUNTY	484		206	461	Injection		4
LAC-33Z2	LOS ANGELES COUNTY	499		310	444	Injection		4
LAC-33ZP1T	LOS ANGELES COUNTY	146		116	135	Monitoring		1
LAC-33ZP1U	LOS ANGELES COUNTY	90		62	85	Monitoring		1
LAC-33ZP1X	LOS ANGELES COUNTY	360		336	346	Monitoring		1
LAC-34D	LOS ANGELES COUNTY	494		219	474	Injection		4
LAC-34D01	LOS ANGELES COUNTY	83		73	83	Monitoring		1
LAC-34DG	LOS ANGELES COUNTY	477		405	450	Monitoring		1,6
LAC-34DP6	LOS ANGELES COUNTY	477		415	445	Monitoring		1
LAC-34EP13	LOS ANGELES COUNTY	363		305	335	Monitoring		1
LAC-34EP23	LOS ANGELES COUNTY	108		48	88	Monitoring		1
LAC-34EP48	LOS ANGELES COUNTY	735		255	265	Monitoring		1
LAC-34EV	LOS ANGELES COUNTY	288		145	250	Injection		4
LAC-34EY	LOS ANGELES COUNTY	488		410	455	Injection		4
LAC-34F	LOS ANGELES COUNTY	487		410	450	Injection		4
LAC-34F5T	LOS ANGELES COUNTY	185		140	170	Monitoring		1,6
LAC-34F5V	LOS ANGELES COUNTY	242		195	225	Monitoring		1
LAC-34F5W	LOS ANGELES COUNTY	288		235	275	Monitoring		1
LAC-34F5X	LOS ANGELES COUNTY	372		300	360	Monitoring		1
LAC-34F5Y	LOS ANGELES COUNTY	482		415	455	Monitoring		1
LAC-34FP13V	LOS ANGELES COUNTY	120		95	105	Monitoring		1
LAC-34FP13X	LOS ANGELES COUNTY	315		193	203	Monitoring		1
LAC-34FP40	LOS ANGELES COUNTY	68		45	55	Monitoring		1
LAC-34FX	LOS ANGELES COUNTY	489		410	450	Injection		4
LAC-34G	LOS ANGELES COUNTY	475		285	350	Injection		4
LAC-34G2V	LOS ANGELES COUNTY	280		140	250	Injection		4
LAC-34G2Y	LOS ANGELES COUNTY	489		405	445	Injection		4
LAC-34GH	LOS ANGELES COUNTY	479		415	455	Monitoring		1,6
LAC-34H	LOS ANGELES COUNTY	490		405	445	Injection		4
LAC-34HJX	LOS ANGELES COUNTY	368		315	345	Monitoring		1
LAC-34HJY	LOS ANGELES COUNTY	503		410	440	Monitoring		1,6
LAC-34HP17	LOS ANGELES COUNTY	90		55	75	Monitoring		1
LAC-34HP17P	LOS ANGELES COUNTY	95		51	76	Other Active Production		2
LAC-34HP18P	LOS ANGELES COUNTY	206		145	175	Other Active Production		2
LAC-34J	LOS ANGELES COUNTY	456		270	315	Injection		4
LAC-34JL	LOS ANGELES COUNTY	440		385	420	Monitoring		1,6
LAC-34JP12	LOS ANGELES COUNTY	109		43	93	Monitoring		1
LAC-34L	LOS ANGELES COUNTY	420		146	400	Injection		4
LAC-34LP1U	LOS ANGELES COUNTY	88		67	77	Monitoring		1
LAC-34LP1V	LOS ANGELES COUNTY	210		166	176	Monitoring		1
LAC-34LP1Z	LOS ANGELES COUNTY	900		609	619	Monitoring		1
LAC-34NP16	LOS ANGELES COUNTY	0		41	71	Monitoring		1
LAC-34QP22	LOS ANGELES COUNTY	91		55	80	Monitoring		1
LAC-34SP22P	LOS ANGELES COUNTY	95		52	77	Other Active Production		2
LAC-34VP18	LOS ANGELES COUNTY	85		48	73	Monitoring		1
LAC-35SP24U	LOS ANGELES COUNTY	83		59	69	Monitoring		1
LAC-35SP24Z1	LOS ANGELES COUNTY	180		157	167	Monitoring		1
LAC-35SP24Z2	LOS ANGELES COUNTY	825		210	220	Monitoring		1
LAC-35VP32Z1	LOS ANGELES COUNTY	213		189	199	Monitoring		1
LAC-35VP32Z2	LOS ANGELES COUNTY	855		483	493	Monitoring		1
LAC-36WP80	LOS ANGELES COUNTY	870		293	303	Monitoring		1
LAC-PZ1	LOS ANGELES COUNTY	16		10	16	Monitoring		1
LAC-PZ2	LOS ANGELES COUNTY	14		0	0	Monitoring		1
LAC-PZ3	LOS ANGELES COUNTY	16		0	0	Monitoring		1
LAC-PZ4	LOS ANGELES COUNTY	25		14	22	Monitoring		1
LAC-PZ5	LOS ANGELES COUNTY	64		33	49	Monitoring		1
LXMS-A	LYON CHRISTMAS TREE FARMS	240		0	0	Inactive Production		2,3
MAGM-GG	MAGNOLIA MEMORIAL PARK	168		0	0	Other Active Production		2,3
MNEE-A	MALLONEE	400		0	0	Inactive Production		2,3
HMW-01	MANHEIM CA (COX ENTERPRISES)	75		55	75	Monitoring	S	1
HMW-02	MANHEIM CA (COX ENTERPRISES)	72		52	72	Monitoring		1
HMW-03	MANHEIM CA (COX ENTERPRISES)	50		30	50	Monitoring		1
HMW-04	MANHEIM CA (COX ENTERPRISES)	47		27	47	Monitoring		1
W-3789	MARDEN SUSCO PIPE SUPPLY CO.	0		0	0	Inactive Production		2
USMC-01MW101	MARINE CORPS AIR STATION	159		118	148	Monitoring		1

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
USMC-01MW102	MARINE CORPS AIR STATION	142		95	135	Monitoring		1
USMC-01MW201	MARINE CORPS AIR STATION	77		27	57	Monitoring		1
USMC-02NEW01	MARINE CORPS AIR STATION	143		115	135	Monitoring		1
USMC-02NEW07	MARINE CORPS AIR STATION	150		103	143	Monitoring		1
USMC-02NEW11	MARINE CORPS AIR STATION	81		45	65	Monitoring		1
USMC-02NEW12	MARINE CORPS AIR STATION	256		209	249	Monitoring		1
USMC-02NEW13	MARINE CORPS AIR STATION	107		60	100	Monitoring		1
USMC-02NEW14	MARINE CORPS AIR STATION	111		40	105	Monitoring		1
USMC-02NEW15	MARINE CORPS AIR STATION	70		25	65	Monitoring		1
USMC-02NEW16	MARINE CORPS AIR STATION	70		25	65	Monitoring		1
USMC-02NEW2	MARINE CORPS AIR STATION	105		75	95	Monitoring		1
USMC-02NEW8A	MARINE CORPS AIR STATION	111		84	104	Monitoring		1
USMC-02UGMW25	MARINE CORPS AIR STATION	84		55	75	Monitoring		1
USMC-05NEW1	MARINE CORPS AIR STATION	210		163	203	Monitoring		1
USMC-16MPE1	MARINE CORPS AIR STATION	194		146	191	Monitoring		1
USMC-16MW1	MARINE CORPS AIR STATION	183		155	180	Monitoring		1
USMC-16MW10	MARINE CORPS AIR STATION	199		165	195	Monitoring		1
USMC-16MW11	MARINE CORPS AIR STATION	182		160	180	Monitoring	S	1
USMC-16MW12	MARINE CORPS AIR STATION	180		160	180	Monitoring		1
USMC-16MW13	MARINE CORPS AIR STATION	181		160	180	Monitoring		1
USMC-16MW14	MARINE CORPS AIR STATION	199		185	195	Monitoring		1
USMC-16MW15	MARINE CORPS AIR STATION	182		160	180	Monitoring		1
USMC-16MW16	MARINE CORPS AIR STATION	201		190	200	Monitoring		1
USMC-16MW2	MARINE CORPS AIR STATION	185		153	178	Monitoring	S	1
USMC-16MW3	MARINE CORPS AIR STATION	185		158	183	Monitoring		1
USMC-16MW4	MARINE CORPS AIR STATION	196		155	190	Monitoring		1
USMC-16MW5	MARINE CORPS AIR STATION	196		155	190	Monitoring		1
USMC-16MW7	MARINE CORPS AIR STATION	194		145	190	Monitoring		1
USMC-16MW8	MARINE CORPS AIR STATION	189		165	183	Monitoring		1
USMC-16MW9	MARINE CORPS AIR STATION	187		165	183	Monitoring		1
USMC-17NEW1	MARINE CORPS AIR STATION	233		186	226	Monitoring		1
USMC-17NEW2	MARINE CORPS AIR STATION	131		83	123	Monitoring		1
USMC-24EX10	MARINE CORPS AIR STATION	165		115	160	Monitoring		1
USMC-24EX11	MARINE CORPS AIR STATION	222		135	180	Monitoring		1
USMC-24EX12A	MARINE CORPS AIR STATION	252		115	160	Monitoring		1
USMC-24EX12B	MARINE CORPS AIR STATION	225		165	210	Monitoring		1
USMC-24EX12C	MARINE CORPS AIR STATION	272		220	260	Monitoring		1
USMC-24EX13A	MARINE CORPS AIR STATION	172		110	160	Monitoring		1
USMC-24EX13B	MARINE CORPS AIR STATION	213		165	205	Monitoring		1
USMC-24EX13C	MARINE CORPS AIR STATION	282		230	270	Monitoring		1
USMC-24EX14	MARINE CORPS AIR STATION	195		115	185	Monitoring		1
USMC-24EX2	MARINE CORPS AIR STATION	215		109	209	Other Active Production		2
USMC-24EX20B	MARINE CORPS AIR STATION	210		107	205	Other Active Production		2
USMC-24EX3	MARINE CORPS AIR STATION	186		0	0	Monitoring		1
USMC-24EX30B1	MARINE CORPS AIR STATION	158		105	150	Monitoring		1
USMC-24EX30B2	MARINE CORPS AIR STATION	156		105	150	Monitoring		1
USMC-24EX30B3	MARINE CORPS AIR STATION	182		170	175	Monitoring		1
USMC-24EX4	MARINE CORPS AIR STATION	195		104	190	Other Active Production		2
USMC-24EX40B2	MARINE CORPS AIR STATION	156		106	106	Monitoring		1
USMC-24EX5	MARINE CORPS AIR STATION	160		104	154	Other Active Production		2
USMC-24EX50B1	MARINE CORPS AIR STATION	156		105	150	Monitoring		1
USMC-24EX50B2	MARINE CORPS AIR STATION	156		105	150	Monitoring		1
USMC-24EX6	MARINE CORPS AIR STATION	178		0	0	Monitoring		1
USMC-24EX60B1	MARINE CORPS AIR STATION	160		106	151	Monitoring		1
USMC-24EX60B2	MARINE CORPS AIR STATION	158		105	150	Monitoring		1
USMC-24EX60B3	MARINE CORPS AIR STATION	225		218	223	Monitoring		1
USMC-24EX9	MARINE CORPS AIR STATION	214		120	200	Monitoring		1
USMC-24IN03	MARINE CORPS AIR STATION	169		91	160	Injection		4
USMC-24IN20B1	MARINE CORPS AIR STATION	300		194	271	Injection		4
USMC-24MW10AB	MARINE CORPS AIR STATION	143		130	140	Monitoring	S	1
USMC-24MW10CD	MARINE CORPS AIR STATION	245		230	240	Monitoring		1
USMC-24MW11AB	MARINE CORPS AIR STATION	145		130	140	Monitoring	S	1
USMC-24MW11CD	MARINE CORPS AIR STATION	240		210	220	Monitoring		1
USMC-24MW12AB	MARINE CORPS AIR STATION	140		127	137	Monitoring	S	1
USMC-24MW12CD	MARINE CORPS AIR STATION	231		203	213	Monitoring		1
USMC-24MW13AB	MARINE CORPS AIR STATION	124		111	121	Monitoring	S	1
USMC-24MW13CD	MARINE CORPS AIR STATION	228		212	222	Monitoring		1

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
USMC-24MW14AB	MARINE CORPS AIR STATION	129		115	125	Monitoring	S	1
USMC-24MW14CD	MARINE CORPS AIR STATION	223		211	221	Monitoring		1
USMC-24MW15AB	MARINE CORPS AIR STATION	137		125	135	Monitoring	S	1
USMC-24MW15CD	MARINE CORPS AIR STATION	236		220	230	Monitoring		1
USMC-24MW16	MARINE CORPS AIR STATION	340		80	300	Multiport Monitoring		1
USMC-24MW17	MARINE CORPS AIR STATION	340		75	310	Multiport Monitoring		1
USMC-24MW5	MARINE CORPS AIR STATION	181		140	168	Monitoring		1
USMC-24MW6	MARINE CORPS AIR STATION	195		170	190	Monitoring		1
USMC-24MW7	MARINE CORPS AIR STATION	208		120	200	Monitoring		1
USMC-24MW8	MARINE CORPS AIR STATION	380		105	350	Multiport Monitoring		1
USMC-24MW9AB	MARINE CORPS AIR STATION	151		140	150	Monitoring	S	1
USMC-24MW9CD	MARINE CORPS AIR STATION	243		230	240	Monitoring		1
USMC-24NEW1	MARINE CORPS AIR STATION	260		225	245	Monitoring		1
USMC-24NEW4	MARINE CORPS AIR STATION	160		108	148	Monitoring	S	1
USMC-24NEW5	MARINE CORPS AIR STATION	262		230	250	Monitoring		1
USMC-24NEW6	MARINE CORPS AIR STATION	193		165	185	Monitoring		1
USMC-24NEW7	MARINE CORPS AIR STATION	174		118	158	Monitoring		1
USMC-24NEW8	MARINE CORPS AIR STATION	170		122	162	Monitoring	S	1
USMC-DW135	MARINE CORPS AIR STATION	135		115	135	Monitoring	S	1
USMC-DW250	MARINE CORPS AIR STATION	254		215	250	Monitoring		1
USMC-DW350	MARINE CORPS AIR STATION	353		310	350	Monitoring		1
USMC-DW450	MARINE CORPS AIR STATION	454		414	450	Monitoring		1
USMC-DW540	MARINE CORPS AIR STATION	541		490	540	Monitoring		1
USMC-MP06	MARINE CORPS AIR STATION	500		105	455	Multiport Monitoring		1
USMC-MP08	MARINE CORPS AIR STATION	500		61	449	Multiport Monitoring		1
USMC-MP09	MARINE CORPS AIR STATION	500		59	463	Multiport Monitoring		1
USMC-MP10	MARINE CORPS AIR STATION	1202		218	1011	Multiport Monitoring		1
USMC-MW01A	MARINE CORPS AIR STATION	500		466	486	Monitoring		1
USMC-MW01B	MARINE CORPS AIR STATION	421		396	416	Monitoring		1
USMC-MW01C	MARINE CORPS AIR STATION	358		330	350	Monitoring		1
USMC-MW01D	MARINE CORPS AIR STATION	270		242	262	Monitoring		1
USMC-MW01E	MARINE CORPS AIR STATION	233		205	225	Monitoring		1
USMC-MW02A	MARINE CORPS AIR STATION	500		462	482	Monitoring		1
USMC-MW02C	MARINE CORPS AIR STATION	386		358	378	Monitoring		1
USMC-MW02D	MARINE CORPS AIR STATION	319		294	314	Monitoring		1
USMC-MW02E	MARINE CORPS AIR STATION	253		198	233	Monitoring		1
USMC-MW03A	MARINE CORPS AIR STATION	471		370	390	Monitoring		1
USMC-MW03B	MARINE CORPS AIR STATION	310		280	300	Monitoring		1
USMC-MW03C	MARINE CORPS AIR STATION	250		222	242	Monitoring		1
USMC-MW03E	MARINE CORPS AIR STATION	172		124	164	Monitoring	S	1
USMC-MW04A	MARINE CORPS AIR STATION	421		286	306	Monitoring		1
USMC-MW04B	MARINE CORPS AIR STATION	421		190	210	Monitoring		1
USMC-MW05A	MARINE CORPS AIR STATION	500		462	482	Monitoring		1
USMC-MW05B	MARINE CORPS AIR STATION	364		321	341	Monitoring		1
USMC-MW05C	MARINE CORPS AIR STATION	500		225	245	Monitoring		1
USMC-MW05D	MARINE CORPS AIR STATION	147		83	133	Monitoring		1
USMC-MW05E	MARINE CORPS AIR STATION	160		80	130	Monitoring		1
USMC-MW07	MARINE CORPS AIR STATION	90		25	65	Monitoring		1
USMC-MW100	MARINE CORPS AIR STATION	179		131	171	Monitoring		1
USMC-MW100A	MARINE CORPS AIR STATION	138		93	132	Monitoring		1
USMC-MW101	MARINE CORPS AIR STATION	140		90	130	Monitoring		1
USMC-MW101A	MARINE CORPS AIR STATION	105		68	98	Monitoring		1
USMC-MW103	MARINE CORPS AIR STATION	499		395	495	Monitoring		1
USMC-MW19A	MARINE CORPS AIR STATION	500		448	468	Monitoring		1
USMC-MW19B	MARINE CORPS AIR STATION	425		400	420	Monitoring		1
USMC-MW19C	MARINE CORPS AIR STATION	500		257	277	Monitoring		1
USMC-MW19D	MARINE CORPS AIR STATION	500		150	170	Monitoring	S	1
USMC-MW19E	MARINE CORPS AIR STATION	148		98	138	Monitoring		1
USMC-MW23	MARINE CORPS AIR STATION	115		64	104	Monitoring	S	1
USMC-MW24	MARINE CORPS AIR STATION	80		51	71	Monitoring		1
USMC-MW25	MARINE CORPS AIR STATION	84		55	75	Monitoring		1
USMC-MW29	MARINE CORPS AIR STATION	120		95	135	Monitoring		1
USMC-MW29A	MARINE CORPS AIR STATION	115		75	100	Monitoring		1
USMC-MW31	MARINE CORPS AIR STATION	153		105	145	Monitoring	S	1
USMC-MW37	MARINE CORPS AIR STATION	137		89	130	Monitoring		1
USMC-MW39	MARINE CORPS AIR STATION	276		230	270	Monitoring		1
USMC-MW398-01	MARINE CORPS AIR STATION	231		198	228	Monitoring		1

List of Wells in OCWD Monitoring Programs

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
USMC-MW398-02	MARINE CORPS AIR STATION	231		199	229	Monitoring		1
USMC-MW398-03	MARINE CORPS AIR STATION	242		208	238	Monitoring		1
USMC-MW398-04	MARINE CORPS AIR STATION	232		201	231	Monitoring		1
USMC-MW398-05	MARINE CORPS AIR STATION	230		197	227	Monitoring		1
USMC-MW398-06	MARINE CORPS AIR STATION	228		196	226	Monitoring		1
USMC-MW398-08	MARINE CORPS AIR STATION	233		200	230	Monitoring		1
USMC-MW398-09	MARINE CORPS AIR STATION	242		190	240	Monitoring		1
USMC-MW398-10	MARINE CORPS AIR STATION	260		200	250	Monitoring		1
USMC-MW398-11	MARINE CORPS AIR STATION	267		200	250	Monitoring		1
USMC-MW398-12	MARINE CORPS AIR STATION	7		190	240	Monitoring		1
USMC-MW398-13	MARINE CORPS AIR STATION	245		193	243	Monitoring		1
USMC-MW398-13D	MARINE CORPS AIR STATION	301		251	301	Monitoring		1
USMC-MW398-14	MARINE CORPS AIR STATION	242		192	242	Monitoring		1
USMC-MW398-15	MARINE CORPS AIR STATION	249		199	249	Monitoring		1
USMC-MW398-16	MARINE CORPS AIR STATION	247		194	244	Monitoring		1
USMC-MW398-17	MARINE CORPS AIR STATION	241		189	239	Monitoring		1
USMC-MW398-18	MARINE CORPS AIR STATION	267		194	244	Monitoring		1
USMC-MW398-19	MARINE CORPS AIR STATION	252		202	252	Monitoring		1
USMC-MW398-20	MARINE CORPS AIR STATION	253		201	251	Monitoring		1
USMC-MW398-21	MARINE CORPS AIR STATION	254		193	243	Monitoring		1
USMC-MW398-22	MARINE CORPS AIR STATION	162		120	160	Monitoring		1
USMC-MW398-23	MARINE CORPS AIR STATION	160		120	160	Monitoring		1
USMC-MW398-24	MARINE CORPS AIR STATION	162		120	160	Monitoring		1
USMC-MW398-25	MARINE CORPS AIR STATION	254		201	251	Monitoring		1
USMC-MW398-26	MARINE CORPS AIR STATION	253		202	252	Monitoring		1
USMC-MW398-27	MARINE CORPS AIR STATION	0		202	252	Monitoring		1
USMC-MW40	MARINE CORPS AIR STATION	275		220	260	Monitoring		1
USMC-MW41	MARINE CORPS AIR STATION	228		182	222	Monitoring		1
USMC-MW41A	MARINE CORPS AIR STATION	194		145	185	Monitoring		1
USMC-MW43	MARINE CORPS AIR STATION	200		150	190	Monitoring		1
USMC-MW43B	MARINE CORPS AIR STATION	143		100	141	Monitoring		1
USMC-MW45	MARINE CORPS AIR STATION	169		117	157	Monitoring		1
USMC-MW47	MARINE CORPS AIR STATION	169		116	156	Monitoring		1
USMC-MW48	MARINE CORPS AIR STATION	140		95	135	Monitoring		1
USMC-MW48A	MARINE CORPS AIR STATION	111		74	104	Monitoring		1
USMC-MW50	MARINE CORPS AIR STATION	168		120	160	Monitoring		1
USMC-MW51	MARINE CORPS AIR STATION	172		125	165	Monitoring		1
USMC-MW52	MARINE CORPS AIR STATION	228		182	222	Monitoring		1
USMC-MW56	MARINE CORPS AIR STATION	140		92	132	Monitoring		1
USMC-MW57	MARINE CORPS AIR STATION	93		63	83	Monitoring		1
USMC-MW58	MARINE CORPS AIR STATION	86		69	89	Monitoring		1
USMC-MW59	MARINE CORPS AIR STATION	99		69	89	Monitoring		1
USMC-MW63	MARINE CORPS AIR STATION	281		235	237	Monitoring		1
USMC-MW64	MARINE CORPS AIR STATION	294		245	285	Monitoring		1
USMC-MW64A	MARINE CORPS AIR STATION	255		210	250	Monitoring		1
USMC-MW65X	MARINE CORPS AIR STATION	279		230	270	Monitoring		1
USMC-MW65XA	MARINE CORPS AIR STATION	249		201	236	Monitoring		1
USMC-MW66	MARINE CORPS AIR STATION	305		250	290	Monitoring		1
USMC-MW66A	MARINE CORPS AIR STATION	235		190	230	Monitoring		1
USMC-MW67	MARINE CORPS AIR STATION	245		187	227	Monitoring		1
USMC-MW67A	MARINE CORPS AIR STATION	195		150	190	Monitoring		1
USMC-MW68	MARINE CORPS AIR STATION	308		190	210	Monitoring		1
USMC-MW68A	MARINE CORPS AIR STATION	194		147	187	Monitoring		1
USMC-MW70	MARINE CORPS AIR STATION	172		125	165	Monitoring		1
USMC-MW71	MARINE CORPS AIR STATION	163		115	155	Monitoring		1
USMC-MW72	MARINE CORPS AIR STATION	159		90	130	Monitoring		1
USMC-MW73	MARINE CORPS AIR STATION	140		90	130	Monitoring		1
USMC-MW74	MARINE CORPS AIR STATION	140		90	130	Monitoring		1
USMC-MW75	MARINE CORPS AIR STATION	150		114	154	Monitoring		1
USMC-MW77	MARINE CORPS AIR STATION	145		150	170	Monitoring	S	1
USMC-MW79	MARINE CORPS AIR STATION	166		118	158	Monitoring		1
USMC-MW81	MARINE CORPS AIR STATION	223		176	216	Monitoring		1
USMC-MW82	MARINE CORPS AIR STATION	270		235	255	Monitoring		1
USMC-MW90	MARINE CORPS AIR STATION	145		95	135	Monitoring		1
USMC-MW91	MARINE CORPS AIR STATION	160		110	150	Monitoring		1
USMC-PS1	MARINE CORPS AIR STATION	123		102	122	Monitoring		1
USMC-PS2	MARINE CORPS AIR STATION	135		103	133	Monitoring		1

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
USMC-PS3	MARINE CORPS AIR STATION	123		102	122	Monitoring		1
USMC-PS3A	MARINE CORPS AIR STATION	111		70	105	Monitoring		1
USMC-PS4	MARINE CORPS AIR STATION	123		98	118	Monitoring		1
USMC-PS5	MARINE CORPS AIR STATION	124		106	126	Monitoring	S	1
USMC-PS6	MARINE CORPS AIR STATION	155		130	150	Monitoring		1
USMC-PS7	MARINE CORPS AIR STATION	129		106	126	Monitoring		1
USMC-PS8	MARINE CORPS AIR STATION	145		125	145	Monitoring	S	1
USMC-RW1	MARINE CORPS AIR STATION	504		430	470	Monitoring		1
USMC-RW2	MARINE CORPS AIR STATION	475		270	310	Monitoring		1
USMC-RW3	MARINE CORPS AIR STATION	403		370	390	Monitoring		1
USMC-RW4	MARINE CORPS AIR STATION	86		65	85	Monitoring		1
USMC-SGU1	MARINE CORPS AIR STATION	217		96	206	Other Active Production		2
USMC-SGU10	MARINE CORPS AIR STATION	230		99	199	Other Active Production		2
USMC-SGU11	MARINE CORPS AIR STATION	231		106	216	Other Active Production		2
USMC-SGU12	MARINE CORPS AIR STATION	228		99	219	Other Active Production		2
USMC-SGU13	MARINE CORPS AIR STATION	228		98	218	Other Active Production		2
USMC-SGU14	MARINE CORPS AIR STATION	237		106	226	Other Active Production		2
USMC-SGU15	MARINE CORPS AIR STATION	229		99	219	Other Active Production		2
USMC-SGU16	MARINE CORPS AIR STATION	236		105	185	Other Active Production		2
USMC-SGU17	MARINE CORPS AIR STATION	236		105	180	Other Active Production		2
USMC-SGU18	MARINE CORPS AIR STATION	235		106	226	Other Active Production		2
USMC-SGU19	MARINE CORPS AIR STATION	246		111	231	Other Active Production		2
USMC-SGU2	MARINE CORPS AIR STATION	219		100	170	Other Active Production		2
USMC-SGU20	MARINE CORPS AIR STATION	239		111	231	Other Active Production		2
USMC-SGU21	MARINE CORPS AIR STATION	234		104	194	Other Active Production		2
USMC-SGU22	MARINE CORPS AIR STATION	227		99	219	Other Active Production		2
USMC-SGU23	MARINE CORPS AIR STATION	230		99	219	Other Active Production		2
USMC-SGU24	MARINE CORPS AIR STATION	234		99	224	Other Active Production		2
USMC-SGU25	MARINE CORPS AIR STATION	235		99	224	Other Active Production		2
USMC-SGU26	MARINE CORPS AIR STATION	235		160	225	Other Active Production		2
USMC-SGU27	MARINE CORPS AIR STATION	165		90	155	Other Active Production		2
USMC-SGU28	MARINE CORPS AIR STATION	220		146	211	Other Active Production		2
USMC-SGU29	MARINE CORPS AIR STATION	155		81	146	Other Active Production		2
USMC-SGU3	MARINE CORPS AIR STATION	225		99	114	Other Active Production		2
USMC-SGU30	MARINE CORPS AIR STATION	230		151	221	Other Active Production		2
USMC-SGU31	MARINE CORPS AIR STATION	149		70	140	Other Active Production		2
USMC-SGU32	MARINE CORPS AIR STATION	217		140	205	Other Active Production		2
USMC-SGU33	MARINE CORPS AIR STATION	154		70	145	Other Active Production		2
USMC-SGU34	MARINE CORPS AIR STATION	220		145	210	Other Active Production		2
USMC-SGU35	MARINE CORPS AIR STATION	155		75	145	Other Active Production		2
USMC-SGU36	MARINE CORPS AIR STATION	250		90	240	Other Active Production		2
USMC-SGU37	MARINE CORPS AIR STATION	250		90	240	Other Active Production		2
USMC-SGU38	MARINE CORPS AIR STATION	250		95	240	Other Active Production		2
USMC-SGU39	MARINE CORPS AIR STATION	200		90	190	Other Active Production		2
USMC-SGU4	MARINE CORPS AIR STATION	219		99	209	Other Active Production		2
USMC-SGU5	MARINE CORPS AIR STATION	215		96	206	Other Active Production		2
USMC-SGU6	MARINE CORPS AIR STATION	228		100	200	Other Active Production		2
USMC-SGU7	MARINE CORPS AIR STATION	230		104	224	Other Active Production		2
USMC-SGU8	MARINE CORPS AIR STATION	231		100	210	Other Active Production		2
USMC-SGU9	MARINE CORPS AIR STATION	228		98	218	Other Active Production		2
USMC-TF1MW1	MARINE CORPS AIR STATION	150		109	149	Monitoring		1
USMC-TF2MW1	MARINE CORPS AIR STATION	164		120	160	Monitoring		1
USMC-TF2MW4	MARINE CORPS AIR STATION	161		120	160	Monitoring		1
MSG-BP10L	MCCOLL SITE GROUP	274		247	257	Monitoring	S	1,10
MKSSN-SA	MCKESSON WATER PRODUCTION. CO.	272		160	260	Other Active Production		2,3
W-2048	MEL MACK CO.	358		112	150	Inactive Production		2
ABBY-A	MELROSE ABBEY FUNERAL CENTER	250		0	0	Other Active Production		2,3
MVCC-COSD1	MESA VERDE COUNTRY CLUB	200		0	0	Other Active Production		2,3,6
MVCC-COSD2	MESA VERDE COUNTRY CLUB	462		200	450	Other Active Production	P	2,3,6
MVCC-COSD3	MESA VERDE COUNTRY CLUB	460		200	450	Other Active Production	P	2,3,6
MCWD-11	MESA WATER DIST.	1060		330	1000	Active Large Production	P	2,7
MCWD-1B	MESA WATER DIST.	612		305	580	Active Large Production	P	2,6,7
MCWD-2	MESA WATER DIST.	670		300	650	Monitoring	P	1
MCWD-3B	MESA WATER DIST.	610		242	572	Active Large Production	P	2,6,7
MCWD-3BM	MESA WATER DIST.	1006		880	920	Monitoring	P	1,6
MCWD-5	MESA WATER DIST.	980		400	940	Active Large Production	P	2,6,7
MCWD-6	MESA WATER DIST.	1093		310	1025	Active Large Production	P	2,6,7

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
MCWD-7	MESA WATER DIST.	830		363	753	Active Large Production	P	2,6,7
MCWD-8	MESA WATER DIST.	626		300	572	Inactive Production	P	2,6,7
MCWD-8M	MESA WATER DIST.	1000		870	880	Monitoring	P	1,6
MCWD-9	MESA WATER DIST.	625		350	580	Active Large Production	P	2,6,7
W-12133	METROPOLITAN WATER DIST.	400		0	0	Cathodic Protection		9
MIDC-2	MIDWAY CITY MUTUAL WATER CO.	420		228	420	Active Small Production		2,7
MISQ-FV	MILE SQUARE PARK	300		0	0	Other Active Production		2,3
W-11192	MONITORINGTANA LAND CO.	981		870	916	Inactive Production		2
W-14809	MUTUAL WATER CO.	225		0	0	Inactive Production		2,3
W-14811	MUTUAL WATER CO.	265		0	0	Inactive Production		2,3
NATR-TW1	NATURE CONSERVANCY	150		20	150	Other Active Production		2,3
NVLR-LAG1	NAVAL RECREATION STATION	546		478	524	Other Active Production		2,3
NVLR-LAH1	NAVAL RECREATION STATION	836		0	0	Other Active Production		2,3
NVLR-LAN1	NAVAL RECREATION STATION	634		580	620	Inactive Production		2,3
NVLW-4010	NAVAL WEAPONS STATION	59		45	55	Monitoring		1
NVLW-4012	NAVAL WEAPONS STATION	59		45	55	Monitoring		1
NVLW-4013	NAVAL WEAPONS STATION	58		45	55	Monitoring		1
NVLW-4014	NAVAL WEAPONS STATION	59		30	40	Monitoring		1
NVLW-4016	NAVAL WEAPONS STATION	58		42	52	Monitoring		1
NVLW-4018	NAVAL WEAPONS STATION	62		50	60	Monitoring		1
NVLW-4020	NAVAL WEAPONS STATION	62		50	60	Monitoring		1
NVLW-4021	NAVAL WEAPONS STATION	62		51	61	Monitoring		1
NVLW-7001	NAVAL WEAPONS STATION	33		20	30	Monitoring		1
NVLW-7002	NAVAL WEAPONS STATION	32		20	30	Monitoring		1
NVLW-7003	NAVAL WEAPONS STATION	32		20	30	Monitoring		1
NVLW-7004	NAVAL WEAPONS STATION	62		49	59	Monitoring		1
NVLW-7005	NAVAL WEAPONS STATION	62		50	60	Monitoring		1
NVLW-7006	NAVAL WEAPONS STATION	62		50	60	Monitoring		1
NVLW-7007	NAVAL WEAPONS STATION	62		50	60	Monitoring		1
NVLW-7008	NAVAL WEAPONS STATION	111		96	105	Monitoring	S	1
NVLW-7009	NAVAL WEAPONS STATION	175		160	169	Monitoring		1
NVLW-7010	NAVAL WEAPONS STATION	41		30	40	Monitoring		1
NVLW-7011	NAVAL WEAPONS STATION	102		80	100	Monitoring	S	1
NVLW-7012	NAVAL WEAPONS STATION	115		100	110	Monitoring		1
NVLW-7013	NAVAL WEAPONS STATION	108		95	105	Monitoring	S	1
NVLW-7014	NAVAL WEAPONS STATION	187		160	170	Monitoring		1
NVLW-7015	NAVAL WEAPONS STATION	179		161	170	Monitoring		1
NVLW-7016	NAVAL WEAPONS STATION	110		95	105	Monitoring	S	1
NVLW-7017	NAVAL WEAPONS STATION	42		30	40	Monitoring		1
NVLW-7018	NAVAL WEAPONS STATION	102		80	100	Monitoring	S	1
NVLW-7019	NAVAL WEAPONS STATION	42		30	40	Monitoring		1
NVLW-7020	NAVAL WEAPONS STATION	0		19	29	Monitoring		1
NVLW-7021	NAVAL WEAPONS STATION	172		150	170	Monitoring		1
NVLW-7022	NAVAL WEAPONS STATION	32		20	30	Monitoring		1
NVLW-7023	NAVAL WEAPONS STATION	132		110	130	Monitoring		1
NVLW-7024	NAVAL WEAPONS STATION	27		15	25	Monitoring		1
NVLW-7025	NAVAL WEAPONS STATION	62		50	60	Monitoring	S	1
NVLW-7027	NAVAL WEAPONS STATION	36		26	36	Monitoring		1
NVLW-7028	NAVAL WEAPONS STATION	62		50	60	Monitoring	S	1
NVLW-7031	NAVAL WEAPONS STATION	145		130	140	Monitoring		1
NVLW-7032	NAVAL WEAPONS STATION	110		95	105	Monitoring		1
NVLW-7033	NAVAL WEAPONS STATION	170		155	165	Monitoring		1
NVLW-7034	NAVAL WEAPONS STATION	60		46	56	Monitoring		1
NVLW-7035	NAVAL WEAPONS STATION	103		90	100	Monitoring	S	1
NVLW-7036	NAVAL WEAPONS STATION	170		150	160	Monitoring		1
NVLW-7037	NAVAL WEAPONS STATION	112		89	109	Monitoring		1
NVLW-7038	NAVAL WEAPONS STATION	102		80	100	Monitoring	S	1
NVLW-7039	NAVAL WEAPONS STATION	159		143	153	Monitoring		1
NVLW-7040	NAVAL WEAPONS STATION	160		140	150	Monitoring		1
NVLW-7041	NAVAL WEAPONS STATION	146		133	143	Monitoring	S	1
NVLW-7042	NAVAL WEAPONS STATION	151		136	146	Monitoring	S	1
NVLW-7043	NAVAL WEAPONS STATION	150		136	146	Monitoring	S	1
NVLW-7044	NAVAL WEAPONS STATION	158		123	143	Monitoring	S	1
NVLW-7045	NAVAL WEAPONS STATION	157		135	155	Monitoring	S	1
NVLW-7046	NAVAL WEAPONS STATION	107		85	105	Monitoring		1
NVLW-70POC02	NAVAL WEAPONS STATION	0		190	201	Monitoring		1,6
NVLW-70POC03	NAVAL WEAPONS STATION	205		190	200	Monitoring		1,6

List of Wells in OCWD Monitoring Programs

KEY

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
NVLW-70POC04	NAVAL WEAPONS STATION	210		195	206	Monitoring		1,6
NVLW-EW7001	NAVAL WEAPONS STATION	33		20	30	Inactive Production		2
NVLW-EW7003	NAVAL WEAPONS STATION	130		95	120	Inactive Production		2
NVLW-RDO1	NAVAL WEAPONS STATION	110		65	105	Monitoring		1
NVLW-RDO2	NAVAL WEAPONS STATION	110		65	105	Monitoring		1
NVLW-RDO3A	NAVAL WEAPONS STATION	31		20	30	Monitoring		1
NVLW-RDO3B	NAVAL WEAPONS STATION	107		65	105	Monitoring		1
NVLW-RDO4	NAVAL WEAPONS STATION	112		65	105	Monitoring		1
NVLW-RDO5	NAVAL WEAPONS STATION	107		65	105	Monitoring		1
NVLW-RDO6A	NAVAL WEAPONS STATION	109		95	105	Monitoring		1
NVLW-RDO6B	NAVAL WEAPONS STATION	145		130	140	Monitoring		1
NVLW-SB2	NAVAL WEAPONS STATION	424		207	407	Inactive Production		2,3,6
NVLW-SB6	NAVAL WEAPONS STATION	802		548	655	Inactive Production	P	2
BYNT-YLSE	NEFF RANCH, LTD	90		34	70	Other Active Production		2,3
NB-DOLD	NEWPORT BEACH	824		399	729	Active Large Production	P	2,7
NB-DOLS	NEWPORT BEACH	385		201	356	Active Large Production	P	2,7
NB-TAMD	NEWPORT BEACH	758		395	690	Active Large Production	P	2,7
NB-TAMS	NEWPORT BEACH	390		170	360	Active Large Production	P	2,7
NBGC-GA10	NEWPORT BEACH GOLF COURSE	65		32	62	Monitoring	S	1,6
NBGC-MW2	NEWPORT BEACH GOLF COURSE	65		35	65	Monitoring		1
NBGC-MW3	NEWPORT BEACH GOLF COURSE	65		35	65	Monitoring		1
NBGC-NB	NEWPORT BEACH GOLF COURSE	498		192	218	Other Active Production		2,3,6
NDW-1	NIAGARA DRINKING WATER	510		270	500	Inactive Production		2,9
COCA-A	NOR-CAL BEVERAGE CO. INC.	654		0	0	Inactive Production		2,3,8
NCS-NO2	NORCO COMMUNITY SERVICES	114		47	114	Other Active Production		2
GRGC-CO1	O.C. FLOOD CONTROL DIST.	96		34	67	Other Active Production		2,3
GRGC-COR1	O.C. FLOOD CONTROL DIST.	92		34	61	Other Active Production		2,3
GRGC-YL14	O.C. FLOOD CONTROL DIST.	0		0	0	Other Active Production		2,3
GRGC-YL15	O.C. FLOOD CONTROL DIST.	0		0	0	Other Active Production		2,3
GRGC-YL16	O.C. FLOOD CONTROL DIST.	0		0	0	Other Active Production		2,3
GRGC-YL4	O.C. FLOOD CONTROL DIST.	0		0	0	Other Active Production		2,3
GRGC-YL9	O.C. FLOOD CONTROL DIST.	0		0	0	Other Active Production		2,3
GRGC-YLA1	O.C. FLOOD CONTROL DIST.	0		0	0	Other Active Production		2,3
W-3763	O.C. FLOOD CONTROL DIST.	610		144	385	Inactive Production		2
W-629	O.C. FLOOD CONTROL DIST.	267		81	256	Monitoring		1
W-638	O.C. FLOOD CONTROL DIST.	176		71	162	Monitoring		1
VECT-GG	O.C. VECTOR CNT. DIST.	224		0	0	Other Active Production		2,3
BSOA-I	OC COUNCIL BOY SCOUTS/ANAHEIM	0		100	200	Other Active Production		2,3
W-19059	OC WASTE MANAGEMENT	60		27	57	Monitoring		1
OVWC-HB	OCEAN VIEW MUTUAL WATER	180		0	0	Inactive Production		2,6
ABS-1	OCWD	286	MP1	25	35	Multiport Monitoring	P	1
ABS-1	OCWD	286	MP2	75	85	Multiport Monitoring	P	1
ABS-1	OCWD	286	MP3	255	265	Multiport Monitoring	P	1
ABS-2	OCWD	180		155	165	Monitoring	S	1
AM-1	OCWD	140		97	115	Monitoring	S	1
AM-10	OCWD	300		217	235	Monitoring	S	1
AM-11	OCWD	278		218	240	Monitoring	P	1
AM-12	OCWD	299		210	225	Monitoring	S	1
AM-13	OCWD	279		252	270	Monitoring	P	1
AM-14	OCWD	321		297	315	Monitoring	P	1,8
AM-15	OCWD	320		300	317	Monitoring	P	1,8
AM-15A	OCWD	231		214	220	Monitoring	S	1,8
AM-16	OCWD	320		300	315	Monitoring	P	1,8
AM-16A	OCWD	227		215	222	Monitoring		1,8
AM-17	OCWD	320		290	308	Monitoring	P	1,8
AM-18	OCWD	320		291	309	Monitoring	P	1,8
AM-18A	OCWD	232		208	215	Monitoring		1,8
AM-19	OCWD	240		217	225	Monitoring		1
AM-19A	OCWD	127		115	123	Monitoring	S	1
AM-2	OCWD	160		87	100	Monitoring	S	1
AM-20	OCWD	397		361	379	Monitoring	P	1
AM-20A	OCWD	268		250	258	Monitoring		1
AM-21	OCWD	269		250	258	Monitoring		1
AM-21A	OCWD	179		157	165	Monitoring	S	1
AM-22	OCWD	356		339	353	Monitoring	P	1,8
AM-22A	OCWD	239		216	224	Monitoring		1,8
AM-23	OCWD	351		330	347	Monitoring	P	1,8

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
AM-24	OCWD	378		335	350	Monitoring	P	1,8
AM-24A	OCWD	305		279	294	Monitoring		1,8
AM-25	OCWD	365		340	358	Monitoring	P	1,8
AM-25A	OCWD	217		188	195	Monitoring	S	1,8
AM-26	OCWD	388		377	383	Monitoring	P	1
AM-27	OCWD	337		287	305	Monitoring	P	1
AM-28	OCWD	398		358	376	Monitoring		1
AM-29	OCWD	365		340	358	Monitoring	P	1,8
AM-29A	OCWD	96		75	95	Monitoring		1,8
AM-3	OCWD	115		91	107	Monitoring	S	1,10
AM-30	OCWD	375		349	367	Monitoring	P	1,8
AM-30A	OCWD	398		152	159	Monitoring	S	1,8
AM-31	OCWD	358		335	353	Monitoring	P	1,8
AM-31A	OCWD	360		162	170	Monitoring	S	1,8
AM-32	OCWD	398		335	353	Monitoring	P	1,8
AM-33	OCWD	378		354	372	Monitoring	P	1,8
AM-33A	OCWD	238		206	221	Monitoring		1,8
AM-34	OCWD	354		317	335	Monitoring	P	1
AM-34A	OCWD	271		252	260	Monitoring		1
AM-35	OCWD	400		332	350	Monitoring	P	1
AM-36	OCWD	398		369	387	Monitoring	P	1
AM-37	OCWD	378		349	367	Monitoring	P	1
AM-38	OCWD	358		316	334	Monitoring	P	1
AM-39	OCWD	192		168	188	Monitoring		1,8
AM-39A	OCWD	140		115	135	Monitoring	S	1,8
AM-4	OCWD	300		187	205	Monitoring	S	1
AM-40	OCWD	193		175	190	Monitoring		1,8
AM-40A	OCWD	168		145	165	Monitoring	S	1,8
AM-41	OCWD	200		190	200	Monitoring		1,8
AM-41A	OCWD	167		156	166	Monitoring	S	1,8
AM-42	OCWD	198		180	190	Monitoring		1,8
AM-42A	OCWD	135		115	130	Monitoring	S	1,8
AM-43	OCWD	100		80	100	Monitoring		1
AM-44	OCWD	162		140	160	Monitoring	S	1
AM-44A	OCWD	90		78	88	Monitoring		1
AM-45	OCWD	133		102	132	Monitoring	S	1,8
AM-46	OCWD	130		94	124	Monitoring	S	1
AM-47	OCWD	290		227	242	Monitoring	P	1,8
AM-47A	OCWD	170		160	170	Monitoring	S	1,8
AM-48	OCWD	312		270	300	Monitoring	P	1,8
AM-48A	OCWD	152		116	146	Monitoring	S	1,8
AM-49	OCWD	160		120	150	Monitoring	S	1,8
AM-5	OCWD	250		230	245	Monitoring	P	1
AM-50	OCWD	170		140	150	Monitoring	S	1
AM-51	OCWD	130		105	125	Monitoring	S	1
AM-51A	OCWD	80		50	70	Monitoring		1
AM-5A	OCWD	182		168	175	Monitoring	S	1
AM-6	OCWD	300		232	250	Monitoring	P	1
AM-7	OCWD	296		210	225	Monitoring	S	1
AM-8	OCWD	300		268	285	Monitoring	S	1,8
AM-9	OCWD	317		285	303	Monitoring	S	1,8
AMD-1	OCWD	1511	MP1	104	114	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP2	135	145	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP3	180	190	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP4	246	256	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP5	330	340	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP6	384	394	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP7	524	534	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP8	760	770	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP8	1038	1048	Multiport Monitoring	S/P/D	1,10
AMD-1	OCWD	1511	MP10	1390	1400	Multiport Monitoring	S/P/D	1,10
AMD-10	OCWD	1510		934	954	Monitoring	P	1
AMD-11	OCWD	1510		906	926	Monitoring	P	1
AMD-12	OCWD	1020		940	960	Monitoring	P	1
AMD-2	OCWD	1508	MP1	156	166	Multiport Monitoring	S/P/D	1
AMD-2	OCWD	1508	MP2	260	270	Multiport Monitoring	S/P/D	1
AMD-2	OCWD	1508	MP3	384	394	Multiport Monitoring	S/P/D	1

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
AMD-2	OCWD	1508	MP4	510	520	Multiport Monitoring	S/P/D	1
AMD-2	OCWD	1508	MP5	658	668	Multiport Monitoring	S/P/D	1
AMD-2	OCWD	1508	MP6	820	830	Multiport Monitoring	S/P/D	1
AMD-2	OCWD	1508	MP7	1012	1022	Multiport Monitoring	S/P/D	1
AMD-2	OCWD	1508	MP8	1150	1160	Multiport Monitoring	S/P/D	1
AMD-2	OCWD	1508	MP9	1290	1300	Multiport Monitoring	S/P/D	1
AMD-2	OCWD	1508	MP10	1440	1450	Multiport Monitoring	S/P/D	1
AMD-3	OCWD	1416	MP1	66	76	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP2	134	144	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP3	210	220	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP4	360	370	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP5	480	490	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP6	570	580	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP7	820	830	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP8	920	930	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP9	1170	1180	Multiport Monitoring	S/P	1,8,10
AMD-3	OCWD	1416	MP10	1282	1292	Multiport Monitoring	S/P	1,8,10
AMD-4	OCWD	1515	MP1	204	214	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP2	295	305	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP3	380	390	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP4	560	570	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP5	700	710	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP6	790	800	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP7	935	945	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP8	1055	1065	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP9	1120	1130	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP10	1265	1275	Multiport Monitoring	S/P/D	1,8
AMD-4	OCWD	1515	MP11	1405	1415	Multiport Monitoring	S/P/D	1,8
AMD-5	OCWD	1495	MP1	100	110	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP2	200	210	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP3	300	310	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP4	414	424	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP5	495	505	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP6	640	650	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP7	750	760	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP8	920	930	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP9	1025	1035	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP10	1210	1220	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP11	1320	1330	Multiport Monitoring	S/P/D	1
AMD-5	OCWD	1495	MP12	1420	1430	Multiport Monitoring	S/P/D	1
AMD-6	OCWD	1528	MP1	110	120	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP2	150	160	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP3	220	230	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP4	275	285	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP5	370	380	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP6	495	505	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP7	620	630	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP8	710	720	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP9	790	800	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP10	900	910	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP11	1090	1100	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP12	1260	1270	Multiport Monitoring	S/P	1
AMD-6	OCWD	1528	MP13	1405	1415	Multiport Monitoring	S/P	1
AMD-7	OCWD	1520	MP1	120	130	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP2	220	230	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP3	270	280	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP4	310	320	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP5	370	380	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP6	470	480	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP7	578	588	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP8	690	700	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP9	805	815	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP10	930	940	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP11	1070	1080	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP12	1165	1175	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP13	1295	1305	Multiport Monitoring	S/P/D	1,10
AMD-7	OCWD	1520	MP14	1420	1430	Multiport Monitoring	S/P/D	1,10

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
AMD-8	OCWD	2080	MP1	78	88	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	P2	178	188	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP3	314	324	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP4	524	534	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP5	660	670	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP6	760	770	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP7	856	866	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP8	1000	1010	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP9	1160	1170	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP10	1286	1296	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP11	1450	1460	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP12	1564	1574	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP13	1760	1770	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP14	1944	1954	Multiport Monitoring	S/P/D	1
AMD-8	OCWD	2080	MP15	2010	2020	Multiport Monitoring	S/P/D	1
AMD-9	OCWD	1163		896	916	Monitoring	S/P	1
BPM-1	OCWD	2211	MP1	128	138	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP2	248	258	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP3	456	466	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP4	612	622	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP5	776	786	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP6	886	896	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP7	1036	1046	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP8	1264	1274	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP9	1388	1398	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP10	1498	1508	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP11	1684	1694	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP12	1800	1810	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP13	1930	1940	Multiport Monitoring	S/P/D	1,10
BPM-1	OCWD	2211	MP14	2105	2115	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP1	180	190	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP2	336	346	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP3	494	504	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP4	580	590	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP5	774	784	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP6	900	910	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP7	1024	1034	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP8	1240	1250	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP9	1364	1374	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP10	1490	1500	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP11	1610	1620	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP12	1760	1770	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP13	1928	1938	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP14	2070	2080	Multiport Monitoring	S/P/D	1,10
BPM-2	OCWD	2227	MP15	2170	2180	Multiport Monitoring	S/P/D	1,10
CB-1	OCWD	1543	MP1	76	86	Multiport Monitoring	S/P/D	1,8
CB-1	OCWD	1543	MP2	140	150	Multiport Monitoring	S/P/D	1,8
CB-1	OCWD	1543	MP3	440	450	Multiport Monitoring	S/P/D	1,8
CB-1	OCWD	1543	MP4	659	669	Multiport Monitoring	S/P/D	1,8
CB-1	OCWD	1543	MP5	870	880	Multiport Monitoring	S/P/D	1,8
CB-1	OCWD	1543	MP6	1050	1060	Multiport Monitoring	S/P/D	1,8
CB-1	OCWD	1543	MP7	1190	1200	Multiport Monitoring	S/P/D	1,8
CB-1	OCWD	1543	MP8	1329	1339	Multiport Monitoring	S/P/D	1,8
CB-1	OCWD	1543	MP9	1460	1470	Multiport Monitoring	S/P/D	1,8
COSM-1	OCWD	2000	MP1	90	100	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP2	152	162	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP3	270	280	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP4	350	360	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP5	450	460	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP6	540	550	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP7	620	630	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP8	720	730	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP9	850	860	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP10	980	990	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP11	1100	1110	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP12	1212	1222	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP13	1432	1442	Multiport Monitoring	S/P/D	1,6,10

List of Wells in OCWD Monitoring Programs

KEY

Aquifer Zone: S=Shallow Aquifer, P=Principal Aquifer, D= Deep Aquifer

Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
COSM-1	OCWD	2000	MP14	1594	1604	Multiport Monitoring	S/P/D	1,6,10
COSM-1	OCWD	2000	MP15	1760	1770	Multiport Monitoring	S/P/D	1,6,10
COSM-2	OCWD	1142	MP1	58	68	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP2	113	123	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP3	198	208	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP4	307	317	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP5	406	416	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP6	540	550	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP7	649	659	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP8	757	767	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP9	886	896	Multiport Monitoring	S/P	1,6
COSM-2	OCWD	1142	MP10	1051	1061	Multiport Monitoring	S/P	1,6
FFS-1	OCWD	1490	MP1	180	190	Multiport Monitoring	S/P/D	1,8,10
FFS-1	OCWD	1490	MP2	360	370	Multiport Monitoring	S/P/D	1,8,10
FFS-1	OCWD	1490	MP3	529	539	Multiport Monitoring	S/P/D	1,8,10
FFS-1	OCWD	1490	MP4	819	829	Multiport Monitoring	S/P/D	1,8,10
FFS-1	OCWD	1490	MP5	1059	1069	Multiport Monitoring	S/P/D	1,8,10
FFS-1	OCWD	1490	MP6	1159	1169	Multiport Monitoring	S/P/D	1,8,10
FFS-1	OCWD	1490	MP7	1299	1309	Multiport Monitoring	S/P/D	1,8,10
FFS-1	OCWD	1490	MP7	1419	1429	Multiport Monitoring	S/P/D	1,8,10
FM-1	OCWD	359		348	356	Monitoring	P	1,8
FM-10	OCWD	250		215	235	Monitoring	P	1,8
FM-10A	OCWD	183		151	171	Monitoring	S	1,8
FM-11	OCWD	280		236	256	Monitoring	P	1,8
FM-11A	OCWD	162		134	154	Monitoring	S	1,8
FM-12	OCWD	241		206	226	Monitoring	P	1,8
FM-12A	OCWD	162		135	155	Monitoring	S	1,8
FM-13	OCWD	243		210	230	Monitoring	P	1,8
FM-13A	OCWD	173		140	160	Monitoring	S	1,8
FM-14	OCWD	277		234	254	Monitoring	P	1,8
FM-14A	OCWD	182		147	167	Monitoring	S	1,8
FM-15	OCWD	261		218	238	Monitoring	P	1,8
FM-15A	OCWD	160		120	140	Monitoring	S	1,8
FM-16	OCWD	282		248	268	Monitoring	P	1,8
FM-16A	OCWD	160		125	145	Monitoring	S	1,8
FM-17	OCWD	280		250	270	Monitoring	P	1,8
FM-18	OCWD	367		224	244	Monitoring	P	1,8
FM-18A	OCWD	160		121	151	Monitoring	S	1,8
FM-19A	OCWD	145		115	135	Monitoring	S	1,8
FM-19B	OCWD	270		230	260	Monitoring		1,8
FM-19C	OCWD	399		365	385	Monitoring	P	1,8
FM-1A	OCWD	197		164	172	Monitoring	S	1,8
FM-2	OCWD	352		320	338	Monitoring	P	1,8
FM-20	OCWD	290		221	241	Monitoring	P	1,8
FM-20A	OCWD	160		130	150	Monitoring	S	1,8
FM-21	OCWD	286		260	270	Monitoring	P	1,8
FM-21A	OCWD	169		140	160	Monitoring	S	1,8
FM-22	OCWD	290		242	262	Monitoring	P	1,8
FM-22A	OCWD	180		150	170	Monitoring	S	1,8
FM-23	OCWD	290		234	249	Monitoring	P	1,8
FM-23A	OCWD	155		128	143	Monitoring	S	1,8
FM-24	OCWD	302		271	291	Monitoring	P	1,8
FM-24A	OCWD	200		154	174	Monitoring	S	1,8
FM-25	OCWD	160		132	152	Monitoring	S	1,8
FM-26	OCWD	155		145	155	Monitoring	S	1,8
FM-27	OCWD	125		105	125	Monitoring	S	1,8
FM-2A	OCWD	237		226	234	Monitoring		1,8
FM-3	OCWD	298		257	263	Monitoring	P	1,8
FM-4	OCWD	355		327	345	Monitoring	P	1,8
FM-4A	OCWD	170		142	160	Monitoring	S	1,8
FM-5	OCWD	142		121	141	Monitoring	S	1,8
FM-6	OCWD	405		150	310	Monitoring	S	1,10
FM-7	OCWD	205		187	197	Monitoring		1,8
FM-7A	OCWD	172		160	170	Monitoring	S	1,8
FM-8	OCWD	150		114	134	Monitoring	S	1,8
FM-9	OCWD	260		220	240	Monitoring	P	1,8
FM-9A	OCWD	240		166	186	Monitoring	S	1,8

List of Wells in OCWD Monitoring Programs

KEY

Aquifer Zone: S=Shallow Aquifer, P=Principal Aquifer, D= Deep Aquifer

Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
FVM-1	OCWD	2000	MP1	134	145	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP3	172	182	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP3	220	230	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP4	360	370	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP5	450	460	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP6	500	510	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP7	560	570	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP8	630	640	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP9	810	820	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP10	894	904	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP11	1000	1010	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP12	1120	1130	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP13	1175	1185	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP14	1230	1240	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP15	1320	1330	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP16	1492	1502	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP17	1582	1592	Multiport Monitoring	S/P/D	1,10
FVM-1	OCWD	2000	MP18	1834	1844	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP1	150	160	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP2	300	310	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP3	464	474	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP4	550	560	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP5	740	750	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP6	825	835	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP7	950	960	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP8	1070	1080	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP9	1260	1270	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP10	1515	1525	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP11	1650	1660	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP12	1768	1778	Multiport Monitoring	S/P/D	1,10
GGM-1	OCWD	2086	MP13	2008	2018	Multiport Monitoring	S/P/D	1,10
GGM-2	OCWD	2057	MP1	212	222	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP2	294	304	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP3	460	470	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP4	715	725	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP5	950	960	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP6	1045	1055	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP7	1145	1155	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP8	1250	1260	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP	1485	1495	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP10	1625	1635	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP11	1740	1750	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP12	1900	1910	Multiport Monitoring	S/P/D	1
GGM-2	OCWD	2057	MP13	1990	2000	Multiport Monitoring	S/P/D	1
GGM-3	OCWD	2020	MP1	195	205	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP2	310	320	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP3	545	555	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP4	640	650	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP5	837	847	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP6	1004	1014	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP7	1104	1114	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP8	1274	1284	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP9	1539	1549	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP10	1680	1690	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP11	1780	1790	Multiport Monitoring	S/P	1
GGM-3	OCWD	2020	MP12	1950	1960	Multiport Monitoring	S/P	1
HBM-1	OCWD	2013	MP1	90	100	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP2	190	200	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP3	320	330	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP4	482	492	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP5	560	570	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP6	700	710	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP7	920	930	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP8	1034	1044	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP9	1126	1136	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP10	1348	1358	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP11	1460	1470	Multiport Monitoring	S/P/D	1,10

List of Wells in OCWD Monitoring Programs

KEY

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
HBM-1	OCWD	2013	MP12	1540	1550	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP13	1640	1650	Multiport Monitoring	S/P/D	1,10
HBM-1	OCWD	2013	MP14	1930	1940	Multiport Monitoring	S/P/D	1,10
HBM-2	OCWD	1010	MP1	110	120	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP2	160	170	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP3	245	255	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP4	305	315	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP5	360	370	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP6	445	455	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP7	520	530	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP8	570	580	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP9	675	685	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP10	735	745	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP11	845	855	Multiport Monitoring	S/P	1,6,10
HBM-2	OCWD	1010	MP12	925	935	Multiport Monitoring	S/P	1,6,10
HBM-4	OCWD	830	MP1	75	85	Multiport Monitoring	S/P	1,6
HBM-4	OCWD	830	MP2	120	130	Multiport Monitoring	S/P	1,6
HBM-4	OCWD	830	MP3	180	190	Multiport Monitoring	S/P	1,6
HBM-4	OCWD	830	MP4	230	240	Multiport Monitoring	S/P	1,6
HBM-4	OCWD	830	MP5	295	305	Multiport Monitoring	S/P	1,6
HBM-4	OCWD	830	MP6	350	360	Multiport Monitoring	S/P	1,6
HBM-4	OCWD	830	MP7	415	425	Multiport Monitoring	S/P	1,6
HBM-4	OCWD	830	MP8	550	560	Multiport Monitoring	S/P	1,6
HBM-4	OCWD	830	MP9	690	700	Multiport Monitoring	S/P	1,6
HBM-5	OCWD	1019	MP3	70	90	Multiport Monitoring	S/P	1,6
HBM-5	OCWD	1019	MP1	70	90	Multiport Monitoring	S/P	1,6
HBM-5	OCWD	1019	MP2	70	90	Multiport Monitoring	S/P	1,6
HBM-5	OCWD	1019	MP4	125	135	Multiport Monitoring	S/P	1,6
HBM-5	OCWD	1019	MP5	170	180	Multiport Monitoring	S/P	1,6
HBM-5	OCWD	1019	MP6	215	225	Multiport Monitoring	S/P	1,6
HBM-5	OCWD	1019	MP7	245	255	Multiport Monitoring	S/P	1,6
HBM-5	OCWD	1019	MP8	270	280	Multiport Monitoring	S/P	1,6
HBM-6	OCWD	800	MP1	52	62	Multiport Monitoring	S/P	1,6,10
HBM-6	OCWD	800	MP2	84	94	Multiport Monitoring	S/P	1,6,10
HBM-6	OCWD	800	MP3	108	118	Multiport Monitoring	S/P	1,6,10
HBM-6	OCWD	800	MP4	214	224	Multiport Monitoring	S/P	1,6,10
HBM-6	OCWD	800	MP5	263	273	Multiport Monitoring	S/P	1,6,10
HBM-6	OCWD	800	MP6	294	304	Multiport Monitoring	S/P	1,6,10
HBM-6	OCWD	800	MP7	506	516	Multiport Monitoring	S/P	1,6,10
HBM-6	OCWD	800	MP8	576	586	Multiport Monitoring	S/P	1,6,10
IDM-1	OCWD	1123	MP1	85	95	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP2	270	280	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP3	335	345	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP4	435	445	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP5	630	640	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP6	700	710	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP7	760	770	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP8	875	885	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP9	990	1000	Multiport Monitoring	S/P/D	1,10
IDM-1	OCWD	1123	MP10	1050	1060	Multiport Monitoring	S/P/D	1,10
IDM-2	OCWD	1487	MP1	126	136	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP2	234	244	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP3	284	294	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP4	352	362	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP5	492	502	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP6	612	622	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP7	710	720	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP8	886	896	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP9	1050	1060	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	MP10	1178	1188	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	M0-11	1256	1266	Multiport Monitoring	S/P/D	1,9,10
IDM-2	OCWD	1487	M012	1400	1410	Multiport Monitoring	S/P/D	1,9,10
IDM-3	OCWD	704		652	672	Monitoring	S/P	1
IDM-4	OCWD	726		654	674	Monitoring	S/P	1
IDP-1	OCWD	708		121	681	Injection		4
IDP-2R	OCWD	680		300	340	Monitoring	S/P	1
IDP-3	OCWD	602		125	505	Monitoring		1

List of Wells in OCWD Monitoring Programs

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Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
KBS-1	OCWD	244		209	219	Monitoring	S/P	1
KBS-2	OCWD	303	MP1	96	106	Multiport Monitoring	S/P	1
KBS-2	OCWD	303	MP2	210	220	Multiport Monitoring	S/P	1
KBS-3	OCWD	92		80	90	Monitoring		1
KBS-4	OCWD	160		138	158	Monitoring	S	1
KBS-4A	OCWD	92		80	90	Monitoring		1
LAM-1	OCWD	2211	MP1	70	80	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP2	220	230	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP3	270	280	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP4	470	480	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP5	570	580	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP6	830	840	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP7	992	1002	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP8	1070	1080	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP9	1150	1160	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP10	1250	1260	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP11	1494	1504	Multiport Monitoring	S/P/D	1,10
LAM-1	OCWD	2211	MP12	1610	1620	Multiport Monitoring	S/P/D	1,10
MBI-1	OCWD	1239		530	1190	Injection		4,5
MCAS-1	OCWD	620	MP1	60	70	Multiport Monitoring	S/P	1
MCAS-1	OCWD	620	MP2	150	160	Multiport Monitoring	S/P	1
MCAS-1	OCWD	620	MP3	210	220	Multiport Monitoring	S/P	1
MCAS-1	OCWD	620	MP4	270	280	Multiport Monitoring	S/P	1
MCAS-1	OCWD	620	MP5	330	340	Multiport Monitoring	S/P	1
MCAS-1	OCWD	620	MP6	450	460	Multiport Monitoring	S/P	1
MCAS-1	OCWD	620	MP7	540	550	Multiport Monitoring	S/P	1
MCAS-10	OCWD	389		347	377	Monitoring	P	1
MCAS-2	OCWD	680	MP1	40	50	Multiport Monitoring	S/P	1
MCAS-2	OCWD	680	MP2	130	140	Multiport Monitoring	S/P	1
MCAS-2	OCWD	680	MP3	200	210	Multiport Monitoring	S/P	1
MCAS-2	OCWD	680	MP4	370	380	Multiport Monitoring	S/P	1
MCAS-2	OCWD	680	MP5	420	430	Multiport Monitoring	S/P	1
MCAS-2	OCWD	680	MP6	490	500	Multiport Monitoring	S/P	1
MCAS-2	OCWD	680	MP7	550	560	Multiport Monitoring	S/P	1
MCAS-2	OCWD	680	MP8	620	630	Multiport Monitoring	S/P	1
MCAS-3	OCWD	603	MP1	80	90	Multiport Monitoring	S/P	1,10
MCAS-3	OCWD	603	MP2	160	170	Multiport Monitoring	S/P	1,10
MCAS-3	OCWD	603	MP3	220	230	Multiport Monitoring	S/P	1,10
MCAS-3	OCWD	603	MP4	340	350	Multiport Monitoring	S/P	1,10
MCAS-3	OCWD	603	MP5	420	430	Multiport Monitoring	S/P	1,10
MCAS-3	OCWD	603	MP6	490	500	Multiport Monitoring	S/P	1,10
MCAS-4	OCWD	317		181	238	Monitoring	S/P	1
MCAS-5A	OCWD	159		120	130	Monitoring	S	1
MCAS-6	OCWD	455		167	222	Monitoring	S	1
MCAS-7	OCWD	1297	MP1	90	100	Multiport Monitoring	S/P	1,10
MCAS-7	OCWD	1297	MP2	190	200	Multiport Monitoring	S/P	1,10
MCAS-7	OCWD	1297	MP3	350	360	Multiport Monitoring	S/P	1,10
MCAS-7	OCWD	1297	MP4	440	450	Multiport Monitoring	S/P	1,10
MCAS-7	OCWD	1297	MP5	510	520	Multiport Monitoring	S/P	1,10
MCAS-7	OCWD	1297	MP6	800	810	Multiport Monitoring	S/P	1,10
MCAS-7	OCWD	1297	MP7	910	920	Multiport Monitoring	S/P	1,10
MCAS-7	OCWD	1297	MP8	980	990	Multiport Monitoring	S/P	1,10
MCAS-7	OCWD	1297	MP9	1100	1110	Multiport Monitoring	S/P	1,10
MCAS-8	OCWD	437		392	410	Monitoring	P	1
MCAS-9	OCWD	450		372	445	Monitoring	P	1
MSP-10P	OCWD	59		40	50	Monitoring		1
MSP-10T	OCWD	211		70	140	Monitoring		1
OCWD-33Z11	OCWD	527		435	485	Monitoring		1,6
OCWD-34F10	OCWD	490		420	460	Monitoring		1,6
OCWD-34H25	OCWD	490		410	465	Monitoring		1
OCWD-34H5	OCWD	480		405	455	Monitoring		1,6
OCWD-34L10	OCWD	478		405	450	Monitoring		1,6
OCWD-34LS	OCWD	400		340	380	Monitoring		1,6
OCWD-34N21	OCWD	494		424	464	Monitoring		1,6
OCWD-34NP7	OCWD	312		225	300	Monitoring		1,6
OCWD-34S	OCWD	380		312	347	Injection		4
OCWD-34T01	OCWD	375		290	345	Monitoring		1,6

List of Wells in OCWD Monitoring Programs

KEY

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
OCWD-34U8	OCWD	424		359	384	Monitoring		1,6
OCWD-34V	OCWD	320		260	300	Injection		4
OCWD-34V20	OCWD	456		387	417	Monitoring		1,6
OCWD-34VZX	OCWD	199		147	177	Monitoring		1,6
OCWD-34VZY	OCWD	265		215	235	Monitoring		1,6
OCWD-34WP5	OCWD	212		165	180	Monitoring		1,6
OCWD-34X40	OCWD	450		333	358	Monitoring	S	1,6
OCWD-34Z	OCWD	191		110	150	Injection		4
OCWD-35DP5	OCWD	130		92	107	Monitoring		1,6
OCWD-35E01X	OCWD	98		65	85	Monitoring		1,6
OCWD-35E01Y	OCWD	343		105	125	Monitoring		1,6
OCWD-35F	OCWD	168		80	115	Injection		4
OCWD-35F20	OCWD	300		235	265	Monitoring		1,6
OCWD-35FP21	OCWD	85		36	71	Monitoring		1,6
OCWD-35G	OCWD	182		80	145	Injection		4
OCWD-35H11	OCWD	230		200	220	Monitoring	S	1,6
OCWD-35H12	OCWD	300		137	147	Monitoring		1,6
OCWD-35H1X	OCWD	257		131	171	Injection		4
OCWD-35H1Y	OCWD	271		215	237	Injection		4
OCWD-35H2	OCWD	260		112	241	Injection		4
OCWD-35J1	OCWD	271		190	240	Monitoring		1,6
OCWD-35J1Y	OCWD	378		264	294	Monitoring		1,6
OCWD-35K1	OCWD	275		193	243	Monitoring		1,6
OCWD-35K1V	OCWD	112		90	110	Monitoring		1,6
OCWD-35K1Y	OCWD	395		366	386	Monitoring		1,6
OCWD-35KP12	OCWD	87		47	67	Monitoring		1
OCWD-35N01	OCWD	101		80	85	Monitoring	S	1,6
OCWD-35T9	OCWD	1020		390	411	Monitoring		1,6
OCWD-36FP14Z1	OCWD	150		115	125	Monitoring		1,6
OCWD-36FP14Z2	OCWD	705		357	367	Monitoring		1,6
OCWD-36FP1X	OCWD	160		136	146	Monitoring		1
OCWD-36FP1Z	OCWD	1020		504	514	Monitoring	P	1,6
OCWD-7	OCWD	48		28	48	Monitoring		1
OCWD-AIR1	OCWD	1518		1375	1460	Monitoring	S/P	1,10
OCWD-ALK	OCWD	320		217	317	Other Active Production		2,3
OCWD-AN1	OCWD	115		35	115	Monitoring		1
OCWD-AN2	OCWD	119		35	115	Monitoring		1
OCWD-BESS	OCWD	302		172	189	Other Active Production	S	2,3
OCWD-BIO1	OCWD	124		25	115	Inactive Production	S	2
OCWD-BP1	OCWD	40		20	40	Monitoring		1
OCWD-BP2	OCWD	70		50	70	Monitoring		1
OCWD-BP3	OCWD	205		185	205	Monitoring	S	1
OCWD-BP4	OCWD	180		140	180	Monitoring	S	1
OCWD-BP5	OCWD	240		147	167	Monitoring	S	1
OCWD-BP6	OCWD	245		148	168	Monitoring	S	1
OCWD-BP7	OCWD	270		148	168	Monitoring	S	1
OCWD-BS10	OCWD	906		595	605	Monitoring	S/P	1,6
OCWD-BS103A	OCWD	16		10	15	Monitoring		1,6
OCWD-BS105A	OCWD	12		6	11	Monitoring		1,6
OCWD-BS11	OCWD	741		580	590	Monitoring	S/P	1,6
OCWD-BS15	OCWD	105		60	70	Monitoring		1,6
OCWD-BS16	OCWD	95		60	80	Monitoring	S	1,6
OCWD-BS16A	OCWD	24		16	21	Monitoring		1,6
OCWD-BS18	OCWD	95		72	82	Monitoring	S	1,6
OCWD-BS18A	OCWD	17		11	16	Monitoring		1,6
OCWD-BS19	OCWD	100		63	83	Monitoring	S	1,6
OCWD-BS20A	OCWD	27		6	11	Monitoring		1
OCWD-BS20B	OCWD	85		71	81	Monitoring	S	1,6
OCWD-BS21	OCWD	0		0	0	Monitoring	S	1,6
OCWD-CTG1	OCWD	1330		1060	1220	Monitoring	S/P/D	1,10
OCWD-CTG5	OCWD	1600		1040	1120	Monitoring	P/D	1
OCWD-CTK1	OCWD	1444		1260	1315	Monitoring	P/D	1
OCWD-D1	OCWD	926		780	880	Other Active Production	P	2,3
OCWD-D3	OCWD	1050		560	1000	Other Active Production	P	2,3
OCWD-D4	OCWD	1033		531	979	Other Active Production	P	2,3
OCWD-D5	OCWD	1050		597	1005	Inactive Production		2,3
OCWD-EW1	OCWD	324		160	295	Inactive Production		2,8

List of Wells in OCWD Monitoring Programs

KEY

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
OCWD-EW2	OCWD	230		130	196	Inactive Production	S	2,8
OCWD-EW2A	OCWD	207		122	188	Inactive Production	S	2,8
OCWD-EW3	OCWD	270		150	249	Inactive Production		2,8
OCWD-EW3A	OCWD	0		0	0	Inactive Production	S	2,8
OCWD-EW4	OCWD	275		130	255	Inactive Production	S	2,8
OCWD-FBM1	OCWD	140		38	138	Monitoring	S	1
OCWD-FBM2	OCWD	140		39	139	Monitoring	S	1
OCWD-FBR1	OCWD	100		30	90	Injection		4
OCWD-FC1	OCWD	185		165	185	Monitoring	P	1
OCWD-FC2	OCWD	115		95	115	Monitoring	S	1
OCWD-FH1	OCWD	140		120	140	Monitoring	S	1
OCWD-GA1	OCWD	45		30	40	Monitoring		1
OCWD-GA2	OCWD	45		30	40	Monitoring	S	1,6
OCWD-GA3	OCWD	45		30	40	Monitoring		1
OCWD-GA4	OCWD	45		30	40	Monitoring		1
OCWD-GA5	OCWD	45		30	40	Monitoring		1
OCWD-GA6	OCWD	45		30	40	Monitoring		1
OCWD-GA7	OCWD	45		30	40	Monitoring		1,9
OCWD-GA9	OCWD	30		19	29	Monitoring		1
OCWD-HBM5A	OCWD	22		16	21	Monitoring		1
OCWD-HBM6A	OCWD	17		11	16	Monitoring		1
OCWD-I1	OCWD	407		365	400	Injection		4
OCWD-I10	OCWD	330		305	330	Injection		4
OCWD-I11	OCWD	310		200	225	Injection		4
OCWD-I12	OCWD	320		290	310	Injection		4
OCWD-I13	OCWD	315		280	305	Injection		4
OCWD-I14	OCWD	310		265	300	Injection		4
OCWD-I15	OCWD	295		262	285	Injection		4
OCWD-I16	OCWD	308		245	285	Injection		4
OCWD-I17	OCWD	309		250	275	Injection		4
OCWD-I18	OCWD	315		260	275	Injection		4
OCWD-I19	OCWD	292		235	270	Injection		4
OCWD-I2	OCWD	402		350	390	Injection		4
OCWD-I20	OCWD	275		240	265	Injection		4
OCWD-I21	OCWD	265		230	250	Injection		4
OCWD-I22	OCWD	306		250	275	Injection		4
OCWD-I23	OCWD	325		215	255	Injection		4
OCWD-I24	OCWD	720		420	605	Injection	P	4
OCWD-I25	OCWD	662		120	320	Injection		4
OCWD-I26A	OCWD	220		60	195	Injection	S	4
OCWD-I26B	OCWD	430		271	400	Injection		4
OCWD-I26C	OCWD	697		476	660	Injection	P	4
OCWD-I27A	OCWD	171		78	148	Injection	S	4
OCWD-I27B	OCWD	280		211	261	Injection		4
OCWD-I27C	OCWD	592		355	420	Injection	P	4
OCWD-I27M1	OCWD	23		17	22	Monitoring		1
OCWD-I28A	OCWD	163		80	140	Injection	S	4
OCWD-I28B	OCWD	258		185	235	Injection		4
OCWD-I28C	OCWD	698		360	460	Injection	P	4
OCWD-I28M1	OCWD	24		19	24	Monitoring		1
OCWD-I29A	OCWD	156		90	120	Injection	S	4
OCWD-I29B	OCWD	275		200	250	Injection		4
OCWD-I29C	OCWD	515		365	475	Injection	P	4
OCWD-I3	OCWD	380		340	380	Injection		4
OCWD-I30A	OCWD	187		95	160	Injection	S	4
OCWD-I30B	OCWD	322		230	295	Injection		4
OCWD-I30C	OCWD	708		425	650	Injection	P	4
OCWD-I31A	OCWD	192		90	165	Injection	S	4
OCWD-I31B	OCWD	321		235	295	Injection		4
OCWD-I31C	OCWD	688		440	590	Injection	P	4
OCWD-I32A	OCWD	181		90	155	Injection	S	4
OCWD-I32B	OCWD	326		226	295	Injection		4
OCWD-I32C	OCWD	703		425	670	Injection	P	4
OCWD-I33A	OCWD	183		61	156	Injection	S	4
OCWD-I34A	OCWD	160		60	135	Injection	S	4
OCWD-I35A	OCWD	155		60	115	Injection	S	4

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
OCWD-I36A	OCWD	143		60	110	Injection	S	4
OCWD-I4	OCWD	360		330	355	Injection		4
OCWD-I5	OCWD	365		320	345	Injection		4
OCWD-I6	OCWD	355		315	335	Injection		4
OCWD-I7	OCWD	345		315	336	Injection		4
OCWD-I8	OCWD	335		300	325	Injection		4
OCWD-I9	OCWD	340		300	330	Injection		4
OCWD-KB1	OCWD	200		180	200	Monitoring	S	1
OCWD-LB1	OCWD	177		148	168	Monitoring	S	1
OCWD-LB2	OCWD	65		15	30	Monitoring		1
OCWD-LB3	OCWD	175		145	165	Monitoring	S	1
OCWD-LB4	OCWD	130		78	88	Monitoring	S	1
OCWD-LV1	OCWD	155		135	155	Monitoring	S	1
OCWD-M1	OCWD	123		75	110	Monitoring	S	1,6
OCWD-M10	OCWD	336		280	305	Monitoring	S	1
OCWD-M10A	OCWD	17		11	16	Monitoring		1
OCWD-M11	OCWD	310		260	290	Monitoring	S	1
OCWD-M12	OCWD	400		330	350	Monitoring	S	1
OCWD-M13	OCWD	400		360	395	Monitoring	S	1
OCWD-M13A	OCWD	21		16	21	Monitoring		1
OCWD-M14A	OCWD	360		200	300	Monitoring	S	1
OCWD-M14B	OCWD	360		320	340	Monitoring		1
OCWD-M15A	OCWD	340		195	290	Monitoring	S	1
OCWD-M15B	OCWD	340		310	335	Monitoring		1
OCWD-M16	OCWD	337		295	315	Monitoring	S	1
OCWD-M17A	OCWD	360		330	345	Monitoring	S	1
OCWD-M17B	OCWD	360		210	305	Monitoring		1
OCWD-M18	OCWD	358		310	335	Monitoring		1
OCWD-M19	OCWD	285		215	265	Monitoring	S	1
OCWD-M2	OCWD	162		85	150	Monitoring	S	1,6
OCWD-M20	OCWD	278		255	270	Monitoring	S	1
OCWD-M21	OCWD	355		320	340	Monitoring	S	1
OCWD-M22	OCWD	348		230	270	Monitoring	S	1
OCWD-M23A	OCWD	337		190	260	Monitoring		1
OCWD-M23B	OCWD	337		295	320	Monitoring		1
OCWD-M24	OCWD	330		290	310	Monitoring	S	1
OCWD-M25	OCWD	200		65	185	Monitoring	S	1,6
OCWD-M26	OCWD	151		70	135	Monitoring	S	1,6,10
OCWD-M26A	OCWD	16		11	16	Monitoring		1,6
OCWD-M27	OCWD	127		60	110	Monitoring	S	1,6
OCWD-M27A	OCWD	22		11	16	Monitoring		1,6
OCWD-M28	OCWD	161		80	145	Monitoring	S	1,6
OCWD-M2A	OCWD	25		17	22	Monitoring		1
OCWD-M30	OCWD	128		90	110	Monitoring	S	1,6
OCWD-M31	OCWD	180		82	162	Monitoring	S	1,6
OCWD-M36	OCWD	340		290	300	Monitoring	S	1,6
OCWD-M37	OCWD	368		338	348	Monitoring	S	1,6
OCWD-M38	OCWD	700		516	526	Monitoring	S/P	1,6
OCWD-M39	OCWD	622		250	270	Monitoring	P	1,6
OCWD-M4	OCWD	352		295	330	Monitoring	S	1,6
OCWD-M40	OCWD	900		330	520	Monitoring	S/P	1,6
OCWD-M41	OCWD	450		370	390	Monitoring	S/P	1,6
OCWD-M42	OCWD	645		608	628	Monitoring	S/P	1,6
OCWD-M43	OCWD	695		520	540	Monitoring	P	1,6
OCWD-M44	OCWD	502		295	305	Monitoring	S/P	1,6
OCWD-M44A	OCWD	125		100	125	Monitoring		1,6
OCWD-M45	OCWD	1014		780	790	Monitoring	S/P	1
OCWD-M46	OCWD	1035		890	910	Monitoring	P	1
OCWD-M46A	OCWD	391		350	370	Monitoring		1
OCWD-M47	OCWD	1010		940	960	Monitoring	P	1
OCWD-M48	OCWD	505		470	480	Monitoring	S/P	1,6
OCWD-M49A	OCWD	24		16	21	Monitoring		1,6
OCWD-M49B	OCWD	85		56	81	Monitoring		1,6
OCWD-M5	OCWD	325		285	305	Monitoring	S	1,6
OCWD-M50	OCWD	25		16	21	Monitoring		1,6
OCWD-M51A	OCWD	43		28	38	Monitoring		1,6
OCWD-M51B	OCWD	130		75	105	Monitoring		1,6

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
OCWD-M52A	OCWD	61		46	56	Monitoring		1,6
OCWD-M52B	OCWD	150		120	140	Monitoring		1,6
OCWD-M52C	OCWD	237		210	230	Monitoring	P	1,6
OCWD-M52D	OCWD	460		330	350	Monitoring	P	1,6
OCWD-M53A	OCWD	38		22	32	Monitoring		1,6
OCWD-M53B	OCWD	132		115	125	Monitoring	S	1,6
OCWD-M53C	OCWD	229		208	218	Monitoring		1,6
OCWD-M54B	OCWD	150		105	125	Monitoring		1,6
OCWD-M6A	OCWD	305		260	285	Monitoring	S	1,6
OCWD-M6B	OCWD	305		185	235	Monitoring		1,6
OCWD-M7A	OCWD	293		190	220	Monitoring	S	1,6
OCWD-M7B	OCWD	293		240	260	Monitoring		1,6
OCWD-M8	OCWD	346		275	310	Monitoring	S	1,6
OCWD-M9	OCWD	311		250	295	Monitoring	S	1,6
OCWD-MRSH	OCWD	540		199	219	Monitoring	P	1,6
OCWD-P1	OCWD	197		64	179	Monitoring	S	1,6
OCWD-P10	OCWD	150		90	130	Monitoring	S	1,6
OCWD-P2	OCWD	186		56	174	Monitoring	S	1
OCWD-P3	OCWD	181		66	166	Monitoring	S	1,6
OCWD-P4	OCWD	163		70	150	Monitoring	S	1,6
OCWD-P6	OCWD	178		85	150	Monitoring	S	1,6
OCWD-P7	OCWD	149		80	135	Monitoring	S	1,6
OCWD-PD3A	OCWD	11		4	9	Monitoring		1
OCWD-PD3B	OCWD	22		15	20	Monitoring		1
OCWD-PD6A	OCWD	10		3	8	Monitoring		1
OCWD-PD6B	OCWD	22		15	20	Monitoring		1
OCWD-PDE4	OCWD	0		30	213	Monitoring		1
OCWD-PDHQ	OCWD	180		100	180	Other Active Production		2
OCWD-PZ6	OCWD	32		10	30	Monitoring		1
OCWD-PZ8	OCWD	32		10	30	Monitoring		1
OCWD-RVW1	OCWD	80		67	77	Monitoring	S	1
OCWD-RVW1A	OCWD	50		39	49	Monitoring		1
OCWD-SA22R	OCWD	350		310	330	Monitoring	S/P	1,6
OCWD-T2	OCWD	380		300	360	Monitoring	S/P	1,6
OCWD-T3	OCWD	180		110	170	Monitoring	S	1,6
OCWD-T4	OCWD	178		68	168	Monitoring	S	1,6
OCWD-T5	OCWD	396		285	295	Monitoring	S	1,6
OCWD-W1	OCWD	398		0	0	Monitoring		1
OCWD-YLR1	OCWD	51		35	40	Monitoring	S	1
OCWD-YLR2	OCWD	51		32	37	Monitoring	S	1
OCWD-YLR3	OCWD	51		31	36	Monitoring	S	1
OM-1	OCWD	245		217	235	Monitoring		1
OM-2	OCWD	250		211	219	Monitoring		1
OM-2A	OCWD	135		118	125	Monitoring	S	1
OM-4	OCWD	253		221	230	Monitoring		1
OM-4A	OCWD	122		112	117	Monitoring	S	1
OM-6	OCWD	251		196	204	Monitoring		1
OM-8	OCWD	320		285	293	Monitoring		1
OM-8A	OCWD	180		156	164	Monitoring	S	1
SAM-1	OCWD	215		191	196	Monitoring	S	1,9
SAM-2	OCWD	220		204	214	Monitoring	S	1,9
SAM-3	OCWD	225		198	208	Monitoring	S	1,9
SAM-4	OCWD	210		185	195	Monitoring	S	1,9
SAM-5	OCWD	205		182	192	Monitoring	S	1,9
SAM-6	OCWD	205		176	186	Monitoring	S	1,9
SAR-1	OCWD	1530	MP1	150	170	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP2	290	300	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP3	320	330	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP4	360	370	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP5	510	530	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP6	580	590	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP7	820	840	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP8	890	900	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP9	910	920	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP10	1010	1020	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP11	1110	1120	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP12	1280	1290	Multiport Monitoring	S/P/D	1,10

List of Wells in OCWD Monitoring Programs

KEY

Aquifer Zone: S=Shallow Aquifer, P=Principal Aquifer, D= Deep Aquifer

Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
SAR-1	OCWD	1530	MP13	1370	1380	Multiport Monitoring	S/P/D	1,10
SAR-1	OCWD	1530	MP14	1441	1451	Multiport Monitoring	S/P/D	1,10
SAR-10	OCWD	1150		1100	1115	Monitoring	P	1,5
SAR-11	OCWD	1214		1100	1110	Monitoring	P	1,5
SAR-2	OCWD	1520	MP1	140	150	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP2	270	280	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP3	310	320	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP4	470	480	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP5	610	620	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP6	740	750	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP7	880	890	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP8	980	990	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP9	1020	1030	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP10	1100	1110	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP11	1230	1240	Multiport Monitoring	S/P/D	1
SAR-2	OCWD	1520	MP12	1350	1360	Multiport Monitoring	S/P/D	1
SAR-3	OCWD	1494	MP1	160	170	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP2	230	240	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP3	410	420	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP4	510	520	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP5	640	650	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP6	770	780	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP7	950	960	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP8	1070	1080	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP9	1195	1205	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP10	1265	1275	Multiport Monitoring	S/P/D	1,10
SAR-3	OCWD	1494	MP11	1390	1400	Multiport Monitoring	S/P/D	1,10
SAR-4	OCWD	1520	MP1	115	125	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP2	320	330	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP3	470	480	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP4	590	600	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP5	730	740	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP6	860	870	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP7	970	980	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP8	1060	1070	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP9	1160	1170	Multiport Monitoring	S/P/D	1
SAR-4	OCWD	1520	MP10	1395	1405	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP1	80	90	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP2	170	180	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP3	360	370	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP4	616	626	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP5	760	770	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP6	940	950	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP7	1080	1090	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP8	1190	1200	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP9	1290	1300	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP10	1540	1550	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP11	1730	1740	Multiport Monitoring	S/P/D	1
SAR-5	OCWD	1964	MP12	1820	1830	Multiport Monitoring	S/P/D	1
SAR-6	OCWD	1574	MP1	200	210	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP2	360	370	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP3	470	480	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP4	574	584	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP5	700	710	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP6	780	790	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP7	1080	1090	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP8	1180	1190	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP9	1270	1280	Multiport Monitoring	P	1
SAR-6	OCWD	1574	MP10	1500	1510	Multiport Monitoring	P	1
SAR-7	OCWD	1483	MP1	110	120	Multiport Monitoring	S/P	1
SAR-7	OCWD	1483	MP2	170	180	Multiport Monitoring	S/P	1
SAR-7	OCWD	1483	MP3	310	320	Multiport Monitoring	S/P	1
SAR-7	OCWD	1483	MP4	440	450	Multiport Monitoring	S/P	1
SAR-7	OCWD	1483	MP5	604	614	Multiport Monitoring	S/P	1
SAR-7	OCWD	1483	MP6	740	750	Multiport Monitoring	S/P	1
SAR-7	OCWD	1483	MP7	856	866	Multiport Monitoring	S/P	1
SAR-7	OCWD	1483	MP8	1190	1200	Multiport Monitoring	S/P	1

List of Wells in OCWD Monitoring Programs

KEY

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
SAR-7	OCWD	1483	MP9	1350	1360	Multiport Monitoring	S/P	1
SAR-8	OCWD	267	MP1	34	44	Multiport Monitoring	S	1
SAR-8	OCWD	267	MP2	84	94	Multiport Monitoring	S	1
SAR-8	OCWD	267	MP3	150	160	Multiport Monitoring	S	1
SAR-9	OCWD	2008	MP1	148	160	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP2	236	248	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP3	406	418	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP4	488	500	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP5	604	616	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP6	724	736	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP7	872	884	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP8	1068	1080	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP9	1258	1270	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP10	1473	1484	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP11	1567	1578	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP12	1719	1730	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP13	1815	1826	Multiport Monitoring	S/P/D	1,10
SAR-9	OCWD	2008	MP14	1889	1900	Multiport Monitoring	S/P/D	1,10
SBM-1	OCWD	2023	MP1	74	84	Multiport Monitoring	S/P/D	1,6,10
SBM-1	OCWD	2023	MP2	144	154	Multiport Monitoring	S/P/D	1,6,10
SBM-1	OCWD	2023	MP3	240	250	Multiport Monitoring	S/P/D	1,6,10
SBM-1	OCWD	2023	MP4	370	380	Multiport Monitoring	S/P/D	1,6,10
SBM-1	OCWD	2023	MP5	510	520	Multiport Monitoring	S/P/D	1,6,10
SBM-1	OCWD	2023	MP6	696	706	Multiport Monitoring	S/P/D	1,6,10
SBM-1	OCWD	2023	MP7	910	920	Multiport Monitoring	S/P/D	1,6,10
SBM-1	OCWD	2023	MP8	1250	1260	Multiport Monitoring	S/P/D	1,6,10
SC-1	OCWD	720	MP1	44	54	Multiport Monitoring	S/P	1
SC-1	OCWD	720	MP2	90	100	Multiport Monitoring	S/P	1
SC-1	OCWD	720	MP3	150	160	Multiport Monitoring	S/P	1
SC-1	OCWD	720	MP4	194	204	Multiport Monitoring	S/P	1
SC-1	OCWD	720	MP5	294	304	Multiport Monitoring	S/P	1
SC-1	OCWD	720	MP6	390	400	Multiport Monitoring	S/P	1
SC-2	OCWD	879	MP1	46	56	Multiport Monitoring	S/P	1
SC-2	OCWD	879	MP2	94	104	Multiport Monitoring	S/P	1
SC-2	OCWD	879	MP3	146	156	Multiport Monitoring	S/P	1
SC-2	OCWD	879	MP4	190	200	Multiport Monitoring	S/P	1
SC-2	OCWD	879	MP5	248	258	Multiport Monitoring	S/P	1
SC-2	OCWD	879	MP6	300	310	Multiport Monitoring	S/P	1
SC-3	OCWD	1500	MP1	224	234	Multiport Monitoring	P/D	1
SC-3	OCWD	1500	MP2	410	420	Multiport Monitoring	P/D	1
SC-3	OCWD	1500	MP3	576	586	Multiport Monitoring	P/D	1
SC-3	OCWD	1500	MP4	710	720	Multiport Monitoring	P/D	1
SC-3	OCWD	1500	MP5	1018	1028	Multiport Monitoring	P/D	1
SC-3	OCWD	1500	MP6	1150	1160	Multiport Monitoring	P/D	1
SC-3	OCWD	1500	MP7	1230	1240	Multiport Monitoring	P/D	1
SC-3	OCWD	1500	MP8	1370	1380	Multiport Monitoring	P/D	1
SC-3	OCWD	1500	MP9	1460	1470	Multiport Monitoring	P/D	1
SC-4	OCWD	1498	MP1	100	111	Multiport Monitoring	S/P/D	1,10
SC-4	OCWD	1498	MP2	198	209	Multiport Monitoring	S/P/D	1,10
SC-4	OCWD	1498	MP3	268	279	Multiport Monitoring	S/P/D	1,10
SC-4	OCWD	1498	MP4	391	402	Multiport Monitoring	S/P/D	1,10
SC-4	OCWD	1498	MP5	482	493	Multiport Monitoring	S/P/D	1,10
SC-4	OCWD	1498	MP6	572	583	Multiport Monitoring	S/P/D	1,10
SC-4	OCWD	1498	MP7	658	669	Multiport Monitoring	S/P/D	1,10
SC-4	OCWD	1498	MP8	827	838	Multiport Monitoring	S/P/D	1,10
SC-4	OCWD	1498	MP9	1078	1089	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP1	123	133	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP2	196	206	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP3	290	300	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP4	468	478	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP5	667	677	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP6	804	814	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP7	932	942	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP8	1020	1030	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP9	1234	1244	Multiport Monitoring	S/P/D	1,10
SC-5	OCWD	1500	MP10	1426	1436	Multiport Monitoring	S/P/D	1,10
SC-6	OCWD	2213	MP1	90	100	Multiport Monitoring	S/P/D	1

List of Wells in OCWD Monitoring Programs

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
SC-6	OCWD	2213	MP2	200	210	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP3	300	310	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP4	540	550	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP5	785	795	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP6	960	970	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP7	1120	1130	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP8	1325	1335	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP9	1460	1470	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP10	1540	1550	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP11	1680	1690	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP12	1890	1900	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP13	2025	2035	Multiport Monitoring	S/P/D	1
SC-6	OCWD	2213	MP14	2115	2125	Multiport Monitoring	S/P/D	1
SCS-1	OCWD	313	MP1	24	34	Multiport Monitoring	S/P	1
SCS-1	OCWD	313	MP2	90	100	Multiport Monitoring	S/P	1
SCS-1	OCWD	313	MP3	142	152	Multiport Monitoring	S/P	1
SCS-1	OCWD	313	MP4	178	188	Multiport Monitoring	S/P	1
SCS-1	OCWD	313	MP5	220	230	Multiport Monitoring	S/P	1
SCS-1	OCWD	313	MP6	295	305	Multiport Monitoring	S/P	1
SCS-10	OCWD	230		206	216	Monitoring		1
SCS-11	OCWD	405		384	394	Monitoring	S	1
SCS-12	OCWD	405		275	285	Monitoring	S	1
SCS-13	OCWD	200		180	190	Monitoring		1
SCS-2	OCWD	401	MP1	134	145	Multiport Monitoring	S/P	1,10
SCS-2	OCWD	401	MP2	174	185	Multiport Monitoring	S/P	1,10
SCS-2	OCWD	401	MP3	212	223	Multiport Monitoring	S/P	1,10
SCS-2	OCWD	401	MP4	260	270	Multiport Monitoring	S/P	1,10
SCS-2	OCWD	401	MP5	325	335	Multiport Monitoring	S/P	1,10
SCS-3	OCWD	52		31	42	Monitoring		1
SCS-4	OCWD	50		21	32	Monitoring		1
SCS-5	OCWD	51		22	43	Monitoring		1
SCS-6	OCWD	154		147	153	Monitoring	S	1
SCS-7	OCWD	142		125	141	Monitoring	S	1
SCS-8	OCWD	130		108	129	Monitoring	S	1
SCS-9	OCWD	205		153	173	Monitoring	S	1
SCS-B1	OCWD	43		18	43	Monitoring		1
SCS-B2	OCWD	29		19	29	Monitoring		1
SCS-B3	OCWD	26		16	26	Monitoring		1
TIC-67	OCWD	902		245	900	Monitoring	P	1
W-14659	OCWD	27		12	27	Monitoring		1
WBS-2A	OCWD	177	MP1	50	60	Multiport Monitoring	S	1
WBS-2A	OCWD	177	MP2	90	100	Multiport Monitoring	S	1
WBS-2A	OCWD	177	MP3	135	145	Multiport Monitoring	S	1
WBS-3R	OCWD	256	MP1	75	85	Monitoring	S	1
WBS-3R	OCWD	256	MP2	215	225	Monitoring	S	1
WBS-4	OCWD	295		55	220	Multiport Monitoring	S/P	1,10
WMM-1	OCWD	2015	MP1	109	119	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP2	359	369	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP3	480	490	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP4	600	610	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP5	740	750	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP6	810	820	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP7	889	899	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP8	980	990	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP9	1060	1070	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP10	1210	1220	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP11	1309	1319	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP12	1364	1374	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP13	1430	1440	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP14	1565	1575	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP15	1619	1629	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP16	1740	1750	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP17	1800	1810	Multiport Monitoring	S/P/D	1
WMM-1	OCWD	2015	MP18	1940	1950	Multiport Monitoring	S/P/D	1
O-1	ORANGE	500		236	416	Inactive Production		2
O-15	ORANGE	506		200	492	Active Large Production	P	2,7
O-18	ORANGE	714		372	574	Active Large Production	P	2,7

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
O-19	ORANGE	1060		444	1014	Active Large Production	P	2,7
O-20	ORANGE	1210		400	1130	Active Large Production	P	2,7
O-21	ORANGE	1366		482	1252	Active Large Production	P	2,7
O-22	ORANGE	1282		342	802	Active Large Production	P	2,7
O-23	ORANGE	958		370	640	Active Large Production	P	2,7
O-24	ORANGE	826		420	800	Active Large Production	P	2,7
O-25	ORANGE	993		430	885	Active Large Production	P	2,7
O-26	ORANGE	1210		460	1170	Active Large Production	P	2,7
O-27	ORANGE	960		425	890	Inactive Production		2,7
O-3	ORANGE	216		207	216	Active Large Production		2,7
O-4	ORANGE	726		280	711	Active Large Production	P	2,7
O-5	ORANGE	751		156	723	Active Large Production		2,7
O-8	ORANGE	870		570	850	Active Large Production	P	2,7
O-9	ORANGE	910		546	888	Active Large Production	P	2,7
OASI-SA	ORANGE COAST PLUMBING	326		226	288	Inactive Production		2
EMA-AH5	ORANGE COUNTY	84		0	0	Other Active Production		2,3
TIC-73	ORANGE COUNTY	926		324	915	Inactive Production		2,3
CEM2-A	ORANGE COUNTY CEMETERY DIST.	401		0	0	Other Active Production		2,3,8
NVLW-SB	ORANGE COUNTY PRODUCTIONUCE LLC	430		200	420	Other Active Production		2,3
RUIZ-5A1	ORANGE COUNTY PRODUCTIONUCE LLC	0		0	0	Other Active Production		2,3
RUIZ-5A3	ORANGE COUNTY PRODUCTIONUCE LLC	425		210	390	Other Active Production		2,3
RUIZ-6F1	ORANGE COUNTY PRODUCTIONUCE LLC	426		210	390	Other Active Production		2,3,6
OWOD-GG	ORANGEWOOD ACADEMY	180		159	179	Other Active Production	S	2,3
PSCI-AM14	PACIFIC SCIENTIFIC	118		93	113	Other Active Production		2
PSCI-AM21	PACIFIC SCIENTIFIC	116		95	116	Other Active Production		2
PSCI-AM22	PACIFIC SCIENTIFIC	119		99	119	Other Active Production		2
PSCI-AM25	PACIFIC SCIENTIFIC	115		69	114	Other Active Production		2
PSCI-AM26	PACIFIC SCIENTIFIC	120		69	114	Other Active Production		2
PSCI-AM31	PACIFIC SCIENTIFIC	114		68	113	Other Active Production		2
PSCI-AM32R	PACIFIC SCIENTIFIC	116		70	115	Monitoring		1
PSCI-AM33	PACIFIC SCIENTIFIC	115		7	114	Other Active Production		2
PSCI-AM34	PACIFIC SCIENTIFIC	114		102	112	Other Active Production		2
PSCI-AM35	PACIFIC SCIENTIFIC	115		7	112	Other Active Production		2
PSCI-AM36	PACIFIC SCIENTIFIC	115		9	114	Other Active Production		2
PSCI-AM37	PACIFIC SCIENTIFIC	114		102	112	Or Active Production		2
PSCI-AM38	PACIFIC SCIENTIFIC	114		69	113	Or Active Production		2
PSCI-AM39	PACIFIC SCIENTIFIC	115		69	113	Or Active Production		2
PSCI-AM40	PACIFIC SCIENTIFIC	127		109	124	Monitoring		1
PSCI-AM41	PACIFIC SCIENTIFIC	116		109	114	Monitoring		1
PSCI-AM6	PACIFIC SCIENTIFIC	115		103	113	Monitoring		1
PSCI-AT1	PACIFIC SCIENTIFIC	146		129	144	Monitoring		1
PAGE-F	PAGE AVE. MUTUAL WATER CO.	378		186	364	Active Small Production		2,7,8
PLMW-A	PALM MUTUAL WATER CO.	280		0	0	Inactive Production		2,3
PLMD-HB	PALMDALE-CEDAR WATER ASSOC.	180		0	0	Inactive Production		2
PUSD-LB	PARAMOUNT UNIFIED SCHOOL DIST.	155		126	139	Other Active Production		2
W-3767	PARK STANTON PLACE	131		0	0	Inactive Production		2,3
PWC-29H	PARK WATER CO.	462		388	409	Inactive Production		2
PWC-6G	PARK WATER CO.	854		421	807	Other Active Production		2
W-15063	PARKVIEW MUTUAL WATER CO.	250		0	0	Inactive Production		2
PAUL-COS	PAULARINO WATER ASSOC.	450		0	0	Inactive Production		2
PINE-O	PINE WATER CO.	0		0	0	Inactive Production		2
PIRT-HB	PIRATE WATER CO.	156		0	0	Other Active Production		2,6
W-17527	POWERLINE OIL CO.	0		0	0	Inactive Production		2,3
SNDR-SA	PRIVATE	1030		930	990	Other Active Production	D	2,3,9
SHAF-WM	PRIVATE	125		0	0	Other Active Production		2
ANDR-A	PRIVATE	82		0	0	Other Active Production		2
ANNA-O	PRIVATE	0		0	0	Other Active Production		2
ARAK-WM	PRIVATE	0		0	0	Other Active Production		2
BLSO-SA	PRIVATE	100		0	0	Inactive Production		2,3
BOIS-A	PRIVATE	235		0	0	Other Active Production		2
BSBY-GG	PRIVATE	148		0	0	Other Active Production		2
BXBY-SB	PRIVATE	305		150	290	Other Active Production		2,3
CALL-FV	PRIVATE	214		0	0	Other Active Production		2,3
CO-8	PRIVATE	221		0	0	Other Active Production		2,3
CO-9	PRIVATE	250		144	234	Other Active Production		2,3
COOP-SA	PRIVATE	138		0	0	Inactive Production		2
COUR-HBB2	PRIVATE	138		0	0	Inactive Production		2

List of Wells in OCWD Monitoring Programs

KEY

Aquifer Zone: S=Shallow Aquifer, P=Principal Aquifer, D= Deep Aquifer

Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
COUR-HBB3	PRIVATE	226		120	216	Inactive Production		2,3
CREST-BR	PRIVATE	530		187	523	Other Active Production		2,3
CULBK-CE1	PRIVATE	0		0	0	Other Active Production		2
DAVI-O	PRIVATE	185		0	0	Other Active Production		2
DETT-BP	PRIVATE	0		0	0	Inactive Production		2
DOSS-BP	PRIVATE	0		0	0	Inactive Production		2
ECKH-A	PRIVATE	260		0	0	Or Active Production		2
ENCS-GG	PRIVATE	155		0	0	Inactive Production		2,3
FAVI-C	PRIVATE	130		0	0	Inactive Production		2
GHAV-GG	PRIVATE	200		168	188	Other Active Production	S	2,3
GORD-LW	PRIVATE	0		0	0	Other Active Production		2
GRNT-CE	PRIVATE	0		0	0	Other Active Production		2
HNCK-C	PRIVATE	90		0	0	Inactive Production		2,3
HOWD-A	PRIVATE	217		0	0	Inactive Production		2
HTCH-WM	PRIVATE	120		0	0	Inactive Production		2
HUNTZ-SA	PRIVATE	146		100	145	Other Active Production		2,3
ICHI-HB	PRIVATE	128		0	0	Other Active Production		2
JAME-CO	PRIVATE	376		192	250	Other Active Production		2
KNAS-S	PRIVATE	205		0	0	Other Active Production		2
KUBO-FV	PRIVATE	133		122	132	Other Active Production		2
LCRO-FV	PRIVATE	0		0	0	Other Active Production		2
MCGA-A	PRIVATE	0		0	0	Other Active Production		2
MCGN-BP1	PRIVATE	260		50	255	Other Active Production	S	2
MKSN-WM	PRIVATE	137		127	137	Inactive Production		2
MONITORINGG-O	PRIVATE	480		80	480	Other Active Production		2,3
MONITORINGT-A	PRIVATE	110		0	0	Other Active Production		2
MSER-A	PRIVATE	100		0	0	Other Active Production		2
MSSM-A	PRIVATE	135		0	0	Inactive Production		2
NAKM-A	PRIVATE	120		0	0	Inactive Production		2
NAKT-BP	PRIVATE	110		0	0	Other Active Production		2
NESL-GG	PRIVATE	0		0	0	Other Active Production		2
NORT-A	PRIVATE	0		0	0	Inactive Production		2
NVLW-SB3	PRIVATE	680		0	0	Other Active Production	P	2,3
PEAR-GG	PRIVATE	143		0	0	Inactive Production		2
PEIR-A	PRIVATE	137		0	0	Inactive Production		2
PTCK-SA	PRIVATE	300		0	0	Inactive Production		2,3
PURS-SB	PRIVATE	252		0	0	Other Active Production		2,3,6
RMW-SFS	PRIVATE	540		0	0	Other Active Production		2
RWLM-GG	PRIVATE	132		0	0	Other Active Production		2
SAND-BP	PRIVATE	70		0	0	Inactive Production		2
SANZ-C	PRIVATE	84		76	83	Other Active Production	S	2
SCHN-GG	PRIVATE	144		0	0	Other Active Production		2
SINC-C	PRIVATE	130		0	0	Inactive Production		2
SWAN-C	PRIVATE	185		0	0	Inactive Production		2
TAOR-A	PRIVATE	254		0	0	Inactive Production		2
VGNA-A	PRIVATE	165		0	0	Inactive Production		2,3
W-10699	PRIVATE	141		0	0	Inactive Production		2
W-10894	PRIVATE	365		357	364	Inactive Production		2
W-11104	PRIVATE	320		230	300	Inactive Production		2
W-12745	PRIVATE	270		0	0	Inactive Production		2
W-12753	PRIVATE	250		0	0	Inactive Production		2
W-12791	PRIVATE	80		0	0	Inactive Production		2
W-12819	PRIVATE	0		0	0	Inactive Production		2
W-1311	PRIVATE	345		0	345	Inactive Production		2
W-13112	PRIVATE	935		701	933	Inactive Production		2
W-13118	PRIVATE	600		343	575	Inactive Production		2,3
W-13207	PRIVATE	260		0	0	Inactive Production		2
W-13285	PRIVATE	130		0	0	Inactive Production		2
W-14805	PRIVATE	170		0	0	Inactive Production		2,3
W-15791	PRIVATE	0		0	0	Inactive Production		2,3
W-15793	PRIVATE	0		0	0	Inactive Production		2,3
W-15803	PRIVATE	0		0	0	Inactive Production		2,3
W-15817	PRIVATE	158		0	0	Inactive Production		2
W-15857	PRIVATE	100		0	0	Inactive Production		2
W-15880	PRIVATE	97		0	0	Inactive Production		2,3
W-15962	PRIVATE	450		0	0	Inactive Production		2,3
W-16004	PRIVATE	165		0	0	Inactive Production		2

List of Wells in OCWD Monitoring Programs

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
W-18700	PRIVATE	300		200	300	Other Active Production		2,3
W-19049	PRIVATE	340		60	260	Other Active Production		2,3
W-19051	PRIVATE	430		180	400	Other Active Production		2,3
W-19053	PRIVATE	440		360	440	Other Active Production		2
W-19055	PRIVATE	360		140	360	Other Active Production		2,3
W-20906	PRIVATE	0		0	0	Inactive Production		2,3
W-2268	PRIVATE	226		140	190	Inactive Production	S	2,3
W-2447	PRIVATE	180		157	178	Inactive Production	S	2,3
W-3063	PRIVATE	310		292	300	Inactive Production		2,3
W-376	PRIVATE	370		290	370	Inactive Production		2
W-3765	PRIVATE	0		0	0	Inactive Production		2
W-3795	PRIVATE	0		0	0	Inactive Production		2,3
W-428	PRIVATE	311		0	0	Inactive Production		2,10
W-432	PRIVATE	300		117	137	Inactive Production	S	2,10
W-5304	PRIVATE	0		0	0	Inactive Production		2
W-5306	PRIVATE	292		0	0	Inactive Production		2
W-615	PRIVATE	374		188	364	Inactive Production		2,3
W-6523	PRIVATE	175		0	0	Inactive Production		2
W-702	PRIVATE	324		294	318	Inactive Production		2,3
W-7040	PRIVATE	192		0	0	Inactive Production		2,3
W-7046	PRIVATE	257		0	0	Inactive Production	S	2
W-830	PRIVATE	200		191	200	Inactive Production		2
W-856	PRIVATE	406		271	401	Inactive Production		2
W-860	PRIVATE	348		0	0	Inactive Production		2
W-9172	PRIVATE	98		50	97	Inactive Production		2
W-9180	PRIVATE	200		0	0	Inactive Production		2
WALL-A	PRIVATE	45		16	45	Other Active Production		2
WARN-WHNY	PRIVATE	0		0	0	Inactive Production		2,3
WLMS-A	PRIVATE	0		0	0	Other Active Production		2
WMIL-WM	PRIVATE	300		260	300	Inactive Production		2
WMIL-WM2	PRIVATE	650		150	640	Other Active Production		2
WRNE-WTOM	PRIVATE	0		0	0	Other Active Production		2
NOBL-O	R.J. NOBLE CO.	476		290	474	Other Active Production	P	2
FURU-HB	RAINBOW DISPOSAL	150		0	0	Other Active Production		2,6
W-4152	RAINBOW DISPOSAL	202		142	178	Inactive Production		2
RAY-MW06	RAYON CO.	191		150	190	Monitoring		1
RAY-MW09	RAYON CO.	194		152	192	Monitoring		1
RAY-MW16	RAYON CO.	180		149	179	Monitoring		1
RAY-MW17	RAYON CO.	204		173	193	Monitoring		1
RAY-MW21	RAYON CO.	238		212	232	Monitoring		1
RAY-MW23	RAYON CO.	236		215	235	Monitoring		1
RAY-MW24	RAYON CO.	338		310	330	Monitoring	D	1
RAY-MW25	RAYON CO.	805		449	480	Monitoring	D	1
RAY-MW26	RAYON CO.	805		459	499	Monitoring	P	1
RAY-MW27	RAYON CO.	550		475	515	Monitoring	P	1
RAY-MW28	RAYON CO.	425		335	375	Monitoring	P	1
RAY-MW29	RAYON CO.	266		200	240	Monitoring	P	1
RAY-MW30	RAYON CO.	635		596	616	Monitoring	P	1
RAY-MW31	RAYON CO.	1100		946	996	Monitoring	P	1
RAY-MW32	RAYON CO.	1153		1070	1100	Monitoring	P/D	1
RAY-MW33	RAYON CO.	1080		980	1020	Monitoring	P	1
RAY-MW34A	RAYON CO.	290		220	280	Monitoring		1
RAY-MW34B	RAYON CO.	540		486	536	Monitoring	P	1
RAY-MW34C	RAYON CO.	709		556	576	Monitoring	P	1
RAY-MW35	RAYON CO.	1104		990	1040	Monitoring	P	1
RAY-MW36	RAYON CO.	1030		934	994	Monitoring	P	1
RAY-MW37	RAYON CO.	916		770	820	Monitoring	P	1
RAY-MW39	RAYON CO.	1080		982	1012	Monitoring	P	1
RAY-MW40	RAYON CO.	1040		930	970	Monitoring	P	1
RAY-P07	RAYON CO.	117		108	130	Monitoring	S	1
RAY-P09	RAYON CO.	130		110	130	Monitoring	S	1
RIDG-O	RIDGELINE PERATIONS, INC.	63		55	60	Inactive Production		2
RVGC-SA	RIVER VIEW GOLF	300		156	216	Other Active Production		2,3
ROBSN-YL1	ROBERTSON READY MIX	67		21	65	Inactive Production		2,3
RCA-AR	ROMAN CATHOLIC ARCHBISHOP-LA	0		0	0	Other Active Production		2
W-8813	S FARGO BANK, INC.	13		3	13	Monitoring		1
SAKI-SAJ3	SAKIOKA & SONS, ROY K.	463		0	0	Other Active Production		2,3,9

List of Wells in OCWD Monitoring Programs

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
SAKI-SAJ1	SAKIOKA FARMS	187		0	0	Inactive Production		2,9
SA-16	SANTA ANA	978		305	950	Active Large Production	P	2,7
SA-18	SANTA ANA	654		245	623	Active Large Production	P	2,7
SA-20	SANTA ANA	981		390	940	Active Large Production	P	2,7
SA-21	SANTA ANA	986		400	960	Active Large Production	P	2,7
SA-24	SANTA ANA	688		352	654	Active Large Production	P	2,7
SA-26	SANTA ANA	1186		330	1140	Active Large Production	P	2,7,9
SA-27	SANTA ANA	1152		396	1140	Active Large Production	P	2,7
SA-28	SANTA ANA	1200		250	980	Active Large Production	P	2,7
SA-29	SANTA ANA	1090		450	1050	Active Large Production	P	2,7
SA-30	SANTA ANA	989		440	900	Active Large Production	P	2,7
SA-31	SANTA ANA	1310		465	1240	Active Large Production	P	2,7
SA-32	SANTA ANA	1060		307	1030	Inactive Production	P	2,7
SA-33	SANTA ANA	1080		425	935	Active Large Production	P	2,7
SA-34	SANTA ANA	1000		370	520	Active Large Production	P	2,7
SA-35	SANTA ANA	1520		429	1480	Active Large Production	P	2,7
SA-36	SANTA ANA	1510		570	1290	Active Large Production	P	2,7
SA-37	SANTA ANA	1560		348	1480	Active Large Production	P	2,7
SA-38	SANTA ANA	1510		400	1270	Active Large Production	P	2,7
SA-39	SANTA ANA	1350		590	1290	Active Large Production	P	2,7
SA-40	SANTA ANA	1335		550	1305	Active Large Production	P	2,7
SA-41	SANTA ANA	1010		525	978	Active Large Production	P	2,7
SA-7	SANTA ANA	960		426	907	Inactive Production		2
W-12903	SANTA ANA	423		0	0	Inactive Production		2
SACC-SA	SANTA ANA COUNTRY CLUB	536		205	406	Other Active Production	P	2,3,6
SAVI-16	SANTA ANA VALLEY IRRIGATION CO	752		262	825	Inactive Production		2,3
SFE-2	SANTA FE ENERGY CO.	294		0	0	Inactive Production		2,3
SFE-3	SANTA FE ENERGY CO.	205		0	0	Inactive Production		2,3
SFE-4	SANTA FE ENERGY CO.	180		0	0	Inactive Production		2,3
SFS-12	SANTA FE SPRINGS	1556		940	1430	Active Large Production		2
SFS-2	SANTA FE SPRINGS	1250		336	1218	Other Active Production		2,3
SAVS-ASC	SAVANNA SCHOOL DIST.	1301		0	0	Other Active Production		2,3
SB-BC	SEAL BEACH	1050		370	1020	Active Large Production	P	2,7
SB-BEV	SEAL BEACH	920		400	800	Active Large Production	P	2,6,7
SB-LAM	SEAL BEACH	1200		360	1170	Active Large Production	P	2,7
SB-LEI	SEAL BEACH	840		420	840	Active Large Production	P	2,6,7
SID-3	SERRANO WATER DIST.	604		296	584	Active Large Production	P	2,7
SID-4	SERRANO WATER DIST.	650		290	520	Active Large Production	P	2,7
SWD-5	SERRANO WATER DIST.	750		310	720	Active Large Production	P	2,7
SCC-D1	SERVICE CHEMICAL	124		113	123	Monitoring		1,9
W-15094	SHELL OIL CO.	104		58	95	Inactive Production		2
W-15098	SHELL OIL CO.	350		0	0	Inactive Production		2
W-15100	SHELL OIL CO.	115		80	115	Inactive Production		2
W-2507	SHELL OIL CO.	437		230	340	Inactive Production		2
W-2523	SHELL OIL CO.	115		70	100	Inactive Production		2
W-2505	SIGNAL OIL AND GAS	121		76	104	Inactive Production		2,3
W-9170	SIGNAL OIL AND GAS	92		80	90	Inactive Production		2
RODE-A	SILICON SALVAGE	218		178	208	Other Active Production	S	2
SILV-YL	SILVERADO CONSTRUCTORS	78		40	66	Other Active Production	S	2,3,10
W-3783	SO. CA EDISON	458		0	0	Inactive Production		2,9
SMWC-BF4	SOMERSET MUTUAL WATER CO.	1070		0	0	Other Active Production		2
SMWC-BFFWR	SOMERSET MUTUAL WATER CO.	1076		0	0	Active Small Production		2
W-13380	SOMERSET MUTUAL WATER CO.	875		0	0	Inactive Production		2
FOND-A	SOURCE REFRIGERATION	250		0	0	Inactive Production		2
MIYA-BP	SOURN CA EDISON	400		0	0	Inactive Production		2,3
SCE-DASUB	SOURN CA EDISON	0		0	0	Other Active Production		2
SCE-LBDM	SOURN CA EDISON	366		100	347	Inactive Production		2,3
SCE-LBSG	SOURN CA EDISON	340		190	340	Inactive Production		2,3
SCE-YLCS	SOURN CA EDISON	104		5	103	Inactive Production	S	2,3,10
TIC-127	SOURN CA EDISON	134		0	0	Monitoring	S	1
TIC-140	SOURN CA EDISON	787		0	0	Monitoring		1
W-13195	SOURN CA EDISON	527		0	0	Inactive Production		2,3
W-15807	SOURN CA EDISON	150		0	0	Inactive Production		2,3
W-15874	SOURN CA EDISON	188		0	0	Inactive Production		2
SCGC-I	SOURN CA GAS CO.	300		0	0	Other Active Production		2,3
SCGC-O	SOURN CA GAS CO.	405		0	0	Other Active Production		2,3
W-11198	SOURN SERVICE CO., LTD.	952		716	948	Other Active Production		2,3

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Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
SCSH-SA1	SOUTH COAST SHORE HOA	450		280	430	Other Active Production		2,3
SMID-D4	SOUTH MIDWAY CITY WATER CO.	142		0	0	Inactive Production		2
SMID-D5	SOUTH MIDWAY CITY WATER CO.	630		300	600	Active Small Production		2,7
SPRK-SA	SPARKLETTS DRINKING WATER CORP	246		154	212	Other Active Production		2,3
W-8292	SPRAYON PRODUCTIONUCTS	105		80	98	Monitoring		1
W-8294	SPRAYON PRODUCTIONUCTS	101		80	100	Monitoring		1
W-8296	SPRAYON PRODUCTIONUCTS	99		70	90	Monitoring		1
W-3801	STATE OF CA	725		254	407	Inactive Production		2,3
STEP-A	STEPAN CO.	275		210	275	Other Active Production		2,3,8
SWS-26B7	SUBURBAN WATER SYSTEMS	820		0	0	Inactive Production		2,3
SWS-409W3	SUBURBAN WATER SYSTEMS	1460		540	1420	Active Large Production		2
SWS-410W1	SUBURBAN WATER SYSTEMS	1312		617	1237	Other Active Production		2
ANGS-HBM3	TERMO PETROLEUM	1510		146	1440	Multiport Monitoring		1
TEX-W1	TEXACO, INC.	30		5	30	Monitoring		1
W-8805	TEXACO, INC.	45		15	45	Monitoring		1
W-8807	TEXACO, INC.	45		15	45	Monitoring		1
W-8809	TEXACO, INC.	45		15	45	Monitoring		1
W-8811	TEXACO, INC.	45		15	45	Monitoring		1
W-8815	TEXACO, INC.	35		25	35	Monitoring		1
W-18289	TOSCO MARKETING CO.	150		120	150	Monitoring		1
W-18291	TOSCO MARKETING CO.	140		105	140	Monitoring		1
W-18293	TOSCO MARKETING CO.	140		105	140	Monitoring		1
T868-S1	TRACT 868 MUTUAL WATER CO.	200		0	0	Inactive Production		2
T868-S2	TRACT 868 MUTUAL WATER CO.	0		0	0	Inactive Production		2
TREE-SA	TREESWEET PRODUCTIONUCT CO.	416		150	398	Inactive Production		2,3
TLLC-F2	TRUE LOVE LURAN CHURCH	350		190	350	Other Active Production		2,3,8
T-17S1	TUSTIN	375		200	311	Inactive Production		2
T-17S2	TUSTIN	1003		310	490	Inactive Production		2
T-17S4	TUSTIN	520		200	480	Active Large Production	P	2,7
T-BENE	TUSTIN	627		290	590	Inactive Production	P	2
T-COLU	TUSTIN	1470		560	1160	Active Large Production	P	2,7
T-ED	TUSTIN	1492		500	840	Inactive Production		2,7
T-LIVI	TUSTIN	617		300	617	Inactive Production		2
T-MS3	TUSTIN	630		300	630	Active Large Production	P	2,7
T-MS4	TUSTIN	1180		330	880	Active Large Production	P	2,7
T-NEWP	TUSTIN	375		234	267	Active Large Production	S	2,7
T-PANK	TUSTIN	614		323	614	Inactive Production	P	2,9
T-PAS	TUSTIN	1260		440	1225	Active Large Production	P	2,7
T-PROS	TUSTIN	630		270	630	Active Large Production	P	2,7
T-TUST	TUSTIN	827		306	776	Active Large Production	P	2,7
T-VNBG	TUSTIN	1129		480	900	Active Large Production	P	2,7
T-WALN	TUSTIN	1191		397	995	Active Large Production	P	2,7,9
T-YORB	TUSTIN	863		385	850	Inactive Production	P	2
USGS-NAWQA1	U.S. GEOLOGICAL SURVEY	24		14	24	Monitoring		1
USGS-NAWQA10	U.S. GEOLOGICAL SURVEY	24		14	19	Monitoring		1
USGS-NAWQA11	U.S. GEOLOGICAL SURVEY	49		39	44	Monitoring		1
USGS-NAWQA12	U.S. GEOLOGICAL SURVEY	24		14	19	Monitoring		1
USGS-NAWQA13	U.S. GEOLOGICAL SURVEY	34		24	29	Monitoring		1
USGS-NAWQA14	U.S. GEOLOGICAL SURVEY	74		69	74	Monitoring		1
USGS-NAWQA15	U.S. GEOLOGICAL SURVEY	39		29	34	Monitoring		1
USGS-NAWQA16	U.S. GEOLOGICAL SURVEY	44		34	39	Monitoring		1
USGS-NAWQA17	U.S. GEOLOGICAL SURVEY	19		9	14	Monitoring		1
USGS-NAWQA18	U.S. GEOLOGICAL SURVEY	29		19	24	Monitoring		1
USGS-NAWQA19	U.S. GEOLOGICAL SURVEY	19		9	14	Monitoring		1
USGS-NAWQA2	U.S. GEOLOGICAL SURVEY	21		10	15	Monitoring		1
USGS-NAWQA20	U.S. GEOLOGICAL SURVEY	0		14	19	Monitoring		1
USGS-NAWQA21	U.S. GEOLOGICAL SURVEY	24		14	19	Monitoring		1
USGS-NAWQA22	U.S. GEOLOGICAL SURVEY	144		134	139	Monitoring		1
USGS-NAWQA23	U.S. GEOLOGICAL SURVEY	34		24	29	Monitoring		1
USGS-NAWQA24	U.S. GEOLOGICAL SURVEY	49		34	39	Monitoring		1
USGS-NAWQA25	U.S. GEOLOGICAL SURVEY	19		9	19	Monitoring		1
USGS-NAWQA26	U.S. GEOLOGICAL SURVEY	29		19	24	Monitoring		1
USGS-NAWQA27	U.S. GEOLOGICAL SURVEY	19		9	19	Monitoring		1
USGS-NAWQA28	U.S. GEOLOGICAL SURVEY	19		9	19	Monitoring		1
USGS-NAWQA29	U.S. GEOLOGICAL SURVEY	19		9	19	Monitoring		1
USGS-NAWQA3	U.S. GEOLOGICAL SURVEY	21		12	17	Monitoring		1
USGS-NAWQA30	U.S. GEOLOGICAL SURVEY	19		9	19	Monitoring		1

List of Wells in OCWD Monitoring Programs

KEY

Aquifer Zone: S=Shallow Aquifer, P=Principal Aquifer, D= Deep Aquifer

Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
USGS-NAWQA31	U.S. GEOLOGICAL SURVEY	24		14	19	Monitoring		1
USGS-NAWQA4	U.S. GEOLOGICAL SURVEY	24		14	19	Monitoring		1
USGS-NAWQA5	U.S. GEOLOGICAL SURVEY	20		10	15	Monitoring		1
USGS-NAWQA5	U.S. GEOLOGICAL SURVEY	20		10	15	Monitoring		9
USGS-NAWQA6	U.S. GEOLOGICAL SURVEY	20		10	15	Monitoring		1
USGS-NAWQA7	U.S. GEOLOGICAL SURVEY	29		19	24	Monitoring		1
USGS-NAWQA8	U.S. GEOLOGICAL SURVEY	23		13	18	Monitoring		1
USGS-NAWQA9	U.S. GEOLOGICAL SURVEY	29		19	24	Monitoring		1
UOC-B8	UNION OIL CO.	79		60	75	Inactive Production		2,3
UOC-B9	UNION OIL CO.	79		60	75	Inactive Production		2,3
COS-PLAZ	UNKNOWN	779		0	0	Monitoring	P	1
W-14764	UNKNOWN	0		0	0	Inactive Production		2
W-18102	UNKNOWN	130		110	130	Monitoring		1
W-3629	UNKNOWN	162		0	0	Inactive Production		2,3
W-8298	UNKNOWN	115		0	0	Monitoring		1
W-8300	UNKNOWN	85		0	0	Monitoring		1
W-8304	UNKNOWN	49		0	0	Monitoring		1
W-8306	UNKNOWN	85		0	0	Monitoring		1
W-8308	UNKNOWN	182		0	0	Monitoring		1
W-18607	UNOCAL BIRCH HILLS	130		25	130	Other Active Production		2
W-18609	UNOCAL BIRCH HILLS	0		25	120	Monitoring		1
W-18611	UNOCAL BIRCH HILLS	120		25	120	Monitoring		1
W-18613	UNOCAL BIRCH HILLS	120		45	120	Injection		4
W-18615	UNOCAL BIRCH HILLS	120		45	120	Injection		4
W-18617	UNOCAL BIRCH HILLS	120		45	120	Injection		4
W-18637	UNOCAL BIRCH HILLS	120		45	120	Injection		4
W-18639	UNOCAL BIRCH HILLS	120		45	120	Injection		4
W-18641	UNOCAL BIRCH HILLS	120		45	120	Injection		4
MTSN-SA	VERSAILLES ON LAKE APT	914		0	0	Other Active Production		2,3
CRES-A	VICTORY BAPTIST CHURCH	541		485	525	Active Small Production		2,7
A1-HB	VILLAGE NURSERIES	305		188	300	Other Active Production		2,3
W-13235	VIRGINIA COUNTRY CLUB	1285		915	1010	Monitoring		1
CATH-S	W. CARINE ST. MUT. WTR. CO.	170		0	0	Other Active Production		2,3
DISN-AE1	WALT DISNEY PRODUCTIONS	400		0	0	Inactive Production		2,3
DISN-AH1	WALT DISNEY PRODUCTIONS	0		0	0	Inactive Production		2,3
FUJS-A	WALT DISNEY PRODUCTIONS	642		446	628	Inactive Production		2,3
W-846	WALT DISNEY PRODUCTIONS	325		0	0	Inactive Production		2
WRD-CERRITOS-1	WATER REPLENISHMENT DIST.	1221		1155	1175	Monitoring		1
WRD-CERRITOS-2	WATER REPLENISHMENT DIST.	1504		1350	1370	Monitoring		1
WRD-LAKEWOOD-1A	WATER REPLENISHMENT DIST.	1020		989	1009	Monitoring		1
WRD-LAKEWOOD-1B	WATER REPLENISHMENT DIST.	172		140	160	Monitoring		1
WRD-LAKEWOOD-2	WATER REPLENISHMENT DIST.	2160		1960	2000	Monitoring		1
WRD-LAMIRADA-1	WATER REPLENISHMENT DIST.	1257		1130	1150	Monitoring		1
WRD-LONGBEACH-1	WATER REPLENISHMENT DIST.	1495		1430	1450	Monitoring		1,6
WRD-LONGBEACH-6	WATER REPLENISHMENT DIST.	1550		1490	1510	Monitoring		1
WRD-LONGBEACH-8	WATER REPLENISHMENT DIST.	1515		1435	1455	Monitoring		1
WRD-NORWALK-1	WATER REPLENISHMENT DIST.	1432		1400	1420	Monitoring		1
WRD-NORWALK-2	WATER REPLENISHMENT DIST.	1502		1460	1480	Monitoring		1
WRD-SEALBEACH-1	WATER REPLENISHMENT DIST.	1505		1345	1365	Monitoring	S/P/D	1,6
WRD-WHITTIER-1A	WATER REPLENISHMENT DIST.	1298		1180	1200	Monitoring		1
WRD-WHITTIER-1B	WATER REPLENISHMENT DIST.	640		600	620	Monitoring		1
WM-107A	WESTMINSTER	1040		350	980	Active Large Production	P	2,7
WM-11	WESTMINSTER	820		325	790	Active Large Production	P	2,7
WM-125	WESTMINSTER	930		374	860	Active Large Production	P	2,6,7
WM-3	WESTMINSTER	365		285	365	Active Large Production	P	2,7
WM-4	WESTMINSTER	1209		345	1125	Active Large Production	P	2,7
WM-6	WESTMINSTER	694		176	660	Active Large Production		2,7
WM-75A	WESTMINSTER	1041		410	996	Active Large Production	P	2,7
WM-RES1	WESTMINSTER	920		390	880	Active Large Production	P	2,7
WM-RES2	WESTMINSTER	960		340	937	Active Large Production	P	2,6,7
WM-SC4	WESTMINSTER	454		425	454	Active Large Production	P	2,7
WMEM-WE	WESTMINSTER MEMORIAL PARK	149		0	0	Inactive Production		2,3
WMEM-WPAR	WESTMINSTER MEMORIAL PARK	614		140	599	Inactive Production		2,3
WMEM-WW	WESTMINSTER MEMORIAL PARK	488		95	442	Other Active Production		2,3
WHS-CHS40	WHITTIER UNION H.S. DIST.	836		0	0	Inactive Production		2
WHS-SH550	WHITTIER UNION H.S. DIST.	804		228	780	Active Small Production		2
W-14807	WILLIAM LYON CO	490		0	0	Inactive Production		2

List of Wells in OCWD Monitoring Programs

KEY

Aquifer Zone: S=Shallow Aquifer, P=Principal Aquifer, D= Deep Aquifer

Program: 1) monitoring well, 2) production well, 3) irrigation or industrial well, 4) injection well, 5) Mid-Basin Injection well, 6) seawater intrusion monitoring well, 7) well monitored by OCWD for Title 22 compliance, 8) North Basin Groundwater Protection Program wells, 9) South Basin Groundwater Protection Program wells, 10) wells in CASGEM monitoring program

Well Name	Well Owner	Bore Depth (ft. bgs)	Casing Sequence	Screened Interval (ft.bgs) Top	Bottom	Type of Well	Aquifer Zone	Program
WOOD-INLK	WOODBRIDGE VILL HOMEOWNER ASSN	910		370	890	Inactive Production	P	2,3
WOOD-ISLK	WOODBRIDGE VILL HOMEOWNER ASSN	845		210	800	Inactive Production	P	2,3
YLCC-35C2	YORBA LINDA COUNTRY CLUB	425		388	404	Inactive Production		2,3
YLCC-35C4	YORBA LINDA COUNTRY CLUB	510		188	472	Other Active Production		2,3
YLCC-35F3	YORBA LINDA COUNTRY CLUB	460		130	450	Other Active Production		2,3
YLWD-1	YORBA LINDA WATER DIST.	427		90	340	Active Large Production		2,7
YLWD-10	YORBA LINDA WATER DIST.	465		90	406	Active Large Production		2,7
YLWD-11	YORBA LINDA WATER DIST.	547		149	514	Active Large Production		2,7
YLWD-12	YORBA LINDA WATER DIST.	544		80	498	Active Large Production		2,7
YLWD-15	YORBA LINDA WATER DIST.	213		133	198	Active Large Production	S	2,7
YLWD-18	YORBA LINDA WATER DIST.	1050		250	570	Active Large Production	P	2,7
YLWD-19	YORBA LINDA WATER DIST.	611		280	581	Active Large Production	P	2,7
YLWD-20	YORBA LINDA WATER DIST.	600		225	570	Active Large Production	P	2,7
YLWD-5	YORBA LINDA WATER DIST.	395		90	340	Active Large Production		2,7
YLWD-7	YORBA LINDA WATER DIST.	361		137	259	Active Large Production		2,7

Basin 8-1 Alternative

South East
Management Area

Prepared by: Irvine Ranch Water District

In collaboration with: El Toro Water District and
City of Orange

January 1, 2017

Irvine Ranch
WATER DISTRICT

Basin 8-1 Alternative

South East Management Area

CERTIFIED HYDROGEOLOGIST • THOMAS E. HARDER No: 588 • STATE OF CALIFORNIA

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Prepared for the Department of Water Resources, pursuant to Water Code §10733.6(b)(3)

January 1, 2017

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SECTION 1. EXECUTIVE SUMMARY

The South East Management Area consists of several small, fringe areas located south east of the Orange County Management Area that overlie portions of Irvine Ranch Water District (IRWD), El Toro Water District (ETWD) and the City of Orange service areas. Figure 1-1 shows the boundary of each South East Management Area agency along with the Orange County Water District (OCWD). Table 1-1 shows the area associated with each agency within the South East Management Area. The South East Management Area represents approximately 4.4 percent of the total area of Basin 8-1.

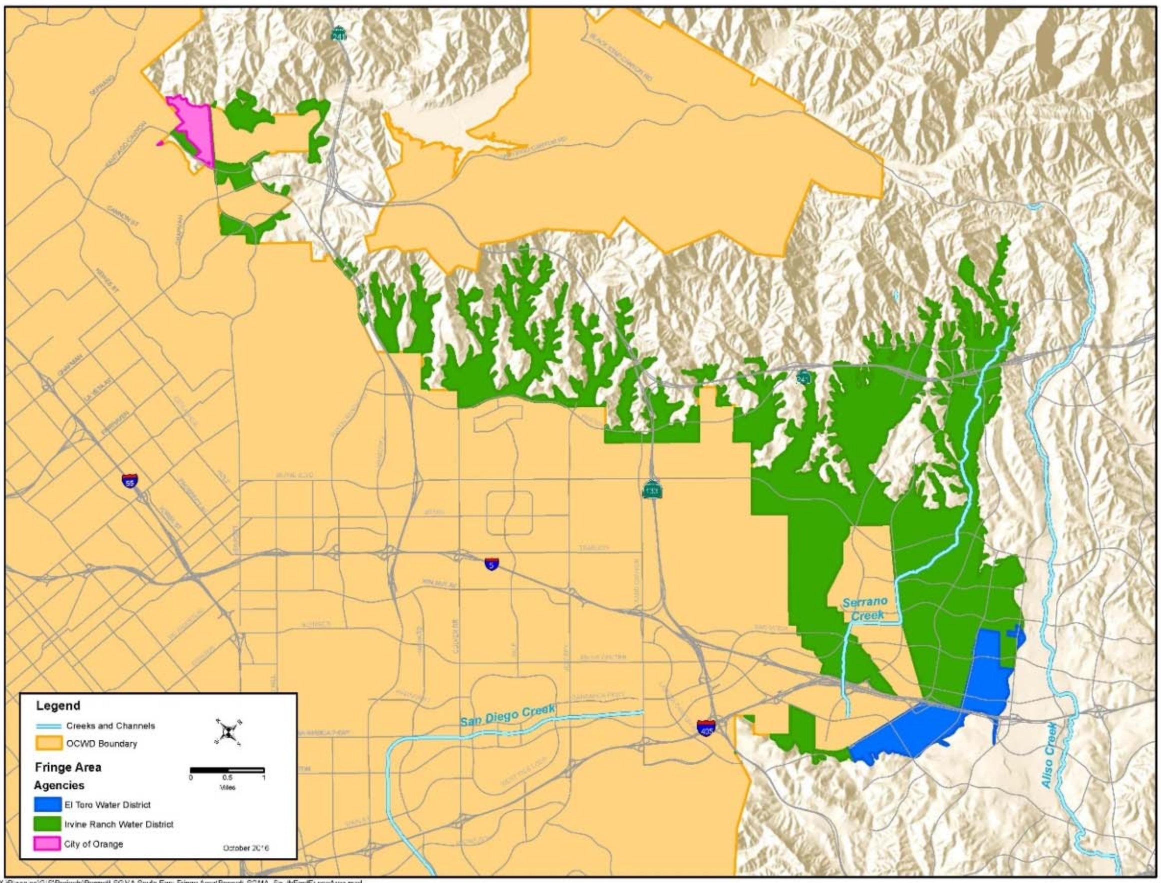

Figure 1-1: Agencies in the South East Management Area

Table 1-1 List of Agencies in South East Management Area and Area Covered

Agency	Area (acres)
Irvine Ranch Water District	8,870
El Toro Water District	762
City of Orange	134
Total Area	9,766

Water resources in the South East Management Area include Serrano Creek, numerous smaller tributaries and groundwater. Serrano Creek provides surface waters that flow into and/or out of the IRWD's Lake Forest portion of the South East Management Area (Boyle, 2002).

The only groundwater production in the South East Management Area has historically been from six wells located in the city of Lake Forest, within IRWD's service area. Currently only one well is active with an average production of about 125 acre-feet per year over the last 10 years. Imported water from the Metropolitan Water District of Southern California is the primary water supply source for the entire South East Management Area. Groundwater production within the South East Management Area represents less than 2 percent of the potable water supply for IRWD's Lake Forest area and less than 0.2 percent of IRWD's 2015 potable supply. And despite several recent years of significant drought, groundwater production in this area has approximately remained the same. Due to the relatively low yield of the Aquifer in the South East Management Area, groundwater production is expected to remain a relatively insignificant water supply source for the area.

The six wells within IRWD's Lake Forest portion of the South East Management Area are currently used for monitoring groundwater levels and water quality on a monthly basis. Because groundwater production is minimal throughout the year, there are no other programs in the South East Management Area responsible for managing or monitoring groundwater resources.

The Sustainability Goal for the South East Management Area is to recognize it is a small part of the larger OCWD management area whose groundwater levels and water quality will be monitored to assure that conditions do not lead to significant and unreasonable (1) lowering of groundwater levels, (2) reduction in storage, (3) water quality degradation, (4) inelastic land subsidence or (5) unreasonable adverse effect on surface water resources

SECTION 2. AGENCY INFORMATION

2.1 HISTORY OF AGENCIES IN SOUTH EAST BASIN MANAGEMENT AREA

As shown in Figure 1-1, the South East Management Area contains portions of IRWD, ETWD and the City of Orange. The South East Management Area was developed in 2016 in collaboration with OCWD, an agency responsible for managing groundwater in Basin 8-1 within OCWD's boundaries. In compliance with the Sustainable Groundwater Management Act (SGMA), the South East Management Area represents the Basin 8-1 areas located southeast and outside of the OCWD boundaries. As agencies within the South East Management Area of Basin 8-1, IRWD, ETWD and the City of Orange have the option to participate in an Alternative to a Groundwater Sustainability Plan (GSP) for Basin 8-1.

The Lake Forest portion of IRWD's South East Management Area was formerly owned and operated by the Los Alisos Water District (LAWD). In 2001 when LAWD consolidated with IRWD the former District became known as the Los Alisos System of IRWD.

2.2 GOVERNANCE AND MANAGEMENT STRUCTURE

As described later in this section, groundwater withdrawals in the South East Management Area are relatively minor. As a result, there is currently no need to establish formal groundwater governance or management via GSA formation in the South East Management Area. However, groundwater production, level and quality data will be collected and reported to DWR, and coordinated with OCWD and La Habra, in compliance with SGMA.

2.3 LEGAL AUTHORITY

The Orange County Well Ordinance (County Ordinance No. 2607) requires that a permit be obtained prior to the construction or destruction of any well. In unincorporated areas and in twenty-nine of thirty-four Orange County cities, the Orange County Health Officer is responsible for enforcement of the well ordinance. In the remaining five cities (Anaheim, Buena Park, Fountain Valley, Orange and San Clemente), well ordinances are enforced by city personnel.

The SGMA allows local agencies to participate in the development of an Alternative to a GSP in accordance with Water Code § 10733.6. As defined by SGMA (Water Code 10721(n), "Local Agency" means a local public agency that has water supply, water management, or land use responsibilities within a groundwater basin), and therefore IRWD, ETWD and City of Orange are all "local agencies" for purposes of SGMA within those areas of their respective jurisdictions that overlie the Basin 8-1. The legal authority for IRWD, ETWD and the City of Orange to participate in the groundwater plan for the South East Management Area is as follows:

<u>IRWD:</u> IRWD's participation in the South East Management Area is within IRWD's legal authority as a Special District formed under the California Water District Code in 1961 that has water supply authority within a portion of the South East Management Area.

<u>ETWD:</u> ETWD's participation in the South East Management Area is within ETWD's legal authority as a Special District formed under the California Water District Code in 1960 that has water supply authority within a portion of the South East Management Area.

<u>City of Orange:</u> The City of Orange is a local municipality within the South East Management Area. Orange's participation in the South East Management Area is within Orange's legal authority as the City is the permitted water supplier as approved by the State of California to supply water for domestic purposes within the City's water service area.

2.4 BUDGET

The budget required to monitor and report groundwater information for the South East Management Area has not been defined. As part of its standard operations, IRWD regularly collects and maintains information on its groundwater production, groundwater levels and water quality testing. Currently, there is no groundwater production in ETWD or City of Orange areas of the South East Management Area, therefore these agencies would not be responsible for monitoring and reporting groundwater information.

SECTION 3. MANAGEMENT AREA DESCRIPTION

3.1 SOUTH EAST SERVICE AREA

The South East Management Area is located in the south east portion of the Coastal Plain of Orange County Groundwater Basin (Basin 8-1). A geologic map of the major geologic formations in the area taken from the U.S. Geological Survey is presented in Figure 3-1.

IRWD: The areas associated with IRWD's portion of the South East Management Area can be broadly broken into two groups; northern and southern. The northern portion is dominated by steep mountain tributaries that contain quaternary alluvium and terrace deposits beneath ephemeral streams that discharge directly to the OCWD Management Area. The southern, or Lake Forest portion, consists of quaternary alluvium, quaternary terrace deposits and the Capistrano formation. These deposits are drained by Serrano Creek, an ephemeral stream that discharges to the OCWD Management Area. Studies referenced in this South East Management Area describe IRWD's southern Lake Forest portion of the South East Management Area.

ETWD: No studies have been performed on the ETWD portion of the South East Management Area.

City of Orange: No studies have been performed on the City of Orange portion of the South East Management Area

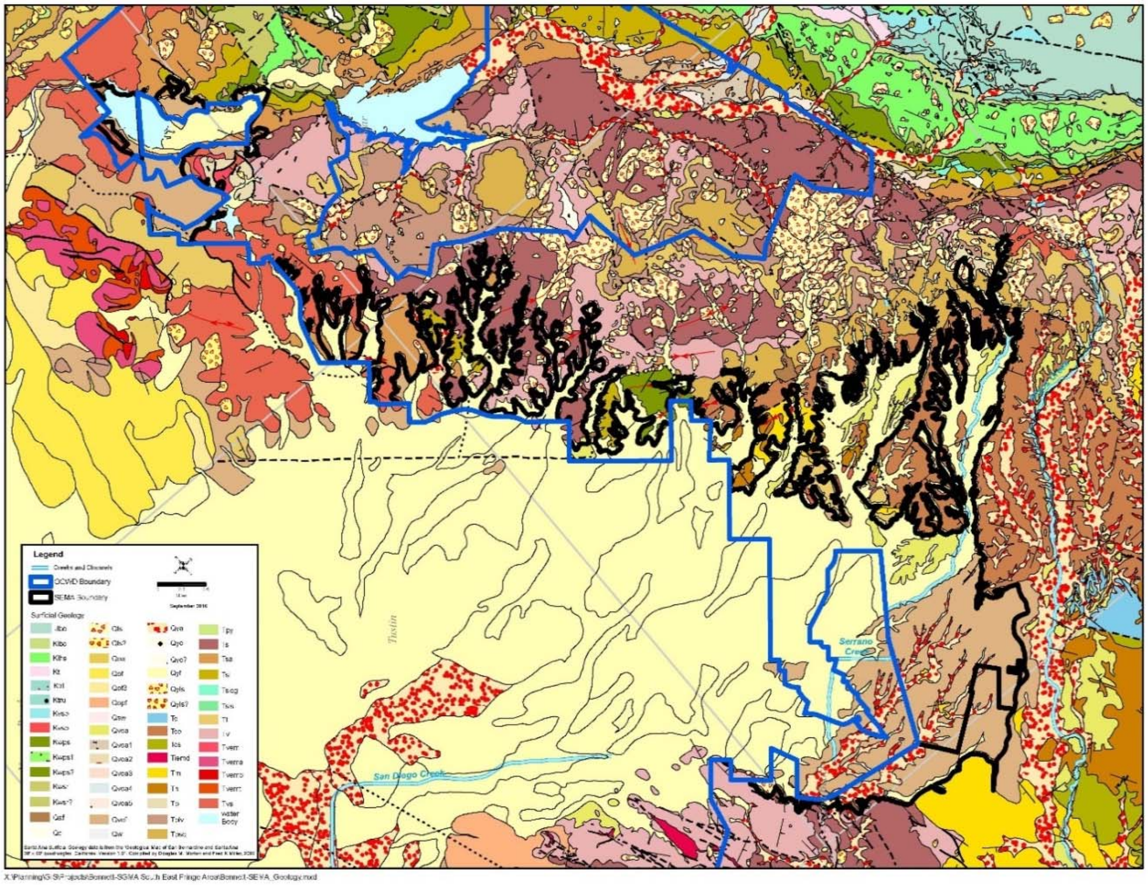

Figure 3-1: Geologic Location Map

3.1.1 Jurisdictional Boundaries

As described in Section 2 and shown in Figure 1-1, there are three jurisdictional agencies within the South East Management Area: IRWD, ETWD and the City of Orange. The western boundary of the South East Management Area is the south-eastern boundary of the OCWD Management Area. The South East Management Area's eastern boundary is the edge of Basin 8-1 as defined by the DWR Bulletin 118.

3.1.2 Land Use Designations

Land use designations for the South East Management Area have been consolidated into three major groups as follows:

1. Residential (single family, multi-family),
2. Commercial (commercial/industrial/mixed use), and
3. Open Space (open space/rights-of-way/water bodies).

As presented in Figure 3-2, IRWD's portion of the South East Management Area is primarily made up of Residential and Commercial land use types. The ETWD's portion is primarily residential, and the City of Orange is primarily Open Space.

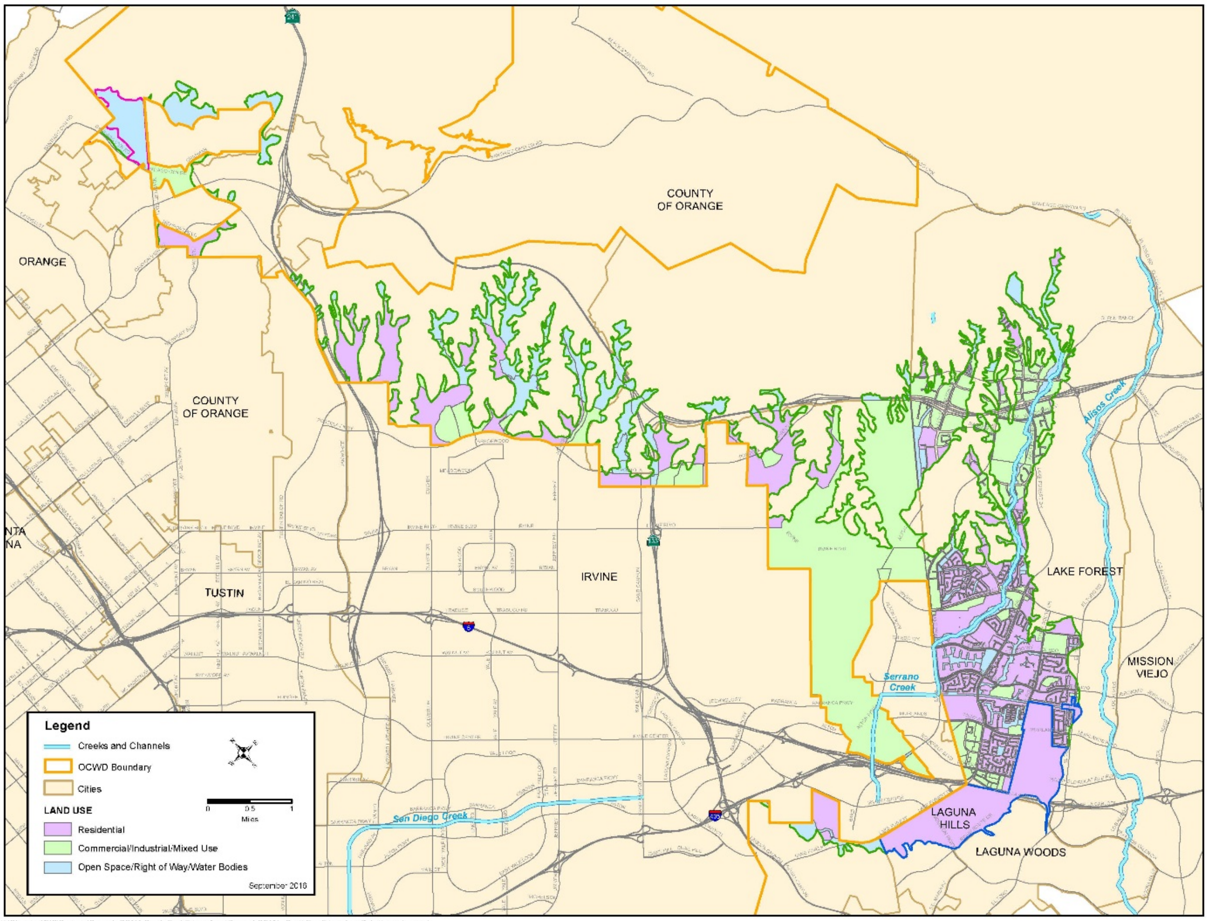

Figure 3-2: Land Use Designations

3.2 GROUNDWATER CONDITIONS

There is relatively little existing, or potential, groundwater development within the South East Management Area. Historically, IRWD's Lake Forest portion of the South East Management Area has had limited, inconsistent groundwater production from six existing wells, of which, only LF-2, is currently operational. Figure 3-3 shows the locations of the constructed wells within the South East Management Area.

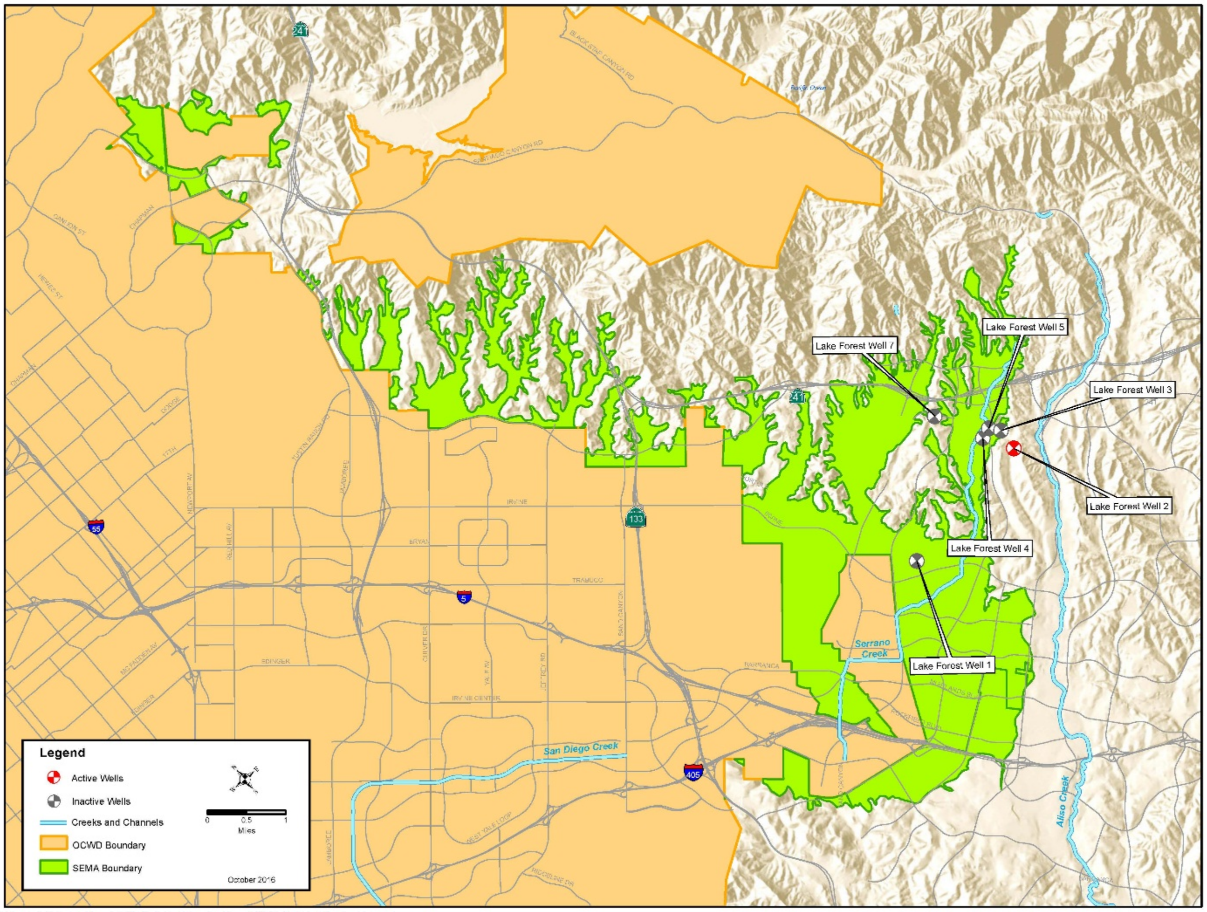

Figure 3-3: Groundwater Production Wells (Active and Inactive)

3.2.1 Groundwater Levels

The range of observed groundwater levels in the South East Management Area from 2012 to 2015 are summarized in Table 3-1 by agency. As shown, no groundwater level data exists in the ETWD and City of Orange portions of the South East Management Area. Historic and estimated groundwater levels from 1991 to 2015 for IRWD's Lake Forest wells are shown in Figure 3-4 where observed data are shown as points connected with solid lines and data estimated by correlation with the CASGEM well MCAS-3/MP2 is shown as a dashed line. Current monthly groundwater levels from IRWD's Lake Forest wells for 2015 to 2016 are shown in Figure 3-5.

Table 3-1: Observed Groundwater Levels 2012-2015

Agency	From (ft-bgs)	To (ft-bgs)
IRWD	17	168
ETWD	N/A	N/A
City of Orange	N/A	N/A

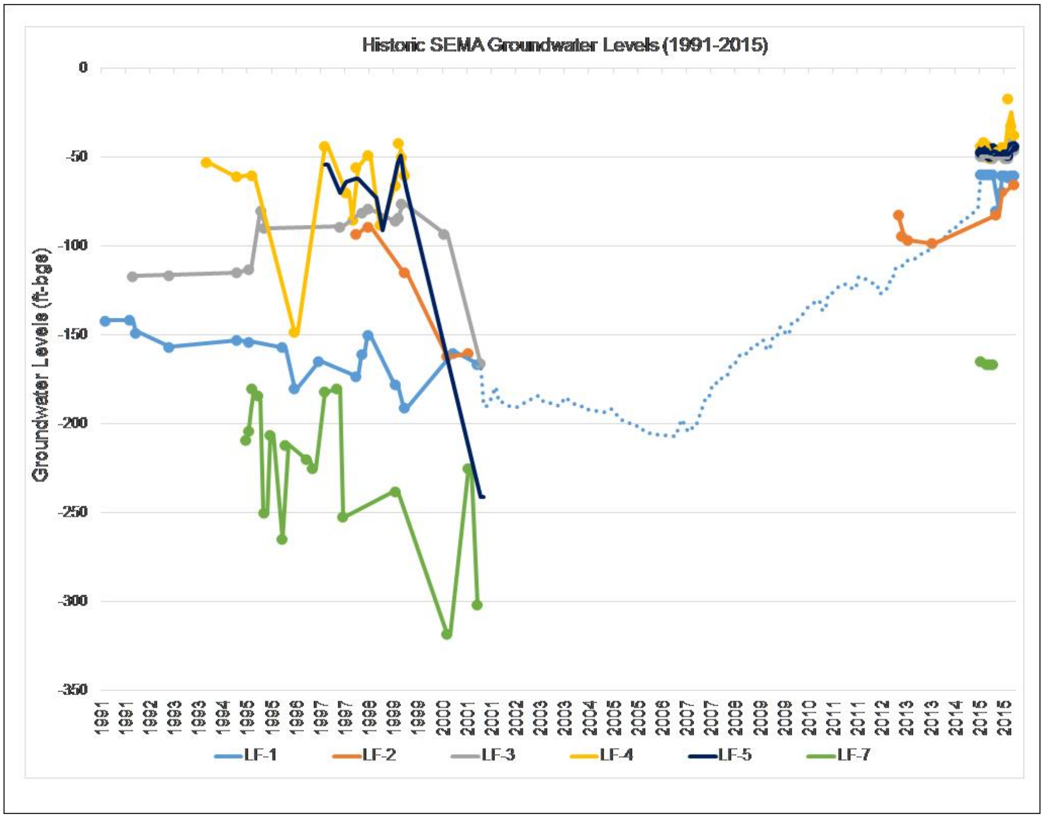

Figure 3-4: Historic Groundwater Levels, 1991-2015

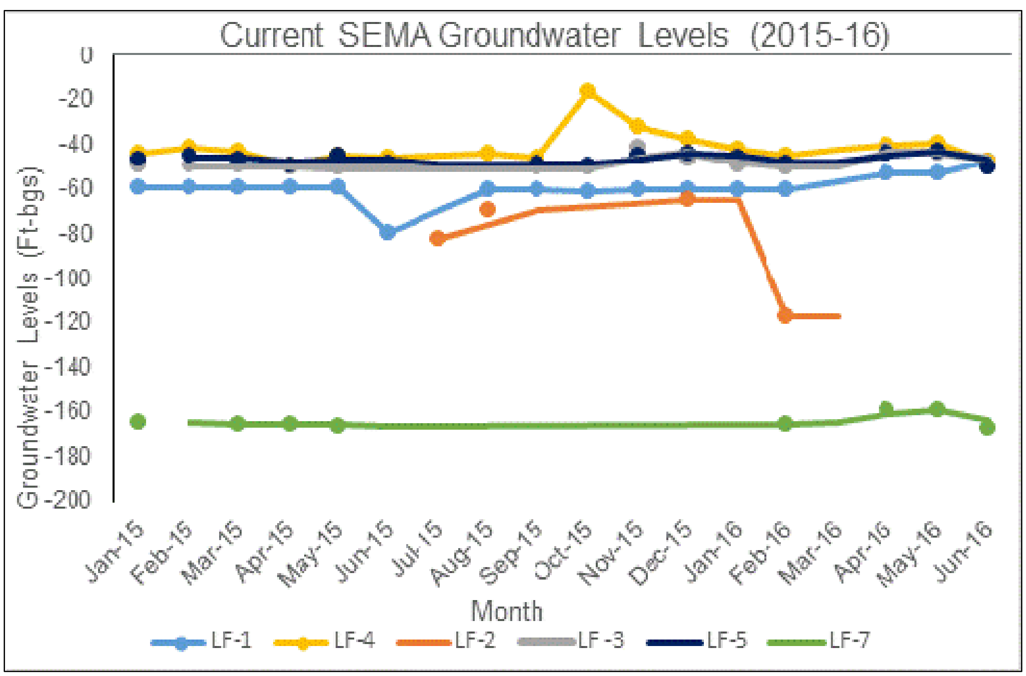

Figure 3-5: Current Groundwater Levels, 2015-16

3.2.2 Regional Pumping Patterns

Table 3-2 summarizes information on all the wells that are known to exist within the South East Management Area by agency. As presented, well design flows range from 125 to 350 gallons per minute (gpm) and well depths range from 675 to 1,000 feet below ground surface (ft-bgs).

Table 3-2: Wells and Flow Data

Agency	Well	State Well No.	System	Status	Design Flow (gpm)	Drilled	Depth (ft-bgs)	Perforated Intervals (ft)
IRWD	LF-1	06S/08W-15A00	Nonpotable	Inactive	300	1989	800	200-790
IRWD	LF-2	06S/08W-12Q02	Potable	Active	300	1957, *redrilled 2010*	675	200-675
IRWD	LF-3	06S/08W-12J01	Potable	Inactive	350	1950	800	270-395; 400-785
IRWD	LF-4	06S/08W-12L02	Nonpotable	Inactive	200	1993	810	350-470 510-790
IRWD	LF-5	06S/08W-12A01	Nonpotable	Inactive	140	1997	800	350-780
IRWD	LF-7	06S/08W-12E00	Potable	Inactive	125	1994	1000	430-980
ETWD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Orange	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3-3 summarizes average annual pumping from 2006 – 2015 within the South East Management Area by agency. As shown, no groundwater development exists in the ETWD and City of Orange portions of the South East Management Area. In IRWD's portion of the South East Management Area only one well (LF-2) is currently active. Over the last 10 years, LF-2's annual pumping ranged from 0 acre-feet to 436 acre-feet and averaged approximately 125 acre-feet.

Table 3-3: Annual Pumping Average 2006-2015

Agency	Average Annual Production (AF/yr)
IRWD	125
ETWD	0
City of Orange	0
Total	**125**

Historical groundwater development within IRWD's portion of the South East Management Area has been limited to six wells in the Lake Forest region. However, only one well, LF-2, is currently operating. Due to the relatively low yield of these wells, IRWD considers production from these wells as a supplemental supply and does not rely on these wells to meet its firm demands.

Representative monthly pumping patterns for IRWD's LF-2 well are presented in Figure 3-6. As shown, monthly values vary considerably from one year to the next and have consisted of either: year round pumping, partial year pumping (5-7 months), or minimal pumping (0-2 months). Figure 3-7 shows a history of the total annual pumping for IRWD's LF-2 well from 2006 to 2015.

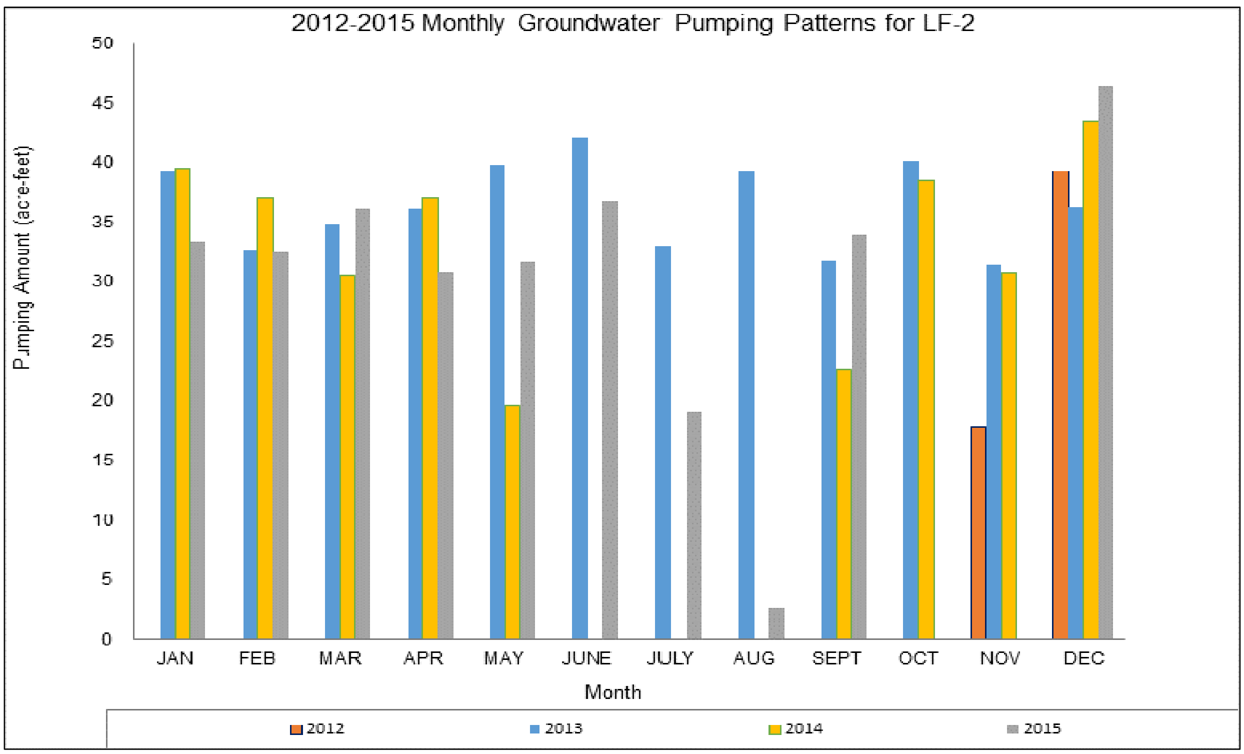

Figure 3-6: Monthly Groundwater Pumping Pattern in Well LF-2, 2012-2015

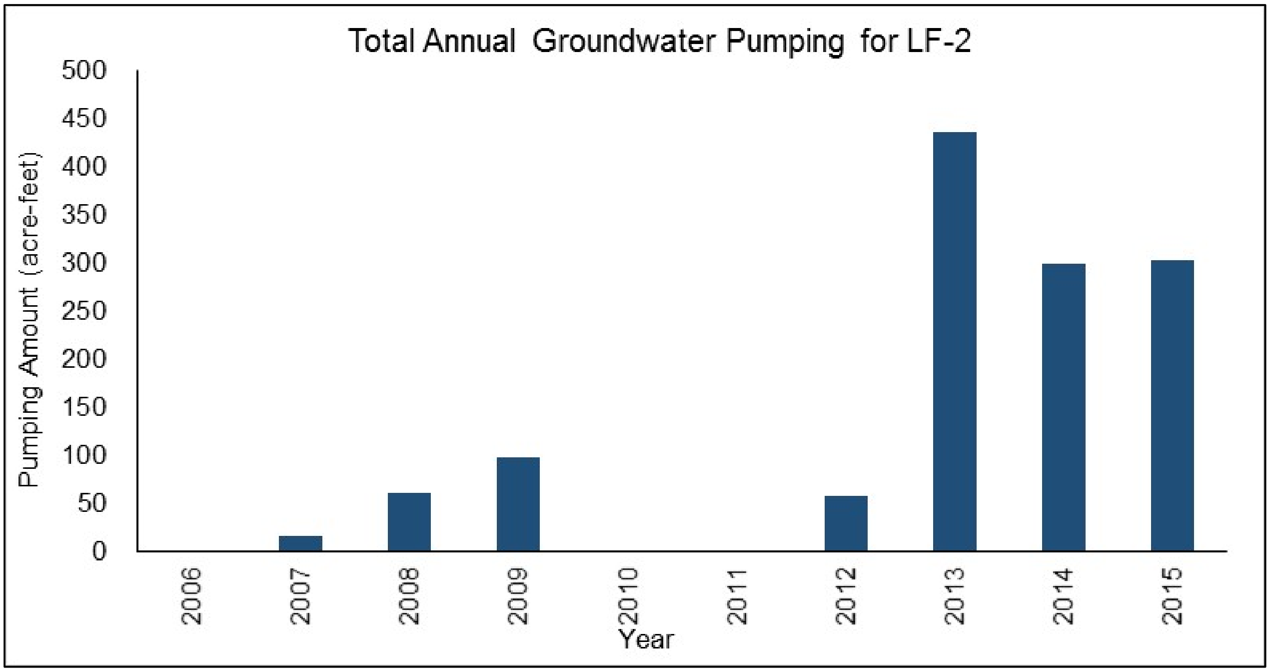

Figure 3-7: Total Annual Pumping for Well LF-2, 2006-2015

3.2.3 Groundwater Storage Data

Groundwater storage data for the South East Management Area are limited to IRWD's southern Lake Forest area. Based on available data, the total storage capacity within the South East Management Area is approximately 360,000 acre-feet: about 350,000 acre-feet in the IRWD's southern Lake Forest portion and about 11,000 acre-feet in the northern portion. The Lake Forest estimate includes the formation thicknesses at each well and an estimate of the aquifer's specific yield. The northern portion is estimated to contain approximately 11,000 acre-feet based on an estimated depth and specific yield of this region. To put this storage capacity into context, the total estimated storage within the OCWD Management Area is over 66 million acre-feet.

3.2.4 Groundwater Quality Conditions

Historically, only three of the six IRWD Lake Forest wells were permitted for potable use as the other three Lake Forest wells have had elevated levels of iron, manganese (Mn), electrical conductivity (EC) and total dissolved solids (TDS). Recent groundwater quality data for the South East Managementg Area which includes results for arsenic (As) is presented in Table 3-4. As presented, no other water quality data exists for the ETWD and City of Orange areas within the South East Management Area.

Table 3-4: Groundwater Quality in Selected Wells

Agency	Well Name	Well Use	Date Range	Avg TDS (#)[1] (mg/L)	Avg As (ug/L)	Avg Mn (mg/L)
IRWD	LF-2	Production	2011-2015	593	0.035	25.5
IRWD	LF-1	Production	1961-2000	>500 (21)		
IRWD	LF-4	Production	1993-2000	>500 (12)		
IRWD	LF-5	Production	1997-2001	>500 (5)		
IRWD	LF-3	Production	1991-1998	>500 (12)		
IRWD	LF-7	Production	1994-2001	<500 (12)		
City of Orange	N/A	N/A	N/A	N/A	N/A	N/A
ETWD	N/A	N/A	N/A	N/A	N/A	N/A

1 # = Number of Samples

3.2.5 Land Subsidence

No known land subsidence issues are known to exist in the South East Management Area.

3.2.6 Groundwater and Surface Water Interactions and Groundwater Dependent Ecosystems

IRWD's Lake Forest portion of the South East Management Area contains quaternary alluvium and terrace deposits that interact with and are drained by Serrano Creek. Serrano Creek is an intermittent stream that only flows during the rainy season following storm events. As a result, there are no groundwater dependent ecosystems present.

SECTION 4. WATER BUDGET

No groundwater development exists in the ETWD and City of Orange portions of the South East Management Area. In IRWD's Lake Forest portion of the South East Management Area only one well (LF-2) is currently operational. IRWD's LF-2 groundwater production is dependent upon infiltration from ephemeral creeks, precipitation and incidental recharge from irrigation. From 2006-2015, LF-2's annual pumping ranged from 0 acre-feet to 436 acre-feet and averaged 125 acre-feet. An average annual groundwater budget for the South East Management Area for the last 10 years is presented in Table 4-1. The development of individual components in the average annual groundwater budget are described in the following subsections.

4.1 BUDGET COMPONENTS

No groundwater development exists in the ETWD and City of Orange portions of the South East Management Area. For IRWD's Lake Forest portion of the South East Management Area, the components of the groundwater budget are presented in Table 4-1 and described below.

Table 4-1: Average Annual Groundwater Budget

Item	Total (acre-feet)
Recharge	2,935
Total Inflow	2,935
Groundwater Production	125
Subsurface Outflow	2,810
Total Outflow	2,935
Change in Storage	0

4.1.1 Recharge

Recharge includes infiltration from ephemeral creeks, precipitation and incidental recharge from irrigation. It was estimated to equal the total outflow as summarized in Table 4-1.

4.1.2 Groundwater Production

Groundwater production was taken from measured records by IRWD as summarized in Table 4-1.

4.1.3 Subsurface Outflow

Subsurface outflow was estimated to equal the subsurface inflow to the OCWD Management Area from foothills into the Irvine subbasin prorated by the fraction of that area located in the South East Management Area as summarized in Table 4-1.

4.2 CHANGES IN GROUNDWATER STORAGE

As presented in Section 4.1, groundwater pumping in the South East Management Area is relatively minor and averages only 125 acre-feet per year over the last 10 years. In addition, Section 3.2 indicates historic groundwater levels from 1991 to 2015 have been highly variable without any undesirable results. Groundwater levels are currently at or above historical high levels despite recent increased groundwater production and multiple years of below normal precipitation. These conditions indicate groundwater storage changes within the South East Management Area are within an acceptable range.

4.3 WATER YEAR TYPE

The water year type has little impact on the water budget in the South East Management Area given the minimal changes in groundwater levels observed through time

4.4 ESTIMATE OF SUSTAINABLE YIELD

As shown in Table 4-1 and described in Section 3.2, average annual groundwater production over the last 10 years has ranged from 0 acre-feet to 436 acre-feet and has averaged approximately 125 acre-feet without significant reductions in groundwater elevations. However, the recent years are considered relatively dry and the sustainable yield of the South East Management Area may be significantly greater than the 10-year average under normal and wet hydrologic cycles. Based upon the limited groundwater resources in the area it is unlikely demands would ever rise to the level of straining the water budget of the area. In terms of sustainable yield, it is more appropriate to look at the South East Management Area as part of the larger OCWD Management Area.

4.5 CURRENT, HISTORICAL, AND PROJECTED WATER BUDGET

No groundwater development exists in the ETWD and City of Orange portions of the South East Management Area. In IRWD's Lake Forest portion of the South East Management Area, a 2002 study by Boyle Engineering Corporation and a 2015 study by Dudek were performed in order to assess the potential for development of two future wells, LF-6 and LF-8, as well as the redrilling of existing inactive wells. A capital project for the design, construction and equipping of LF-1 is included in IRWD's 2016-17 capital budget. IRWD has no near term plans to drill wells LF-6 and LF-8. In 2000, its last active year, LF-1 pumped about 230 acre-feet. Over the last 10 years LF-2's annual pumping has ranged from 0 acre-feet to 436 acre-feet and averaged about 125 acre-feet. It is expected that when LF-1 is redrilled, groundwater production from IRWD's southern portion of the South East Management Area could increase significantly. Water produced from LF-1 could be used to provide supply to the nearby lake which currently is supplied by untreated imported water. Water produced could also potentially be pumped and conveyed to the Baker Water Treatment Plant for treatment if needed (Dudek, 2015). Due to the consistently lower yields from the aquifer in this area, it is expected that additional production from LF-1 will continue to be considered supplemental, and therefore insignificant in terms of IRWD's overall water supply for its Lake Forest area.

SECTION 5. WATER RESOURCE MONITORING PROGRAMS

5.1 OVERVIEW

This section describes surface and groundwater monitoring programs in the South East Management Area

5.2 GROUNDWATER MONITORING PROGRAMS

No groundwater development exists in the ETWD and City of Orange portions of the South East Management Area. In IRWD's Lake Forest portion of the South East Management Area six wells (both active and inactive) have been, and will continue to be, used to monitor the groundwater levels on a monthly basis. Section 3.2.1 provides information on the South East Management Area groundwater levels, and Figure 3-3 shows the locations of the Lake Forest wells within the South East Management Area.

5.3 OTHER MONITORING PROGRAMS

IRWD monitors groundwater quality in LF-2 as required by the California Code of Regulation (Title 22) and California Division of Drinking Water, Santa Ana District.

SECTION 6. WATER RESOURCE MANAGEMENT PROGRAMS

IRWD works with ETWD and City of Orange on plans for groundwater development within the South East Management Area and updates demand projections and the water budget accordingly.

IRWD: The compilation of land use data is the basis for IRWD's water resource planning including its portion of the South East Management Area. Per IRWD's 2015 Urban Water Management Plan (UWMP), the land use data obtained from multiple jurisdictions in IRWD's service area is used in conjunction with IRWD's applied water use factors in order to estimate water requirements.

ETWD: ETWD's water resource planning is based on the 2015 UWMP demand projections. Regional demands are forecasted by the Municipal Water District of Orange County and are then tailored to ETWD's service area using available data for land use, population, and economic growth, intermixed with a trajectory of conservation, which includes both additional future passive measures and active measures.

City of Orange: The City of Orange's current UWMP (2015) provides the basis for water resource planning in Orange's water service area. The UWMP, in conjunction with applicable water use factors, form the basis for any potential water use estimates required for potential planning use in the service area.

SECTION 7. NOTICE AND COMMUNICATION

There are three agencies within the South East Management Area, as follows:

- IRWD
- ETWD
- City of Orange

On May 30, 2016 a meeting was held with representatives from IRWD, ETWD, City of Orange and OCWD to discuss SGMA compliance via an Alternative to a GSP and the designation of IRWD as the lead agency for the South East Management Area. Draft copies of this South East Management Area plan were provided to ETWD and the City of Orange for review on September 15 and October 3, 2016.

The public was notified of this South East Management Area plan when it was presented to each agencies' governing body. Additional public notice and communication of this plan was provided by OCWD prior to its public meeting of its Board of Directors on December 14, 2016.

SECTION 8. SUSTAINABLE MANAGEMENT APPROACH

The Sustainable management approach for the South East Management Area is to continue monitoring groundwater levels and water quality to assure that conditions do not lead to significant and unreasonable (1) lowering of groundwater levels, (2) reduction in storage, (3) water quality degradation, (4) inelastic land subsidence or (5) unreasonable adverse effect on surface water resources.

SECTION 9. SUSTAINABLE MANAGEMENT RELATED TO GROUNDWATER LEVELS

9.1 HISTORY

As shown on Figure 3-4 historic groundwater levels in the IRWD's Lake Forest portion of the South East Management Area have been variable but have recovered to historical highs. Because existing groundwater pumping in the South East Management Area is relatively minor groundwater levels are expected to remain relatively steady in the future.

9.2 MONITORING OF GROUNDWATER LEVELS

Groundwater levels are currently monitored monthly in the six wells located in IRWD's Lake Forest portion of the South East Management Area. Because existing groundwater use is relatively minor the existing level of groundwater monitoring is expected to continue in the future.

9.3 DEFINITION OF SIGNIFICANT AND UNREASONABLE LOWERING OF GROUNDWATER LEVELS

No long-term reduction in groundwater levels in the South East Management Area are expected to occur.

9.4 DETERMINATION OF MINIMUM THRESHOLDS

Determination of a minimum threshold for groundwater levels has not been determined since no undesirable effects due to ground water levels have occurred in the past and are not foreseen in the future. Nevertheless, IRWD's Lake Forest well monitoring program is expected to continue to monitor water levels and groundwater quality in the future. If water levels start to show a consistent, long term decline and undesirable results are observed then minimum thresholds may be established.

SECTION 10. SUSTAINABLE MANAGEMENT RELATED TO BASIN STORAGE

No groundwater development exists in the ETWD and City of Orange portions of the South East Management Area. The total volume of groundwater storage in IRWD's portion of the South East Management Area has been estimated to be approximately 360,000 acre-feet (see Section 3.2.3).

10.1 DEFINITION OF SIGNIFICANT AND UNREASONABLE REDUCTION IN STORAGE

No significant long-term reduction in groundwater storage is expected to occur in the South East Management Area because of the limited groundwater use. However, a decline in groundwater storage may be determined unreasonable if one more of the following occurred:

1. Significant loss of well production capacity.
2. Degradation of water quality that significantly impacts the use of groundwater.

10.2 DETERMINATION OF MINIMUM THRESHOLDS

A minimum threshold for the reduction of groundwater storage in the South East Management Area is not anticipated since no undesirable effects have occurred in the past and are not foreseen in the future. Nevertheless, IRWD's Lake Forest monitoring program continuously tracks water levels and groundwater quality. If water levels show a consistent decline, IRWD's Lake Forest monitoring program would be expanded to examine any potential impacts and action would be taken to identify minimum thresholds as appropriate.

SECTION 11. SUSTAINABLE MANAGEMENT RELATED TO WATER QUALITY

No groundwater development exists in the ETWD and City of Orange portions of the South East Management Area. Groundwater quality in IRWD's portion of the South East Management Area is affected by the quality of recharge from Serrano Creek and precipitation and incidental recharge from irrigation.

11.1 DEFINITION OF SIGNIFICANT AND UNREASONABLE DEGREDATION OF WATER QUALITY

There are three elements that must be considered when evaluating the impact of groundwater quality degradation.

The first element is considering the causal nexus between groundwater management activities and groundwater quality. For example, groundwater contamination due to improper handling of toxic materials impacts groundwater quality; however, this water quality degradation is not caused by groundwater management activities.

The second element is the beneficial uses of the groundwater and water quality regulations, such as Maximum Contaminant Levels (MCLs) and other potable water quality requirements.

The third element that must be considered is the volume of groundwater impacted by groundwater quality degradation. If small volumes are negatively affected that don't materially affect the use of the aquifer or basin for its existing beneficial uses, then this would not represent a significant and unreasonable degradation of water quality. However, if the impacted volume grows, then it could reach a level that it becomes significant and unreasonable.

When considering all three elements, the definition of significant and unreasonable degradation of water quality is defined as degradation of groundwater quality in the South East Management Area to the extent that a significant volume of groundwater becomes unusable for its designated beneficial uses.

11.2 DETERMINATION OF MINIMUM THRESHOLDS

The minimum thresholds for groundwater quality are exceedances of Maximum Contaminant Levels (MCLs) or other applicable regulatory limits that are directly attributable to groundwater management actions in the South East Management Area that prevents the use of groundwater for its designated beneficial uses.

SECTION 12. SUSTAINABLE MANAGEMENT RELATED TO SEAWATER INTRUSION

The South East Management Area is located far from the ocean and thus there is no reason to consider the potential impact of seawater intrusion in this management area.

SECTION 13. SUSTAINABLE MANAGEMENT RELATED TO LAND SUBSIDENCE

Subsidence is not an issue for the South East Management Area given the following:

1. Minimal groundwater development exists in the South East Management Area.
2. The presence of shale and sandstone bedrock underlying the alluvial aquifer.
3. The alluvial aquifer is relatively thin and comprised mainly of sand and gravel with little clay.
4. Steady groundwater and storage levels.
5. Low risk of substantial groundwater level declines due to a minimal amount of groundwater production.

SECTION 14. SUSTAINABLE MANAGEMENT RELATED TO GROUNDWATER DEPLETIONS IMPACTING SURFACE WATER

Existing groundwater use in the South East Management Area is relatively minor (see section 4.1.1) and the surface streams and creeks are ephemeral. Therefore, there is no need for a program to manage groundwater depletions that may impact surface water.

SECTION 15. PROTOCOLS FOR MODIFYING MONITORING PROGRAMS

Protocols for modifying monitoring programs are based on changes from historical conditions or changes in water quality that begin to approach or exceed regulatory limits.

15.1 ESTABLISHMENT OF PROTOCOLS FOR WATER QUALITY

Changes in the South East Management Area water quality sampling program can be triggered by one or more of the following:

1. A change or anticipated change in water quality regulations;
2. A constituent in a sample approaches or exceeds a regulatory water quality limit or Maximum Contaminant Level, notification level, or first time detection of a constituent;
3. Analysis of water quality trends.

15.2 ESTABLISHMENT OF PROTOCOLS FOR GROUNDWATER ELEVATIONS/STORAGE

Because it is desirable to use the same well to obtain water level records over long periods of time it is rare that changes are made to an existing groundwater level monitoring program. The most common reason a well is dropped from a monitoring program is that it is no longer available. If this occurs, IRWD will evaluate the nearest similar well or the need to construct a replacement well and add it to the monitoring program as appropriate.

The frequency of groundwater level monitoring in IRWD's Lake Forest portion of the South East Management Area is monthly and historic water levels tend to be relatively consistent (see Figure 3-4). Therefore, the monitoring frequency may be reduced in the future. However, if water levels start to change and storage levels start to decline, then the frequency of groundwater level monitoring would likely return to a monthly frequency.

SECTION 16. PROCESS TO EVALUATE NEW PROJECTS

When new projects are proposed within the South East Management Area, the agency proposing the project will be responsible for preparing a CEQA document to ensure alternatives have been evaluated and any significant and unreasonable results are mitigated.

SECTION 17. REFERENCES

Following are references and technical studies for the South East Management Area.

- Groundwater Supply Evaluation for the Los Alisos System Phase 1, July 2002, Boyle Engineering Corporation.
- Lake Forest Groundwater Conveyance Analysis Results (Dudek, November 5, 2015).
- Geohydrology and Acritical-Recharge Potential of the Irvine Area Orange County, California (J. A. Singer, January 8, 1973).
- Ground Water Management, Irvine Area, Orange County, California (Harvey O. Banks, Consulting Engineer, Inc.).
- Communication with OCWD. Email dated November 28, 2016.

Basin 8-1 Alternative

Santa Ana Canyon Management Area

Prepared by: Orange County Water District

In collaboration with: Cities of Anaheim, Chino Hills, Yorba Linda, Corona; Yorba Linda Water District; Counties of Orange and Riverside

January 1, 2017

ORANGE COUNTY WATER DISTRICT

SINCE 1933

Basin 8-1 Alternative

Santa Ana Canyon Management Area

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Prepared for the Department of Water Resources, pursuant to Water Code §10733.6(b)(3)

January 1, 2017

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SECTION 1. EXECUTIVE SUMMARY

The Santa Ana Canyon Management Area covers the easternmost extent of the Department of Water Resources (DWR) Basin 8-1, Coastal Plain of Orange County Groundwater Basin. This Management Area is created for this Alternative (under 23 CCR 354.20) because of the unique characteristics of the Santa Ana Canyon and the appropriateness of developing different management objectives and strategies for this portion of the Basin. These different objectives and management approaches, as described in this Section, account for the significant differences in groundwater use, geology, aquifer characteristics, and other factors which distinguish Santa Ana Canyon from other portions of the Basin. Figure 1-1 shows the extent of the Santa Ana Canyon Management Area and the agencies with jurisdiction in the Santa Ana Canyon Management Area. Table 1-1 lists the agencies shown on Figure 1-1.

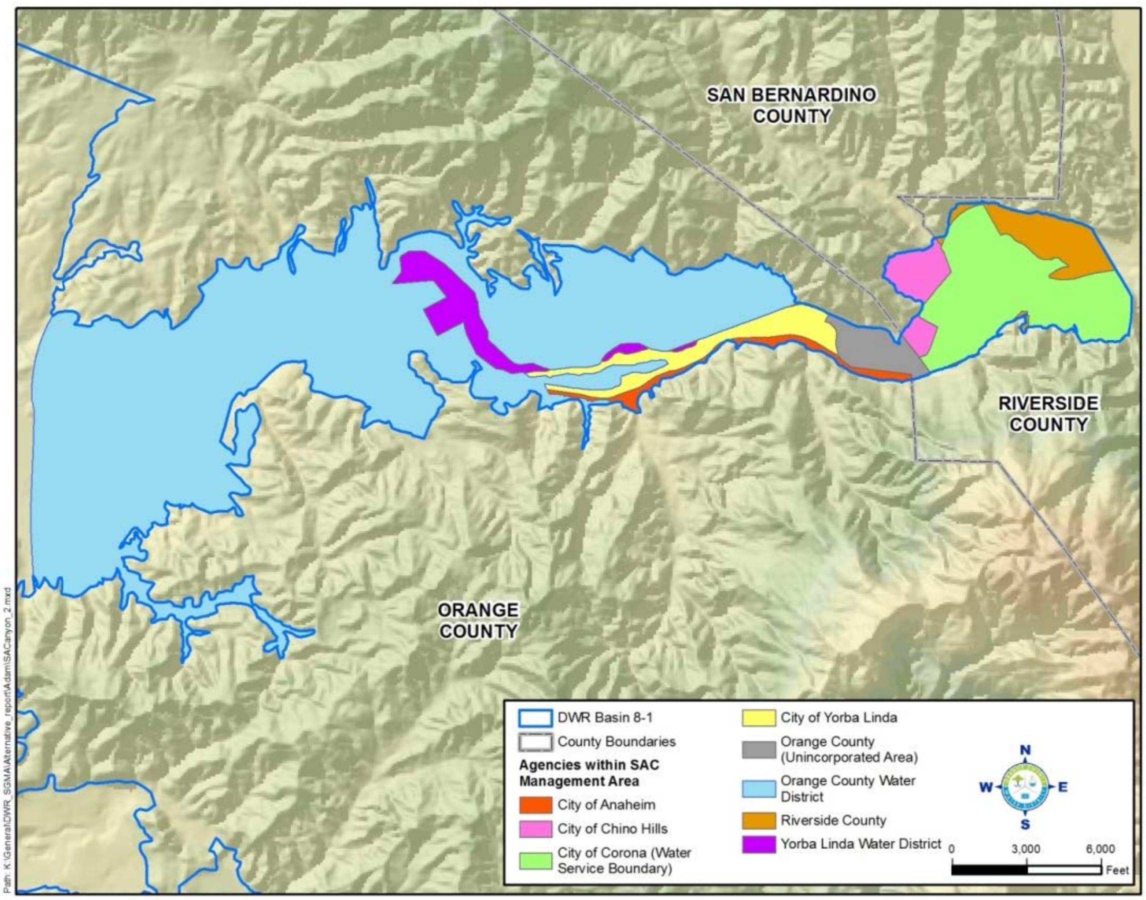


Figure 1-1: Agencies in the Santa Ana Canyon Management Area

The water resources in the Santa Ana Canyon Management Area include the Santa Ana River and limited groundwater. Groundwater is primarily located in a thin alluvial aquifer that is 90 to 100 feet thick and is a combination of infiltrated Santa Ana River water and subsurface inflow from the adjacent foothills. Groundwater production from the alluvial aquifer is primarily used for irrigation but some is also used for potable purposes. Groundwater production represents one to two percent of the total available water supply to the Santa Ana Canyon Management Area due to the significantly larger flow of the Santa Ana River as shown on Table 1-2. Even under projected dry conditions, groundwater production is expected to be less than four percent of the total available water supply.

Table 1-1: Agencies in Santa Ana Canyon Management Area

Agency
City of Anaheim
City of Chino Hills
City of Yorba Linda
City of Corona Water Service Area
Orange County Water District
County of Orange
Riverside County
Yorba Linda Water District

Table 1-2: Water Budget, 10-Year Average (2006-15) and Dry-Year Condition

Flow Component	10-Yr Avg: 2006-15 (afy)	Dry-Year Condition (afy)
Santa Ana River Base Flow	100,400	44,000
Santa Ana River Storm Flow	72,300	11,300
Subsurface Inflow	5,000	5,000
TOTAL INFLOW	**177,700**	**60,300**
Santa Ana River Base Flow	98,820	42,030
Santa Ana River Storm Flow	72,300	11,300
Evapotranspiration	740	740
Groundwater Production	1,840	2,230
Subsurface Outflow	4,000	4,000
TOTAL OUTFLOW	**177,700**	**60,300**

Per the monitoring discussed in Section 5, groundwater levels in the Santa Ana Canyon Management Area are relatively stable, having been consistently 20 to 30 feet below ground surface since 1991, indicating that the supply of subsurface inflow and surface water from the Santa Ana River is more than sufficient to sustain local groundwater production. Groundwater quality is suitable for irrigation and potable uses. Native groundwater from the surrounding foothills tends to have naturally elevated total dissolved solids (TDS) and manganese concentrations. Most wells in the canyon appear to produce a blend of infiltrated Santa Ana River water, and native groundwater, with some wells producing more infiltrated Santa Ana River water than others.

OCWD monitors Santa Ana River flow and quality as well as groundwater levels, quality, and production in the Santa Ana Canyon Management Area (see Section 5). Moreover, OCWD has a wide variety of water resource management programs that cover the OCWD Management Area as well as programs in the upper Santa Ana River watershed to address Santa Ana River flow and quality (see Section 6). These programs are important in protecting the quality of the Santa Ana River, which has a significant influence on the groundwater quality in the Santa Ana Canyon Management Area.

The approach to managing the Santa Ana Canyon Management Area is for OCWD, in cooperation with the County of Orange, to continue monitoring sustainable conditions and monitor to ensure that no significant and unreasonable results occur in the future, both in the Santa Ana Canyon portion of the Basin and in the other hydrologically connected portions of the Basin.

Due to the unique conditions documented within the Santa Ana Canyon Management Area, it will not be difficult to prevent conditions that could lead to significant and unreasonable undesirable results due to the low risk of increased groundwater production, little available developable land, and continued high flows of the Santa Ana River relative to the amount of groundwater production. A summary of the applicable undesirable results that must be prevented under SGMA is presented below. A more detailed description of these can be found in Sections 8 to 13.

1. **Water Levels:** Long-term reduction in groundwater levels in the Santa Ana Canyon Management Area are not foreseeable given the high volume of Santa Ana River flow relative to the amount of groundwater production and the high rate at which the shallow groundwater formations recharge as a result of surface flow in the Santa Ana Canyon; however, if an unforeseen long-term reduction in groundwater levels were to occur, water levels could reach a significant and unreasonable level if one or more of the following occurred as a result of reduced groundwater levels:
    a. Loss of significant riparian habitat along the Santa Ana River.
    b. Significant loss of well production capacity (in the Santa Ana Canyon Management Area).
    c. Degradation of water quality that significantly impacts the beneficial uses of groundwater.
2. **Storage:** As with groundwater levels, long-term reduction in groundwater storage in the Santa Ana Canyon Management Area is not projected to occur; however, an unforeseen decline in groundwater storage could reach a significant and unreasonable level if such a decline caused one or more of the following:
    a. Loss of significant riparian habitat along the Santa Ana River.
    b. Significant loss of well production capacity.
    c. Degradation of water quality that significantly impacts the beneficial uses of groundwater.
3. **Water Quality:** The significant and unreasonable degradation of water quality is defined as the degradation of groundwater quality in the Santa Ana Canyon Management Area that is attributable to groundwater production or recharge practices within the Santa Ana

Canyon Management Area that cause a significant volume of groundwater to become unusable for its designated beneficial uses.

4. **Seawater Intrusion:** This does not apply to the Santa Ana Canyon Management Area because this area if far removed from the coastline.
5. **Subsidence:** This does not apply to the Santa Ana Canyon Management Area due to:
   a. The presence of shale and sandstone bedrock underlying the alluvial aquifer.
   b. The alluvial aquifer is thin, generally less than 100 feet, and comprised mainly of sand and gravel with little clay.
   c. Groundwater levels and groundwater storage are stable.
   d. Very low risk of substantial groundwater level declines due to de minimis amount of groundwater production relative to the overall inflow of water to the Santa Ana Canyon Management Area.
6. **Groundwater Depletions Impacting Surface Water:** Due to hydrogeologic conditions and land use limitations, groundwater production in the Santa Ana Canyon Management area has had and is projected to have a de minimis effect on groundwater conditions and flows of surface water through the canyon. Therefore, this factor does not apply to the Santa Ana Canyon Management Area.

SECTION 2. AGENCY INFORMATION

2.1 HISTORY OF AGENCIES IN SANTA ANA CANYON MANAGEMENT AREA

As shown on Figure 2-1, eight agencies have jurisdiction within the Santa Ana Canyon Management Area. The footprint of the various agencies within the Santa Ana Canyon Management Area has evolved over time due to annexations and changes in the sphere of influence (e.g., City of Corona water service area, OCWD annexation). In Fall 2013 OCWD completed annexing a portion of the Yorba Linda Water District (YLWD) and City of Anaheim into OCWD's service area. The annexation was done in response to a request from these agencies to have a portion of their service area included within OCWD's boundaries. Table 2-1 lists the agencies and the approximate area covered by each.

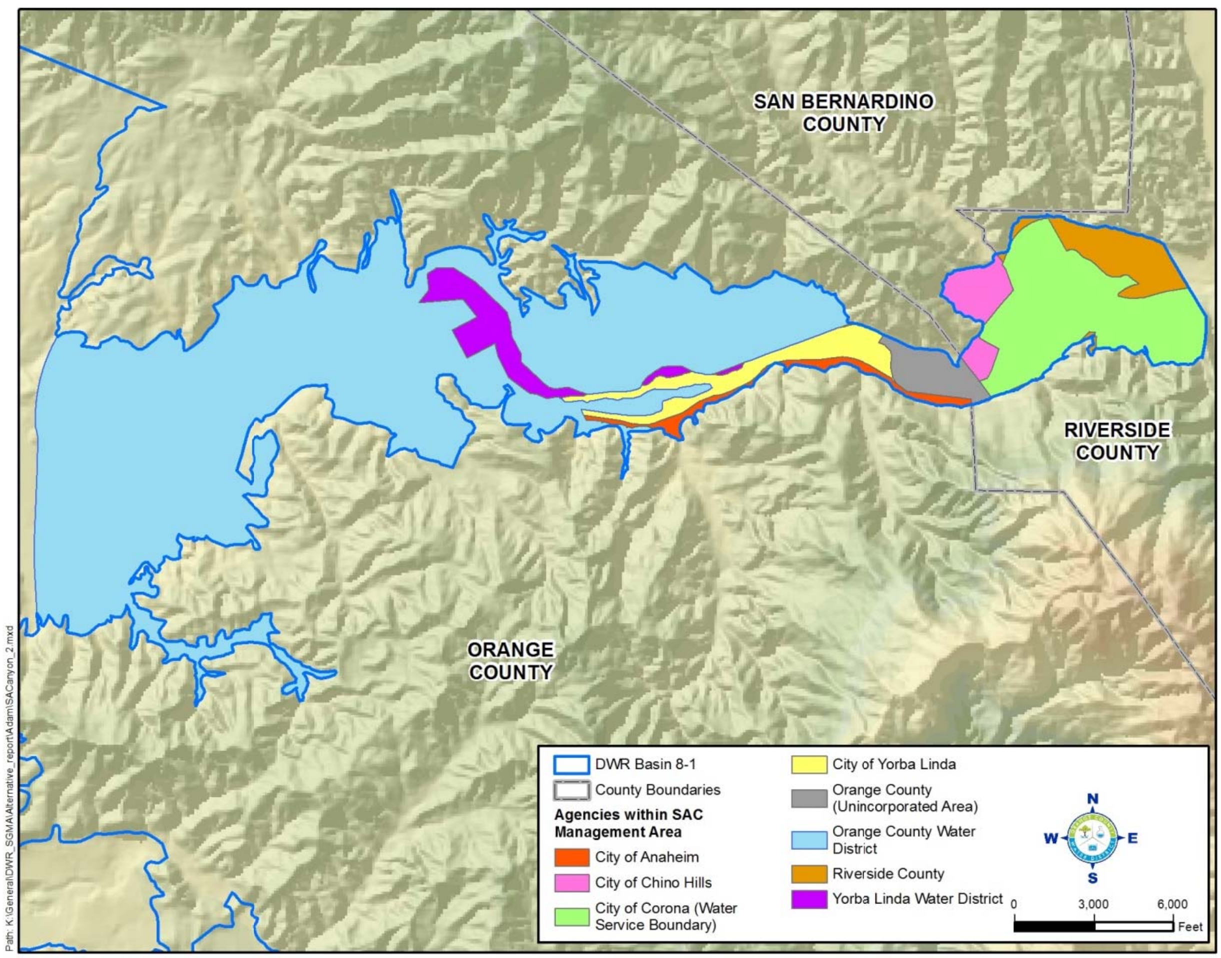


Figure 2-1: Agencies in the Santa Ana Canyon Management Area

Table 2-1: Agencies in Santa Ana Canyon Management Area and Area Covered

Agency	Area Covered (acres)
City of Anaheim	90
City of Chino Hills	130
City of Yorba Linda	220
City of Corona Water Service Area*	660
Orange County Water District	4,310
County of Orange	120
Riverside County	200
Yorba Linda Water District	190
Total Area	**5,920**

*Note that the City of Corona's service area includes areas within the County of Orange.

The Santa Ana Canyon Management Area covers 2.6 percent of Basin 8-1, which has a total area of 223,600 acres or 350 mi^2.

As shown on Figure 2-1 and in Table 2-1, the City of Corona represents the largest water service provider in the Riverside County portion of the Management Area, covering about 660 acres. In this area, Corona provides about 368 acre-feet per year (2015 total) of water to approximately 663 connections, including 639 single family residences, 1 multi-family residence, 17 commercial, and 6 additional connections (including landscape). Water source types include groundwater pumped from the adjacent Temescal Subbasin and treated imported Colorado River water purchased from Metropolitan Water District of Southern California.

2.2 GOVERNANCE AND MANAGEMENT STRUCTURE

There are currently no groundwater withdrawals or plans for withdrawals within the portions of the Santa Ana Canyon Management Area that are overlain by the City of Anaheim, City of Chino Hills, City of Yorba Linda, Riverside County, and the Yorba Linda Water District. Key reasons for the lack of significant production are the lack of demands in these areas, the relatively poor quality of groundwater in the Santa Ana Canyon Management Area, and lack of developable land due to land use limitations. In addition, there are no groundwater withdrawals or plans for withdrawals by the City of Corona; although there are existing groundwater withdrawals within the Corona service area, the wells are owned and operated by the County of Orange for golf course irrigation. As mentioned above, Corona delivers water from sources outside of the Santa Ana Canyon Management Area.

Accordingly, no formal groundwater governance and management structure is needed for the areas in the Santa Ana Canyon Management Area covered by these agencies other than the existing monitoring program that OCWD already carries out in accordance with its authorities under the OCWD Act. The governance and management structure of OCWD is described in the OCWD Management Area part of this report. As will be shown later in this section, groundwater withdrawals by the County of Orange and private users within the Santa Ana

Canyon Management Area are de minimis compared to the overall flow of water through the Santa Ana Canyon Management Area, and they are expected to remain at current sustainable levels. As a result, there is no need for other agencies to establish groundwater governance or management in the Santa Ana Canyon Management Area beyond existing levels of monitoring; however, groundwater production, level and quality data will continue to be collected and reported to DWR by OCWD per CASGEM and SGMA requirements.

2.3 LEGAL AUTHORITY

The legal authority of OCWD is described in the OCWD Management Area part of this report. As described in the OCWD Management Area part of the report, OCWD has obtained water rights from the State Water Resources Control Board (SWRCB) to all of the flows in the Santa Ana River arriving at Prado Dam. As a result, any future groundwater production within the Santa Ana Canyon Management Area would be reviewed by OCWD and the SWRCB to ensure it does not interfere with OCWD's existing water rights. Moreover, though outside of OCWD's boundaries, OCWD currently monitors portions of Santa Ana Canyon pursuant to its authority under Section 2, subparagraphs 5, 6, 7 and 14, of the OCWD Act.

The Orange County Well Ordinance (County Ordinance No. 2607) requires that a permit be obtained from Orange County prior to the construction or destruction of any well. In unincorporated areas and in 29 of 34 Orange County cities, the Orange County Health Officer is responsible for enforcement of the well ordinance. In the remaining five cities (Anaheim, Buena Park, Fountain Valley, Orange and San Clemente), well ordinances are enforced by city personnel. Any plans for wells in areas covered by Riverside and San Bernardino Counties would be reviewed by OCWD to ensure they did not interfere with OCWD's rights to Santa Ana River flows.

2.4 BUDGET

OCWD's costs for data collection within the Santa Ana Canyon Management Area are contained within OCWD's budget for data collection in the OCWD Management Area, which is presented in the OCWD Management Area portion of this report. The only future costs that will be incurred by the County of Orange are related to collecting production data from wells used to irrigate the County-owned Green River Golf Course. The other agencies within the Santa Ana Canyon Management Area will not incur any additional costs to comply with this Section of the Alternative since no further monitoring other that already undertaken by OCWD and Orange County is believed needed in order to prevent undesirable results from occurring. As a result, an estimated budget for other agencies has not been defined for the Santa Ana Canyon Management Area due to the minimal nature of the effort to collect and report groundwater production, level and water quality data.

SECTION 3. MANAGEMENT AREA DESCRIPTION

3.1 SANTA ANA CANYON MANAGEMENT AREA

The Santa Ana Canyon is a narrow east-west trending canyon between the Santa Ana Mountains to the south and the Chino Hills to the north near the intersection of Orange, San Bernardino and Riverside Counties. As shown on Figure 3-1, a key feature is the Santa Ana River, which is southern California's longest coastal river, extending 96 miles from its headwaters in the San Bernardino Mountains to the Pacific Ocean with a watershed that covers over 2,600 square miles. Just upstream of the Santa Ana Canyon is Prado Dam, which was constructed by the US Army Corps of Engineers in 1941 to reduce flood risks to Orange County.

The canyon has been infilled by Quaternary age (2.6M years to present) alluvial deposits of the Santa Ana River. The adjacent Chino Hills and Santa Ana Mountains are composed of various older consolidated sedimentary, igneous and metamorphic rocks. The water resources in the Santa Ana Canyon Management Area include the Santa Ana River and groundwater. Groundwater occurs in the alluvial deposits under generally unconfined conditions and is sourced from a combination of Santa Ana River recharge and subsurface inflow from the adjacent Chino Hills and Santa Ana Mountains. The DWR Basin 8-1 boundary in the Santa Ana Canyon follows the trace of the alluvial deposits as shown on Figure 3-2. In 2016, portions of the previous basin 8-1 boundary were revised by DWR at the request of OCWD to more closely align with the recent geologic mapping of the alluvial deposits.

The Santa Ana Canyon Management Area covers the area of alluvial deposits in the Santa Ana Canyon east of Imperial Highway (Hwy 90), as shown on Figure 3-3. Imperial Highway was selected as the western boundary of the Santa Ana Canyon Management Area because this is where the groundwater basin transitions from a relatively thin alluvial aquifer to a deep multi-layered alluvial basin. Moreover, Imperial Highway is the approximate boundary of OCWD's groundwater flow model, allowing subsurface outflows from the entire Santa Ana Canyon Management Area to be readily quantified for purposes of the water budget and monitoring groundwater in storage.

Previously published reports indicated that the alluvial deposits in Santa Ana Canyon ranged from 90 to 100 feet thick (USGS, 1964). To further characterize the alluvial deposits in the Santa Ana Canyon, all available well logs were reviewed and two cross-sections were developed. Figure 3-4 shows the cross-section locations and the wells used to develop the cross sections. Figure 3-5 presents cross-sections A-A' and B-B'. As shown on Figure 3-5, the thickness of the alluvial deposits in the Santa Ana Canyon are consistent with those reported by the USGS (1964).

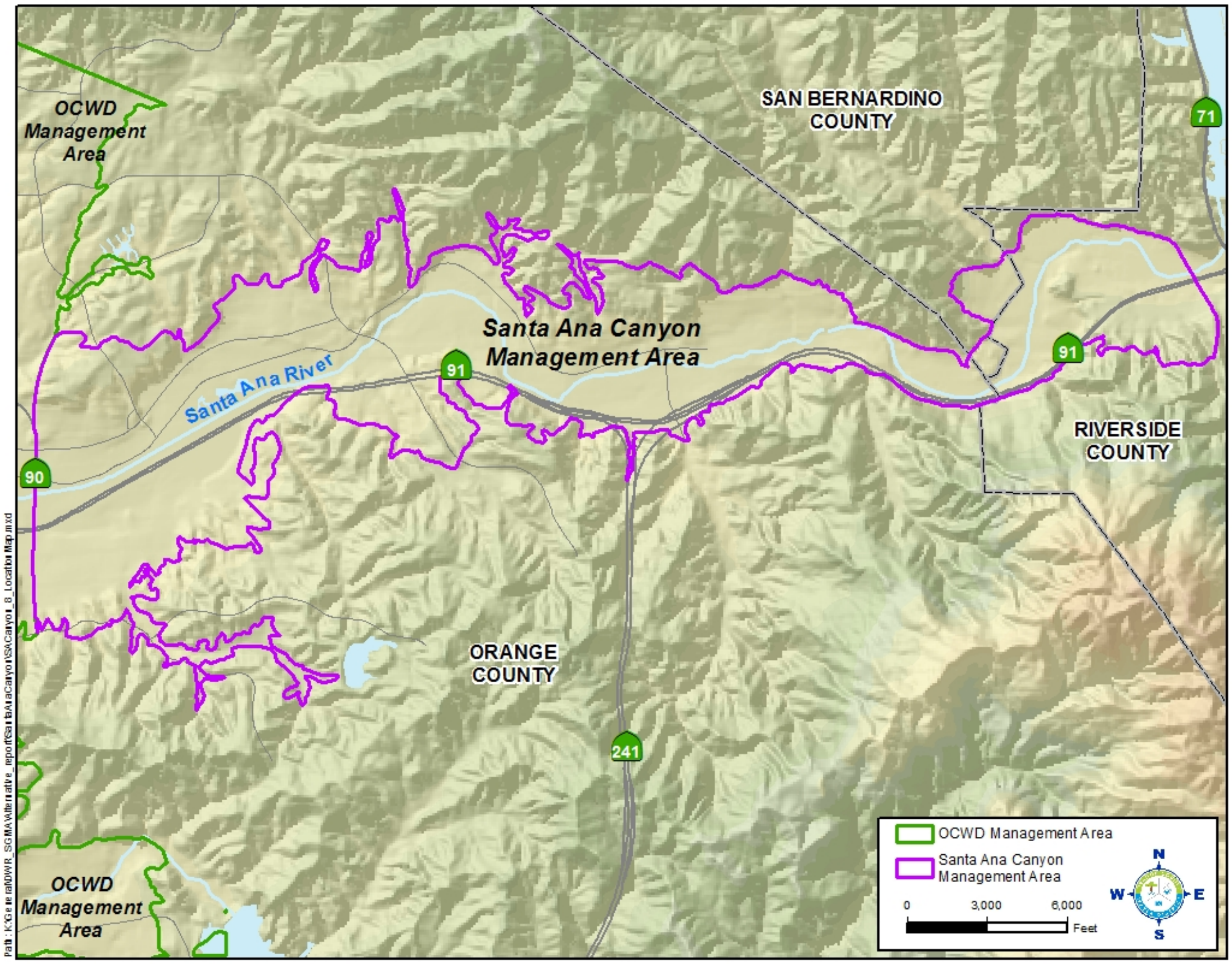


Figure 3-1: Boundaries of Santa Ana Canyon Management Area

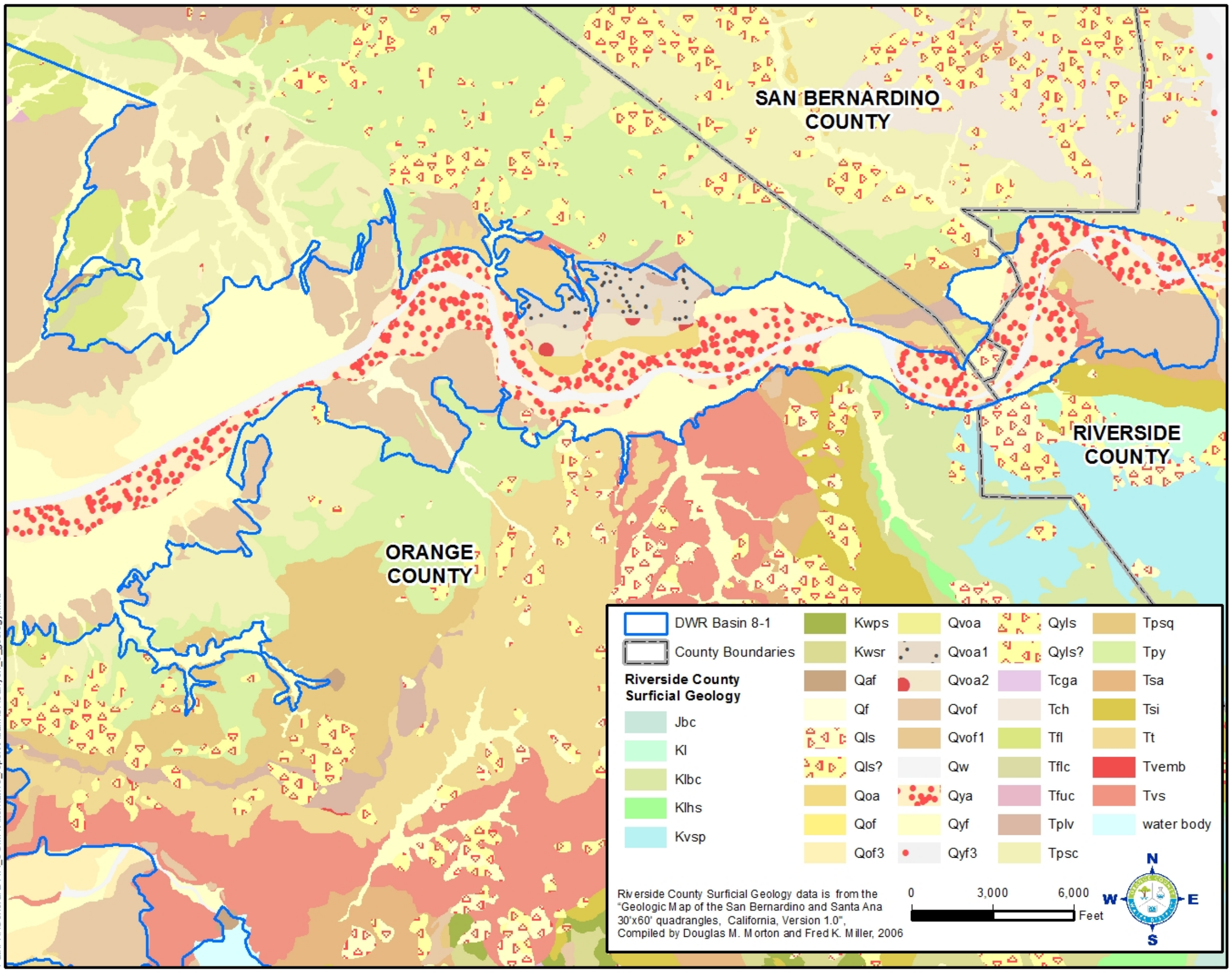


Figure 3-2: Geology

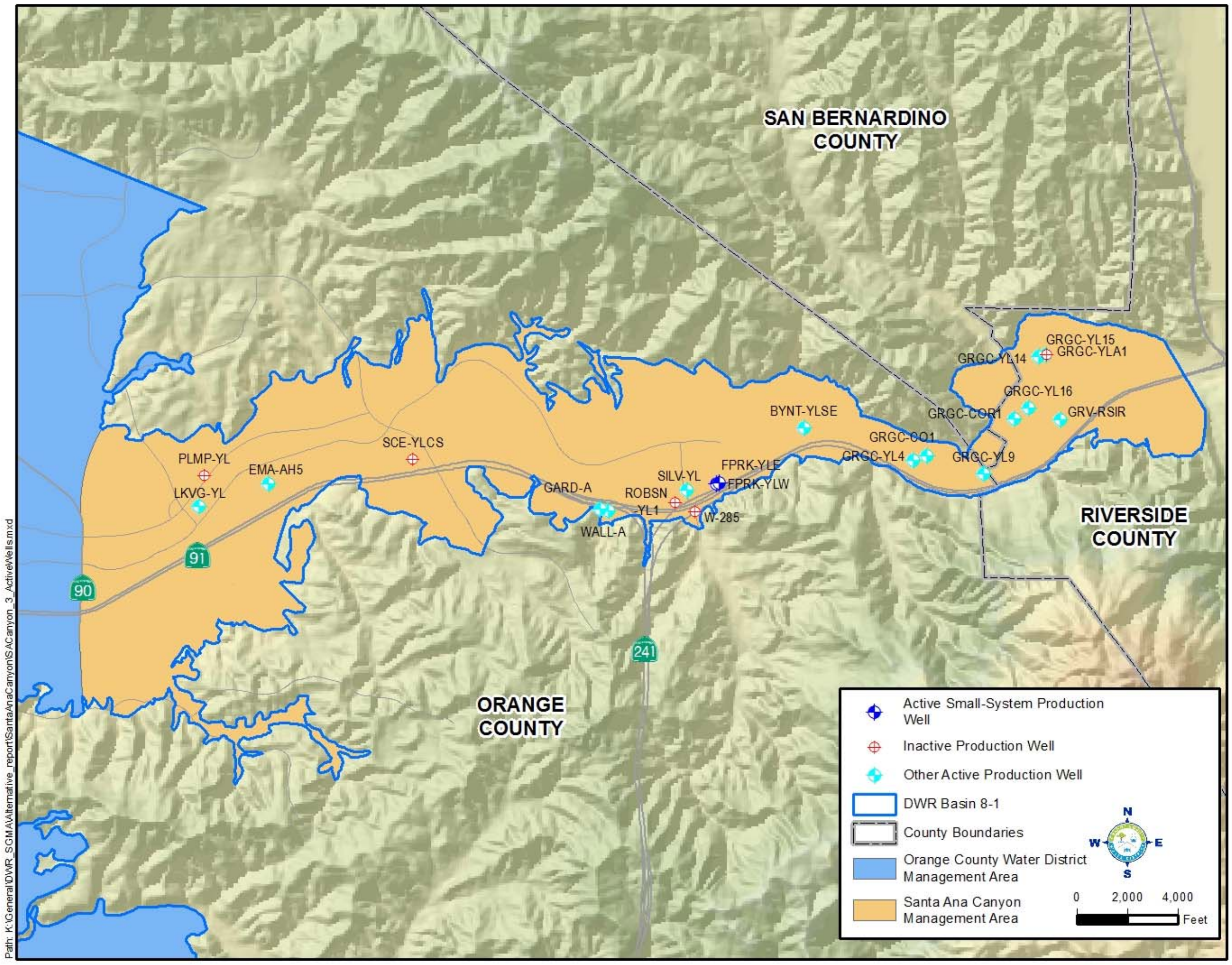


Figure 3-3: Groundwater Production Wells (Active and Inactive)

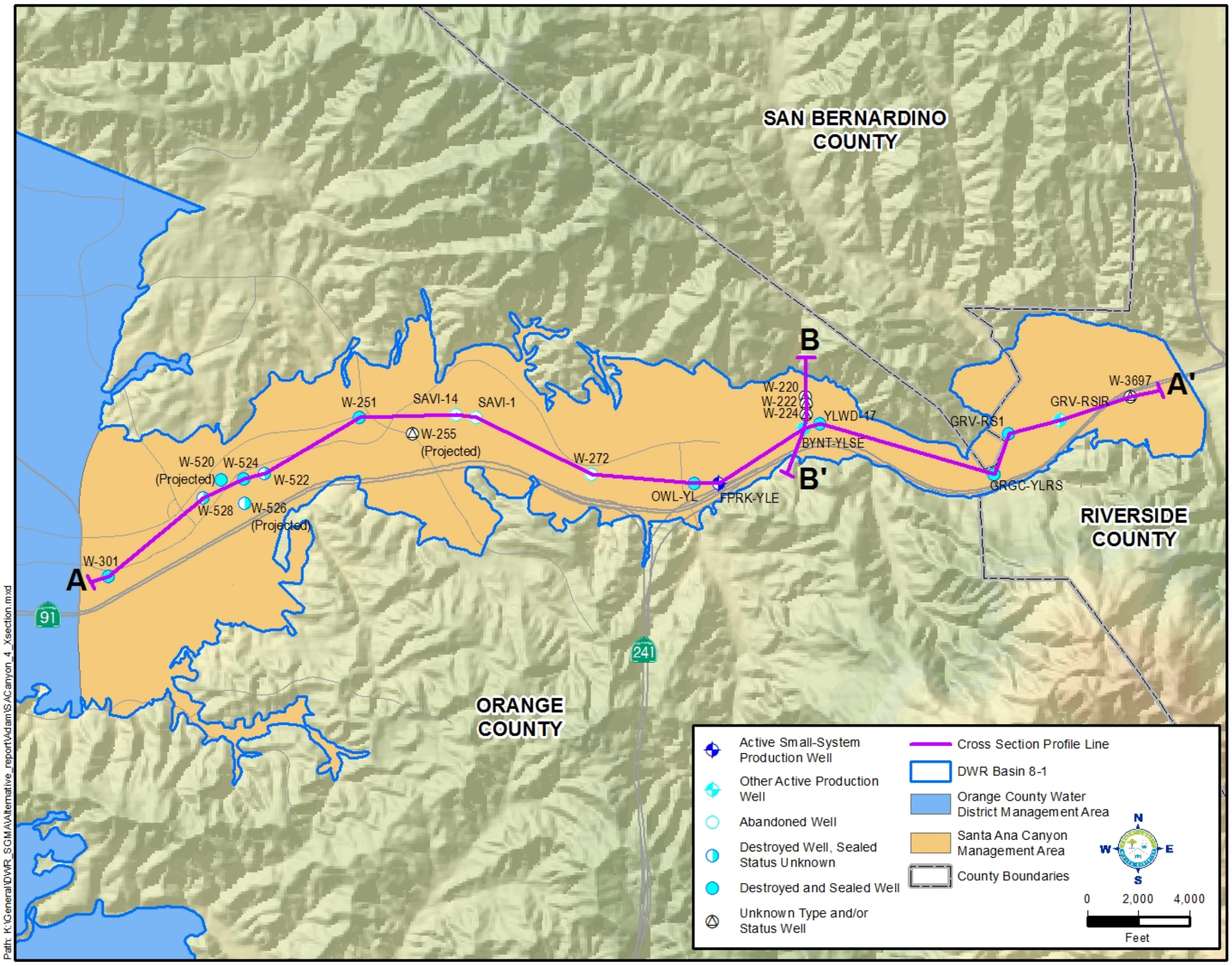


Figure 3-4:Cross-Section Locations

3.1.1 Jurisdictional Boundaries

As described in Section 2, there are eight agencies with jurisdiction in the Santa Ana Canyon Management Area as shown on Figure 2-1. The western boundary of the Santa Ana Canyon Management Area is parallel to Imperial Highway and is within OCWD's jurisdiction.

3.1.2 Existing Land Use Designations

As described in the OCWD Management Area part of this report, much of the land use in Orange County is urban. The Santa Ana Canyon Management Area has some dedicated open-space due to the presence of the Santa Ana River and adjacent floodplain and the Chino Hills State Park, located in the far northeastern portion of the Santa Ana Canyon Management Area. The Green River Golf Club owned by the County of Orange covers approximately 220 acres along the river near the intersections of Orange, Riverside, and San Bernardino counties.

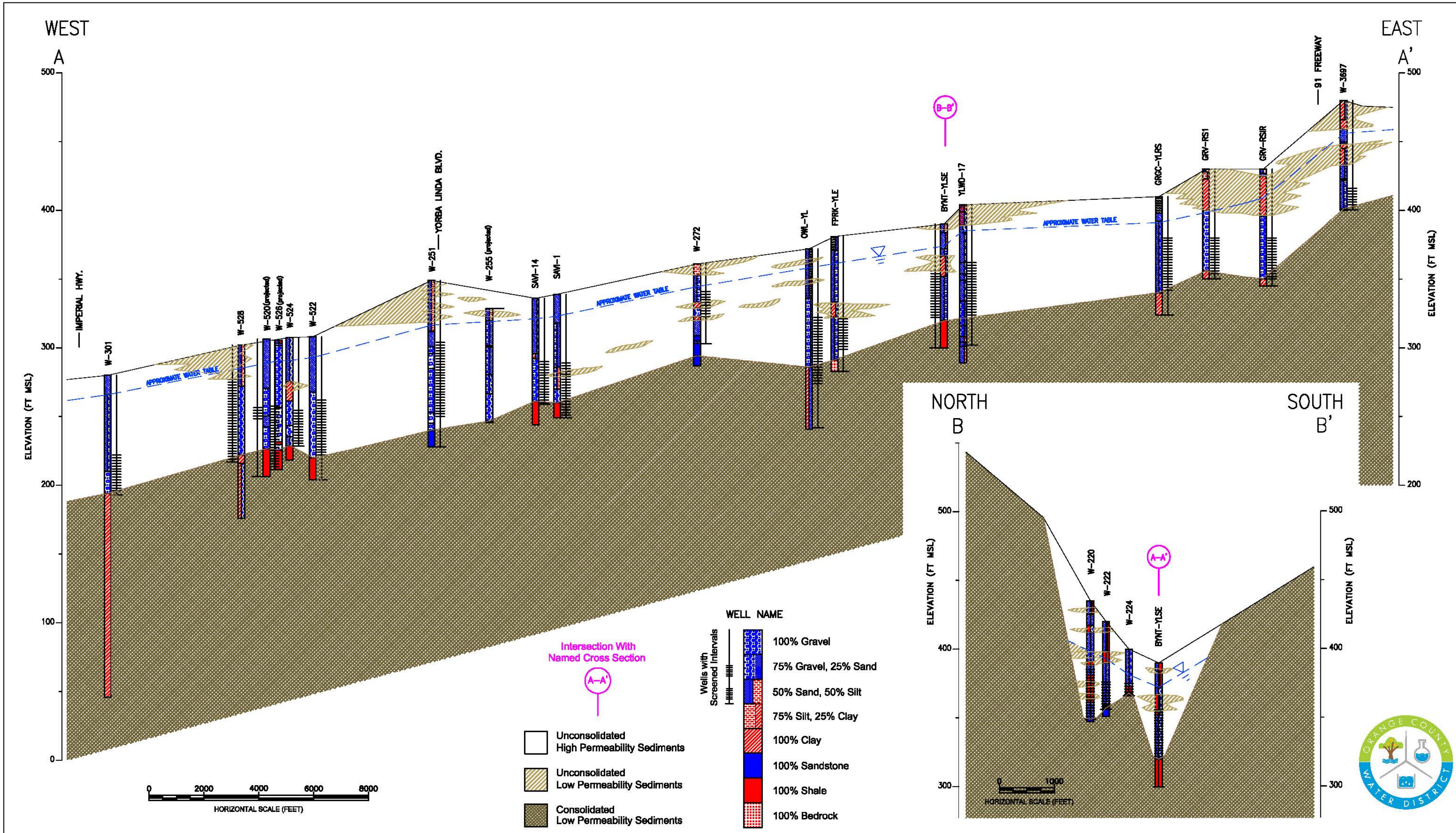


FIGURE 3-5: HYDROGEOLOGIC CROSS SECTION ALONG THE SANTA ANA RIVER BELOW PRADO DAM

Figure 3-6 shows the land uses in the Santa Ana Canyon Management Area as shown by the USGS topographic map of the area. Note that the areas shaded in purple are urbanized areas. There has been additional development in the area since the map was prepared in 2000; however, much of it is outside of the Santa Ana Canyon Management Area in the surrounding foothills.

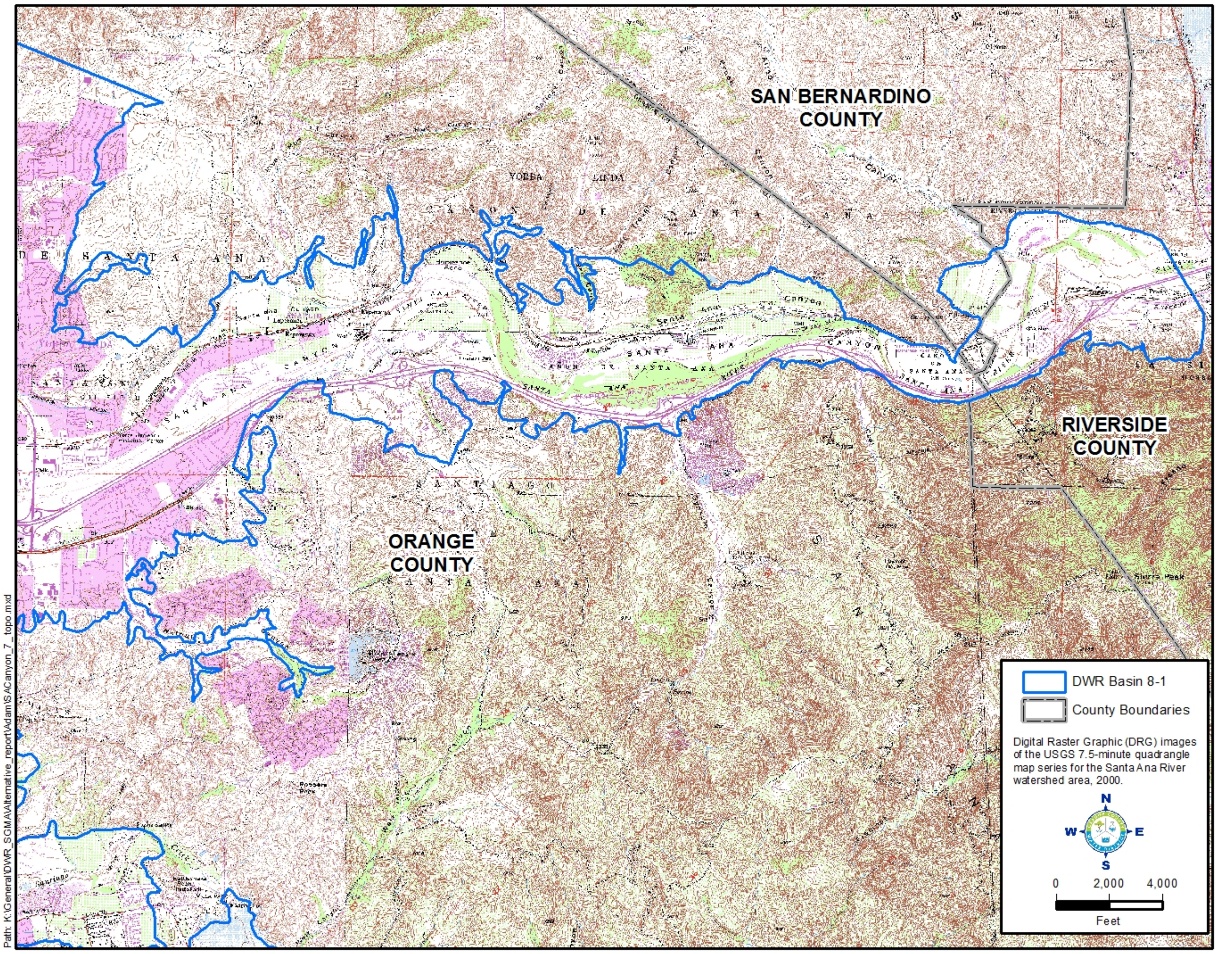


Figure 3-6: Land Uses

3.2 GROUNDWATER CONDITIONS

Groundwater within the Santa Ana Canyon Management Area occurs in a narrow canyon within a relatively thin alluvial aquifer that is less than 100 feet thick in most places (see Figure 3-5).

3.2.1 Groundwater Elevation

Groundwater elevations in the Santa Ana Canyon Management Area tend to be stable. Hydrographs from four wells show that water levels vary over a narrow range as shown on Figure 3-7. Well locations are shown on Figure 3-3 and cover the eastern (GRV-RSIR), south-central (FPRK-YLE/SILV-YL, and western (SCE-YLCS) areas of the Santa Ana Canyon Management Area. Maximum high water levels in many wells were recorded in 2004, which was a record-breaking wet year with very high sustained flows in the Santa Ana River. Low water levels appear to be primarily related to short term local pumping. For all four wells, groundwater is approximately 20 to 30 feet below ground surface in the vicinity of the wells. Since the Santa Ana River channel is incised in some areas by 10 to 15 feet below the surrounding area, the depth to groundwater is even lower directly beneath the river channel.

The consistent, stable nature of groundwater elevations in the Santa Ana Canyon Management Area shows that aquifer is generally full, which is consistent with the finding that here are no measurable losses of flows between upstream Prado Dam and OCWD's diversion to its recharge system just below Imperial Highway.

OCWD, in cooperation with the County of Orange, will begin collecting groundwater elevation data in 2017 at selected wells at the Green River Golf Course to complement existing groundwater elevation monitoring data. Note that wells SILV-YL and SCE-YLCS are monitored for the CASGEM program.

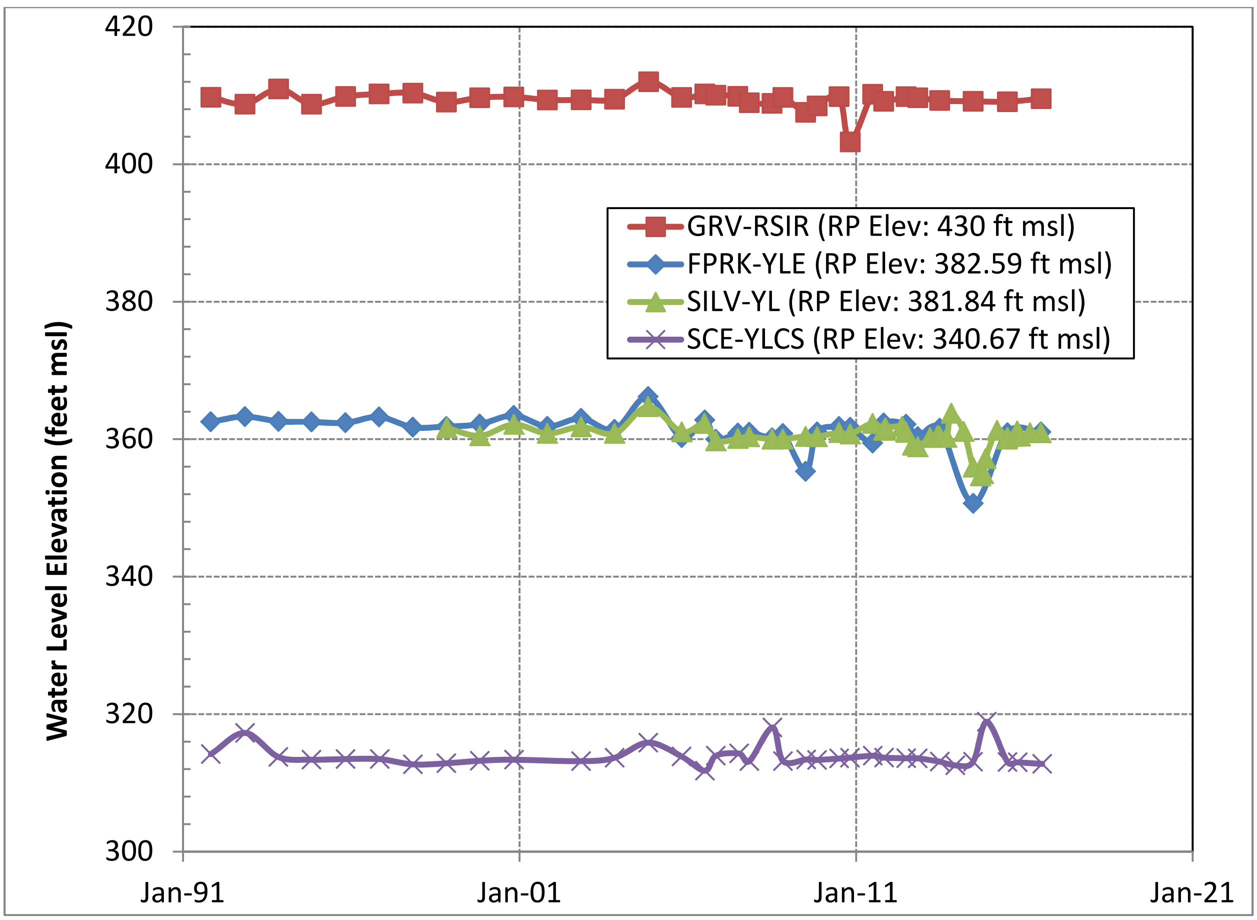


Figure 3-7: Water Level Hydrographs of Selected Wells

3.2.2 Groundwater Beneficial Uses and Regional Pumping Patterns

The Santa Ana Canyon Management Area is within the Santa Ana Region of the California Water Boards and is subject to the Santa Ana Region Basin Plan (January 24, 2014; updated July, 2014). The Basin Plan designates zones related to groundwater management. The Santa Ana Canyon Management Area is included in the Orange County Management Zone. Within this Zone, groundwater has been designated for municipal, agricultural, and industrial (service supply and process) beneficial uses. Currently, local groundwater provides primarily irrigation supply with some residential drinking water (RV Park) and domestic uses.

There are 18 wells that can withdraw groundwater within the Santa Ana Canyon Management Area as shown on Figure 3-2; however, some of the wells shown are not currently being used. Groundwater production at many of the wells is metered and reported to OCWD by the well owners. Eight of the wells are owned by the County of Orange to supply irrigation water to the Green River Golf Course. Even though some of these wells are metered, individual meter readings have not historically been collected by County staff. It is estimated that total production to supply the golf course is approximately 1,000 acre-feet per year (Personal Communication, Merrie Weinstock, County of Orange). The County of Orange will be installing flow meters on wells that are not currently metered and will begin obtaining monthly measurements of production from each well in the near future.

An irrigation well owned by Neff Ranch (BYNT-YLSE) was recently annexed into OCWD's service area. A request has been sent to the owner to register this well and begin to report production as required by the OCWD Act. An estimate of current production is based on the irrigation of 21 acres of mature orange groves.

As shown on Table 3-1, total groundwater production within the Santa Ana Canyon Management Area over the last 10 years is estimated to range from 1,475 to 2,234 acre-feet per year and averaging 1,839 acre-feet per year. Table 3-1 lists the production wells, meter status, and 10-year average production for wells located within the Santa Ana Canyon Management Area.

Prior to 2012, the City of Corona also owned and operated a local production well in the Santa Ana Canyon Management Area. The well, referred to as Well 18, was located in a field northwest of the 91 Freeway and Prado Road and was reportedly drilled in 1984 to an approximate total depth of 86 feet. Although historical production records are incomplete, Well 18 was apparently pumped over several years for supplemental local water supply prior to being officially destroyed in 2012.

Table 3-1: Production Wells, Flow-Meter Status, and 10-Year Average Production

Well Name	Well Use	Owner	Metered	10-Yr Avg 2006-15 (afy)	Max (af)	Min (af)	Notes
BYNT-YLSE	IR	Neff Ranch, Ltd	No	53	53	53	Estimated use, 21 acres of orange groves, meter install requested
EMA-AH5	IR	County Of Orange	Yes	76	98	52	
FPRK-YLE	DW/IR	Canyon RV Park	Yes	59	67	41	
FPRK-YLW	DW/IR	Canyon RV Park	Yes	55	67	33	
GARD-A	IR	Kindred Outreach Ministries	No	1	1	1	Minimum reportable volume
GRGC-CO1	IR	OCFCD	Yes	See estimate for Green River Golf Course			Flow meter not in ideal location
GRGC-COR1	IR	OCFCD	Yes				Flow meter not in ideal location
GRGC-YL14	IR	OCFCD	Yes				Inactive
GRGC-YL15	IR	OCFCD	No				Flow meter to be installed
GRGC-YL16	IR	OCFCD	No				Flow meter to be installed
GRGC-YL4	IR	OCFCD	Yes				Inactive
GRGC-YL9	IR	OCFCD	Yes				Inactive
GRGC-YLA1	IR	OCFCD	Yes				
GRV-RSIR	IR	Green River Village	Yes	11	25	5	
LKVG-YL	IR	Eastlake Village HOA	Yes	79	89	60	
ROBSN-YL1	IR	Robertson Ready Mix	Yes	1	6	0	Inactive for 5 yrs, No data for 2006-7.
SILV-YL	IR	County Of Orange	Yes	503	827	229	No data for 2006, CASGEM well
WALL-A	DOM	Wallace, Dick	No	1	1	1	Minimum reportable volume
Total Estimated Green River Golf Course Usage				1,000	1,000	1,000	8 OCFCD wells
Totals				**1,839**	**2,234**	**1,475**	

IR= Irrigation; DW=Drinking Water; DOM=Domestic
OCFCD = Orange County Flood Control District

3.2.3 Groundwater Storage Data

Groundwater storage in Basin 8-1 is estimated at 66 million acre-feet (OCWD, 2007), which does not include the Santa Ana Canyon Management Area. To estimate the amount of storage in the alluvial aquifer within Santa Ana Canyon Management Area, all well data were used and depths to bedrock estimated. The thickness of the alluvial deposits is assumed to be zero at the basin margin. Using a Topo to Raster Interpolation function in ArcGIS, the total volume of alluvial deposits was estimated at 174,000 acre-feet. Assuming a porosity of 25 percent gives a total potential groundwater storage volume of 43,500 acre-feet. The actual volume of groundwater in storage is smaller given that this estimate does not take into account that the depth to groundwater is typically 20 to 30 feet below ground surface.

3.2.4 Groundwater Quality Conditions

Groundwater quality in the Santa Ana Canyon Management Area is generally good and suitable to meet beneficial uses. Groundwater in the Santa Ana Canyon Management Area is a mixture of infiltrated Santa Ana River water and subsurface inflow. As shown on Figure 3-8, total dissolved solids (TDS) concentrations in groundwater range from just under 600 to 2,180 mg/L. Santa Ana River water at Prado Dam is characterized by lower TDS concentrations. Since 1972, the flow-weighted average TDS of Santa Ana River water has ranged from a low of 348 mg/L in 2005 to a high of 728 mg/L in 1981 (Santa Ana River Watermaster Reports). Based on TDS concentrations, some wells appear to primarily produce local groundwater sourced from subsurface inflow along the boundaries of the Santa Ana Canyon Management area, while others, such as FPRK-YLE, FPRK-YLW and SILV-YL, appear to produce a blend of local groundwater and infiltrated Santa Ana River water.

Except for a few detections of arsenic and nitrate, groundwater meets primary drinking water standards; however, all wells produce groundwater that exceeds secondary standards for TDS and manganese. No volatile organic compounds (VOCs), semi-volatile organics, or other contaminants have been detected. Table 3-2 summarizes the available water quality data for TDS and Nitrate (NO_3 as N). Table 3-3 summarizes the available water quality data for arsenic (As) and manganese (Mn). Table 5-1 summarizes the water quality analyses and frequency of testing conducted at wells in the Santa Ana Canyon Management Area.

Table 3-2: TDS and Nitrate (as N) in Selected Wells

Well Name	Well Use	Date Range	Avg. TDS		Avg. NO3 as N		Notes
			mg/L	# of samples	µg/L	# of samples	
BYNT-YLSE	IR	1969-2016	1,132	6	2.2	7	Exceeded NO3 MCL 1 time in 1969
FPRK-YLE	DW/IR	1988-2016	726	17	2.3	105	
FPRK-YLW	DW/IR	1969-2016	774	25	2.4	74	
GRGC-COR1	IR	2013-2016	1,910	4	0.4	4	
GRV-RSIR	IR	1970-2013	1,487	12	0.13	14	Original well: GRV-RS1(1972-84)
ROBSN-YL1	IR	2001-2004	666	2	1.9	2	
SILV-YL	IR	1995-2007	597	5	1.4	5	
WALL-A	DOM	1968-2014	1,399	4	3.6	3.6	

IR = Irrigation; DW=Drinking Water; DOM=Domestic
TDS Secondary MCL: 500 mg/L

Table 3-3: Arsenic and Manganese in Selected Wells

Well Name	Well Use	Date Range	Avg. As		Avg. Mn		Notes
			ug/L	# of samples	ug/L	# of samples	
BYNT-YLSE	IR	1969-2016	ND	ND	150	2	
FPRK-YLE	DW/IR	1988-2016	8.3	22	756	45	Exceeded As MCL in 3 samples, Jan-March 2003
FPRK-YLW	DW/IR	1969-2016	4	20	900	45	
GRGC-COR1	IR	2013-2016	NS	NS		NS	
GRV-RSIR	IR	1970-2013	8.2	1	578	6	Original well: GRV-RS1 (1972-84)
ROBSN-YL1	IR	2001-2004	NS			NS	
SILV-YL	IR	1995-2007	NS		350	1	
WALL-A	DOM	1968-2014	NS		200	1	

IR= Irrigation; DW=Drinking Water; DOM=Domestic
ND = Not detected
NS = Not sampled
* Mn Secondary MCL: 50 ug/L.

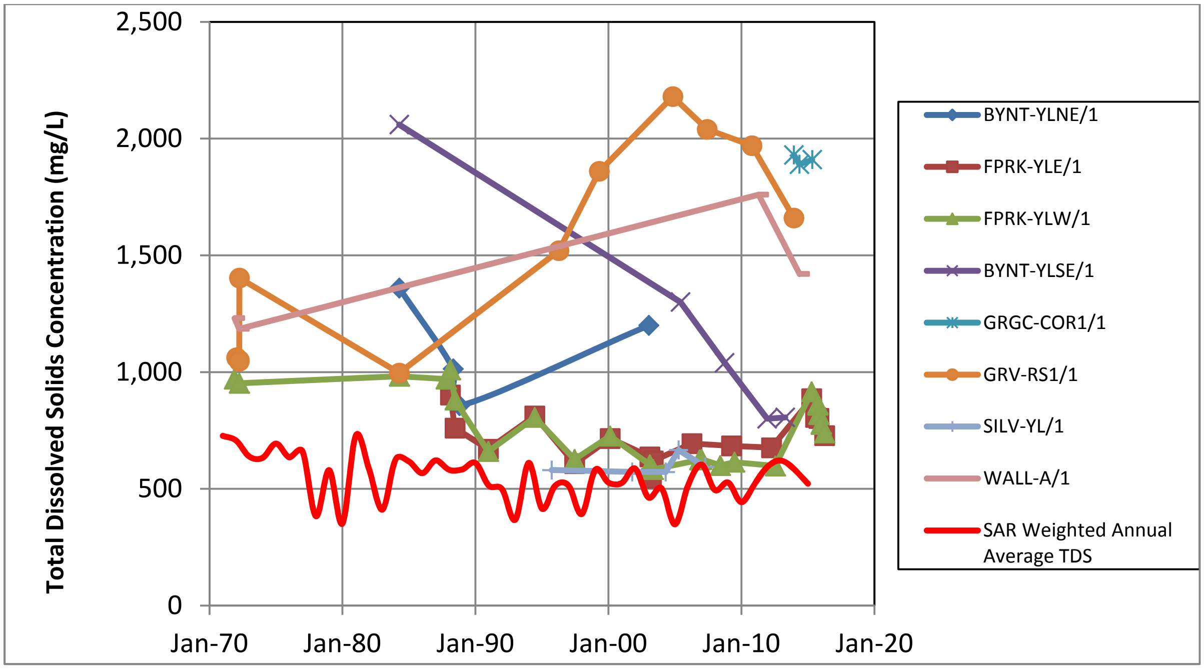


Figure 3-8: TDS Concentrations

3.2.5 Land Subsidence

Land subsidence is monitored within the OCWD Management Area but not within the Santa Ana Canyon Management Area. Subsidence is not an issue for the Santa Ana Canyon Management Area given the following:

1. The presence of shale and sandstone bedrock underlying the alluvial aquifer is not thought to be compressible or subject to inelastic subsidence.
2. The alluvial aquifer is thin, generally less than 100 feet, and comprised mainly of sand and gravel with only minor amounts of clay.
3. Groundwater levels and storage are relatively stable over time.
4. Substantial groundwater level declines are unlikely due to the de minimis amount of groundwater production relative to the overall inflow of water to the Santa Ana Canyon Management Area.

3.2.6 Groundwater and Surface Water Interactions and Groundwater Dependent Ecosystems

Groundwater within the Santa Ana Canyon alluvial aquifer is consistently 20 to 30 feet below ground surface and even less in the incised portions of the Santa Ana River channel. As described in Section 4, Water Budget, the flow of surface water through the canyon dwarfs the documented groundwater production. As a result, groundwater production has a de minimis impact on groundwater conditions and flows of surface water through the canyon. This in turn demonstrates that groundwater production in the Santa Ana Canyon has little to no impact on local groundwater dependent ecosystems in the Santa Ana Canyon Management Area, if any.

SECTION 4. WATER BUDGET

The water budget of the Santa Ana Canyon Management Area is dominated by surface flows of the Santa Ana River with a minor contribution of subsurface inflow, return flows from irrigation, and a small amount of groundwater production. Table 4-1 presents the overall water budget for the Santa Ana Canyon Management Area. This water budget contains both surface water and groundwater components and is not used to analyze change in groundwater storage. The purpose of presenting this water budget is to show the dominance of Santa Ana River flows in the Santa Ana Canyon Management Area.

Table 4-1: Water Budget, 10-Year Average (2006-15)

Flow Component	10-Yr Avg: 2006-15 (afy)	Max (1) (af)	Min (1) (af)
Santa Ana River Base Flow (2)	100,400	147,700	63,500
Santa Ana River Storm Flow (2)	72,300	211,000	18,300
Subsurface Inflow (3)	5,000	5,000	5,000
TOTAL INFLOW	**177,700**	**363,700**	**86,800**
Santa Ana River Base Flow (2)	98,820	145,730	62,280
Santa Ana River Storm Flow (2)	72,300	211,000	18,300
Evapotranspiration (4)	740	740	740
Groundwater Production	1,840	2,230	1,480
Subsurface Outflow (5)	4,000	4,000	4,000
TOTAL OUTFLOW	**177,700**	**363,700**	**86,800**

(1) Note that for Santa Ana River flows, the maximum and minimum base and storm flow years may not occur in the same year. These numbers are for illustrative purposes only.
(2) From Santa Ana River Watermaster Reports (Oct-Sept. Water Year).
(3) Subsurface inflow is estimated and includes irrigation return flow and areal recharge from precipitation.
(4) Evapotranspiration is based on 370 acres of riparian habitat and a usage rate of 2 afy/acre of habitat per Santa Ana River Watermaster Reports.
(5) Subsurface outflow is based on OCWD's calibrated groundwater flow model.

Groundwater level data suggest that groundwater conditions in the Santa Ana Canyon Management Area are essentially at steady state conditions with inflow equaling outflow and no change in groundwater storage. Inflow to the groundwater aquifer includes subsurface inflow and an unquantified amount of infiltrated Santa Ana River water. Outflow includes evapotranspiration, groundwater production and subsurface outflow. Table 4-2 presents the groundwater budget for the Santa Ana Canyon Management Area.

Table 4-2: Groundwater Budget, 10-Year Average (2006-15)

Flow Component	10-Yr Avg: 2006-15 (afy)
Subsurface Inflow (1)	5,000
Infiltrated Santa Ana River Base Flow (2)	1,580
TOTAL INFLOW	**6,580**
Evapotranspiration (3)	740
Groundwater Production	1,840
Subsurface Outflow to OCWD Management Area (4)	4,000
TOTAL OUTFLOW	**6,580**
NET CHANGE	0

(1) Subsurface inflow is estimated and includes irrigation return flow and areal recharge from precipitation.
(2) Estimated infiltration of Santa Ana River base flow to balance outflow.
(3) Evapotranspiration is based on 370 acres of riparian habitat and a usage rate of 2 afy/acre of habitat per Santa Ana River Watermaster Reports.
(4) Subsurface outflow is based on OCWD's calibrated groundwater flow model.

4.1 BUDGET COMPONENTS

The components of the groundwater budget are described below.

4.1.1 Subsurface Inflow/Outflow

During development of OCWD's groundwater flow model, an estimate was made of the inflow to the Santa Ana Canyon Management Area that eventually flowed into the main groundwater basin. The easternmost extent of the groundwater model is at Imperial Highway (SR90), which is also the boundary of the Santa Ana Canyon Management Area with the OCWD Management Area. The outflow estimate is based on the cross-sectional area of the Santa Ana Canyon at Imperial Highway and the average groundwater gradient. This approach yielded an estimated outflow of 4,000 acre-feet per year. During the calibration process it was not necessary to change this estimate and therefore it is assumed to be a reasonable estimate of groundwater outflow from the Santa Ana Canyon Management Area to the main groundwater basin.

Subsurface inflow is a combination of subsurface mountain front recharge, areal recharge from precipitation, and irrigation return flow. It is estimated to be approximately 5,000 afy.

4.1.2 Infiltrated Santa Ana River Base Flow

Water quality data suggests that some of the groundwater produced from wells in the Santa Ana Canyon Management Area is a blend of subsurface inflow and infiltrated Santa Ana River water; however, there is not enough data to determine the relative contribution of each source. For purposes of the groundwater budget, the amount of infiltrated Santa Ana River base flow is the amount necessary to balance the water budget assuming subsurface inflow is 5,000 afy. If the assumed amount of subsurface inflow were to change, the amount of infiltrated Santa Ana River water needed to balance the water budget would change accordingly. Base flow is assumed to be the primary source of supply due to the infrequent nature of storm flows and that groundwater pumping tends to be reduced during the winter months.

4.1.3 Evapotranspiration

Evapotranspiration is assumed to be due to riparian vegetation adjacent to the Santa Ana River. The County of Orange, as part of developing a Habitat Management Plan (HMP), established a baseline of 370 acres of riparian vegetation within the Santa Ana Canyon Management Area (County of Orange, 2016).

The Santa Ana River Watermaster calculates that riparian vegetation consumes approximately 2 afy per acre of vegetated area. Using this approach, the estimated evapotranspiration within the Santa Ana Canyon Management area is estimated to be 740 afy.

4.1.4 Groundwater Production

As described in Section 3.2.2, there are 18 wells that can withdraw groundwater within the Santa Ana Canyon Management Area as shown on Figure 3-3; however, some of the wells shown are not currently being used. Groundwater production from these wells is summarized in Tables 3-1 and 4-1.

4.2 CHANGES IN GROUNDWATER STORAGE

As shown in Figure 3-7, groundwater levels in the Santa Ana Canyon Management Area are stable, indicating that the thin, alluvial aquifer is generally always in a full condition. Therefore, any changes in groundwater storage are small and insignificant.

4.3 WATER YEAR TYPE

The water year type has little impact on the water budget in the Santa Ana Canyon Management Area given the minimal changes in groundwater level observed through time due to the ever present Santa Ana River base flow and subsurface inflow.

4.4 ESTIMATE OF SUSTAINABLE YIELD

As described in Table 4-1, average groundwater production over the last 10 years equates to one percent of the total inflow to the Santa Ana Canyon Management Area. It is clear that the sustainable yield of the Santa Ana Canyon Management Area is much greater than current production levels. Nevertheless, there are no plans for additional wells or groundwater production in the Santa Ana Canyon Management Area and is highly unlikely that groundwater demands would ever rise to the level of changing the water budget of this area significantly. In terms of sustainable yield, it is more appropriate to look at Basin 8-1 as a whole.

4.5 CURRENT, HISTORICAL, AND PROJECTED WATER BUDGET

The current and historical water budget (average over 10 years) is presented in Tables 4-1 and 4-2. A worst-case dry-year water budget is presented in Table 4-3 and is based on the following assumptions:

1. Santa Ana River base flow declines to 44,000 af.
2. Santa Ana River storm flow of only 11,300 af, which equates to the lowest on record (1972) since the Santa Ana River Watermaster started keeping records in 1970.
3. Groundwater production is assumed to be equivalent to the maximum recorded in the period 2006-15, which is 2,230 af.

As shown on Table 4-3, even under dry-year conditions, groundwater production is less than 4 percent of the total water available in the Santa Ana Canyon Management Area. Increases in future production are not likely to be significant given the lack of demands in the area, low well production capacity, availability of imported water sources (such as used in the Corona service area) and relatively poor water quality compared to groundwater in the main OCWD basin.

Table 4-3: Dry-Year Water Budget

Flow Component	Dry-Year Flows (afy)
Santa Ana River Base Flow	44,000
Santa Ana River Storm Flow	11,300
Subsurface Inflow	5,000
TOTAL INFLOW	**60,300**
Santa Ana River Base Flow	42,030
Santa Ana River Storm Flow	11,300
Evapotranspiration	740
Groundwater Production	2,230
Subsurface Outflow	4,000
TOTAL OUTFLOW	**60,300**

SECTION 5. WATER RESOURCE MONITORING PROGRAMS

5.1 OVERVIEW

This section describes OCWD's surface and groundwater monitoring programs in the Santa Ana Canyon Management Area.

5.2 GROUNDWATER MONITORING PROGRAMS

OCWD monitors groundwater levels, quality and production in the Santa Ana Canyon Management Area. As shown on Figure 5-1, groundwater levels are monitored at six wells, two of which are part of the CASGEM program (SCE-YLCS, and SILV-YL).

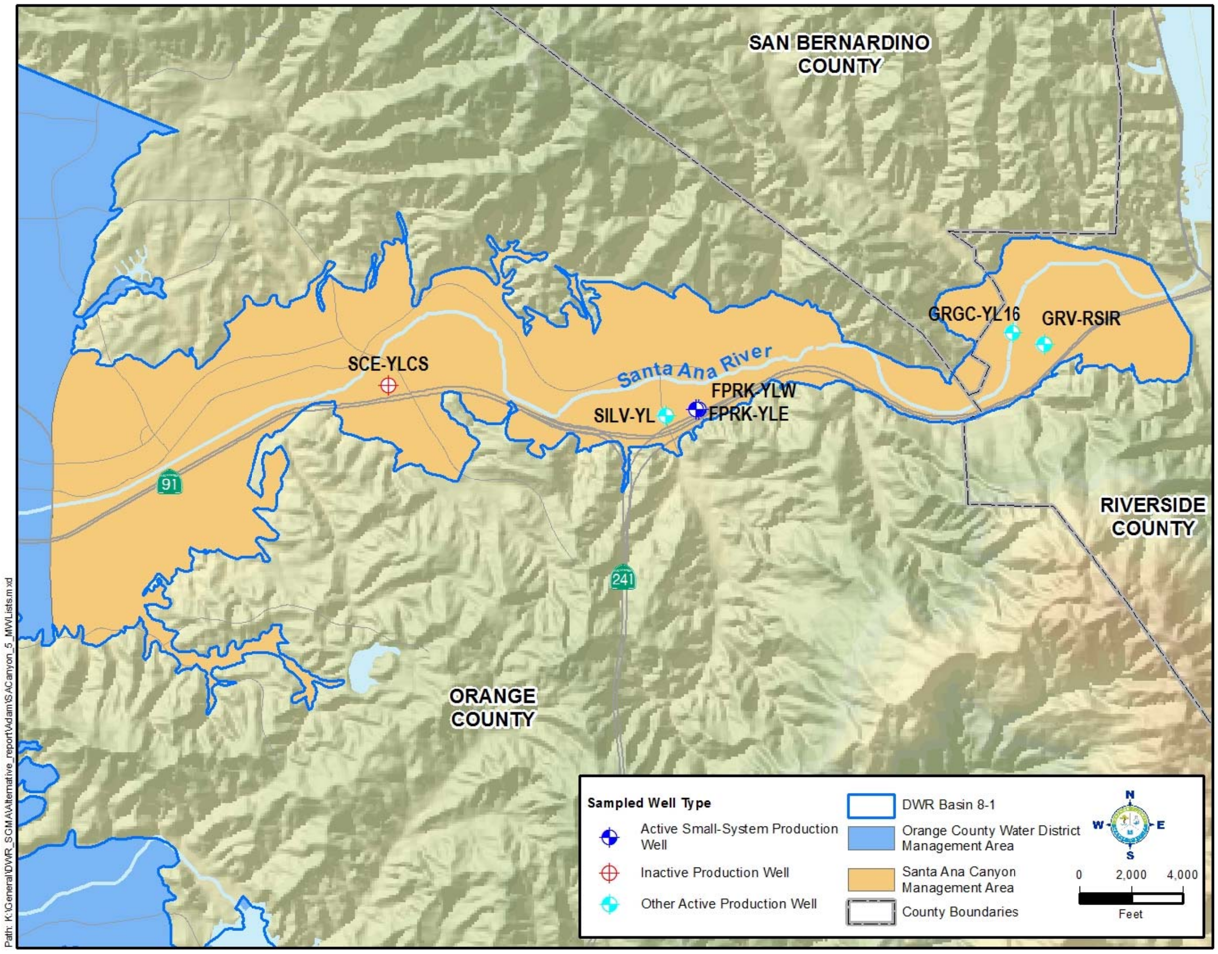


Figure 5-1: Wells Used to Monitor Groundwater Levels

OCWD is collaborating with the County of Orange to collect water levels at selected wells that serve the Green River Golf Course. Data from these wells will be presented in future reports.

For wells within OCWD's boundaries, groundwater production must be reported at a minimum frequency of every 6 months. Groundwater production from the County of Orange's wells that supply the Green River Golf Course will be documented in future reports after meters are installed on all wells and monthly production recorded. It is anticipated that production from all of the wells shown on Table 3-1 will be measured and reported to DWR in future reports.

OCWD also monitors groundwater quality in selected wells in the Santa Ana Canyon Management Area. Table 5-1 lists the wells monitored and the groundwater quality monitoring program each well is part of, which is based on its final use (e.g., irrigation, potable). Wells used for irrigation are sampled every year for volatile organic compounds (VOCs) and every three years for general minerals (major cations and anions), 1,4-dioxane, and perchlorate (ClO_4). The two wells in Featherly Park used for potable supplies are monitored in accordance with drinking water regulations.

Table 5-1: Wells Monitored for Water Quality

Well Name	Water Quality Monitoring Program
BYNT-YLSE EMA-AH5 GARD-A GRGC-CO1 GRGC-COR1 GRGC-YL15 GRGC-YL16 GRGC-YL4 GRV-RSIR LKVG-YL	Annual: Volatile Organic Compounds (VOCs) Every 3 yrs: General Minerals, 1,4-Dioxane, and ClO_4
FPRK-YLE FPRK-YLW	Annual: NO_3, ClO_4, 1,4-Dioxane, Mn, TDS, EC Atrazine/Simazine: every 3 yrs Title 22 Inorganics: every 3 yrs CN: every 9 yrs CrIV: every 3 yrs Radioactivity: every 6 yrs (Gross Alpha, Uranium) Radioactivity: every 9 yrs (Radium 226 & Radium 228)

5.3 OTHER MONITORING PROGRAMS

OCWD monitors the quantity and quality of water in the Santa Ana River just below Prado Dam. The flow of the Santa Ana River below Prado Dam is measured by the USGS at station No. 11074000 (http://waterdata.usgs.gov/ca/nwis/dv/?site_no=11074000). In addition to flow, the USGS measures the electrical conductivity (EC) of the water as well as sampling the water two times per month for TDS. One use of these data is to calculate the flow-weighted average TDS of base and storm flow discharged from Prado Dam (see Figure 3-8). The flow and quality data are collected for the Santa Ana River Watermaster, which was formed to implement the

Stipulated Judgement in the case of Orange County Water District v. City of Chino, et al., Case No. 1172628-County of Orange, entered by the court on April 17, 1969. The most recent watermaster report can be found on OCWD's website at http://www.ocwd.com/media/4247/sar_watermaster_2014-15.pdf. In addition to OCWD, the Santa Ana River Watermaster is comprised of representatives from the Inland Empire Utilities Agency, San Bernardino Valley Municipal Water District, and Western Municipal Water District.

The significance of the 1969 Judgment is that it guarantees a minimum base flow at Prado Dam of 42,000 afy; however, per the terms of the Judgment, the upstream agencies have received (and will continue to receive) credits when base flows exceed of 42,000 af at Prado. With these credits, the required minimum base flow is 34,000 af. As a point of reference, the most recent year base flow in 2014-15 was 63,536 af.

OCWD also closely monitors the quality of water in the Santa Ana River before it is diverted into its recharge system below Imperial Highway. More information about this program can be found in Section 5 of the OCWD Management Area section of this report.

SECTION 6. WATER RESOURCE MANAGEMENT PROGRAMS

OCWD has a wide variety of water resource management programs that cover the main groundwater basin as well as the upper Santa Ana River watershed to address Santa Ana River flow and quality. These programs are important in protecting the quality of the Santa Ana River, which affects groundwater quality in the Santa Ana Canyon Management Area. These programs are described in detail in Section 6 of the OCWD Management Area part of this report. The programs that affect Santa Ana River water quality include:

Groundwater Desalters and the Inland Empire Brineline and Non-Reclaimable Waste Line

Several groundwater desalters have been constructed to reduce the amount of salt buildup in the watershed, which in turn reduces the salinity of the Santa Ana River. The Inland Empire Brine Line (IEBL), formerly called the Santa Ana Regional Interceptor (SARI), built by the Santa Ana Watershed Project Authority (SAWPA), has operated since 1975 to remove salt from the watershed by transporting industrial wastewater and brine produced by desalter operations directly to the Orange County Sanitation District (OCSD) for treatment.

Basin Monitoring Program Task Force

In 1995, a task force of more than 20 water and wastewater resource agencies and local governments, including OCWD, initiated a study to evaluate the impacts to groundwater quality of elevated levels of Total Inorganic Nitrogen (TIN) and TDS in the Santa Ana River watershed. This nearly 10-year effort involved collecting and analyzing data in 25 newly defined groundwater management zones in the watershed to recalculate nitrogen and TDS levels and to establish new water quality objectives. This effort not only protects groundwater quality in the Santa Ana River watershed, it also protects the quality of Santa Ana River water.

Salinity Management and Imported Water Recharge Workgroup

The Salinity Management and Imported Water Recharge Workgroup, in cooperation with the Regional Water Board, implements a cooperative agreement signed in 2008 by water agencies that use imported water for groundwater recharge. The objective of this effort was to evaluate and monitor the long-term impacts of recharging groundwater basins with imported water, which could ultimately impact the quality of Santa Ana River water.

Management of Nitrates

One of the District's programs to reduce nitrate concentrations in Santa Ana River water is diverting Santa Ana River flows through OCWD's extensive system of wetlands in the Prado Basin.

OCWD owns and operates the 465-acre constructed Prado Wetlands. The Prado Wetlands are designed to remove nitrogen and other pollutants from the Santa Ana River before the water is diverted from the river in Orange County into OCWD's surface water recharge system. During summer months the wetlands reduce nitrate concentrations (NO_3 as N) from nearly 10 mg/L to 1 to 2 mg/L.

SECTION 7. NOTICE AND COMMUNICATION

There are eight stakeholder agencies within the Santa Ana Canyon Management Area, including the following:

- City of Anaheim
- City of Chino Hills
- City of Yorba Linda
- City of Corona Water Service Area
- Orange County Water District
- County of Orange
- Riverside County
- Yorba Linda Water District

On May 4, 2016, OCWD sent a letter to each of the agencies listed above to let them know about the option to comply with SGMA via an Alternative. The only exception is the City of Yorba Linda, but contact with them was made through representatives from the Yorba Linda Water District.

Multiple meetings were held with agencies that wished to meet and discuss the Basin 8-1 Alternative. All of the agencies contacted have agreed to participate in the Basin 8-1 Alternative.

The agencies taking the lead to prepare sections of the Basin 8-1 Alternative are summarized in Table 7-1.

Table 7-1: Lead Agencies for Preparation of Basin 8-1 Alternative

Agency	Management Area
City of La Habra	La Habra/Brea
OCWD	OCWD
OCWD	Santa Ana Canyon
Irvine Ranch Water District	South East

OCWD presented a schedule to the agencies listed in Table 7-1 by email for development and completion of the Basin 8-1 Alternative. This schedule included taking the draft Basin 8-1 Alternative to OCWD's board and groundwater producers for comment as well as posting the draft Basin 8-1 Alternative on OCWD's website. It was left up to the individual agencies to assess whether or not it was necessary to present the Basin 8-1 Alternative to their governing body or to the public.

SECTION 8. SUSTAINABLE MANAGEMENT APPROACH

The approach to managing the Santa Ana Canyon Management Area is to continue to monitoring sustainable conditions and monitor to ensure that no significant and unreasonable results occur in the future.

SECTION 9. SUSTAINABLE MANAGEMENT RELATED TO GROUNDWATER LEVELS

9.1 HISTORY

As shown on Figure 3-7, groundwater levels in the Santa Ana Canyon Management Area have been steady over the last 25 years. Given the large amount of surface inflow to the Santa Ana Canyon Management Area relative to the amount of groundwater production, groundwater levels are expected to remain steady in the future.

9.2 MONITORING OF GROUNDWATER LEVELS

OCWD monitors groundwater levels at multiple wells in the Santa Ana Canyon Management Area and will continue to do so in the future. Additional wells at the Green River Golf Course will be monitored and reported in the future.

9.3 DEFINITION OF SIGNIFICANT AND UNREASONABLE LOWERING OF GROUNDWATER LEVELS

No long-term reduction in groundwater levels is foreseen in the Santa Ana Canyon Management Area; however, if that were to occur, a decline in groundwater levels could reach a significant and unreasonable level if one more of the following occurred as a result of reduced groundwater levels:

1. Significant and unreasonable loss of significant riparian habitat along the Santa Ana River.
2. Significant and unreasonable loss of well production capacity.
3. Degradation of water quality that significantly impacts the beneficial uses of groundwater.

9.4 DETERMINATION OF MINIMUM THRESHOLDS

It is not possible to determine a minimum threshold at this time since no undesirable effects due to water levels have occurred in the past and are not foreseen. Nevertheless, OCWD's monitoring program continuously tracks water levels and groundwater quality in the Management Area. If water levels ever started to show a consistent long-term decline, OCWD's monitoring program would be expanded to examine any potential impacts to riparian habitat, well yields, and groundwater quality. If impacts were observed, action would be taken and minimum thresholds would be evaluated and established as appropriate.

SECTION 10. SUSTAINABLE MANAGEMENT RELATED TO BASIN STORAGE

The total volume of groundwater storage in the OCWD Basin is estimated to be 66 million acre-feet (OCWD, 2007). The total potential storage volume in the Santa Ana Canyon Management Area is estimated to be 43,500 acre-feet (see Section 3.2.3).

10.1 DEFINITION OF SIGNIFICANT AND UNREASONABLE REDUCTION IN STORAGE

As with groundwater levels, no long-term reduction in groundwater storage is foreseen in the Santa Ana Canyon Management Area; however, if that were to occur, a decline in groundwater storage could reach a significant and unreasonable level if one more of the following occurred due to a reduction in storage:

1. Significant and unreasonable loss of riparian habitat along the Santa Ana River.
2. Significant and unreasonable loss of well production capacity.
3. Degradation of water quality that significantly impacts the beneficial uses of groundwater.

10.2 DETERMINATION OF MINIMUM THRESHOLDS

It is not possible to determine a minimum threshold at this time since no undesirable effects due to a change in groundwater storage levels has occurred in the past and are not foreseen in the future. Nevertheless, OCWD's monitoring program continuously tracks water levels, which is a proxy for groundwater storage, and groundwater quality in the Management Area. If water levels ever started to show a consistent long-term decline, OCWD's monitoring program would be expanded to examine any potential impacts to riparian habitat, well yields and groundwater quality. If impacts were observed, action would be taken and minimum thresholds would be evaluated and established as appropriate.

SECTION 11. SUSTAINABLE MANAGEMENT RELATED TO BASIN WATER QUALITY

Groundwater quality in the Santa Ana Canyon Management Area is affected by the quality of Santa Ana River water and subsurface inflow from the surrounding foothills. As mentioned in Section 6, Water Resource Programs, OCWD is involved in multiple programs to protect and improve the quality of water in the Santa Ana River. Groundwater from subsurface inflow contains naturally elevated concentrations of TDS and manganese.

OCWD has an extensive groundwater monitoring program in the Santa Ana Canyon Management Area as described in Section 5, Water Resource Monitoring Programs.

11.1 DEFINITION OF SIGNIFICANT AND UNREASONABLE DEGRADATION OF WATER QUALITY

There are three elements that must be considered when evaluating the impact of groundwater quality degradation.

The first element is considering the causal nexus between groundwater management activities and groundwater quality. For example, if subsurface inflow from the surrounding foothills increases during a wet period, TDS and manganese levels could increase; however, this increase is not caused by groundwater management activities, but by natural causes. The same applies to the quality of Santa Ana River water. Although OCWD is involved in many programs to protect and improve the quality of Santa Ana River water, there could be changes in water quality that are outside of the control of Santa Ana Canyon Management Area stakeholders.

The second element is the beneficial uses of the groundwater and water quality regulations, such as Maximum Contaminant Levels (MCLs) and other potable water quality requirements.

The third element that must be considered is the volume of groundwater impacted by groundwater quality degradation. If small volumes are negatively affected that do not materially affect the use of the aquifer for its existing beneficial uses, then this would not represent a significant and unreasonable degradation of water quality. However, if the impacted volume grows, then it could reach a level that it becomes significant and unreasonable.

When considering all three elements, “significant and unreasonable degradation of water quality” is defined as degradation of groundwater quality in the Santa Ana Canyon Management Area that is attributable to groundwater production or recharge practices and to the extent that a significant volume of groundwater becomes unusable for its designated beneficial uses.

11.2 DETERMINATION OF MINIMUM THRESHOLDS

The minimum thresholds for groundwater quality are exceedances of Maximum Contaminant Levels (MCLs) or other applicable regulatory limits that are directly attributable to groundwater production and recharge practices in the Santa Ana Canyon Management Area that prevents the use of groundwater for its designated beneficial uses.

SECTION 12. SUSTAINABLE MANAGEMENT RELATED TO SEAWATER INTRUSION

The Santa Ana Canyon Management Area is located far from the ocean and thus there is no reason to consider the potential impact of seawater intrusion in this management area.

SECTION 13. SUSTAINABLE MANAGEMENT RELATED TO LAND SUBSIDENCE

Land subsidence is monitored within the OCWD Management Area but not within the Santa Ana Canyon Management Area. Subsidence is not an issue for the Santa Ana Canyon Management Area given the following:

1. The presence of shale and sandstone bedrock underlying the alluvial aquifer is not thought to be sufficiently compressible to cause inelastic subsidence.
2. The alluvial aquifer is thin, generally less than 100 feet, and composed mainly of sand and gravel with only minor amounts of clay.
3. Groundwater levels and storage volumes are stable.
4. Substantial groundwater level declines are highly unlikely due to the de minimis amount of groundwater production relative to the overall inflow of water to the Santa Ana Canyon Management Area.

SECTION 14. MANAGING GROUNDWATER DEPLETIONS IMPACTING SURFACE WATER

The primary surface water feature in the Santa Ana Canyon Management Area is the Santa Ana River. In the Santa Ana Canyon Management Area, the Santa Ana River is a soft-bottomed channel that supports riparian habitat (Figure 14-1). Riparian habitat is dependent on river water released through Prado Dam, which is predominantly treated wastewater discharged in the upper watershed when storm flow is not present.

Groundwater within the Santa Ana Canyon alluvial aquifer is consistently 20 to 30 feet below ground surface and even shallower in the incised portions of the Santa Ana River channel. As described in Section 4, Water Budget, the flow of surface water through the canyon is two orders of magnitude larger than groundwater production. As a result, groundwater production has a de minimis impact on groundwater conditions and the flows of surface water through the canyon. This, in turn, means that groundwater production in the Santa Ana Canyon has a de minimis impact on the groundwater dependent ecosystems in the Santa Ana Canyon Management Area. Therefore, the undesirable result of “depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water due to groundwater conditions occurring throughout the basin” does not apply.

Figure 14-1: Santa Ana River, downstream of Prado Dam

SECTION 15. PROTOCOLS FOR MODIFYING MONITORING PROGRAMS

Protocols for modifying monitoring programs are based on changes from historical conditions or changes in water quality that begin to approach or exceed regulatory limits.

15.1 ESTABLISHMENT OF PROTOCOLS FOR WATER QUALITY

Changes in OCWD water quality sampling program can be triggered by one or more of the following:

1. A recommendation by the Independent Advisory Panel that reviews OCWD use of Santa Ana River water for groundwater recharge and related water quality;
2. A change or anticipated change in water quality regulations;
3. A constituent in a sample approaches or exceeds a regulatory water quality limit or Maximum Contaminant Level, notification level, or first time detection of a constituent;
4. OCWD's monitoring program identifies a variation in historical data that may indicate a statistically significant change in water quality;
5. Analysis of water quality trends conducted by water quality, hydrogeology, or recycled water production staff indicate a need to change monitoring; and,
6. OCWD initiates a special study, such as quantifying the removal of contaminants using treatment wetlands or testing the infiltration rate of a proposed new recharge basin.

15.2 ESTABLISHMENT OF PROTOCOLS FOR GROUNDWATER ELEVATION/STORAGE

Given that it is desirable to obtain water level records over long periods of time at the same well, changes are rarely made to reduce key wells in groundwater level monitoring programs. The most common reason for a change is that a well is destroyed. If this occurs, OCWD will evaluate the nearest similar well or the need to construct a replacement well and add it to the monitoring program as appropriate.

The frequency of groundwater level monitoring in the Santa Ana Canyon Management Area varies from quarterly to annually. This frequency can be modified based on the variability of water level changes observed. In the Santa Ana Canyon Management Area, water levels tend to be consistent (see Figure 3-7), therefore, annual monitoring is generally sufficient. If water levels start to change and storage levels start to decline, then the frequency of groundwater level monitoring would likely increase. This occurrence would also likely precipitate changes to other monitoring programs, such as monitoring the health of the riparian habitat in the Santa Ana Canyon Management Area.

SECTION 16. PROCESS TO EVALUATE NEW PROJECTS

For projects within OCWD, the process described in the OCWD Management Area part of this report applies. If new projects are proposed by others outside of OCWD's boundaries, OCWD would collaborate with the agency proposing the project to ensure that any proposed project would not cause significant and unreasonable results. Moreover, OCWD would review proposed projects through the CEQA process (i.e., reviewing and commenting on draft CEQA documents).

SECTION 17. REFERENCES

County of Orange, 2016. County of Orange, Santa Ana River Canyon and Brush Canyon Habitat Management Areas, 2016 Annual Monitoring Report, June 2016.

OCWD, 2007. Report on Evaluation of Orange County Groundwater Basin Storage and Operational Strategy, February 2007.

USGS, 1964. Geology and Oil Resources of the Eastern Puente Hills Area, Southern California. By D.L. Durham and R.F. Yerkes. USGS Professional Paper 420-B.

ATTACHMENT ONE

DOCUMENTATION OF

PUBLIC PARTICIPATION AND AGENCY APPROVALS

OCWD Board of Directors Agenda: October 21, 2015

OCWD Board of Directors Water Issues Committee Agenda: November 9, 2016

OCWD *Hydrospectives* Newsletter: November 2016

OCWD Website Screen Shot of Public Notice for Comments: November 9, 2016

OCWD Groundwater Producers Agenda: November 10, 2016

OCWD Board of Directors Water Issues Committee Agenda: December 14, 2016

OCWD Board of Directors Agenda: December 21, 2016

OCWD Board Resolution

CEQA Notice of Exemption

City of La Habra Letter of Support

AGENDA
REGULAR MEETING BOARD OF DIRECTORS
ORANGE COUNTY WATER DISTRICT
18700 Ward Street, Fountain Valley, CA (714) 378-3200
Wednesday, October 21, 2015 – 5:30 p.m.

PLEDGE OF ALLEGIANCE

ROLL CALL

ITEMS RECEIVED TOO LATE TO BE AGENDIZED

RECOMMENDATION: Adopt resolution determining need to take immediate action on item(s) and that the need for action came to the attention of the District subsequent to the posting of the Agenda (requires two-thirds vote of the Board members present, or, if less than two-thirds of the members are present, a unanimous vote of those members present.)

VISITOR PARTICIPATION

Time has been reserved at this point in the agenda for persons wishing to comment for up to three minutes to the Board of Directors on any item that is not listed on the agenda, but within the subject matter jurisdiction of the District. By law, the Board of Directors is prohibited from taking action on such public comments. As appropriate, matters raised in these public comments will be referred to District staff or placed on the agenda of an upcoming Board meeting.

At this time, members of the public may also offer public comment for up to three minutes on any item on the Consent Calendar. While members of the public may not remove an item from the Consent Calendar for separate discussion, a Director may do so at the request of a member of the public.

CONSENT CALENDAR (ITEMS NOS. 1 - 18)

All matters on the Consent Calendar are to be approved by one motion, without separate discussion on these items, unless a Board member or District staff request that specific items be removed from the Consent Calendar for separate consideration.

1. APPROVAL OF CASH DISBURSEMENTS

   RECOMMENDATION: Ratify/authorize payment of bills

2. APPROVAL OF MINUTES OF BOARD OF DIRECTORS MEETING HELD SEPTEMBER 16, 2015

   RECOMMENDATION: Approve minutes as presented

4) Authorize issuance of Amendment No. 1 to Agreement No. 0916 to CH2M Hill for an amount not to exceed $91,328; and

5) Increase the Alamitos Barrier Improvement Project budget as necessary to incorporate the bid from Best Drilling and Pump, Inc.

20. **INFORMATIONAL ITEMS**

A. WATER RESOURCES SUMMARY

B. GROUNDWATER REMEDIATION MONTHLY STATUS UPDATE

C. SUSTAINABLE GROUNDWATER MANAGEMENT ACT: COMPLIANCE OPTIONS

D. SANTA ANA WATERSHED PROJECT AUTHORITY ACTIVITIES

E. GROUNDWATER PRODUCER MEETING MINUTES – OCTOBER 14, 2015

F. COMMITTEE/CONFERENCE/MEETING REPORTS

1) Oct 08 – Communication and Legislative Liaison Committee (Chair Sidhu)
Oct 12 – GWRS Steering Committee (Vice Chair Yoh)
Oct 14 – Water Issues Committee (Chair Bilodeau)
Oct 15 – Administration and Finance Issues Committee (Chair Dewane)

2) Reports on Conferences/Meetings Attended at District Expense (at which a quorum of the Board was present)

21. **VERBAL REPORTS**

- PRESIDENT'S REPORT
- GENERAL MANAGER'S REPORT
- DIRECTORS' REPORTS
- GENERAL COUNSEL REPORT

22. **ADJOURNMENT TO CLOSED SESSION**

- **CONFERENCE WITH LABOR NEGOTIATORS [Government Code Section 54957.6]**
OCWD designated representative: Stephanie Dosier
⊙ Employee Organization: Orange County Employee Association

RECONVENE IN OPEN SESSION

23. **ADJOURNMENT**

AGENDA ITEM SUBMITTAL

Meeting Date: October 21, 2015

To: Board of Directors

From: Mike Markus

Staff Contact: G. Woodside/A. Hutchinson

Budgeted: N/A
Budgeted Amount: N/A
Cost Estimate: N/A
Funding Source: N/A
Program/Line Item No. N/A
General Counsel Approval: N/A
Engineers/Feasibility Report: N/A
CEQA Compliance: N/A

Subject: **SUSTAINABLE GROUNDWATER MANAGEMENT ACT: COMPLIANCE OPTIONS**

SUMMARY

On January 1, 2015, the Sustainable Groundwater Management Act (Act) took effect. This Act requires that all high and medium priority basins, as ranked by the Department of Water Resources (DWR), be sustainably managed. The Act lists OCWD as the exclusive groundwater manager within its statutory boundaries; however, there are additional steps that must be taken to comply with the Act. Currently available options as well as potential future options will be reviewed with the committee.

Attachment(s): Presentation

RECOMMENDATION

Informational

BACKGROUND/ANALYSIS

On September 16, 2014 Governor Brown signed three bills (SB1168, AB1739, and SB1319), which comprise the Sustainable Groundwater Management Act (Act).

The Act requires that all high- and medium- priority basins designated by the Department of Water Resources (DWR) be sustainably managed by 2020 or 2022 depending on basin conditions. In June 2014, DWR published a report on basin prioritization and designated the Coastal Plain of Orange County Groundwater Basin (Basin 8-1) as a medium-priority basin. This was primarily due to heavy reliance on groundwater within the basin and how this was accounted for in the ranking system. It is not an indication that the basin needs to be managed differently.

The Act requires that there be no unmanaged areas within basin boundaries as defined by DWR Bulletin 118 for high- and medium-priority basins. Bulletin 118 basin boundaries are based on hydrogeologic conditions and political boundary lines whenever practical. OCWD overlies much of the Coastal Plain of Orange County Groundwater Basin (Basin 8-1). Figure 1 shows how the Bulletin 118 boundary compares with the

Figure 1
Areas Outside of OCWD Boundary but Within Bulletin 118 Boundary

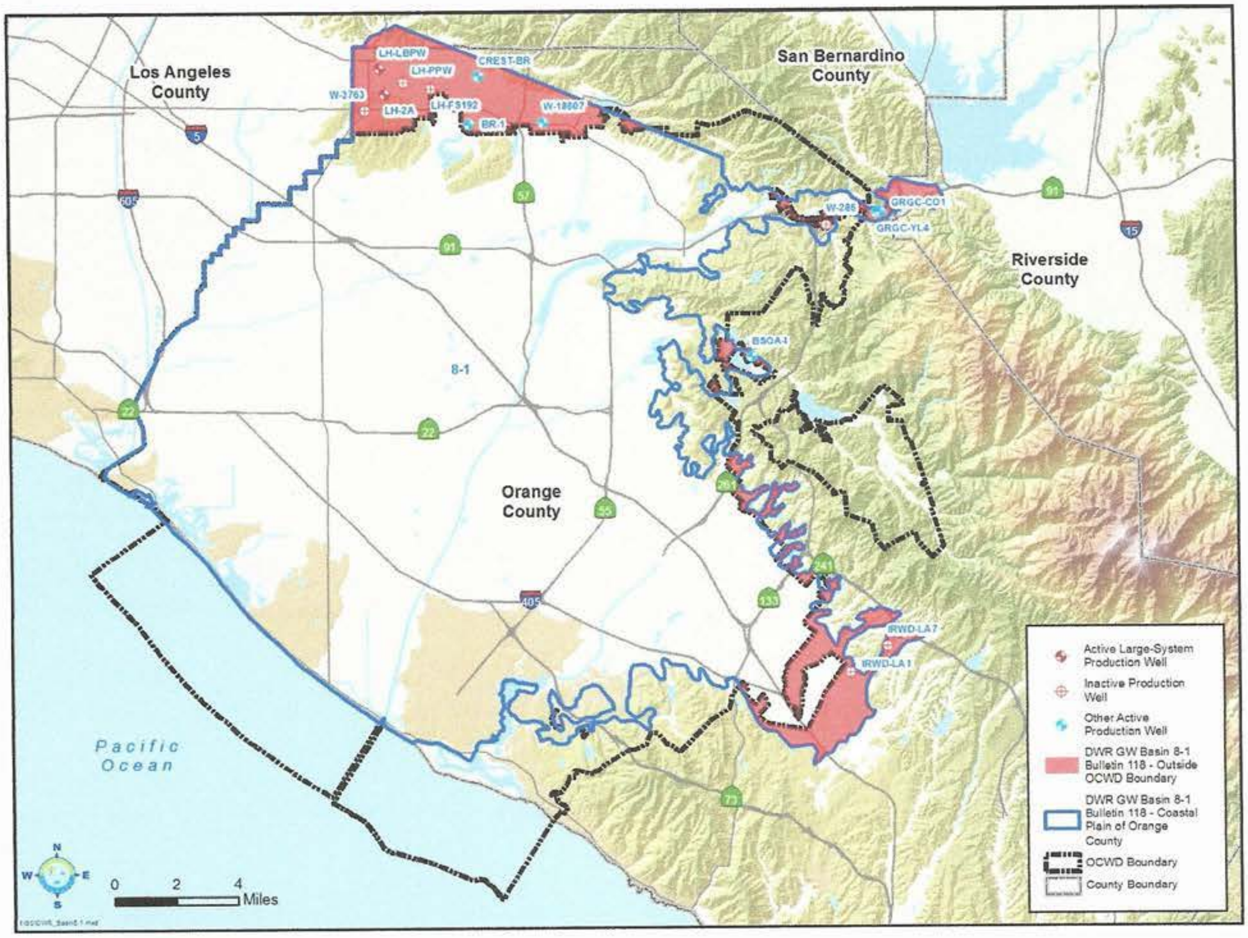


Figure 1 shows how the Bulletin 118 boundary compares with the District's boundary. The red shaded areas are outside of the District's boundary and, per the Act, need to be managed in some fashion. OCWD covers 89 percent of the basin as defined by Bulletin 118. The La Habra area covers 6 percent. The Santa Ana canyon area covers 1 percent and the southern portion covers 4 percent.

District staff worked with the authors of the Act to ensure that special act districts, including OCWD, were listed in the Act as the exclusive groundwater manager within its statutory boundaries. This designation prevents another agency from establishing a Groundwater Sustainability Agency (GSA) within a special district's boundaries. Now that the Act is being implemented and interpreted, compliance options are becoming better defined. At this point, all special act districts must comply with the Act by completing one of two options:

1. Present an Alternative Submittal, which is functionally equivalent to a Groundwater Sustainability Plan.

2. Opting to become a Groundwater Sustainability Agency (GSA) and preparing a Groundwater Sustainability Plan (GSP).

Alternative Submittals

The Department of Water Resources (DWR) is in the process of developing regulations regarding Alternative Submittals, which are described in Water Code Section 10733.6. The key text regarding Alternative Submittals is as follows:

> *10733.6 (a) If a local agency believes that an alternative described in subdivision (b) satisfies the objectives of this part, the local agency may submit the alternative to the department for evaluation and assessment of whether the alternative satisfied the objectives of this part for the **basin** (emphasis mine).*

One key interpretation is that Alternative Submittals must cover the entire Bulletin 118 basin or sub-basin. Since OCWD's boundaries do not cover the entire Bulletin 118 Basin 8-1 boundary, an Alternative Submittal would have to incorporate areas outside of OCWD (areas shown in red in Figure 1).

Staff has had preliminary discussions with agencies with jurisdiction outside of OCWD's boundaries, including Orange County, Irvine Ranch Water District (IRWD) and the cities of La Habra, Brea and Fullerton. For an Alternative Submittal to work, all of these agencies would have to participate. Orange County and IRWD are amenable to participating in an Alternative Submittal; however, at this time, La Habra and Brea are interested in forming a GSA and submitting a GSP (see below). Staff plans to have additional discussions with these agencies about developing an Alternative Submittal that covers the entire Bulletin 118 basin.

Formation of Groundwater Sustainability Agencies (GSAs)

If a special district, like OCWD, does not cover an entire basin or is not able to submit an Alternative Submittal that covers the entire basin, the only compliance option currently available is to form a GSA and submit a GSP. Staff is currently talking with DWR to see if there are other compliance options available within the scope of the Act that would not require formation of a GSA.

If compliance options within the existing Act are not satisfactory, staff may recommend that the District consider proposing cleanup legislation to allow special districts to prepare Alternative Submittals that cover their jurisdictional areas or other potential changes that allow OCWD to manage the basin without having to become a GSA or to require that GSAs be formed in the areas outside of OCWD's boundaries.

La Habra Groundwater Sustainability Agency (GSA) Formation

The City of La Habra is currently planning to form a Groundwater Sustainability Agency (GSA) that covers the northern portion of the groundwater basin that lies outside OCWD's boundary, which includes Brea and a very small portion of Fullerton (see Figure 1). La

Habra has invited OCWD to be part of a Technical Advisory Committee (TAC) that will provide input on the GSA formation process as well as development of their Groundwater Sustainability Plan (GSP).

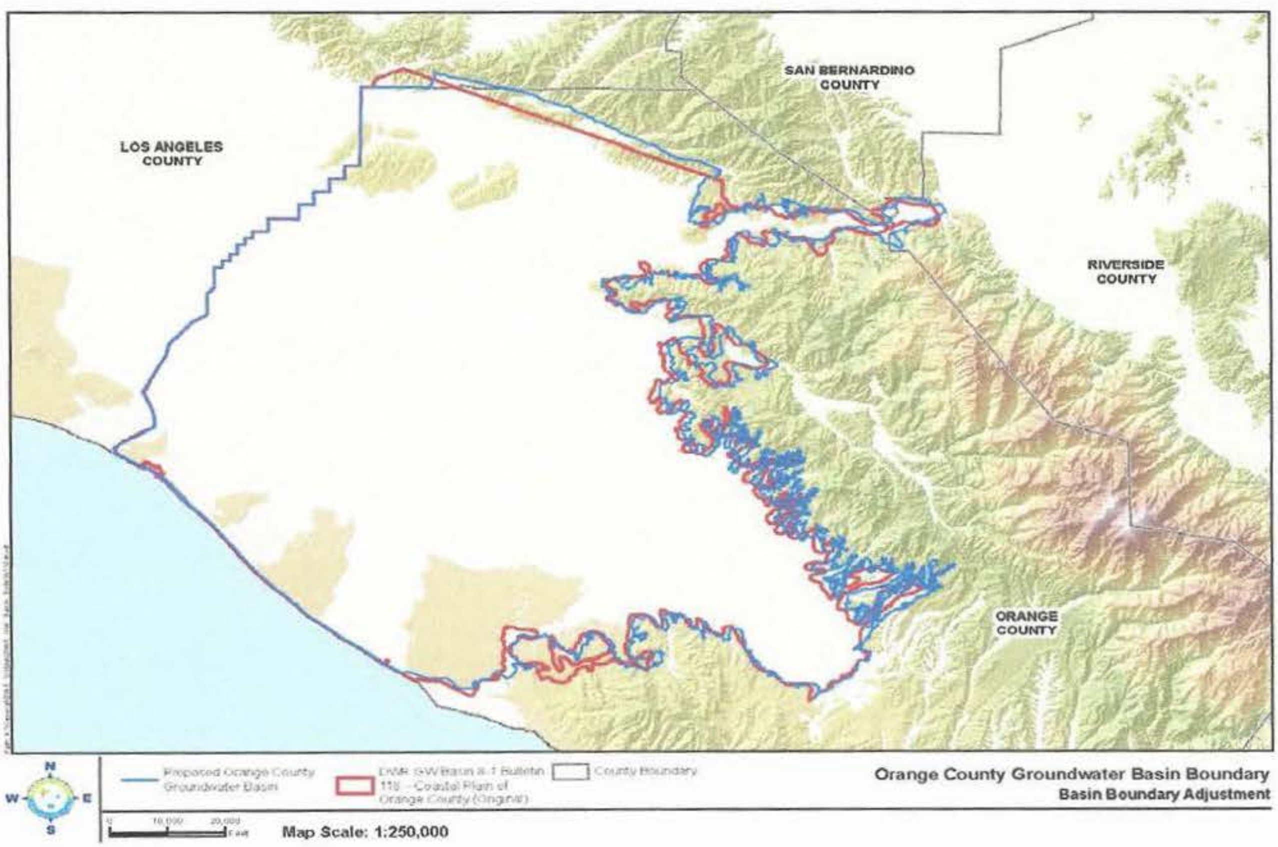
In addition, La Habra has indicated they are planning to request that DWR create a new Bulletin 118 La Habra Basin that is separate and apart from the Coastal Plain of Orange County Groundwater Basin.

Proposed Adjustments to DWR Bulletin 118 Basin Boundaries

The first Bulletin 118 was published in 1975. The boundaries established for the Coastal Plain of Orange County (Basin 8-1) have significant off-sets in some areas from current GIS data. This off-set could be due to distortions caused by digitizing maps created in the 1970s and then projecting them onto current GIS base maps.

To improve the accuracy of the Basin 8-1 boundary, staff reviewed available geologic information and adjusted the boundary as shown on Figure 2. Staff will share these proposed adjustments with La Habra, Orange County and IRWD to obtain their feedback before submitting them to DWR. Because these adjustments are consistent with the original intent of Bulletin 118, they are considered "administrative changes" and are not subject to the boundary change regulations currently being adopted by DWR.

TABLE 2
Current (Red) and Proposed (Blue) Bulletin 118 Boundary, Coastal Plain of Orange County Groundwater Basin (Basin 8-1)



PRIOR RELEVANT BOARD ACTION(S)

10-15-14, M14-160	Direct Staff to Identify Steps for Managing Groundwater Outside of District Boundaries (Sustainable Groundwater Management Act)
08-20-14, M14-119	Adopt Support if Amended Position on State Legislation - SB1168/ AB1739 (Groundwater Management Legislation)
07-16-14, R14-7-104	Adopt Groundwater Management Legislation Policy Principles

AGENDA
WATER ISSUES COMMITTEE MEETING
WITH BOARD OF DIRECTORS *
ORANGE COUNTY WATER DISTRICT
18700 Ward Street, Fountain Valley, CA 92708
Wednesday, November 9, 2016, 8:00 a.m. - Boardroom

* The OCWD Water Issues Committee meeting is noticed as a joint meeting with the Board of Directors for the purpose of strict compliance with the Brown Act and it provides an opportunity for all Directors to hear presentations and participate in discussions. Directors receive no additional compensation or stipend as a result of simultaneously convening this meeting. Items recommended for approval at this meeting will be placed on the **November 16, 2016** Board meeting Agenda for approval.

ROLL CALL

ITEMS RECEIVED TOO LATE TO BE AGENDIZED

RECOMMENDATION: Adopt resolution determining need to take immediate action on item(s) and that the need for action came to the attention of the District subsequent to the posting of the Agenda (requires two-thirds vote of the Board members present, or, if less than two-thirds of the members are present, a unanimous vote of those members present.)

VISITOR PARTICIPATION

Time has been reserved at this point in the agenda for persons wishing to comment for up to three minutes to the Board of Directors on any item that is not listed on the agenda, but within the subject matter jurisdiction of the District. By law, the Board of Directors is prohibited from taking action on such public comments. As appropriate, matters raised in these public comments will be referred to District staff or placed on the agenda of an upcoming Board meeting.

At this time, members of the public may also offer public comment for up to three minutes on any item on the Consent Calendar. While members of the public may not remove an item from the Consent Calendar for separate discussion, a Director may do so at the request of a member of the public.

CONSENT CALENDAR (ITEMS NO. 1 – 7)

All matters on the Consent Calendar are to be approved by one motion, without separate discussion on these items, unless a Board member or District staff request that specific items be removed from the Consent Calendar for separate consideration.

1. MINUTES OF WATER ISSUES COMMITTEE MEETING HELD OCTOBER 12, 2016

   RECOMMENDATION: Approve minutes as presented

2. ENCROACHMENT AGREEMENT WITH THE CITY OF FULLERTON FOR THE NORTH BASIN EXTRACTION WELL EW-1 CONNECTION TO SANITARY SEWER PROJECT

   RECOMMENDATION: Agendize for November 16 Board meeting: Approve and authorize execution of Encroachment Agreement with the City of Fullerton and provide a deposit to City in the amount of $10,000

3. CONTRACT NO. MBI-2017-1 MID-BASIN INJECTION: CENTENNIAL PARK PROJECT - NOTICE INVITING BIDS AND AGREEMENT TO DDB ENGINEERING FOR PROJECT PERMIT ASSISTANCE

RECOMMENDATION: Agendize for November 16 Board meeting:

1. Authorize publication of Notice Inviting Bids for Contract No. MBI-2017-1, Mid-Basin Injection: Centennial Park; and

2. Authorize issuance of Agreement to DDB Engineering in an amount not to exceed $25,000 for permit consulting services

4. REBUILD GREEN ACRES PROJECT SANTA ANA RESERVOIR EFFLUENT PUMP A01

RECOMMENDATION: Authorize payment to Evans Hydro for an amount not to exceed $16,975 to repair and refurbish Green Acres Project Santa Ana Reservoir Effluent Pump A01

5. REBUILD GREEN ACRES PROJECT HIGH PRESSURE EFFLUENT PUMP A03

RECOMMENDATION: Agendize for November 16 Board meeting: Approve and authorize payment to Pamco Machine for an amount not to exceed $33,832 to repair and refurbish Green Acres Project High Pressure Pump A03

6. REBUILD GREEN ACRES PROJECT INFLUENT PUMP A03

RECOMMENDATION: Agendize for November 16 Board meeting: Approve and authorize Pamco Machine to repair and refurbish Green Acres Project Influent Pump A03, for an amount not to exceed $19,800

7. ANNUAL SANTA ANA RIVER STREAM GAUGING JOINT FUNDING AGREEMENT WITH THE UNITED STATES GEOLOGICAL SURVEY (USGS)

RECOMMENDATION: Agendize for November 16 Board meeting:

1. Approve and authorize execution of Joint Funding Agreement with USGS to conduct flow and quality monitoring of the Santa Ana River below Prado Dam and Santiago Creek at Santa Ana for the period of November 1, 2016 to October 31, 2017; and

2. Authorize payment of $59,372 to the USGS for OCWD’s share of costs for stream flow and quality monitoring services

MATTERS FOR CONSIDERATION

8. OCSD/OCWD JOINT AGREEMENT FOR THE GWRS FINAL EXPANSION PROJECT

RECOMMENDATION: Agendize for November 16 Board meeting: Approve and authorize execution of the Agreement between OCSD and OCWD for each agency’s responsibilities for the GWRS Final Expansion Project, subject to minor changes by legal counsel

9. DRAFT BASIN 8-1 ALTERNATIVE TO COMPLY WITH SUSTAINABLE GROUNDWATER MANAGEMENT ACT

RECOMMENDATION: Provide comments on the draft Basin 8-1 Alternative as appropriate

CHAIR DIRECTION AS TO ITEMS IF ANY TO BE AGENDIZED AS MATTERS FOR CONSIDERATION AT THE NOVEMBER 16 BOARD MEETING

DIRECTORS' ANNOUNCEMENTS/REPORTS

GENERAL MANAGER'S ANNOUNCEMENTS/REPORTS

ADJOURNMENT

AGENDA ITEM SUBMITTAL

Meeting Date: November 9, 2016

To: Board of Directors

From: Mike Markus

Staff Contact: G. Woodside/A. Hutchinson
M. Westropp

Budgeted: N/A
Budgeted Amount: N/A
Cost Estimate: N/A
Funding Source: N/A
Program/Line Item No. N/A
General Counsel Approval: N/A
Engineers/Feasibility Report: N/A
CEQA Compliance: N/A

Subject: **DRAFT BASIN 8-1 ALTERNATIVE TO COMPLY WITH SUSTAINABLE GROUNDWATER MANAGEMENT ACT**

SUMMARY

To comply with the Sustainable Groundwater Management Act, a draft Alternative to a Groundwater Sustainability Plan has been prepared that covers the entirety of the Department of Water Resources Basin 8-1, Coastal Plain of Orange County Groundwater Basin. The draft Basin 8-1 Alternative was prepared by District staff and other stakeholders in Basin 8-1 that are outside of the District's boundary. The Alternative shows that the basin has been sustainably managed.

Attachment(s):

- Presentation
- Draft Basin 8-1 Alternative – (to be posted to www.ocwd.com on 11/08/2016)

RECOMMENDATION

Agendize for November 16 Board meeting: Provide comments on draft Basin 8-1 Alternative as appropriate

BACKGROUND/ANALYSIS

On September 16, 2014 Governor Brown signed three bills (SB1168, AB1739, and SB1319), which comprise the Sustainable Groundwater Management Act (Act).

The Act requires that all high- and medium-priority basins designated by the Department of Water Resources (DWR) be sustainably managed. DWR designated the Coastal Plain of Orange County Groundwater Basin (Basin 8-1) as a medium-priority basin, primarily due to heavy reliance on the basin's groundwater as a source of water supply.

Compliance with the Act can be achieved by one of two options:

1) Forming a Groundwater Sustainability Agency (GSA) and submitting a Groundwater Sustainability Plan (GSP), or
2) Submitting an Alternative to a GSP

Basin 8-1, as defined by DWR, includes areas within and outside of OCWD's service area as shown in Figure 1. Approximately 78 percent of Basin 8-1 is within OCWD's jurisdiction. Areas outside of OCWD include a northern section within the cities of La Habra and Brea, land along the Santa Ana River upstream of Imperial Highway, and land outside of the southern and southeastern OCWD boundary within the jurisdiction of Irvine Ranch Water District, El Toro Water District and the city of Orange. To be eligible to submit an Alternative to a GSP, the entirety of Basin 8-1 must be included in the Alternative and it must be demonstrated that Basin 8-1 has been sustainability managed.

The agencies within Basin 8-1 have agreed to prepare and submit an Alternative to a GSP, which is referred to as the Basin 8-1 Alternative. In accordance with §10733.6(b)(3), the Basin 8-1 Alternative presents an analysis of basin conditions that demonstrates that the basin has operated sustainably over a period of at least 10 years. In fact, Basin 8-1 has been operated sustainably for more than 10 years without experiencing the undesirable results, which are defined by the California Water Code as significant and unreasonable lowering of groundwater levels, reduction in storage, water quality degradation, seawater intrusion, or inelastic land subsidence. Since the basin has been sustainably managed, no new actions are required and the Basin 8-1 Alternative essentially describes the ongoing actions that will continue the sustainable management of the basin.

The Basin 8-1 draft Alternative was jointly prepared by the Orange County Water District (OCWD) and agencies with jurisdiction outside of OCWD's boundaries, including the City of La Habra and the Irvine Ranch Water District (IRWD). Table 1 shows the lead agencies responsible for preparing the sections covering the management areas.

Table 1: Lead Agencies for Preparation of Basin 8-1 Alternative

Agency	Management Area
City of La Habra	La Habra/Brea
OCWD	OCWD
OCWD	Santa Ana Canyon
Irvine Ranch Water District	South East

Other agencies within Basin 8-1 support submission of the Basin 8-1 Alternative and either have participated in preparing the Alternative and/or reviewed the Alternative. These agencies include the cities of Brea, Corona, Orange, and Chino Hills; the Counties of Orange, Riverside, and San Bernardino; Yorba Linda Water District, and El Toro Water District. Pursuant to §10733.2, the Basin 8-1 Alternative has been prepared by or under the direction of a professional geologist or professional engineer.

In the Basin 8-1 Alternative, four management areas were identified as shown in Figure 1. Accordingly, the Basin 8-1 Alternative is organized as follows:

- **Overview**: Provides a map and description of Basin 8-1 and a brief description of the basin management areas.
- **Hydrology of Basin 8-1**: Provides a description of the hydrogeology of Basin 8-1 including a description of the basin, the aquifer systems, fault zones, total basin volume, basin cross-sections, basin characteristics, and general groundwater quality.

- **La Habra-Brea Management Area**
- **OCWD Management Area**
- **South East Management Area**
- **Santa Ana Canyon Management Area**

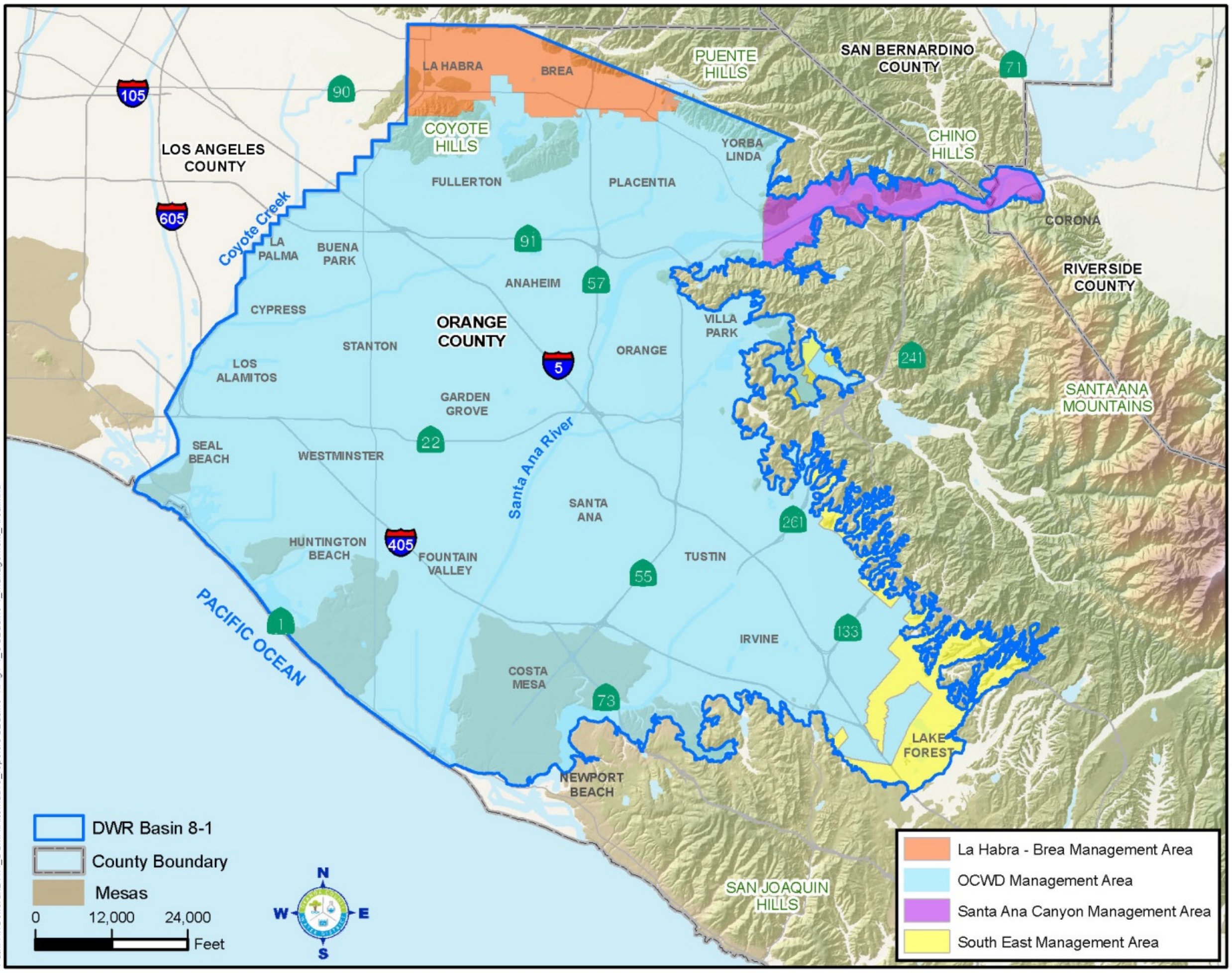
The OCWD Management Area description is based primarily on the information in the OCWD Groundwater Management Plan, which was adopted by the Board in June 2015. The OCWD Management area includes a small portion of the City of Fullerton and unincorporated Orange County that are outside OCWD's boundaries.

The Santa Ana Canyon Management area, which extends eastward into Riverside and San Bernardino Counties, includes the following agencies: OCWD, the cities of Anaheim, Yorba Linda, Chino Hills, Corona, and the counties of Riverside, San Bernardino and Orange.

The Basin 8-1 Alternative is posted on OCWD's website and will also be distributed by the other participating agencies for public review. District staff, La Habra, and IRWD will review the comments submitted on the draft Alternative and prepare the final Basin 8-1 Alternative, which must be submitted to the DWR by the statutory deadline of January 1, 2017.

After the Basin 8-1 Alternative is submitted to DWR, DWR will post on their website to allow for further public review. Once DWR approves the Basin 8-1 Alternative, the lead agencies within each management area will be required to update the Alternative every 5 years.

Figure 1
Management Areas in Basin 8-1 Alternative



PRIOR RELEVANT BOARD ACTION(S)

10-21-15	Informational Item, Sustainable Groundwater Management Act: Compliance Options
10-15-14, M14-160	Direct Staff to Identify Steps for Managing Groundwater Outside of District Boundaries (Sustainable Groundwater Management Act)
08-20-14, M14-119	Adopt Support if Amended Position on State Legislation - SB1168/ AB1739 (Groundwater Management Legislation)
07-16-14, R14-7-104	Adopt Groundwater Management Legislation Policy Principles

OC WATER NEWS
HYDROspectives
ORANGE COUNTY WATER DISTRICT

November 2016

In This Issue:

PRESIDENT'S MESSAGE—STRENGTHENING O.C.'S WATER RELIABILITY

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CALIFORNIA GROUNDWATER BASIN BOUNDARIES CHANGE

The California Department of Water Resources (DWR) released final 2016 modifications to California's groundwater basin boundaries, completing a critical step in the implementation of the state's Sustainable Groundwater Management Act (SGMA). DWR presented the final basin boundaries to the California Water Commission, which approved them. Included in the approved boundary modifications were changes proposed by the Orange County Water District to DWR's Basin 8-1, the Coastal Plain of Orange County Groundwater Basin. Read More...

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DRAFT ALTERNATIVE TO GROUNDWATER SUSTAINABILITY PLAN READY FOR PUBLIC REVIEW

Formal groundwater management in California can be traced back to 1934 when the Department of Water Resources (DWR) mapped and numbered the state's groundwater basins. In Orange County, the basin was named Basin 8-1, the Coastal Plain of Orange County Groundwater Basin. Since that time, jurisdiction over groundwater basins remained a local concern and management programs evolved to varying degrees. Recent drought conditions and, in some places the over-drafting of groundwater basins, demonstrated the need to enhance management of these important water supplies. Read More...

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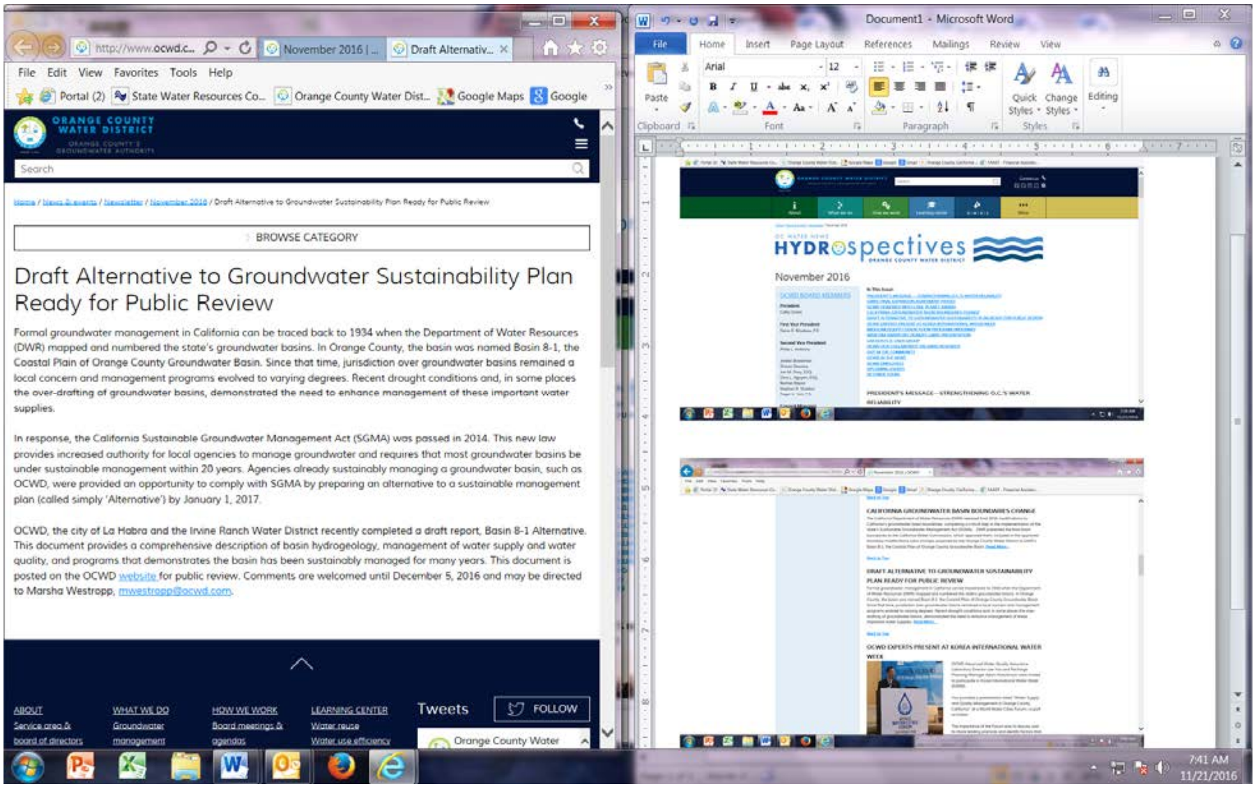
OCWD EXPERTS PRESENT AT KOREA INTERNATIONAL WATER WEEK

OCWD Advanced Water Quality Assurance Laboratory Director Lee Yoo and Recharge Planning Manager Adam Hutchinson were invited to participate in Korea International Water Week (KIWW).

Yoo provided a presentation titled "Water Supply and Quality Management in Orange County, California" at a World Water Cities Forum—a part of KIWW.

The importance of the Forum was to discuss and to share leading practices and identify factors that



http://www.ocwd.c...
November 2016 | ...
Draft Alternativ...
File Edit View Favorites Tools Help
Portal (2)
State Water Resources Co...
Orange County Water Dist...
Google Maps
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Search
Home / News & events / Newsletter / November 2016 / Draft Alternative to Groundwater Sustainability Plan Ready for Public Review
BROWSE CATEGORY
Draft Alternative to Groundwater Sustainability Plan Ready for Public Review
Formal groundwater management in California can be traced back to 1934 when the Department of Water Resources (DWR) mapped and numbered the state's groundwater basins. In Orange County, the basin was named Basin 8-1, the Coastal Plain of Orange County Groundwater Basin. Since that time, jurisdiction over groundwater basins remained a local concern and management programs evolved to varying degrees. Recent drought conditions and, in some places the over-drafting of groundwater basins, demonstrated the need to enhance management of these important water supplies.
In response, the California Sustainable Groundwater Management Act (SGMA) was passed in 2014. This new law provides increased authority for local agencies to manage groundwater and requires that most groundwater basins be under sustainable management within 20 years. Agencies already sustainably managing a groundwater basin, such as OCWD, were provided an opportunity to comply with SGMA by preparing an alternative to a sustainable management plan (called simply 'Alternative') by January 1, 2017.
OCWD, the city of La Habra and the Irvine Ranch Water District recently completed a draft report, Basin 8-1 Alternative. This document provides a comprehensive description of basin hydrogeology, management of water supply and water quality, and programs that demonstrates the basin has been sustainably managed for many years. This document is posted on the OCWD website for public review. Comments are welcomed until December 5, 2016 and may be directed to Marsha Westropp, mwestropp@ocwd.com.
ABOUT
Service area & board of directors
WHAT WE DO
Groundwater management
HOW WE WORK
Board meetings & agendas
LEARNING CENTER
Water reuse
Water use efficiency
Tweets
FOLLOW
Orange County Water
Document1 - Microsoft Word
File Home Insert Page Layout References Mailings Review View
HYDROspectives
November 2016
7:41 AM
11/21/2016

Screen shot of OCWD Webpage

Posted 11/9/16

Public notices

OCWD believes in open and honest government. It strives to be clear about the motivations and standards driving its activities, policy decisions and investments.

OCWD ensures that a proposed project complies with the California Environmental Quality Act (CEQA) and that the appropriate level of CEQA documentation is prepared. CEQA is a multi-purpose law in the State of California that is intended to inform decision makers and the public of the environmental consequences of projects, involve the public in decision-making related to environmental effects, and to prevent needless environmental damage. It is a tool to evaluate the potential impacts on the environment by a proposed project. CEQA review is required for any project undertaken by a public agency.

Current public notices are posted below. If you are seeking a document from a past project, please fill out a public records request.

> South basin additional groundwater monitoring program

> Water production enhancement project

> East Newport Mesa groundwater investigation

View the Basin 8-1 Alternative draft report

OCWD, the city of La Habra and the Irvine Ranch Water District recently completed a draft report, *Basin 8-1 Alternative*.* This document provides a comprehensive description of basin hydrogeology, management of water supply and water quality, and programs that provide for sustainable basin management over the long-term.

The Basin 8-1 Alternative is prepared to comply with the California Sustainable Groundwater Management Act (SGMA) passed in 2014. This new law provides increased authority for local agencies to manage groundwater and requires that most groundwater basins be under sustainable management within 20 years. Agencies already sustainably managing a groundwater basin are eligible to comply with SGMA by preparing an alternative to a sustainable management plan (called simply an Alternative) by January 1, 2017. The agencies with jurisdiction within the boundaries of Basin 8-1 jointly decided to prepare this plan and submit to the Department of Water Resources to comply with provisions of SGMA.

This document is posted here for public review. Comments are welcomed until December 5, 2016. Please direct comments to Marsha Westropp (714-378-8248).

* The California Department of Water Resources mapped the Orange County Groundwater Basin in 1934 and named the basin: *Basin 8-1, the Coastal Plain of Orange County Groundwater Basin.*

→ Basin 8-1 Alternative

From: Kennedy, John
Sent: Wednesday, November 09, 2016 11:16 AM
To: avalenzuela@tustinca.org; Bill Murray; Brian A. Ragland ; Carlo Nafarrete (La Palma) (carlon@cityoflapalma.org); 'Cel Pasillas'; Cook@irwd.com; David Spitz (dspitz@sealbeachca.gov); George Murdoch, NB; Hye Jin Lee - City of Fullerton (HyeJinL@ci.fullerton.ca.us); Jerry Vilander; Jose Diaz (jdiaz@cityoforange.org); Lisa Ohlund; Marc Marcantonio (mmarcantonio@ylwd.com); Mark Lewis (mark.lewis@fountainvalley.org); Michael Grisso (mgrisso@buenapark.com); Michael Moore (mrmoore@anaheim.net); Nabil Saba (Santa Ana); pauls@mesawater.org; Scott Miller - City of Westminster (scottm@CI.WESTMINSTER.CA.US); Steffen Catron (scatron@newportbeachca.gov); Vecchiarelli, Ken
Cc: Markus, Mike; Woodside, Greg; Hutchinson, Adam; Westropp, Marsha
Subject: November 10th Producers Meeting - Sustainable Groundwater Management Act - Alternative Plan

All

At tomorrow's Producers meeting we will discuss the Alternative plan that OCWD has prepared to comply with the Sustainable Groundwater Management Act. Below is a link to the plan if you want to review it ahead of the meeting.

http://www.ocwd.com/media/4792/basin-8-1-alternative-draft-november-4-2016.pdf

John Kennedy
Executive Director of Engineering and Water Resources
Orange County Water District
18700 Ward Street
Fountain Valley, CA 92708
tel: (714) 378-3304
email: jkennedy@ocwd.com

AGENDA ITEM SUBMITTAL

Meeting Date: November 16, 2016

To: Board of Directors

From: Mike Markus

Staff Contact: G. Woodside/A. Hutchinson
M. Westropp

Budgeted: N/A
Budgeted Amount: N/A
Cost Estimate: N/A
Funding Source: N/A
Program/Line Item No. N/A
General Counsel Approval: N/A
Engineers/Feasibility Report: N/A
CEQA Compliance: N/A

Subject: **DRAFT BASIN 8-1 ALTERNATIVE TO COMPLY WITH SUSTAINABLE GROUNDWATER MANAGEMENT ACT**

SUMMARY

To comply with the Sustainable Groundwater Management Act, a draft Alternative to a Groundwater Sustainability Plan has been prepared that covers the entirety of the Department of Water Resources Basin 8-1, Coastal Plain of Orange County Groundwater Basin. The draft Basin 8-1 Alternative was prepared by District staff and other stakeholders in Basin 8-1 that are outside of the District's boundary. The Alternative shows that the basin has been sustainably managed.

Attachment(s):

- Presentation
- Draft Basin 8-1 Alternative – (posted to www.ocwd.com)

RECOMMENDATION

Provide comments on draft Basin 8-1 Alternative as appropriate

BACKGROUND/ANALYSIS

On September 16, 2014 Governor Brown signed three bills (SB1168, AB1739, and SB1319), which comprise the Sustainable Groundwater Management Act (Act).

The Act requires that all high- and medium-priority basins designated by the Department of Water Resources (DWR) be sustainably managed. DWR designated the Coastal Plain of Orange County Groundwater Basin (Basin 8-1) as a medium-priority basin, primarily due to heavy reliance on the basin's groundwater as a source of water supply.

Compliance with the Act can be achieved by one of two options:

1) Forming a Groundwater Sustainability Agency (GSA) and submitting a Groundwater Sustainability Plan (GSP), or
2) Submitting an Alternative to a GSP

Basin 8-1, as defined by DWR, includes areas within and outside of OCWD's service area as shown in Figure 1. Approximately 78 percent of Basin 8-1 is within OCWD's jurisdiction. Areas outside of OCWD include a northern section within the cities of La

Habra and Brea, land along the Santa Ana River upstream of Imperial Highway, and land outside of the southern and southeastern OCWD boundary within the jurisdiction of Irvine Ranch Water District, El Toro Water District and the city of Orange. To be eligible to submit an Alternative to a GSP, the entirety of Basin 8-1 must be included in the Alternative and it must be demonstrated that Basin 8-1 has been sustainability managed.

The agencies within Basin 8-1 have agreed to prepare and submit an Alternative to a GSP, which is referred to as the Basin 8-1 Alternative. In accordance with §10733.6(b)(3), the Basin 8-1 Alternative presents an analysis of basin conditions that demonstrates that the basin has operated sustainably over a period of at least 10 years. In fact, Basin 8-1 has been operated sustainably for more than 10 years without experiencing the undesirable results, which are defined by the California Water Code as significant and unreasonable lowering of groundwater levels, reduction in storage, water quality degradation, seawater intrusion, or inelastic land subsidence. Since the basin has been sustainably managed, no new actions are required and the Basin 8-1 Alternative essentially describes the ongoing actions that will continue the sustainable management of the basin.

The Basin 8-1 draft Alternative was jointly prepared by the Orange County Water District (OCWD) and agencies with jurisdiction outside of OCWD's boundaries, including the City of La Habra and the Irvine Ranch Water District (IRWD). Table 1 shows the lead agencies responsible for preparing the sections covering the management areas.

Table 1: Lead Agencies for Preparation of Basin 8-1 Alternative

Agency	Management Area
City of La Habra	La Habra/Brea
OCWD	OCWD
OCWD	Santa Ana Canyon
Irvine Ranch Water District	South East

Other agencies within Basin 8-1 support submission of the Basin 8-1 Alternative and either have participated in preparing the Alternative and/or reviewed the Alternative. These agencies include the cities of Brea, Corona, Orange, and Chino Hills; the Counties of Orange, Riverside, and San Bernardino; Yorba Linda Water District, and El Toro Water District. Pursuant to §10733.2, the Basin 8-1 Alternative has been prepared by or under the direction of a professional geologist or professional engineer.

In the Basin 8-1 Alternative, four management areas were identified as shown in Figure 1. Accordingly, the Basin 8-1 Alternative is organized as follows:

- **Overview**: Provides a map and description of Basin 8-1 and a brief description of the basin management areas.
- **Hydrology of Basin 8-1**: Provides a description of the hydrogeology of Basin 8-1 including a description of the basin, the aquifer systems, fault zones, total basin volume, basin cross-sections, basin characteristics, and general groundwater quality.
- **La Habra-Brea Management Area**

- **OCWD Management Area**
- **South East Management Area**
- **Santa Ana Canyon Management Area**

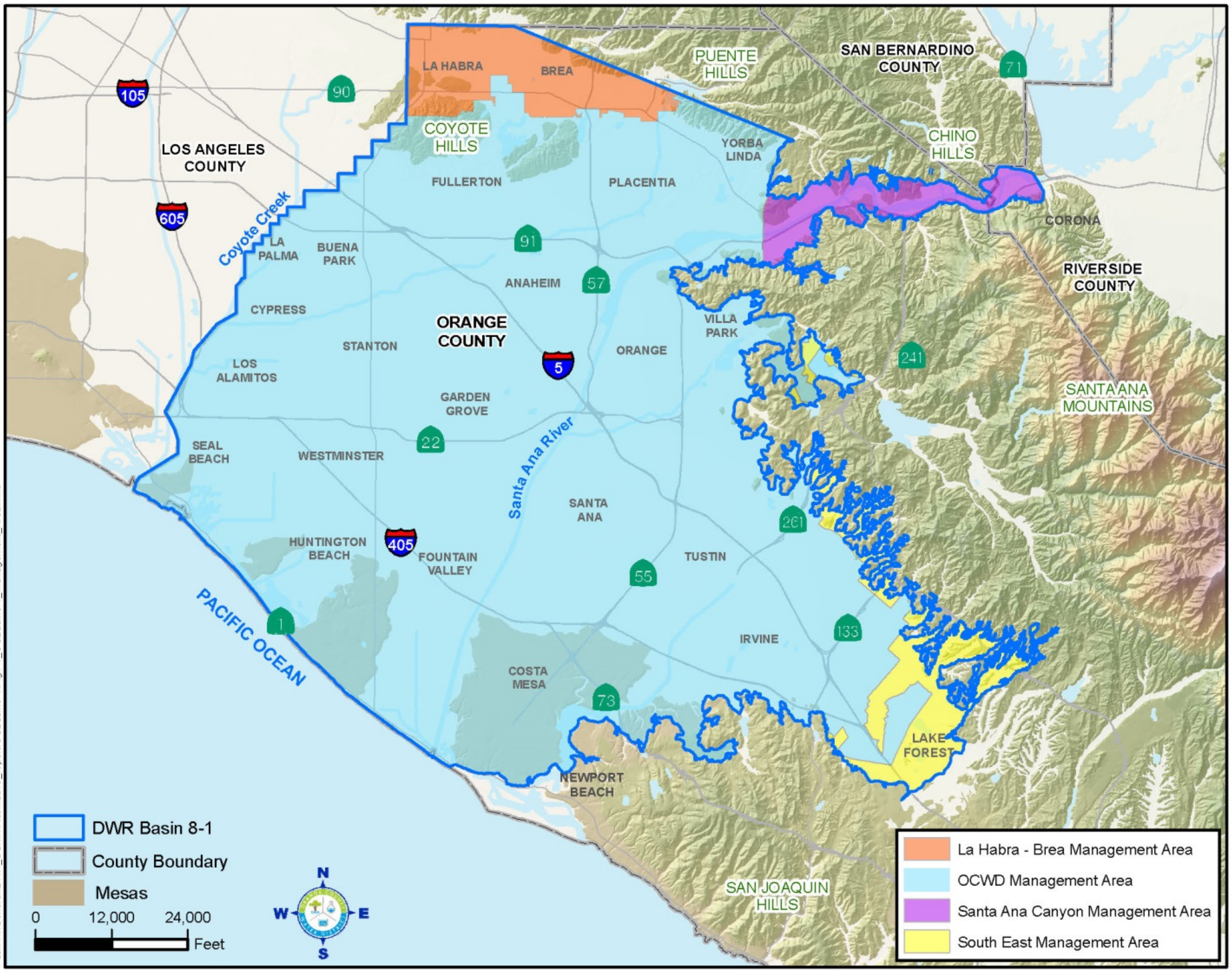
The OCWD Management Area description is based primarily on the information in the OCWD Groundwater Management Plan, which was adopted by the Board in June 2015. The OCWD Management area includes a small portion of the City of Fullerton and unincorporated Orange County that are outside OCWD's boundaries.

The Santa Ana Canyon Management area, which extends eastward into Riverside and San Bernardino Counties, includes the following agencies: OCWD, the cities of Anaheim, Yorba Linda, Chino Hills, Corona, and the counties of Riverside, San Bernardino and Orange.

The Basin 8-1 Alternative is posted on OCWD's website and will also be distributed by the other participating agencies for public review. District staff, La Habra, and IRWD will review the comments submitted on the draft Alternative and prepare the final Basin 8-1 Alternative, which must be submitted to the DWR by the statutory deadline of January 1, 2017.

After the Basin 8-1 Alternative is submitted to DWR, DWR will post on their website to allow for further public review. Once DWR approves the Basin 8-1 Alternative, the lead agencies within each management area will be required to update the Alternative every 5 years.

Figure 1
Management Areas in Basin 8-1 Alternative



PRIOR RELEVANT BOARD ACTION(S)

10-21-15	Informational Item, Sustainable Groundwater Management Act: Compliance Options
10-15-14, M14-160	Direct Staff to Identify Steps for Managing Groundwater Outside of District Boundaries (Sustainable Groundwater Management Act)
08-20-14, M14-119	Adopt Support if Amended Position on State Legislation - SB1168/ AB1739 (Groundwater Management Legislation)
07-16-14, R14-7-104	Adopt Groundwater Management Legislation Policy Principles

AGENDA ITEM SUBMITTAL

Meeting Date: December 14, 2016

To: Water Issues Committee
Board of Directors

From: Mike Markus

Staff Contact: G. Woodside/A. Hutchinson /M. Westropp

Budgeted: N/A
Budgeted Amount: N/A
Cost Estimate: N/A
Funding Source: N/A
Program/Line Item No: N/A
General Counsel Approval: N/A
Engineers/Feasibility Report: N/A
CEQA Compliance: Notice of Exemption

Subject: **FINAL BASIN 8-1 ALTERNATIVE TO COMPLY WITH SUSTAINABLE GROUNDWATER MANAGEMENT ACT**

SUMMARY

To comply with the Sustainable Groundwater Management Act, an Alternative to a Groundwater Sustainability Plan has been prepared that covers the entirety of the Department of Water Resources Basin 8-1, Coastal Plain of Orange County Groundwater Basin. The Basin 8-1 Alternative was prepared by District staff and other stakeholders in Basin 8-1 that are outside of the District's boundary. The Alternative shows that the basin has been sustainably managed for more than 10 years.

Attachment(s):

- Resolution
- Presentation
- Final Basin 8-1 Alternative

RECOMMENDATION

Agendize for December 21 Board meeting: Adopt resolution to support submission of the Basin 8-1 Alternative to the California Department of Water Resources to comply with the Sustainable Groundwater Management Act which includes the following actions:

- Authorize the General Manager to submit the Alternative to DWR
- Authorize the General Manager to submit other required information and make minor modifications to the Alternative
- Authorize staff to file a notice of exemption with respect to the California Environmental Quality Act

BACKGROUND/ANALYSIS

On September 16, 2014 Governor Brown signed three bills (SB1168, AB1739, and SB1319), which comprise the Sustainable Groundwater Management Act (Act).

The Act requires that all high- and medium-priority basins designated by the Department of Water Resources (DWR) be sustainably managed. DWR designated the Coastal Plain of Orange County Groundwater Basin (Basin 8-1) as a medium-priority basin, primarily due to heavy reliance on the basin's groundwater as a source of water supply.

Compliance with the Act can be achieved by one of two options:

1) Forming a Groundwater Sustainability Agency (GSA) and submitting a Groundwater Sustainability Plan (GSP), or
2) Submitting an Alternative to a GSP

Basin 8-1, as defined by DWR, includes areas within and outside of OCWD's jurisdiction as shown in Figure 1. Approximately 89 percent of Basin 8-1 is within OCWD's jurisdiction. Areas outside of OCWD include a northern section within the cities of La Habra and Brea, land along the Santa Ana River upstream of Imperial Highway, and land outside of the southern and southeastern OCWD boundary within the jurisdiction of Irvine Ranch Water District, El Toro Water District and the city of Orange.

SGMA identified OCWD as the exclusive local agency to comply with the SGMA within its boundaries (§10723(c)(1)(K)); however, to be eligible to submit an Alternative to a GSP, the entirety of Basin 8-1 must be included in the Alternative and it must be demonstrated that Basin 8-1 has been sustainability managed.

The agencies within Basin 8-1 have agreed to prepare and submit an Alternative to a GSP, which is referred to as the Basin 8-1 Alternative. In accordance with §10733.6(b)(3), the Basin 8-1 Alternative presents an analysis that demonstrates the basin has operated sustainably over a period of at least 10 years. In fact, Basin 8-1 has been operated sustainably for more than 10 years without experiencing the undesirable results, which are defined by the California Water Code as significant and unreasonable lowering of groundwater levels, reduction in storage, water quality degradation, seawater intrusion, inelastic land subsidence, or depletions of interconnected surface water that impacts beneficial uses of surface water. Since the basin has been sustainably managed and no new actions are required, the Basin 8-1 Alternative essentially describes the ongoing actions that will continue sustainable management of the basin. The Alternative does not authorize or otherwise empower the other submitting agencies (La Habra and IRWD) to require OCWD to take any action or refrain from taking any action.

The Basin 8-1 Alternative was jointly prepared by the Orange County Water District (OCWD) and agencies with jurisdiction outside of OCWD's boundaries, including the City of La Habra and the Irvine Ranch Water District (IRWD). Table 1 shows the lead agencies responsible for preparing the sections covering the management areas.

Table 1: Lead Agencies for Preparation of Basin 8-1 Alternative

Agency	Management Area
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Water District. Pursuant to §10733.2, the Basin 8-1 Alternative has been prepared by or under the direction of a professional geologist or professional engineer.

In the Basin 8-1 Alternative, four management areas were identified as shown in Figure 1. Accordingly, the Basin 8-1 Alternative is organized as follows:

- **Overview**: Provides a map and description of Basin 8-1 and a brief description of the basin management areas.
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- **La Habra-Brea Management Area**
- **OCWD Management Area**
- **South East Management Area**
- **Santa Ana Canyon Management Area**

A draft Basin 8-1 Alternative was posted on OCWD's website on November 8, 2016 and was distributed to the other participating agencies for public review. No public comments were received on the draft document. The final version of this report is complete and ready to submit to DWR.

The Basin 8-1 Alternative is exempt from CEQA because the Alternative is an informational document that does not bind, commit or predispose OCWD or other cooperating agencies to further consideration, approval or implementation of any potential project. Submission of the Basin 8-1 Alternative would not cause either a direct physical change to the environment or a reasonably foreseeable indirect physical change to the environment.

Submission to DWR

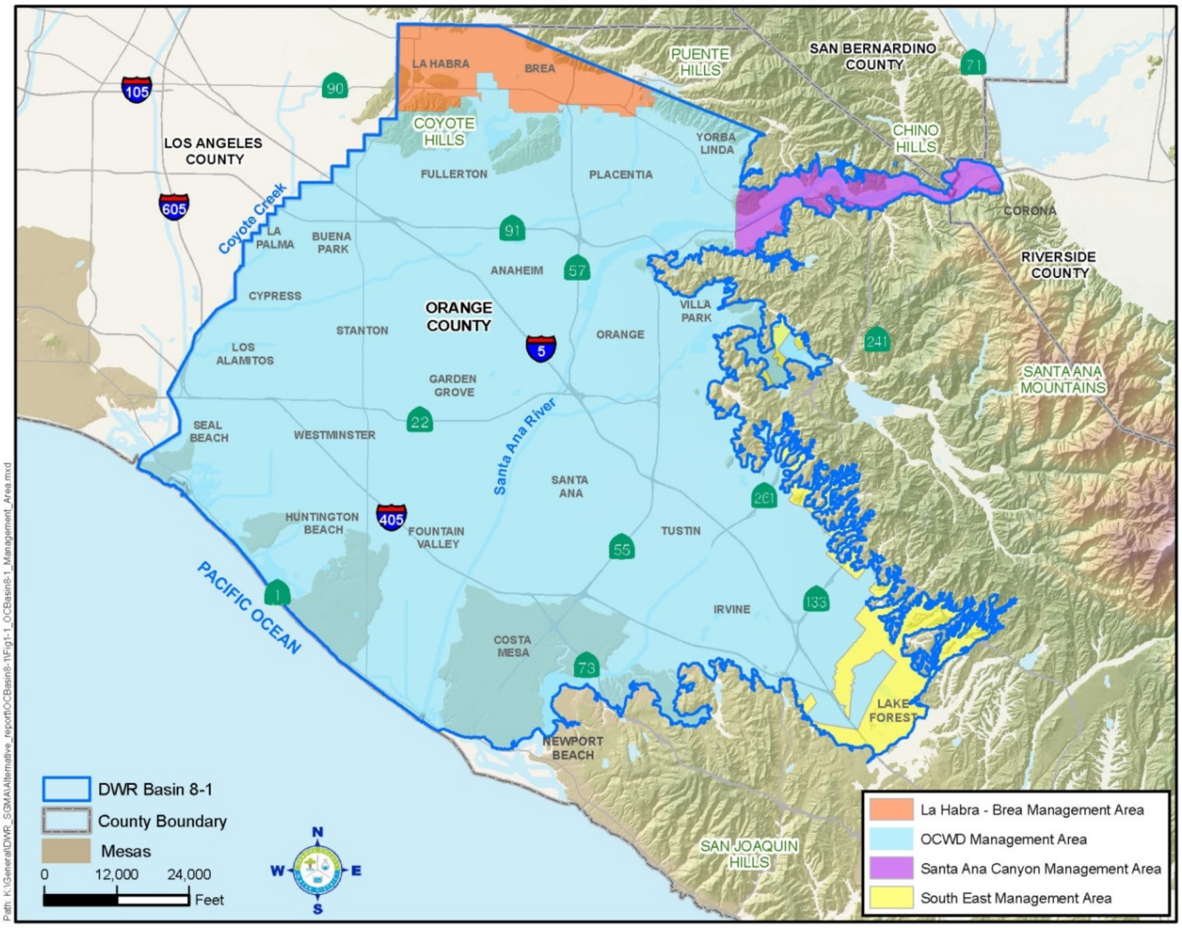
The Basin 8-1 Alternative must be submitted to the DWR by the statutory deadline of January 1, 2017. If the Alternative is not submitted by January 1, 2017, the District would need to become a GSA and submit a GSP. Development of a GSP is more arduous than an Alternative and it is advantageous for the District to comply with SGMA by submitting the Alternative. Additionally, if the District becomes a GSA for the OCWD boundaries, one or more separate GSAs would need to be formed for the areas outside OCWD's boundaries in the Irvine area and the Santa Ana Canyon area.

As part of the submittal to DWR, OCWD must include a resolution or other evidence of compliance that indicates that the Alternative satisfies the objectives of SGMA. The attached resolution satisfied this requirement and authorizes:

- The General Manager or designee to submit the Basin 8-1 Alternative to DWR
- The General Manager or designee to submit other required information and make minor modifications to the Alternative
- District staff to file a notice of CEQA exemption regarding submission of the Basin 8-1 Alternative.

After the Basin 8-1 Alternative is submitted to DWR, DWR will post on their website to allow for 60 days of public review. DWR has indicated that it may take up to one year to complete their review of Alternatives. Once DWR approves the Basin 8-1 Alternative, the lead agencies within each management area will be required to update the Alternative every 5 years.

Figure 1
Management Areas in Basin 8-1 Alternative



PRIOR RELEVANT BOARD ACTION(S)

07-16-14, R14-7-104	Adopt Groundwater Management Legislation Policy Principles
08-20-14, M14-119	Adopt Support if Amended Position on State Legislation - SB1168/ AB1739 (Groundwater Management Legislation)
10-15-14, M14-160	Direct staff to identify steps for managing Groundwater Outside of District Boundaries (Sustainable Groundwater Management Act)
10-21-15	Water Issues Committee – Informational Sustainable Groundwater Management Act: Compliance Options
11-9-16	Water Issues Committee - Provide comments as appropriate on Draft Basin 8-1 Alternative to Comply with the Sustainable Groundwater Management Act.

CERTIFICATION OF SECRETARY

I do hereby certify that at its meeting held December 21, 2016, the Orange County Water District Board of Directors approved and adopted the following resolution:

RESOLUTION OF THE
BOARD OF DIRECTORS OF THE ORANGE COUNTY WATER DISTRICT
TO SUPPORT SUBMISSION OF BASIN 8-1 ALTERNATIVE TO THE CALIFORNIA DEPARTMENT OF WATER RESOURCES TO COMPLY WITH THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT.
(CCR, Title 23, Division 2, Chapter 1.5, Subchapter 1)

WHEREAS, California Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, collectively comprising the Sustainable Groundwater Management Act (SGMA), which took effect on January 1, 2015; and,

WHEREAS, the SGMA requires all high and medium priority groundwater basins as designated by the California Department of Water Resources (DWR) to develop a process that will lead to or ensure continuation of sustainable groundwater management; and,

WHEREAS, the SGMA has designated the Orange County Water District (OCWD) as the exclusive local agency within its statutory boundaries to comply with SGMA per Water Code Section 10723 (c)(1); and,

WHEREAS, the SGMA allows local agencies to submit an Alternative to a Groundwater Sustainability Plan (Alternative) by January 1, 2017 that shows an entire basin has been sustainably managed for 10 years or more and otherwise satisfies the objectives of SGMA (Water Code Section 10733.6 (b)(3)); and,

WHEREAS, OCWD has consulted with and has been working with other affected Counties, local agencies, public water systems, and stakeholders that are within or adjacent to the Coastal Plain of Orange County Groundwater Basin, a medium priority basin, designated in DWR Bulletin 118 as Basin 8-1 (Basin 8-1); and,

WHEREAS, to be approved by DWR an Alternative must demonstrate management of an entire Bulletin 118 basin; and

WHEREAS, OCWD's boundaries cover a majority of, but not all of the area within Basin 8-1; and,

WHEREAS, a number of local agencies overlie areas of Basin 8-1 that fall outside of OCWD's boundaries; and,

WHEREAS, OCWD, in collaboration with other agencies, principally the City of La Habra and Irvine Ranch Water District, has prepared and compiled an Alternative that will facilitate and ensure sustainable management in the entirety of the Basin 8-1; and,

WHEREAS, OCWD, the City of La Habra, and the Irvine Ranch Water District have agreed to jointly submit the Alternative to DWR and are referred to in the Alternative submission as 'submitting agencies'; and,

WHEREAS, the Alternative does not authorize (or otherwise empower) the other submitting agencies to require OCWD to take any action, or refrain from taking any action; and,

WHEREAS, the Alternative discusses Basin 8-1's physical features, the OCWD's facilities and monitoring and operating programs, and the management tools available to manage the basin for each of the submitting agencies, but does not bind, commit, or predispose OCWD to further consideration, approval or implementation of any potential project; and,

WHEREAS, Submission of the Alternative to DWR does not have the effect of approving any current or future project but instead describes a continuing process of groundwater management that OCWD has utilized in largely the same manner since prior to the enactment of the California Environmental Quality Act (CEQA) in 1970; and,

WHEREAS, If any individual future project discussed in the Alternative is carried forward by the District for approval, an Engineer's Report will be prepared for that potential project for consideration by the Board of Directors, as required by Section 20.7 of the District Act. The District will also concurrently conduct appropriate environmental analysis in accordance with CEQA with respect to each potential project that is carried forward for consideration and possible approval by the OCWD Board of Directors; and,

WHEREAS, submission of the Alternative will not cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment, and is therefore not a "project" regulated by CEQA. To the extent it could be considered a "project" for purposes of CEQA, the Alternative is exempt from CEQA per State CEQA Guidelines Sections 15261 (Ongoing Project), 15262 (Feasibility and Planning Studies), and 15306 (Information Collection and Management); and,

WHEREAS, DWR has a statutory deadline of January 1, 2017 by which the Alternative for all of Basin 8-1, must be submitted to DWR; and,

WHEREAS, the submitting agencies are prepared to submit the Alternative covering all of Basin 8-1 to DWR.

NOW, THEREFORE, BE IT RESOLVED AND HEREBY ORDERED that the Orange County Water District Board of Directors approves the following:

1. The Orange County Water District authorizes the General Manager or his designee to submit the Basin 8-1 Alternative to DWR.
2. The General Manager or his designee is authorized to submit other required information associated with the Alternative to DWR and/or make minor modifications to the Alternative in response to comments on the Alternative.

3. District staff is authorized and directed to file a notice of exemption in accordance with CEQA regarding OCWD's submission of the Alternative.

IN WITNESS WHEREOF, I have executed this Certificate on December 21, 2016

____

Judy-Rae Karlsen, Assistant District Secretary

Orange County Water District
18700 Ward Street
Fountain Valley, CA 92708
(714) 378-3200

NOTICE OF EXEMPTION

From the Requirements of the California Environmental Quality Act (CEQA)

TO: County Clerk/County of Orange
P.O. Box 238
Santa Ana, CA 92702

State Clearinghouse
P.O. Box 3044
Sacramento, CA 95812-3044

FROM: Orange County Water District
Planning & Watershed Management
18700 Ward Street
Fountain Valley, CA 92708

PROJECT TITLE: Submission of Basin 8-1 Alternative to comply with Sustainable Groundwater Management Act

APPROVAL DATE: December 21, 2016

PROJECT LOCATION: CA Department of Water Resources Basin 8-1 (primarily in north & central Orange County) – see figure on next page
CITY: Various **COUNTY**: Orange, Riverside, San Bernardino

DESCRIPTION OF THE PROJECT: The submission of the Basin 8-1 Alternative to comply with the Sustainable Groundwater Management Act assists the Orange County Water District with documenting that Basin 8-1 identified by the CA Department of Water Resources (DWR) has been sustainably managed over a period of at least 10 years.

NAME & ADDRESS OF APPLICANT: Orange County Water District, 18700 Ward Street, Fountain Valley CA 92708

NAME OF PUBLIC AGENCY APPROVING PROJECT: Orange County Water District

EXEMPT STATUS:

- ☐ Ministerial (Sec. 15268)
- ☐ Declared Emergency (Sec. 15269 (a))
- ☐ Emergency Project (Sec. 15269(a)&(b))
- ☐ General Rule (Sec. 15061(b)(3))
- X Statutory Exemption: Section 15261, Section 15262
- X Categorical Exemption: Class 6 Section 15306

REASON(S) WHY PROJECT IS EXEMPT FROM CEQA:
Submission of the Basin 8-1 Alternative to DWR does not have the effect of approving any current or future project but instead describes a continuing process of groundwater management that OCWD has utilized in largely the same manner since prior to the enactment of the California Environmental Quality Act (CEQA) in 1970. Additionally, submission of the Alternative will not cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment, and is therefore not a "project" regulated by CEQA. To the extent it could be considered a "project" for purposes of CEQA, the Alternative is exempt from CEQA per State CEQA Guidelines Sections 15261 (Ongoing Project), 15262 (Feasibility and Planning Studies), and 15306 (Information Collection and Management).

Orange County Water District
18700 Ward Street
Fountain Valley, CA 92708
(714) 378-3200

CONTACT PERSON: Adam Hutchinson

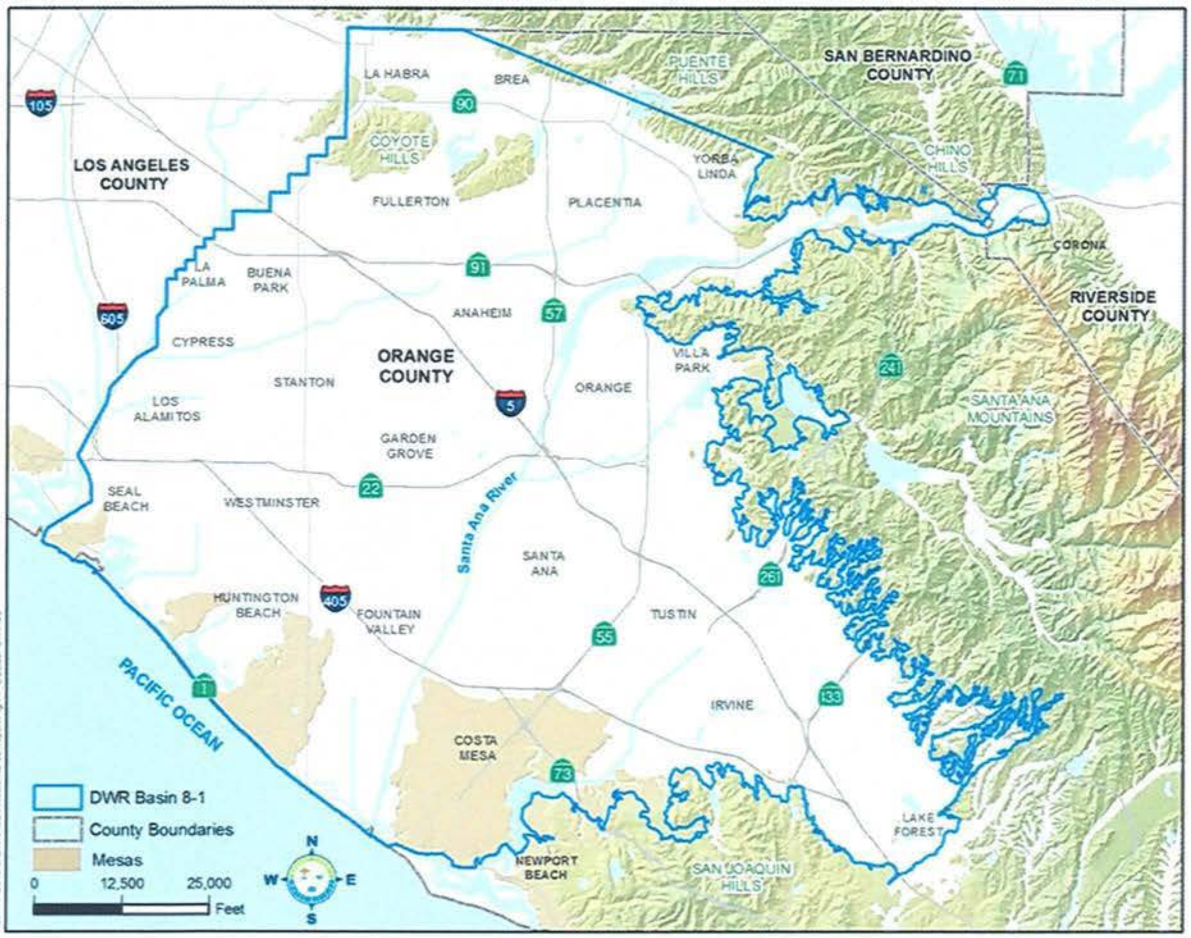
TELEPHONE No: 714 378-3214

SIGNATURE: ____________________

DATE: December 22, 2016

TITLE: Recharge Planning Manager

Figure showing Location of CA Department of Water Resources Basin 8-1



City of La Habra **ADMINISTRATION**

"A Caring Community"

201 E. La Habra Boulevard
Post Office Box 337
La Habra, CA 90633-0785
Office: (562) 383-4010
Fax: (562) 383-4474

December 19, 2016

Michael R. Markus
General Manager
Orange County Water District
18700 Ward Street,
Fountain Valley, CA 92708

Re: City of La Habra Support for Orange County Water District Alternative Plan for Basin 8-1 Under the Sustainable Groundwater Management Act

Dear Mr. Markus:

The City of La Habra ("City") supports Orange County Water District's Alternative Plan under the Sustainable Groundwater Management Act. The City recognizes OCWD's dilemma in satisfying the Department of Water Resources' requirement that the OCWD Alternative Plan must cover portions of Basin 8-1 (DWR Bulletin 118) which are outside of OCWD's jurisdiction. So, when we met in June this year the City agreed to collaborate with OCWD in preparation of the OCWD Alternative Plan. Reciprocally, OCWD adopted a resolution in support the City's request to DWR to re-establish the La Habra Basin as separate from the balance of Basin 8-1.

The City staff, consultants and attorneys have collaborated with OCWD in the development of the OCWD Alternative Plan. The Plan accurately characterizes La Habra Basin as a management area separate and apart from the OCWD management area, even though both are depicted in Bulletin 118 as being within Basin 8-1. The OCWD Alternative plan also accurately describes the City as the recognized the GSA for groundwater resources underlying the cities of La Habra and Brea. The Plan also accurately describes the City's past and current sustainable groundwater management practices and City's intent to develop a Groundwater Sustainability Plan under SGMA for the La Habra management area. The City endorses the portions of the OCWD Alternative Plan which describe the La Habra management area and the past and intended future groundwater sustainability actions therein.

Separate and independent sustainable groundwater management programs for the Orange County Basin and the La Habra Basin have co-existed for many years. The City of La Habra fully intends that relationship to continue into the future. To that end, the City, as GSA for La Habra Basin, will continue to cooperate and collaborate with OCWD on mutual concerns related to SGMA and to sustainable groundwater management practices.

The City of La Habra endorses those portions of the OCWD Alternative Plan related to the La Habra management area and fully supports OCWD's efforts to comply with SGMA through the OCWD Alternative Plan. If OCWD desires, you may use this letter as part of the

OCWD Alternative Plan submittal to DWR.

Sincerely,

Jim Sadro
City Manager

CC: City Manager, City of Brea
City Manager, City of Fullerton