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Acronyms and Abbreviations Used in This Report

AB	Assembly Bill
ACWA	Association of California Water Agencies
af	acre-feet
af/yr.	acre-feet per year
AVEK	Antelope Valley-East Kern Water Agency
AWAC	Alliance for Water Awareness and Conservation
bgs	below ground surface
BLM	Bureau of Land Management
BMO	Basin Management Objective
CASGEM	California Statewide Groundwater Elevation Monitoring
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
CIMIS	California Irrigation Management Information System
cfs	cubic feet per second
CWC	California Water Code
DAC	disadvantaged community
DFW	California Department of Fish and Wildlife
DMA	Disaster Mitigation Act of 2000
DPR	Department of Pesticide Regulation
DWR	California Department of Water Resources
ECSZ	Eastern California Shear Zone
EI	energy intensity
EIR	environmental impact report

EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FPA	Free Production Allowance
GAMA	Groundwater Ambient Monitoring and Assessment
GCM	global climate model
GHG	greenhouse gas
gpc	gallons per capita
gpcd	gallons per capita per day
gpm	gallons per minute
GPS	global positioning system
GWMP	groundwater management plan
HCP	habitat conservation plan
HIP	high population scenario
IPCC	Intergovernmental Panel on Climate Change
IRWM	integrated regional water management
IRWMP	integrated regional water management plan
IWM	integrated flood management
kWh/af	kilowatt hours per acre-foot
LAA	Los Angeles Aqueduct
LACSD	Los Angeles County Sanitation Department
LADWP	Los Angeles Department of Water and Power
LLNL	Lawrence Livermore National Laboratory
LOP	low-population growth scenario
LORP	Lower Owens River Project

maf	million acre-feet
MCWD	Mammoth Community Water District
mg/L	milligrams per liter
MHI	median household income
MWA	Mojave Water Agency
MWD	Metropolitan Water District of Southern California
MWh	megawatt-hour
OVLMP	Owens Valley Land Management Plan
PA	planning areas
PWD	Palmdale Water District
R^3	Regional Recharge and Recovery Program
RAP	Regional Acceptance Process
RWMG	regional water management group
RWQCB	regional water quality control board
SB	Senate Bill
SCWA	Solano County Water Agency
SEA	significant ecological area
SFMP	State Flood Management Planning Program
SWN	State Well Number System
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TDS	total dissolved solids
Update 2013	California Water Plan Update 2013

USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VVWRA	Victor Valley Wastewater Reclamation Authority
VWD	Victorville Water District
WCIP	Water Conservation Incentive Program
WRCC	Western Regional Climate Center
WSSP2	Water Supply Stabilization Project No. 2

Owens Valley, near Bishop, CA. The upper portion of the Owens Valley, as depicted here, is used largely for grazing and contains wilderness areas of the Sierra Nevada range. Overall, the South Lahontan region supports agriculture and cattle ranching, and is the source of water for the South Coast region via the Los Angeles Aqueduct, which originates in the Owens Valley.

South Lahontan Hydrologic Region

South Lahontan Hydrologic Region Summary

Several of California's well-known natural resources are located in the South Lahontan Hydrologic Region. They include Mono Lake, Death Valley, the Owens Valley, and the Mojave Desert. Two of California's fastest developing urban areas over the past several decades are also in the region — the Antelope and Victor valleys. Agriculture, although small in acreage, has remained steady over the years. Projections of continued growth have induced local water agencies to develop new water supplies and increase the reliability of existing water supplies. With additional stakeholders helping to study and resolve these issues under Integrated Regional Water Management planning programs, these actions have intensified in recent years and are reflected in the following discussion.

Current State of the Region

Setting

The South Lahontan Hydrologic Region represents about 17 percent of the land area in California: more than 17 million acres of land. The region includes Inyo County and portions of Mono, San Bernardino, Kern, and Los Angeles counties. It is bounded to the north by the drainage divide between Mono Lake and East Walker River; to the west and south by the Sierra Nevada, San Gabriel, San Bernardino, and Tehachapi mountains; to the southeast by the New York Mountains and to the east by the state of Nevada (Figure SL-1).

The topography of the South Lahontan region is characterized by fault-bounded mountain blocks separated by basins filled principally with alluvial and lake sediments and lesser volcanic material. The region is part of the basin and range province, which spans Nevada, western Utah, southern Idaho, southern Oregon, southeastern California, and southwestern Arizona. The highest and lowest points in the conterminous United States are in the central part of the region: Mt. Whitney with an elevation of 14,495 feet above sea level and Badwater in Death Valley at 282 feet below sea level. The most prominent mountain ranges are the Sierra Nevada, the White-Inyo Mountains, the Panamint Range, the Amargosa Range, the Tehachapi Mountains, the San Gabriel Mountains, and the San Bernardino Mountains.

The region's past tectonic activities and current climate are responsible for the region's present day hydrologic and drainage characteristics. The bordering mountain ranges have left the region without an outlet to the Pacific Ocean. As a result, all rivers and streams drain to internal basins. For most of the year, flows in these waterways are, at best, ephemeral and intermittent — a condition that reflects the region's present day arid conditions. Surface runoff can result from summer thunderstorms and occasionally winter storms. If flow does occur, it provides the water sources for ephemeral and intermittent flows that occur in these normally dry streams. The presence of playas reflects the internal drainage characteristic of the region's many basins.

The perennial flows in the Owens River reflect the wetter conditions found in the northern part of the region. Other perennial rivers benefitting from the higher precipitation and runoff from

Figure SL-1 South Lahontan Hydrologic Region

the snowmelt include Rush, Lee Vining, and Mill creeks which, along with their tributaries, drain into Mono Lake. In the south, water flows in the rivers and streams are more intermittent or ephemeral. When there is flow, it is usually the result of runoff from heavy rainfall events. Important rivers in the southern portion are the Mojave and Amargosa rivers.

The conditions in the north have also resulted in the formation of both natural and human-made lakes, some important for water supplies and others for recreation. Important lakes include Mono Lake, Grant Lake, June Lake, Convict Lake, Crowley Lake, Lake Mary, and Tinemaha and Haiwee reservoirs. In the south, important lakes include Lake Arrowhead and the State Water Project's (SWP) Silverwood Lake.

Native vegetation in the arid valleys and ranges is adapted for drought-tolerance and salt-tolerance, with communities including Mojave Creosote scrub, sagebrush scrub, Joshua Tree woodland, and alkali sink. In the cooler, wetter mountain areas, vegetation communities are zoned by elevation and include pinyon-juniper woodland at intermediate elevations and alpine forest and fell-field communities at the highest elevations. Riparian and other native vegetation communities in the ephemeral streams of the watershed also provide critical habitat for some of the indigenous bird and animal species. These communities are sustained from the flows in streams following rainfall events and from the seeds, nutrients, and organic matter transported in these flows.

Major water facilities include the Los Angeles Aqueduct (LAA) and the West Branch and East Branch of the SWP.

Several large national parks and forests exist in the South Lahontan Hydrologic Region. These include Death Valley National Park, the Inyo National Forest, and the Mojave Natural Preserve. There are also several large military reservations in the region.

Watersheds

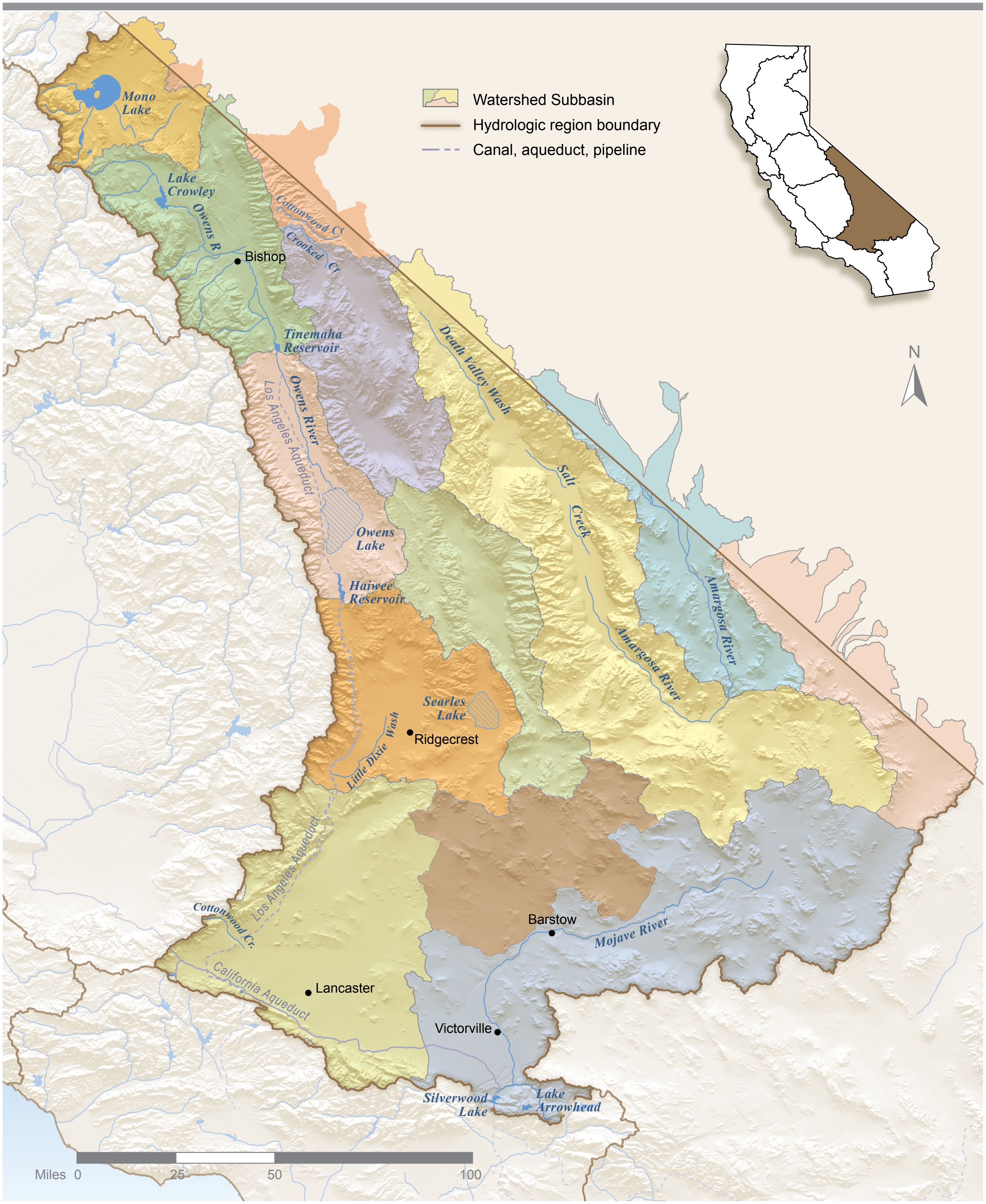
Watersheds in the South Lahontan Hydrologic Region (Figure SL-2) include Antelope Valley, Mojave, Mono Basin, Owens River, Amargosa River, and Mojave River.

Antelope Valley Watershed

The Antelope Valley watershed extends over portions of Kern, Los Angeles, and San Bernardino counties and covers 2,400 square miles (see Figure SL-2). It is bounded by the San Gabriel Mountains on the south, the Tehachapi Mountains to the north, and a series of hills and buttes that generally follow the Los Angeles-San Bernardino County line to the east. Major communities include the cities of Lancaster, Palmdale, and California City; the towns of Boron, Mojave, and Rosamond; and Edwards Air Force Base. Most of the service area of the Antelope Valley-East Kern Water Agency (AVEK) lies within the watershed. Antelope Valley is a closed basin without a natural outlet to the Pacific Ocean.

The watershed is actually a collection of several smaller watersheds. Many of the steams for these watersheds have their headwaters in the San Gabriel Mountains. These include Big Rock Creek, Little Rock Creek, and Amargosa Creek. Oak Creek has its headwaters in the Tehachapi Mountains. Amargosa Creek runs from south to north between the State Route 14 and Sierra Highway.

Figure SL-2 Watersheds in the South Lahontan Hydrologic Region



The construction of new homes and commercial buildings continues in the Antelope Valley but the pace has slowed in recent years because of the recession. Agricultural operations continue to the west, north, and east of the cities of Lancaster and Palmdale. The total irrigated crop acres have averaged slightly less than 20,000 acres in recent years, considerably less than three decades ago.

Littlerock Dam impounds the flowing water in Littlerock Creek in the south. The water stored behind the dam provides water supplies for urban and agricultural users downstream. The dam is operated by the Littlerock Creek Irrigation District and Palmdale Water District (PWD).

Two aqueducts convey water supplies in the watershed. The East and West branches of the SWP convey water supplies to SWP contractors outside of the region and provides water supplies to urban and agricultural users inside the region. The SWP contractor AVEK is responsible for local deliveries. The LAA also passes through the region.

On average, precipitation in the watershed ranges from less than 10 inches per year on the valley floor to more than 12 inches per year in the surrounding mountains. Some areas of the valley floor are subject to flooding due to uncontrolled runoff from these nearby foothills, and this situation is aggravated by the lack of drainage facilities and defined flood channels. Heavy runoff and flooding are prevalent along Big Rock, Little Rock, Amargosa, and Anaverde creeks. Heavy winter rainfall and summer thunderstorms increase the potential for flash floods.

Stormwater runoff that does not percolate into the ground eventually floods to the impermeable dry lakebeds at Edwards Air Force Base, i.e., Rosamond and Rogers Dry lakes. Totaling about 60 square miles, these playas are generally dry, but are likely to be flooded following prolonged precipitation. Fine sediments carried by stormwater inhibit percolation as do the impermeable playa soils. Surface water can remain on the playa for up to five months until the water evaporates.

Mojave Watershed

The Mojave watershed is in San Bernardino County and covers an area of 4,500 square miles (see Figure SL-2). It includes the Mojave River and its associated floodplain. It is bounded to the south by the San Bernardino and San Gabriel mountains. The northern and eastern boundaries are provided by a series of smaller mountain ranges that include the Granite, Bristol, and Providence mountains. From the San Bernardino Mountains, the watershed extends northward to the city of Barstow before turning to the northeast. It includes Silver Lake, a dry lakebed near the community of Baker, and the dry lakebeds of Harper Lake, Coyote Lake, Troy Lake, Soda Lake, West Cronese, and East Cronese.

The main hydrologic feature of the watershed is the Mojave River whose headwaters are in the San Bernardino Mountains. Snowmelt provides most of water for the river and provides an estimated 54,000 acre-feet (af) of annual recharge to the Upper, Middle and Lower Mojave River Groundwater Basins. After descending from Mojave River Dam in the Mojave River Forks Reservoir, the river meanders approximately 120 miles and terminates at Silver Dry Lake. For most of the year, the Mojave River channel is dry downstream of the dam except at the Narrows near Victor Valley and Afton Canyon where the subsurface flow beneath the riverbed is forced to the surface by geologic structures. Deep Creek, tributary to Mojave River, begins near Crestline in the San Bernardino Mountains. It flows most of the time, but may be dry in the summer. The

Deep Creek watershed includes Lake Arrowhead, and the creek joins the Mojave River at Mojave River Forks Reservoir.

The watershed has a combination of urban, agricultural, and environmental land and water uses. The urban area in Victor Valley, which includes the city of Victorville, has been expanding steadily for the past two decades. This expansion of the urban area has significantly modified the amount of waste discharges that could potentially affect water quality, including stormwater and wastewater treatment.

Groundwater is the primary water supply source for all of the uses in the watershed. Overdraft conditions for several groundwater basins in the area, including the Mojave River Valley Groundwater Basin, began in the 1950s. Formal adjudication of the basin occurred in 1996 through a stipulated judgment, which was appealed shortly after. On August 22, 2000, the California Supreme Court issued a decision that affirmed water rights priority in cases of competing water appointment.

Mojave Water Agency (MWA) completed its first pipeline and recharge project (Morongo Basin Pipeline) in 1994. SWP deliveries to the Mojave River at the Rock Springs recharge site began in 1994; in 1995, recharge began in Yucca Valley. The Mojave River Pipeline, built in 1999, delivers SWP water to the Hodge and Lenwood recharge sites; it was extended later to Daggett/Yermo and Newberry Springs recharge sites.

MWA recently completed the Oro Grande Wash Recharge project, which delivers SWP water to a groundwater recharge site in Victorville. MWA completed the Regional Recharge and Recovery (R^3) Project in 2012. R^3 is part of a conjunctive use project that will pump SWP water previously stored in the Mojave River Basin and deliver it to retail water agencies in the Victor Valley area.

Mono Basin

The Mono Basin watershed is on the eastern slope of the Sierra Nevada in southern Mono County (see Figure SL-2). The watershed encompasses more than 800 square miles and is bounded by the Sierra Nevada, Bodie Hills, Cowtrack Mountain, and the Glass Mountains. Mono Lake is the main feature of the watershed, and in 2012 its surface area was 71.35 square miles. Mono Basin is a closed basin, with all streams draining into Mono Lake. These include Mill Creek, Lee Vining Creek, and Rush Creek with its tributaries Parker Creek and Walker Creek. The watershed ranges in elevation from slightly above 6,300 feet on the surface of Mono Lake to more than 13,000 feet near the crest of the Sierra Nevada. Summers range from mild to cool, and winters are cold and snowy.

Native vegetation communities range from scrub to grasslands around Mono Lake to the coniferous forests, including the Jeffrey Pine forests and pinyon juniper woodland habitats in the eastern Sierra Nevada. The watershed is an important nesting and rest stop for over 300 species of nesting and migratory birds. Most of the species are migratory but some, such as the California gull, do nest.

Urbanized areas in the watershed are small and are concentrated mostly in Lee Vining, Grant Lake, and June Lake. Other than livestock grazing on native pasture lands, there is no agriculture. Projects are under way to restore the fishery and riparian vegetation for Rush and Lee Vining creeks. All activities are being monitored to track improvements.

The level of Mono Lake has fluctuated in response to climatic changes and more recently in response to diversions of Mono Lake tributary streams. In 1941, the Los Angeles Department of Water and Power (LADWP) completed a tunnel connecting the Mono Basin with the headwaters of the Owens River, and began diverting water from Mono Basin to supplement the water supplied to the LAA system from the Owens River. From 1941 to 1989, LADWP's average diversions from the Mono Basin were approximately 67,000 acre-feet per year (af/yr.). As a result of litigation seeking to curtail exports and protect Mono Lake, no water was exported from 1990 through 1994. In 1994, the State Water Resources Control Board (SWRCB) ordered exports from Mono Basin to Los Angeles to be indexed to lake level in order to raise the water level of Mono Lake and to restore stream and waterfowl ecosystems. The order allows exports to be curtailed until a target lake level elevation of 6,391 feet is reached, which was estimated to occur in approximately 20 to 30 years depending on the sequence of hydrology. Mono Lake's historic low is 6,372 feet, but current elevation of the lake is 6,380.5 feet as of November 2013.

Owens River

The Owens River watershed (see Figure SL-2) extends from just north of the Town of Mammoth Lakes in southern Mono County to Owens Lake in Inyo County. It is bordered by the crests of the Sierra Nevada to the west and White and Inyo mountains to the east. The watershed encompasses 2,604 square miles, and its main hydrologic feature is the Owns River. Important tributaries to the river include Fish Slough and Convict, Horton, Rock, Bishop, Big Pine, Independence, and Lone Pine creeks.

The LAA was completed in 1913 to export water from the Owens Valley to Los Angeles, and is the principal water conveyance infrastructure in the Owens River watershed. Historically, water exports from the Owens-Mono Planning Area to Los Angeles through the LAA have ranged from approximately 109,000 af/yr. to approximately 532,000 af/yr. Over the last five years, water exports averaged approximately 200,000 af/yr. Crowley Lake, Pleasant Valley Reservoir, Tinemaha Reservoir, and Haiwee Reservoir are associated with the LAA system. Other reservoirs in the Owens watershed are South Lake and Lake Sabrina, operated principally for hydropower generation by Southern California Edison. The California Department of Fish and Wildlife (DFW) (formerly the California Department of Fish and Game) operates Hot Creek Hatchery, Fish Springs Hatchery, and Blackrock Hatchery to produce fish to support a recreational fishery.

In 1970, Los Angeles completed construction of a second aqueduct from Owens Valley that increased the export capacity of LAA from 480 cubic feet per second (cfs) to 780 cfs. Increased groundwater pumping in the Owens Valley was one measure being used to help supply this increased capacity. However, in 1972, Inyo County filed suit regarding the increased pumping and its impacts to the Owens Valley environment and the need for an environmental impact report (EIR) concerning the operation of the second aqueduct. The litigation resulted in the development of the Inyo/Los Angeles Long-Term Water Agreement, which provides environmental protection of the Owens Valley while providing Los Angeles with a reliable supply of water. This agreement also includes provisions for groundwater management, monitoring of hydrologic and environmental conditions, and mitigation for negative impacts of groundwater pumping.

Implementation continues for The Lower Owens River Project (LORP) and other environmental enhancement and mitigation projects in the Owens Valley by the City of Los Angeles in conjunction with the County of Inyo and other parties. Two agreements serve as the catalyst for cooperation: the "1991 Agreement Between the County of Inyo and the City of Los Angeles and its Department of Water and Power on a Long Term Groundwater Management Plan for Owens Valley and Inyo County" and "1997 Memorandum of Understanding between the City of Los Angeles Department of Water and Power, County of Inyo, the California Department of Fish and Game, the California State Lands between the principle parties." The 1991 agreement was in response to a settlement of a lawsuit filed by Inyo County to compel the City of Los Angeles to complete California Environmental Quality Act (CEQA) documentation regarding the operations of its second aqueduct, which was completed in 1970.

LORP continues to be one of the largest and most ambitious river restoration projects undertaken in the history of the western United States. In 1913, LADWP began diverting water from Owens River in Inyo County for the LAA, which dried up most of the 62 miles of the river below the intake. Permanent instream flow now exists in the river; and riparian habitat has been created, providing a warm water fishery. LORP has resulted in a permanent water supply for the creation and enhancement of nearly 2,000 acres of wetland and riparian habitat beyond the river banks. The project provides many recreational opportunities.

The ecosystem of the Owens River between Lake Crowley in Mono County and Pleasant Valley Reservoir in Inyo County continues to improve because of the Owens Gorge Rewatering Project. Flows in that segment of the river were accidentally restarted in 1991 because of penstock rupture at LADWP's Control Gorge Power Plant. In response to litigation regarding the new flows, an interim agreement between LADWP and Mono County was reached that permitted the flows to continue. With improvements in the aquatic and riparian habitat, the local trout population has increased and birds and other wildlife have returned. Additional studies have and will be conducted to identify impacts to the ecosystem under different flow regimes. Eventually, the interim agreement will be replaced with a permanent set of guidelines for the water flows and activities that benefit the ecosystem.

Owens Lake serves as the terminal point for the Owens River. For about 75 years, the lake has remained relatively dry because of diversions from the tributaries of the Owens River for the irrigation of crops by local farmers in the 1800s and early 1900s and then by the LAA diversions from the Owens River beginning in 1913. The exposed portions of approximately 110 square miles of lakebed served as a source of alkali particulate matter during windstorms in the valley with the potential for adverse health impacts to residents in the area. However, in 1998, the Great Basin Unified Air Pollution Control District and the City of Los Angeles reached an agreement on dust control operations on Owens Lake. Utilizing water supplies from the LAA, the dust control activities include the shallow spreading of water over portions of the exposed lakebed, re-vegetation with salt grass, and dust control with gravel. By November 2013, 42 square miles is being mitigated in the project with a commitment to mitigate 45 square miles. In fiscal year 2011-2012, 73.8 thousand acre-feet (taf) was utilized for the different activities; in 2012-2013, it was 72.7 taf. Owens Lake currently has the potential to use up to 95 taf/yr. in the event of hot and dry conditions.

Urban land uses within the watershed are minimal and include the major cities of Mammoth Lakes and Bishop. Agriculture is located in the Long, Chalfant, Hamil, and Benton valleys in Mono County, and adjacent to the city of Bishop and communities of Big Pine, Independence, and Lone Pine in Inyo County. Livestock grazing occurs on both public and private lands.

In 2010, LADWP released the Owens Valley Land Management Plan (OVLMP) to address concerns related to livestock grazing and other uses of the Los Angeles-owned land. Priority is being given to riparian areas, irrigated meadows, and sensitive plant and animal habitats. The plan will provide for the continuation of sustainable uses (including recreation, livestock grazing, agriculture, and other activities); will promote biodiversity and a healthy ecosystem; and will consider the enhancement of threatened and endangered species habitats. It will contain an implementation compliance with CEQA and is specifically for land not included in LORP.

The OVLMP is the most recent addition to environmental management projects being implemented along the Owens River since 1991. Other important, on-going programs include the livestock grazing programs for riparian vegetation communities on Convict, McGee, and Mammoth creeks.

Amargosa River

The Amargosa River watershed lies in both Nevada and California. Total area of the watershed in both states is a little less than 1.3 million acres. The watershed includes the Amargosa Valley and Death Valley, and its main hydrologic feature is the Amargosa River. It is also one of the driest areas in the southwestern United States.

The headwaters for the Amargosa River are located in the Black and Timber Mountains near Yucca Mountain, Nevada, and the Nevada National Security Site. Most of the river flows beneath the surface; but near the communities of Shoshone and Tecopa and the Amargosa Canyon, it flows above ground and has created riparian and wetland habitats suitable for wildlife.

In 2007, the Bureau of Land Management (BLM) released a draft of the Amargosa River Area of Critical Environmental Concern Implementation Plan. The plan outlined steps that, when implemented, would protect and restore sensitive riparian and wetland habitats and protect and conserve water resources essential to the maintenance of these critical habitats. The plan is for 21,552 acres of critical habitat in the watershed in California.

Mojave River

The ephemeral Mojave River drains a watershed of approximately 3,800 square-miles and is the largest surface water drainage system of the hydrologic region and extends over 100 miles from its headwaters in the San Bernardino Mountains (Cox et al. 2003; Enzel et al. 2003; Mojave Water Agency 2005). Under present day conditions, perennial flow along the Mojave River is limited to just downstream of the Lower Narrows in the vicinity of the Mojave Narrows, immediately downstream of the Victor Valley Wastewater Reclamation Authority (VVWRA) facility and at Afton Canyon (Mojave Water Agency 2005).

The Mojave River Valley is characterized by deep alluvial basins bordered by non-water bearing igneous and metamorphic mountain ranges and uplands (Mojave Water Agency 2005). Groundwater from the floodplain and regional aquifers is the primary source of water in the region. The floodplain aquifer is approximately 200 feet thick and composed of young, permeable alluvial deposits within and adjacent to the Mojave River channel (Stamos et al. 2001; Stamos et al. 2003). The floodplain aquifer is underlain and surrounded by the regional aquifer, which consists of less permeable unconsolidated alluvial deposits that can be greater than 2,000 feet thick in places (Stamos et al. 2001; Stamos et al. 2003).

Northwest-striking right-lateral faults of the Eastern California Shear Zone (ECSZ) dissect the region (Dokka 1983). These ECSZ faults are oriented parallel to the San Andreas Fault, and many of them impede groundwater flow (Dokka 1983; Mojave Water Agency 2005).

Tribal Communities Relationship to Watersheds

Tribal groups in the South Lahontan region have respected and benefited from their water resources for thousands of years. Early Native American villages were located throughout the Owens-Mono area, especially near water sources. The Owens Valley Paiute developed a sophisticated system of dams and irrigation canals along Bishop and Big Pine creeks, dating back a 1,000 years (Inyo-Mono Integrated Regional Water Management Group 2012). The facilities allowed people to irrigate crops and plants, which were used for food, fiber, and medicine (Steward 1933; Lawton et al. 1976; Walton 1992). Settlers, cattlemen, and gold prospectors from other parts of the United States began entering the area in the 1850s; and subsequent competition over water and other resources led to strife and eventually the establishment of reservations for the Native American people. By 1939, four reservations were established in Owens Valley, the Lone Pine Paiute-Shoshone, Fort Independence Paiute, Big Pine Paiute, and Bishop Paiute reservations. In 1975, the Benton Paiute Tribe had a reservation formally established. The Timbisha Shoshone Tribe achieved federal recognition in 1983, but had no land base within the tribe's ancestral homeland until 2000, when a reservation was established by Congress.

Today, most tribes in the area manage their own domestic water and surface water irrigation systems. The Bishop, Big Pine, and Lone Pine tribes receive annual allotments of irrigation water supplies from LADWP. Fort Independence has its own rights to water from Oak Creek. The Benton tribe has federally reserved rights to groundwater under their reservation, and the Timbisha tribe has federally reserved water rights for their reservation lands. The Big Pine Paiute Tribe and Bishop Paiute Tribe both have U.S. Environmental Protection Agency (EPA)-approved water quality standards for their reservations.

Groundwater Aquifers and Wells

Groundwater resources in the South Lahontan Hydrologic Region are supplied by both alluvial and fractured rock aquifers. Alluvial aquifers are composed of sand and gravel or finer grained sediments, with groundwater stored within the voids, or pore space, between the alluvial sediments. Fractured-rock aquifers consist of impermeable granitic, metamorphic, volcanic, and hard sedimentary rocks, with groundwater being stored within cracks, fractures, or other void spaces. The distribution and extent of alluvial and fractured-rock aquifers and water wells vary significantly within the region. The region is in a very earthquake-prone area. Numerous faults displace and deform the rocks, mountains, and basins within the region. This has resulted in the formation of numerous basins that were subsequently filled with sediment capable of storing large volumes of water. A brief description of the aquifers for the region is provided below.

Alluvial Aquifers

California's Groundwater, Bulletin 118-2003 (California Department of Water Resources 2003) recognizes 77 alluvial groundwater basins and 2 subbasins, which underlie approximately 14,800 square miles or 55 percent of the region. The majority of the groundwater in the region is stored in alluvial aquifers.

Figure SL-3 shows the location of the alluvial groundwater basins and subbasins, and Table SL-1 lists the associated names and numbers. The most heavily used groundwater basin in the region is the Antelope Valley Groundwater Basin, which is bordered by the Garlock Fault Zone and the Tehachapi Mountains to the northwest and the San Andreas Fault Zone and the San Gabriel Mountains to the southwest. Other significant groundwater basins in the region are the Lower, Middle, and Upper Mojave River valleys; Owens Valley; Indian Wells Valley; and Fremont Valley groundwater basins.

Fractured-Rock Aquifers

Fractured-rock aquifers are generally found in the mountain and foothill areas adjacent to alluvial groundwater basins. Due to the highly variable nature of the void spaces within fractured-rock aquifers, wells drawing from fractured-rock aquifers tend to have less capacity and less reliability than wells drawing from alluvial aquifers. On average, wells drawing from fractured-rock aquifers yield 10 gallons per minute (gpm) or less. Although fractured-rock aquifers are less productive compared to alluvial aquifers, they commonly serve as the sole source of water and a critically important water supply for many communities. In the South Lahontan Hydrologic Region, fractured-rock aquifers are not a significant source of groundwater.

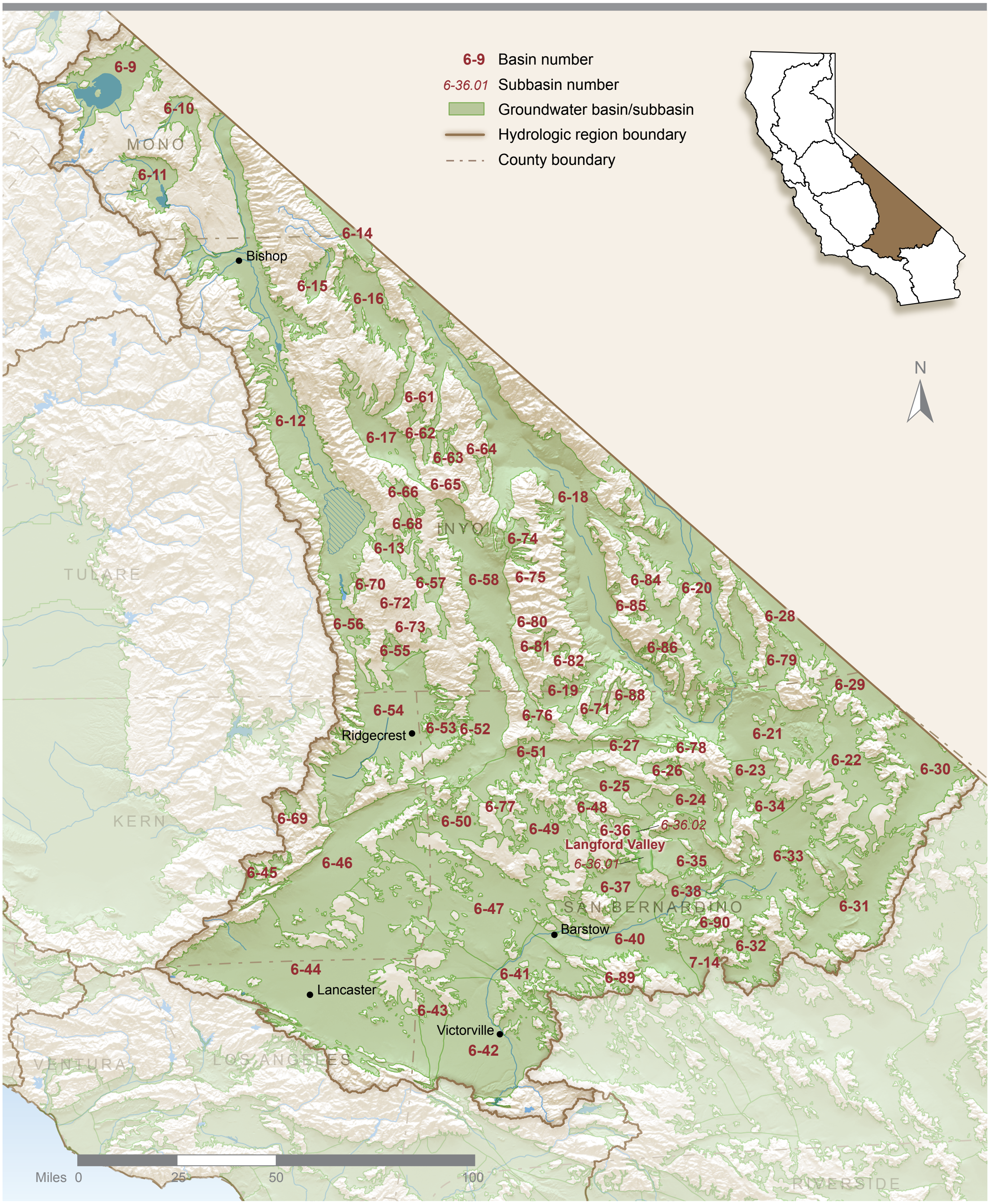
More detailed information regarding the aquifers in the South Lahontan Hydrologic Region is available online from *California Water Plan Update 2013* (Update 2013) Volume 4, *Reference Guide,* the article,"California's Groundwater Update 2013" and California Department of Water Resources (DWR) *Bulletin 118-2003*.

Well Infrastructure and Distribution

Well logs submitted to DWR for water supply wells completed during 1977 through 2010 were used to evaluate the distribution of water wells and the uses of groundwater in the South Lahontan Hydrologic Region. Many wells could have been drilled prior to 1977 or without submitting well logs. As a result, the total number of wells in the region is probably higher than is reported here. DWR does not have well logs for all wells drilled in the region; and for some well logs, information regarding well location or use is inaccurate, incomplete, ambiguous, or missing. Hence, some well logs could not be used in the current assessment. However, for a regional scale evaluation of well installation and distribution, the quality of the data is considered adequate and informative. The number and distribution of wells in the region are grouped according to their location by county and according to six most common well-use types: domestic, irrigation, public supply, industrial, monitoring, and other. Public supply wells include all wells identified in the well completion report as municipal or public. Wells identified as "other" include a combination of the less common well types, such as stock wells, test wells, or unidentified wells (no information listed on the well log).

Well log data for counties that fall within multiple hydrologic regions were assigned to the hydrologic region containing the majority of alluvial groundwater basins within the county. Well log information listed in Table SL-2 and illustrated in Figure SL-4 show that the distribution and number of wells vary widely by county and by use. The total number of wells installed in the region between 1977 and 2010 is approximately 13,000. The number of wells installed in San Bernardino County far exceeds the combined number of wells installed in Mono and Inyo counties. In all three counties, domestic wells and monitoring wells make up the majority of the well logs. Communities with a high percentage of monitoring wells compared to other well types

Figure SL-3 Alluvial Groundwater Basins and Subbasins within the South Lahontan Hydrologic Region



may indicate the presence of groundwater quality monitoring to help characterize groundwater quality issues.

Figure SL-5 shows that domestic wells make up the majority of well logs (56 percent) for the region, followed by monitoring wells (18 percent). Public supply wells account for about 10 percent and irrigation wells for only 4 percent of well logs.

Figure SL-6 shows a cyclic pattern of annual well installation for the region, with new well construction ranging from about 200 to more than 550 wells per year, with an average of about 400 wells per year.

Figures SL-5 and SL-6 show that domestic and public supply wells account for more than 65 percent of all the wells installed. These wells are associated with population growth and housing boom in the region, primarily in San Bernardino County. The dramatic decline in well drilling starting in 2007 and continuing to 2010 is likely due to severely declining economic conditions and a related drop in housing construction. One reason for the very low number of well logs recorded for 2009 and 2010 is due to delays in receiving and processing well logs.

Irrigation well installation is more closely related to hydrologic conditions, cropping trends, and surface water supply cutbacks. Figure SL-6 indicates a steady rate of irrigation well installation, with a slight increase during dry year conditions. Most of the irrigation wells in the region are within San Bernardino County and average fewer than 40 wells installed per year.

The onset of monitoring well installation in the late-1980s is likely associated with federal underground storage tank programs signed into law in the mid-1980s. Up to 1990, monitoring well installations in the region averaged about 25 wells per year. From 1991 through 2010, monitoring well installations jumped to an average of over 100 per year.

More detailed information regarding assumptions and methods of reporting well log information is available online from Update 2013, Volume 4, *Reference Guide,* the article, "California's Groundwater Update 2013."

South Lahontan Hydrologic Region Groundwater Monitoring

Groundwater monitoring and evaluation is a key aspect to understanding groundwater conditions, identifying effective resource management strategies, and implementing sustainable resource management practices. California Water Code (CWC) Section 10753.7 requires local agencies seeking State funds administered by DWR to prepare and implement groundwater management plans that include monitoring of groundwater levels, groundwater quality, inelastic land subsidence, and changes in surface water flow and quality that directly affect groundwater levels or quality. This section summarizes some of the groundwater level, and groundwater quality monitoring efforts within the South Lahontan Hydrologic Region.

Additional information regarding the methods, assumptions, and data availability associated with the groundwater monitoring is available online from Update 2013, Volume 4, *Reference Guide,* the article, "California's Groundwater Update 2013."

Table SL-1 Alluvial Groundwater Basins and Subbasins within the South Lahontan Hydrologic Region

Basin/Subbasin		Basin Name	Basin/Subbasin	Basin Name
6-9		Mono Valley	6-47	Harper Valley
6-10		Adobe Lake Valley	6-48	Goldstone Valley
6-11		Long Valley	6-49	Superior Valley
6-12		Owens Valley	6-50	Cuddeback Valley
6-13		Black Springs Valley	6-51	Pilot Knob Valley
6-14		Fish Lake Valley	6-52	Searles Valley
6-15		Deep Springs Valley	6-53	Salt Wells Valley
6-16		Eureka Valley	6-54	Indian Wells Valley
6-17		Saline Valley	6-55	Coso Valley
6-18		Death Valley	6-56	Rose Valley
6-19		Wingate Valley	6-57	Darwin Valley
6-20		Middle Amargosa Valley	6-58	Panamint Valley
6-21		Lower Kingston Valley	6-61	Cameo Area
6-22		Upper Kingston Valley	6-62	Race Track Valley
6-23		Riggs Valley	6-63	Hidden Valley
6-24		Red Pass Valley	6-64	Marble Canyon Area
6-25		Bicycle Valley	6-65	Cottonwood Spring Area
6-26		Avawatz Valley	6-66	Lee Flat
6-27		Leach Valley	6-68	Santa Rosa Flat
6-28		Pahrump Valley	6-69	Kelso Lander Valley
6-29		Mesquite Valley	6-70	Cactus Flat
6-30		Ivanpah Valley	6-71	Lost Lake Valley
6-31		Kelso Valley	6-72	Coles Flat
6-32		Broadwell Valley	6-73	Wild Horse Mesa Area
6-33		Soda Lake Valley	6-74	Harrisburg Flats
6-34		Silver Lake Valley	6-75	Wildrose Canyon
6-35		Cronise Valley	6-76	Brown Mountain Valley
6-36		Langford Valley	6-77	Grass Valley
	6-36.01	Langford Well Lake	6-78	Denning Spring Valley
	6-36.02	Irwin	6-79	California Valley
6-37		Coyote Lake Valley	6-80	Middle Park Canyon
6-38		Caves Canyon Valley	6-81	Butte Valley

Basin/Subbasin	Basin Name	Basin/Subbasin	Basin Name
6-40	Lower Mojave River Valley	6-82	Spring Canyon Valley
6-41	Middle Mojave River Valley	6-84	Greenwater Valley
6-42	Upper Mojave River Valley	6-85	Gold Valley
6-43	El Mirage Valley	6-86	Rhodes Hill Area
6-44	Antelope Valley	6-88	Owl Lake Valley
6-45	Tehachapi Valley East	6-89	Kane Wash Area
6-46	Fremont Valley	6-90	Cady Fault Area

Groundwater Level Monitoring

To strengthen existing groundwater level monitoring in the state by DWR, the U.S. Geological Survey (USGS), U.S. Bureau of Reclamation (USBR), local agencies and communities, the California Legislature passed Senate Bill (SB) X7 6 in 2009. The law requires that groundwater elevation data be collected in a systematic manner on a statewide basis and be made readily and widely available to the public. DWR was charged with administering the program, which is now known as California Statewide Groundwater Elevation Monitoring (CASGEM).

The locations of monitoring wells by monitoring entity and monitoring well type in the South Lahontan region are shown in Figure SL-7. Other wells account for 89 percent of the monitoring wells in the region, while observation wells comprise 8 percent of the monitoring wells.

A list of the number of monitoring wells in the region by monitoring agencies, cooperators, and CASGEM monitoring entities is provided in Table SL-3. Groundwater levels have been actively monitored in 1,066 wells in the region since 2010. USGS monitors 683 wells in 17 basins and subbasins and areas outside of DWR *Bulletin 118-2003* alluvial basins. Five cooperators and five CASGEM monitoring entities monitor the remaining 383 wells in 12 basins and areas outside of DWR *Bulletin 118-2003* alluvial basins.

CASGEM Basin Prioritization

Figure SL-8 shows the groundwater basin prioritization for the South Lahontan region. Of the 77 basins within the region, two basins were identified as high priority, three basins as medium priority, seven basins as low priority, and the remaining 65 basins as very low priority. Table SL-4 lists the high and medium CASGEM priority groundwater basins for the region. The five basins designated as high or medium priority include 94 percent of the population and account for 55 percent of the groundwater supply in the region. Basin prioritization could be a valuable tool to help evaluate, focus, and align limited resources for effective groundwater management and reliable and sustainable groundwater resources.

More detailed information on groundwater basin prioritization is available at http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm.

Table SL-2 Number of Well Logs by County and Use for the South Lahontan Hydrologic Region (1977 - 2010)

Total Number of Well Logs by Well Use							
County	Domestic	Irrigation	Public Supply	Industrial	Monitoring	Other	Total Well Records[a]
Mono	765	34	81	3	91	73	1,047
Inyo	603	55	76	32	170	195	1,131
San Bernardino	6,026	432	1,135	161	2,068	1,112	10,934
Total Well Records	7,394	521	1,292	196	2,329	1,380	13,112

Note: [a] Represents number of wells installed 1977-2010.

Groundwater Quality Monitoring

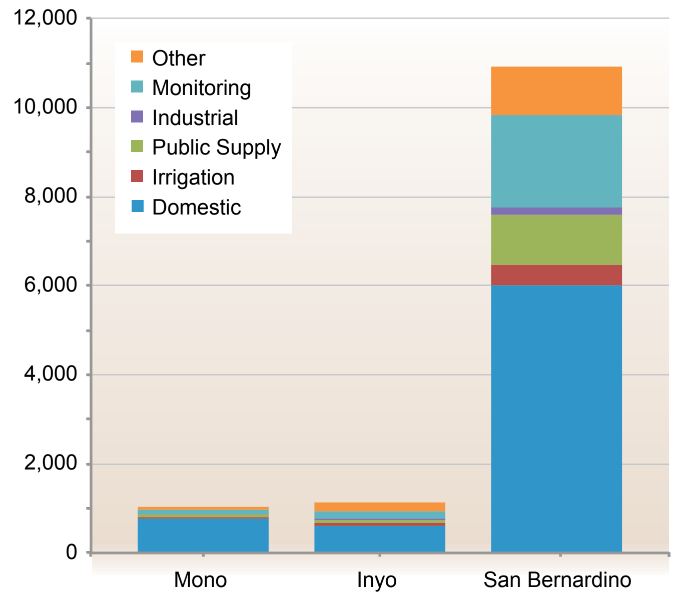
Groundwater quality monitoring is an important aspect to effective groundwater basin management and is one of the components that are required to be included in groundwater management planning in order for local agencies to be eligible for State funds. Numerous State, federal, and local agencies participate in groundwater quality monitoring efforts throughout California.

Regional and statewide groundwater quality monitoring information and data are available on the SWRCB Groundwater Ambient Monitoring and Assessment (GAMA) Web site and the GeoTracker GAMA groundwater information system developed as part of the Groundwater Quality Monitoring Act of 2001. The GAMA Web site describes the GAMA program and provides links to all published GAMA and related reports. The GeoTracker GAMA groundwater information system geographically displays information and includes analytical tools and reporting features to assess groundwater quality. This system currently includes groundwater data from the SWRCB, regional water quality control boards (RWQCBs), California Department of Public Health (CDPH), Department of Pesticide Regulation (DPR), DWR, USGS, and Lawrence Livermore National Laboratory (LLNL). In addition to groundwater quality data, GeoTracker GAMA has more than 2.5 million depth-to-groundwater measurements from the Water Boards and DWR, and also has oil and gas hydraulically fractured well information from the California Division of Oil, Gas, and Geothermal Resources. Table SL-5 provides agency-specific groundwater quality information.

Land Subsidence Monitoring

Land subsidence has been shown to occur in areas experiencing significant declines in groundwater levels. When groundwater is extracted from aquifers in sufficient quantity, the groundwater level is lowered and the water pressure, which supports the sediment grains structure, decreases. In unconsolidated deposits, as aquifer pressures decrease, the increased weight from overlying sediments may compact the fine-grained sediments and permanently decrease the porosity of the aquifer and the ability of the aquifer to store water. Elastic land subsidence is the reversible and temporary fluctuation of earth's surface in response to seasonal groundwater extraction and recharge. Inelastic land subsidence is the irreversible and permanent decline in the earth's surface due to the collapse or compaction of the pore structure within the fine-grained portions of an aquifer system (U.S. Geological Survey 1999). Land subsidence thus results in irreversible compaction of the aquifer and permanent loss of aquifer storage capacity, and has serious effects on groundwater supply and development. Land subsidence due to aquifer compaction causes costly damage to the gradient and flood capacity of conveyance channels, to water system infrastructure (including wells), and to farming operations.

Figure SL-4 Number of Well Logs by County and Use for the South Lahontan Hydrologic Region (1977-2010)



The USGS and the MWA cooperatively monitored and investigated the occurrence of land subsidence in the Mojave Desert within the South Lahontan region. The USGS has conducted land subsidence monitoring and reporting using a global positioning system (GPS) monitoring network in the Lancaster area within Antelope Valley (Phillips et al. 2003). The USGS used extensometer data to study land subsidence at the Edwards Air Force Base in Antelope Valley (Sneed and Galloway 2000).

Results associated with these monitoring activities are provided under the "Land Subsidence" section later in this report.

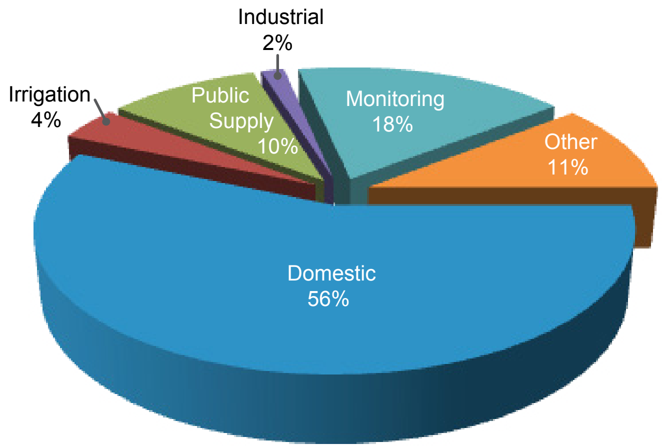
Ecosystems

Antelope Valley

Significant ecological areas (SEAs) identified in the Antelope Valley have unique plant communities and serve as habitat for threatened or endangered species. The areas include Edwards Air Force Base, Big Rock Wash, Little Rock Wash, Rosamond Lake, Saddleback Butte State Park, Alpine Butte, Lovejoy Butte, Piute Butte, Desert-Montane Transect, and Fairmont and Antelope buttes. In addition, there are the Ritter Ridge and Portal Ridge-Liebre Mountain SEAs that are outside the Antelope Valley Integrated Regional Water Management (IRWM) study area.

BLM, U.S. Fish and Wildlife Service (USFWS), DFW, and the cities of Lancaster and Palmdale jointly developed the West Mojave Habitat Conservation Plan, which includes the Antelope Valley. The plan will establish conservation areas to protect the desert tortoise, Mohave ground squirrel, and other sensitive plants, animals, and habitats.

Figure SL-5 Percentage of Well Logs by Use for the South Lahontan Hydrologic Region (1977-2010)



Mojave River

The Mojave River region has several unique and important wetland and riparian areas. They are located along the banks of the Mojave River, at Harper Dry Lake, and along portions of Sheep Creek.

On the Mojave River, a Cottonwood Willow habitat area is located in an area known as the Upper and Lower Narrows. Along the lower reaches of the Mojave River, an area identified as Camp Cady had thriving mesquite trees and three ponds. However, groundwater levels have fallen, and the mesquite groves are drying out. DFW has purchased land on the western boundary and has initiated efforts to maintain channel flows and possibly re-establish surface ponding to maintain habitat for animals.

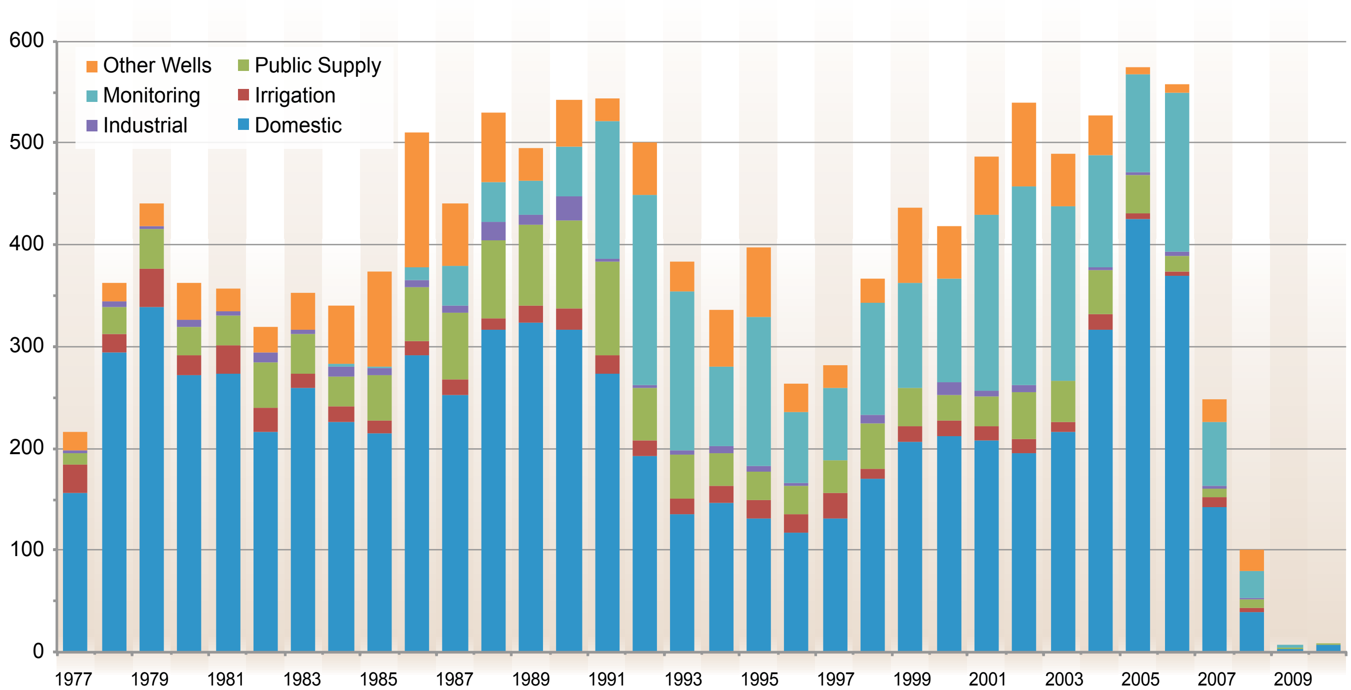
Afton Canyon, adjacent to the Mojave River, has been designated as an Area of Critical Environmental Concern. BLM is working to restore the riparian and wetland features in this area.

A federally designated wetland area exists at Harper Dry Lake. Runoff from agricultural activities produced a small marsh in the southwestern portion of Harper Dry Lake. A reduction in agricultural activities eliminated the source of runoff needed to maintain the marsh. In 2003, BLM initiated groundwater pumping to maintain California Watchable Wildlife Site #87 at Harper Dry Lake, which encompasses approximately 480 acres of marsh and has become a critical resource for migrating birds (U.S. Bureau of Land Management 2007; California Watchable Wildlife Committee 2012). Mitigation funding was obtained from a nearby solar facility to install a well and pipeline for the marsh. BLM applies up to 75 af/yr. to maintain the marsh. Water application is reduced in the summer to simulate natural conditions (California Watchable Wildlife Committee 2012).

Mojave National Preserve

The Mojave National Preserve is located in both the South Lahontan and Colorado River hydrologic regions; a majority of the preserve is in the South Lahontan. The total land area of the preserve is 1.6 million acres. It was established by Congress in 1994 and is presently managed by the National Park Service. The vegetation and the natural springs and seeps in this ecosystem provide habitat for about 300 wildlife species, which include 206 species of birds. There are three federally endangered, one federally threatened, six State-threatened, and one State-endangered plants and wildlife in the preserve. The desert tortoise is an example of a threatened animal species, and much of the preserve has been designated as critical habitat for it. The Joshua Tree Woodlands is an example of a sensitive and unique flora community. The preserve has historical artifacts and is available for recreational activities. The National Park Service has developed a general management plan for the preserve to protect the plant and animal and other resources,

Figure SL-6 Number of Well Logs Filed per Year by Use for the South Lahontan Hydrologic Region (1977-2010)



including the limited water supplies, and permit access from the public for research and recreational purposes.

San Bernardino National Forest Land Management Plan

The land management plan for the San Bernardino National Forest was revised in 2006. The revised plan focuses attention on issues such as public access, future development, community protections, and the conservation of plant and animal species. It establishes protocols for working with and protecting lands owned by Native American tribes

Owens Valley, Fish Slough, and Death Valley National Park

In the Owens Valley, habitat has been restored through the Lower Owens River Project, a joint project between Inyo County and LADWP. Sixty miles of the Owens River channel and embankment have been restored below the intake for the LAA. Fish Slough is a refuge for endemic Owens Valley Pupfish, and has been designated as a BLM Area of Critical Environmental Concern. Mono Lake is recognized as important habitat for waterfowl and shorebirds. Death Valley has a number of important habitats and endemic species. The perennially flowing reach of the Amargosa River between Tecopa and Dumont Dunes was designated as a wild and scenic river in 2009.

Table SL-3 Groundwater Level Monitoring Wells by Monitoring Entity in the South Lahontan Hydrologic Region

State and Federal Agencies	Number of Wells
U.S. Geological Survey	683
Total State and federal wells	**683**
Monitoring Cooperators	**Number of Wells**
Apple Valley Ranchos Water Company	11
Hesperia County Water District	14
Mojave Water Agency	250
Sheep Creek Mutual Water Company	1
Southern California Water Company	14
Total cooperator wells	**290**
CASGEM Monitoring Entities	**Number of Wells**
Indian Wells Valley Cooperative Groundwater Management Group	39
Inyo County	11
Los Angeles Department of Water and Power	27
Mono County	14
Tri-Valley Groundwater Management District	2
Total CASGEM Monitoring Wells	**93**
Grand Total	**1,066**

Notes:

CASGEM = California Statewide Groundwater Elevation Monitoring

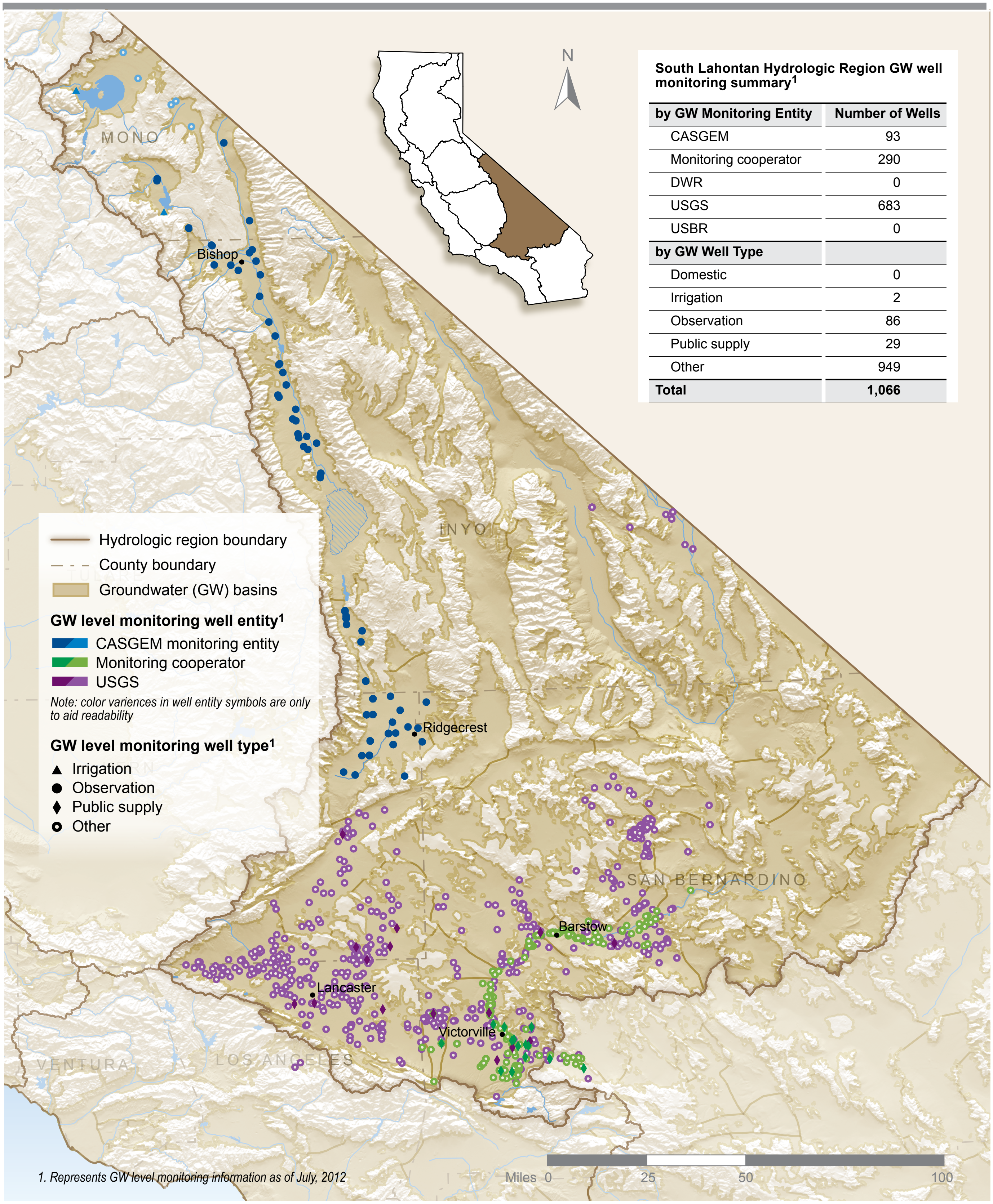
Table represents monitoring information as of July 2012.

Flood

The risk of damage from floods is probably not as great in the South Lahontan region as in other areas of the state because of the lack of significant annual rain and snowfall. However, despite historical trends of rain and snowfall, home and business owners, public and private property, and other assets, even endangered species, in the region are exposed to potentially damaging 500-year flood events in the South Lahontan region. Flash floods, debris flows, stormwater, slow-rise, alluvial fan and engineered structure failure flooding are all possible through the rapid melt of the snowpack in the Sierra Nevada and other ranges or by runoff from intense, prolong, summer thunderstorms. It is also worth noting that the infrequency of flooding events in the region can result in public apathy toward preparing for such events.

In the South Lahontan Region, winter storms generally create the greatest flood damage. The larger streams exhibit slow-rise floods, but storms tend to be intense, also causing flash flooding.

Figure SL-7 Monitoring Well Location by Agency, Monitoring Cooperator, and CASGEM Monitoring Entity in the South Lahontan Hydrologic Region

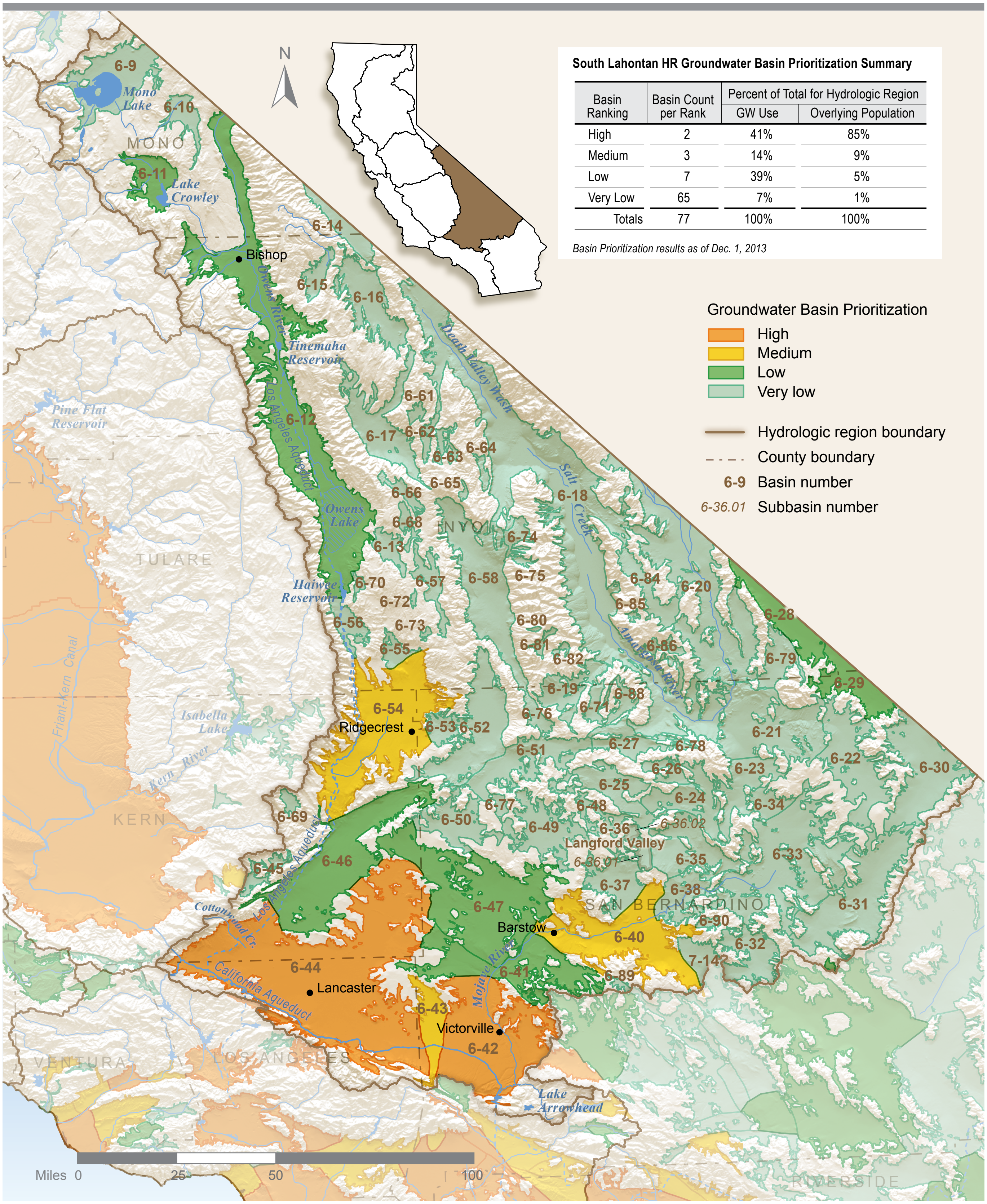


South Lahontan Hydrologic Region GW well monitoring summary[1]

by GW Monitoring Entity	Number of Wells
CASGEM	93
Monitoring cooperator	290
DWR	0
USGS	683
USBR	0
by GW Well Type	
Domestic	0
Irrigation	2
Observation	86
Public supply	29
Other	949
Total	**1,066**

1. Represents GW level monitoring information as of July, 2012

Figure SL-8 CASGEM Groundwater Basin Prioritization for the South Lahontan Hydrologic Region



South Lahontan HR Groundwater Basin Prioritization Summary

Basin Ranking	Basin Count per Rank	Percent of Total for Hydrologic Region	
		GW Use	Overlying Population
High	2	41%	85%
Medium	3	14%	9%
Low	7	39%	5%
Very Low	65	7%	1%
Totals	77	100%	100%

Basin Prioritization results as of Dec. 1, 2013

Table SL-4 CASGEM Groundwater Basin Prioritization for the South Lahontan Hydrologic Region

Basin Prioritization	Count	Basin/Subbasin Number	Basin Name	Subbasin Name	2010 Census Population
High	1	6-42	Upper Mojave River Valley		355,338
High	2	6-44	Antelope Valley		398,864
Medium	1	6-43	El Mirage Valley		10,933
Medium	2	6-54	Indian Wells Valley		34,837
Medium	3	6-40	Lower Mojave River Valley		32,938
Low	7	See California Water Plan Update 2013, Volume 4, Reference Guide, the article "California's Groundwater Update 2013."			
Very Low	65	See *California Water Plan Update 2013*, Volume 4, *Reference Guide,* the article "California's Groundwater Update 2013."			
Totals	**77**	**Population of groundwater basin area**			**889,749**

Notes:

Senate Bill X7 6 (SB X7 6; Part 2.11 to Division 6 of the California Water Code Sections 10920 et seq.) requires, as part of the CASGEM program, DWR to prioritize groundwater basins to help identify, evaluate, and determine the need for additional groundwater level monitoring by considering available data that include the population overlying the basin, the rate of current and projected growth of the population overlying the basin, the number of public supply wells that draw from the basin, the total number of wells that draw from the basin, the irrigated acreage overlying the basin, the degree to which persons overlying the basin rely on groundwater as their primary source of water, any documented impacts on the groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation, and any other information determined to be relevant by the DWR."

Using groundwater reliance as the leading indicator of basin priority, DWR evaluated California's 515 alluvial groundwater basins and categorized them into five groups — very high, high, medium, low, and very low.

Most streams in the region are intermittent in their lower reaches, which have steep channel-bed slopes and little vegetation. Severe local damage from floodwaters or debris flows could be sustained, often in summer, when thunderstorms generate floods upstream of an urban development. Extended storm periods combined with flat terrain may also give rise to shallow flooding of large areas with stormwater.

In March of 1938, USGS reported record flows at four locations where widespread damage occurred, approximately 80 percent in urban areas and the remainder in agricultural areas. Damage was estimated at $2.5 million. Six persons died, and about 60,000 acres were inundated.

In January and February of 1969, rainfall intensities and amounts were greater and, except for the Mojave River and its tributaries, runoff peaks were generally greater during these floods than during the 1938 event. Although flood management facilities functioned during the January flood period, there was insufficient time to perform necessary repairs and maintenance before a late February storm struck, which caused nearly twice as much damage. Losses in San Bernardino County alone from the January storm amounted to more than $23 million, and losses from the February storm totaled more than $31 million. There was widespread flooding and many home evacuations in the Mojave River lowlands. All bridges and crossings between Victorville and

Table SL-5 Sources of Groundwater Quality Information for the South Lahontan Hydrologic Region

Agency	Links to Information
State Water Resources Control Board http://www.waterboards.ca.gov/	Groundwater http://www.waterboards.ca.gov/water_issues/programs/#groundwater • Communities that Rely on a Contaminated Groundwater Source for Drinking Water http://www.waterboards.ca.gov/water_issues/programs/gama/ab2222/index.shtml • Hydrogeologically Vulnerable Areas http://www.waterboards.ca.gov/gama/docs/hva_map_table.pdf • Aquifer Storage and Recovery http://www.waterboards.ca.gov/water_issues/programs/asr/index.shtml GAMA http://www.waterboards.ca.gov/gama/index.shtml • GeoTracker GAMA (Monitoring Data) http://www.waterboards.ca.gov/gama/geotracker_gama.shtml • Domestic Well Project http://www.waterboards.ca.gov/gama/domestic_well.shtml • Priority Basin Project http://www.waterboards.ca.gov/water_issues/programs/gama/sw_basin_assesmt.shtml • Special Studies Project http://www.waterboards.ca.gov/water_issues/programs/gama/special_studies.shtml • California Aquifer Susceptibility Project http://www.waterboards.ca.gov/water_issues/programs/gama/cas.shtml Contaminant Sites • Land Disposal Program http://www.waterboards.ca.gov/water_issues/programs/land_disposal/ • Department of Defense Program http://www.waterboards.ca.gov/water_issues/programs/dept_of_defense/ • Underground Storage Tank Program http://www.waterboards.ca.gov/ust/index.shtml • Brownfields http://www.waterboards.ca.gov/water_issues/programs/brownfields/
California Department of Public Health http://www.cdph.ca.gov/Pages/DEFAULT.aspx	Division of Drinking Water and Environmental Management http://www.cdph.ca.gov/programs/Pages/DDWEM.aspx • Drinking Water Source Assessment and Protection (DWSAP) Program http://www.cdph.ca.gov/certlic/drinkingwater/Pages/DWSAP.aspx • Chemicals and Contaminants in Drinking Water http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Chemicalcontaminants.aspx • Chromium-6 http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Chromium6.aspx • Groundwater Replenishment with Recycled Water http://www.cdph.ca.gov/HealthInfo/environhealth/water/Pages/Waterrecycling.aspx
California Department of Pesticide Regulation http://www.cdpr.ca.gov/	Groundwater Protection Program http://www.cdpr.ca.gov/docs/emon/grndwtr/index.htm • Well Sampling Database http://www.cdpr.ca.gov/docs/emon/grndwtr/gwp_sampling.htm • Groundwater Protection Area Maps http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpa_maps.htm

Agency	Links to Information
California Department of Water Resources http://www.water.ca.gov/	Groundwater Information Center http://www.water.ca.gov/groundwater/index.cfm • Bulletin 118 Groundwater Basins http://www.water.ca.gov/groundwater/bulletin118/gwbasin_maps_descriptions.cfm • California Statewide Groundwater Elevation Monitoring (CASGEM) http://www.water.ca.gov/groundwater/casgem/ • Groundwater Level Monitoring http://www.water.ca.gov/groundwater/data_and_monitoring/gw_level_monitoring.cfm • Groundwater Quality Monitoring http://www.water.ca.gov/groundwater/data_and_monitoring/gw_quality_monitoring.cfm • Well Construction Standards http://www.water.ca.gov/groundwater/well_info_and_other/well_standards.cfm • Well Completion Reports http://www.water.ca.gov/groundwater/well_info_and_other/well_completion_reports.cfm
California Department of Toxic Substances Control http://www.dtsc.ca.gov/	EnviroStor http://www.envirostor.dtsc.ca.gov/public/
U.S. Environmental Protection Agency http://www.epa.gov/safewater/	US EPA STORET Environmental Data System http://www.epa.gov/storet/
U.S. Geological Survey http://ca.water.usgs.gov/	USGS Water Data for the Nation http://waterdata.usgs.gov/nwis)

Barstow were impassable. Major historic flood events in the South Lahontan region are listed in the *California Flood Future Report*, Attachment C: "Flood History of California Technical Memorandum" (California Department of Water Resources and U.S. Army Corps of Engineers 2013a).

Climate

The climate for most of the South Lahontan Hydrologic Region is arid. The valleys and lower foothills of the mountain ranges bordering the region are generally hot and dry during summers and cool and mostly dry in the winters. In the higher elevations of the Sierra Nevada or other mountain ranges in the region, conditions are different. Summers are often mild and dry and the winters are generally cold with significant amounts of rain and snow.

The arid conditions of the region are caused by the region's mountains. The Sierra Nevada can effectively weaken storms sweeping in from Pacific Ocean and from the Gulf of Alaska causing rain shadows for many of the valleys, smaller mountain ranges, and hills to the east. Annual rainfall totals for much of the region averages 10 inches or less. In Death Valley, the average annual rainfall is around 2 inches. In contrast, precipitation along the crests and higher elevations of the Sierra Nevada and other mountain ranges can be impressive. In addition to rainfall, the annual snowfall amounts can range between 4 to 6 feet in average to above-average precipitation years. Lesser amounts of snow fall in the San Bernardino and San Gabriel ranges in the south.

Table SL-6 is an annual summary of maximum and minimum temperatures and rainfall data collected by California Irrigation Management Information System (CIMIS) stations in the South Lahontan region. For the 2005 through 2010 period, hydrologic conditions began very wet, became very dry, and then ended up wet. However, annual maximum and minimum temperatures remain fairly steady, although slight increases did occur in the dry years. Reference evapotranspiration totals were also very steady during the period.

Demographics

Population

Total population for the South Lahontan region in 2010 was 930,800. This is a 29 percent increase since 2000 and 13 percent since 2005. Over 90 percent of the population is concentrated in the Antelope Valley and Mojave River Planning Areas (PAs).

Major cities include Palmdale (152,750) and Lancaster (156,633) in the Antelope Valley PA and Victorville (115,103), Hesperia (90,173), Apple Valley (69,135), Adelanto (31,765), and Barstow (22,639) in the Mojave River PA (2010 U.S. Census). All have exhibited steady growth in population over the past decade and are of ever-increasing significance in the urban landscape of Southern California. Although these cities can be 50 or more miles from jobs throughout the South Coast Hydrologic Region, the affordable housing in these areas continues to be a large attraction for homeowners. In addition, continued improvement in the region's transportation system helps to make the long commutes more tolerable. However, the nation's recent recession slowed growth from what was occurring in the early 2000s. Cities and towns on the eastern slopes of the Sierra Nevada and on the floor of the Owens Valley are smaller and provide the services and accommodations for vacationers and outdoor recreation enthusiasts. Cities include Mammoth Lakes (8,200) and Bishop (3,800). The Naval Air Weapons Station China Lake provides employment for many of the residents in the city of Ridgecrest (27,600). The other city in the Indian Wells Valley is California City (14,120).

In Update 2013, we project population growth based on the assumptions of future scenarios. Discussion of the three scenarios used in Update 2013 and how the region's population may change through 2050 can be found later in this report under the section, "Looking to the Future."

SB 18 requires cities and counties to consult with Native American tribes during the adoption or amendment of local general plans or specific plans (Chapter 905, Statutes of 2004). A contact list of appropriate tribes and representatives within a region is maintained by the Native American Heritage Commission. A Tribal Consultation Guideline, prepared by the Governor's Office of Planning and Research, is available online at http://www.opr.ca.gov/docs/09_14_05_Updated_Guidelines_922.pdf.

Tribal Communities

A discussion of tribal relationship to the watersheds can be found above in the watersheds section. And information can be found in the Tribal Communities subsection under the "Integrated Regional Water Management Summaries" section later in the report.

Table SL-6 South Lahontan Hydrologic Region Summaries of Annual Regional Temperatures and Precipitation

Year	Average Temperatures Maximum (°F)	Average Temperatures Minimum (°F)	Average Daily Temperatures (°F)	Average Precipitation (inches)	Average ETo (inches)
2005	73.01	42.64	57.78	9.17	60.23
2006	73.83	41.73	58.01	6.14	62.36
2007	74.87	42.17	57.75	3.12	64.44
2008	74.11	42.34	58.56	5.91	64.52
2009	73.87	41.92	57.75	5.29	63.33
2010	72.45	41.96	57.32	11.00	63.03

Source: California Irrigation Management Information System

Note: ETo = reference evapotranspiration

Disadvantaged Communities

Disadvantaged communities (DACs) exist throughout the South Lahontan Hydrologic Region. Some are stand-alone communities, but others are suburbs to larger urban centers. In the Mono-Owens PA, cities and census designated places that meet the DAC criteria include Bishop, Big Pine, Independence, Lone Pine, and Keeler. Several Native American reservations meet the criteria including the Bishop Paiute Reservation, Big Pine Paiute Reservation, and the Lone Pine Paiute-Shoshone Reservation. In Death Valley, residents in the areas of Shoshone and Tecopa fall within the criteria, as do the towns of Inyokern and Trona in Indian Wells. In the more heavily populated Mojave River PA, DACs exist in the suburbs of the cities of Barstow, Hesperia, and Adelanto. Some of the suburbs of Lancaster and Palmdale, in the Antelope Valley, would meet these minimum standards in addition to communities of Lake Los Angeles, Littlerock, and Mojave.

DACs are defined in Prop. 50, Chapter 8, as having an annual median household income (MHI) that is less than 80 percent of the statewide annual median household income. Therefore, a DAC is less than $48,706 (California Department of Finance 2012).

Extensive public outreach efforts are currently under way in three IRWM regions in the South Lahontan to encourage representatives from the various DACs to participate in the IRWM planning process. The Inyo-Mono region holds one of five statewide grants with DWR to develop a pilot program to determine how to most efficiently and effectively identify and engage DACs in such a way that empowers them to more aptly address local and regional water priorities.

Land Use Patterns

Urban and agricultural land uses in the north differ from those in the south. Against the scenic backdrop of mountain ranges and large valleys, a majority of the urban and agricultural land uses in the northern half of the South Lahontan Hydrologic Region have remained seemingly unchanged from many decades ago, with a scattering of small towns and tiny hamlets mixed with pockets of ranching and irrigated agriculture. This contrasts with the land uses, particularly urban, developing in the southern portion of the region, which have economic and cultural ties with the busy metropolitan areas of the South Coast Hydrologic Region. Recreation continues to be important, especially the winter-season resorts in the Town of Mammoth Lakes in the Sierra Nevada and the community of Lake Arrowhead in the San Bernardino Mountains. Also notable are the large areas of undeveloped and protected lands that have been set aside for recreation, preservation, managed use, and the military.

Urban Land Use

Most of the region's urban land uses continue to be concentrated in the southern-most planning areas. These are the Antelope Valley and Mojave River PAs. In Antelope Valley, the uses are anchored around the cities of Palmdale and Lancaster. For the Mojave River, it would be the cities of Victorville, Hesperia, Barstow, and Apple Valley. The urban uses within and on the perimeter of the cities have been expanded outward, with some in-filling, to accommodate the steady increases in population over the past decade. However, the nation's recent recession served to slow the growth, in sharp contrast to what was occurring in the early 2000s. In sharp contrast, the urban uses associated with the cities and towns in the eastern slopes of the Sierra Nevada and on the floor of the Owens, Mammoth Lakes and Bishop, are considerably smaller than those in the south. In the Indian Wells Valley, most of the uses are concentrated in the City of Ridgecrest and the Naval Air Weapons Station China Lake.

Agricultural Land Use

Most of the agricultural land uses in the South Lahontan region continue to occur in the Owens-Mono, Antelope Valley, and Mojave River areas. Total irrigated crop acres planted and harvested between 2006 and 2010 have remained relatively stable; ranging from 65,520 and 64,570 acres. The primary crops were alfalfa, pasture grass, grains, and truck crops. Alfalfa and pasture grass represent more than 75 percent of the planted and harvested acres each year.

Almost half (29,600 acres in 2010) of the region's irrigated crop acreage was located in the Owens-Mono area as irrigated native pastureland. There has been little change in irrigated acres from year to year in this planning area. Between 2005 and 2010, the annual total acres of crops in production ranged between 29,500 and 29,700. Most of the acres are for alfalfa and range and improved pasture grass. Production of the alfalfa and pasture grasses occurred mostly between the City of Bishop and the community of Lone Pine in Inyo County, and in the Chalfant, Hammil, Round, and Long valleys in Mono County. In addition, almost 4,800 acres of alfalfa were grown annually in Fish Lake Valley, a rather remote valley whose groundwater is shared with the State of Nevada.

Some of the alfalfa and native and improved pasture grass acres were planted in response to the approved enhancement mitigation projects agreed to by the parties in the 1991 and 1997 agreements between the County of Inyo, City of Los Angeles, and other parties mentioned earlier in this report. It is important to note that many of the native and improved pasture grass fields in both counties receive irrigation water from the LAA. Hence, the farming operations are coordinated with the LADWP.

The next most agriculturally active planning area is the Antelope Valley PA, with 18,500 acres of irrigated crop production in 2010. The agricultural land uses are located mostly away from —

but in some cases adjoining — the urban lands of the planning area. The crops range from truck crops — which include onions, carrots, and potatoes — to deciduous fruits (especially peaches), alfalfa, and grain. There are a little more than 300 acres of vineyards.

The Mojave River area is the third major area for agriculture in the region with 13,300 acres of irrigated crops production in 2010. Most of the acreage is located in the Mojave River Valley, from near Victorville to northeast of the City of Barstow and east beyond the community of Newberry Springs. This is alfalfa country, with much of the acreage irrigated with center pivot systems. There are also several small pockets of agricultural land uses scattered throughout the area. This includes several hundred acres of alfalfa and turf in Mesquite Valley near the Nevada border.

Although the overall total of planted and harvested acres is small, slightly less than 2,100 acres in production, farmers in the Indian Wells Valley produce a variety of crops. In addition to alfalfa, vegetables and deciduous fruit are grown, mostly in the Tehachapi Valley. The Death Valley area, specifically the Mesquite Valley along the California-Nevada border, had a little less than 1,500 acres under production, mostly alfalfa and pasture.

Public Managed Lands

Much of the land within the South Lahontan region is publicly managed, including numerous parks, preserves, and recreation areas. Major units in the north include Death Valley National Park and Inyo National Forest, while the south features the Mojave National Preserve and the Angeles and San Bernardino National forests. Other notable parks include the Mono Lake Tufa State Reserve and Red Rock Canyon State Park. Large military facilities within the region include China Lake Naval Weapons Center, Fort Irwin National Training Center (U.S. Army), and Edwards Air Force Base.

Regional Resource Management Conditions

Water in the Environment

Environmental water uses are concentrated mostly in the Mono-Owens Planning Area of the South Lahontan Hydrologic Region. These uses include instream releases for Mono Lake and LORP and applied water for the irrigation of enhancement mitigation projects being implemented for projects agreed to by the parties in the 1991 and 1997 agreements between the County of Inyo, City of Los Angeles, and other parties. The other important environmental use is tied to the Owens Lake Dust Control Project.

Instream flows for the rivers that drain into Mono Lake averaged 73 taf for 2006 through 2009. That amount decreased slightly in 2010, about 59 taf was reported. For the Owens River, instream flows between 2006 and 2009 averaged a little less than 16 taf annually. In 2010, that increased slightly to 19 taf. Wild and scenic flow requirements were established in the planning area in 2009 for portions of the Amargosa River, Cottonwood Creek, and Upper Owens River. In 2010, the reported amount was about 42 taf.

Some environmental water demands are met with recycled water supplies. The Piute Ponds near the Lancaster Water Reclamation Plant received 8,711 af and 6,089 af in fiscal years 2010-2011 and 2011-2012, respectively. VVWRA discharges in excess of 14,000 af of recycled water supplies into the Mojave River channel, which supports riparian vegetation and habitat for an area managed by DFW.

Water Supplies

Groundwater and surface, imported, and recycled water supplies are used to meet the urban, agricultural, and environmental water demands in the South Lahontan region. In the northern portions of the region, some water agencies located in the foothills of the Sierra Nevada use surface (lake) water for all or a portion of their supplies. Groundwater is the main water source for much of the Owens Valley, Indian Wells, and Mojave. In the Mojave River and Antelope valleys, water agencies are using groundwater, SWP water supplies, or a blend. The southern portion of the South Lahontan region relies primarily on the SWP for its source of imported water supply. AVEK, Crestline-Lake Arrowhead Water Agency, Littlerock Creek Irrigation District, MWA, and PWD each have water supply contracts for SWP supplies with combined contract "Table A" amounts totaling over 260 taf.

The use of SWP water supplies in some communities helps to decrease the amount of water pumped from the groundwater basins. See Figure SL-9 for 2010 regional inflows and outflows.

Total water supplies utilized in the region 2006 and 2010 period ranged from below 600 taf to over 700 taf. The peak was achieved in 2007 when additional water supplies were available from the SWP resulting from the above average precipitation years of 2005 and 2006. These supplies are mainly used for groundwater recharge operations, primarily in the Mojave River area. Most of the urban and agricultural water uses in the region are met with groundwater supplies. Although annual totals fluctuate, groundwater supplies generally meet about 66 percent of the water uses in the region.

AVEK was formed to bring imported surface water from the SWP into this region. In terms of water purveyors, it is the largest SWP water contractor in the region and one of the largest in the state. AVEK provides water to 5 major municipal agencies, 16 smaller water service agencies, Edwards Air Force Base, Palmdale Air Force Plant 42, the U.S. Borax and Chemical Facilities, and some agricultural customers.

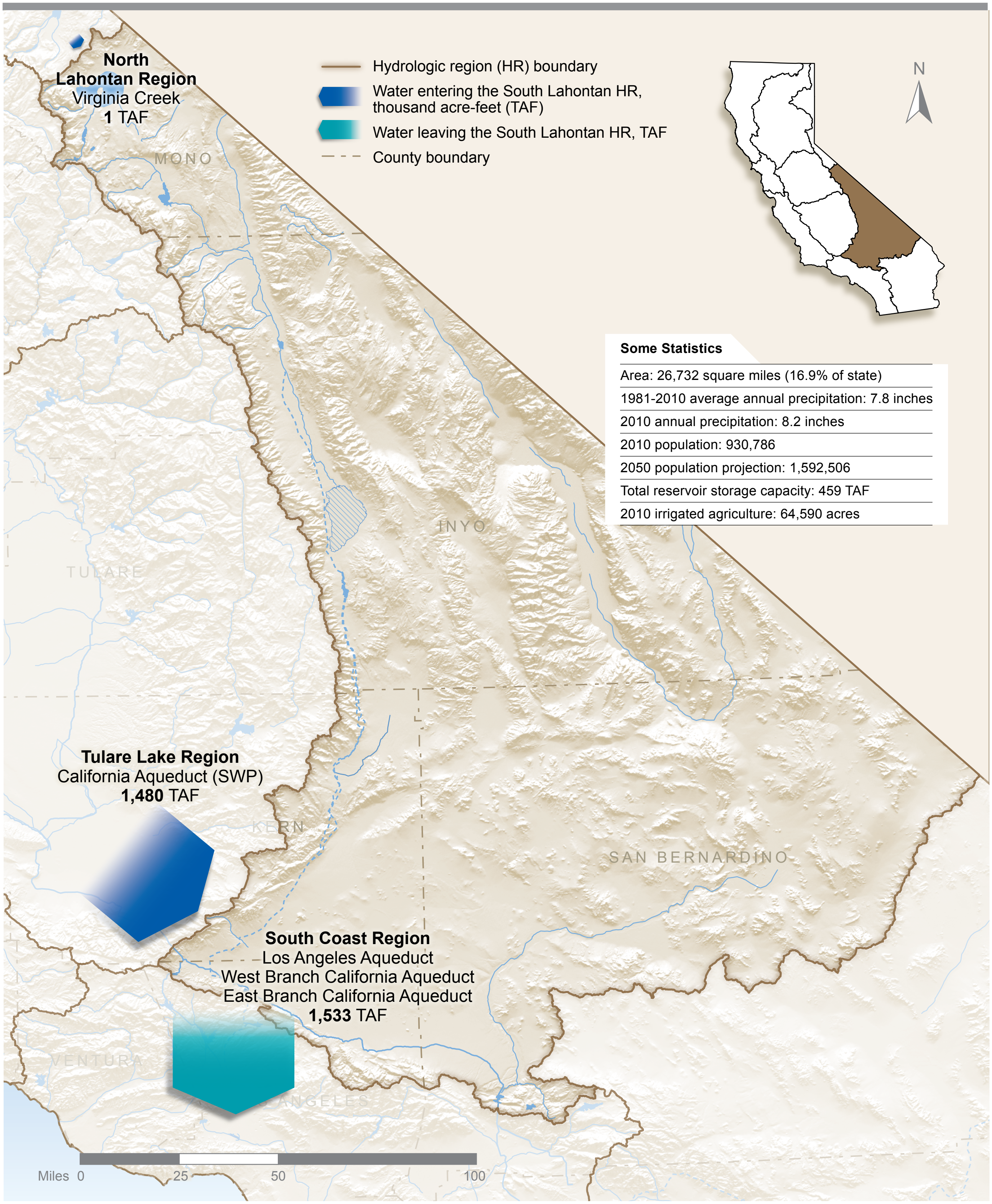
Surface Supplies

Both the West and East branches of the SWP are in the region. Water supplies for the region are diverted from the East Branch. In addition to supplementing local supplies, the supply has helped mitigate the current groundwater issues, and it is a key factor in plans for groundwater banking and storage projects.

MWA has been taking increasing amounts of its SWP contract entitlements in response to recent rapid growth and to implement the Mojave Basin Area Judgment to replenish the Mojave River Valley Groundwater Basin.

In the San Bernardino Mountains, Lake Arrowhead (controlled by the Arrowhead Lake Association) is a 48,000 af reservoir providing recreational opportunities and water for residents in the area. The lake is also a major source of the water supply for the Lake Arrowhead Community Services District, which provides retail water and sewer services to the Lake

Figure SL-9 South Lahontan Hydrologic Region Inflows and Outflows in 2010



Arrowhead area. In addition, Crestline-Lake Arrowhead Water Agency, a SWP contractor, pumps water from Silverwood Lake.

The Littlerock Reservoir has a 3,500-af capacity, provides water to Littlerock Creek Irrigation District and to PWD, and serves urban users. Water supplies from the facility are released into a canal and conveyed to PWD's Palmdale Lake for storage.

Other surface water sources that provide water supplies for mainly urban water users are in the eastern Sierra Nevada and include June and Mary lakes (near the Town of Mammoth Lakes), both of which are in Mono County.

The LAA is the region's other major water infrastructure. In 1913, the initial 233-mile-long aqueduct was completed by LADWP and began transporting water from Owens Valley to the city of Los Angeles. The aqueduct was extended 115 miles north into the Mono Basin in 1940 to divert additional water. A second, 137-mile-long, pipeline was completed in 1970. More recently, exports have been significantly modified and reduced as a result of LADWP's environmental restoration and mitigation projects in Mono Basin and Inyo County.

There are nine reservoirs in the LAA system with a combined storage capacity of about 300,000 af. These reservoirs were built to store and regulate flows in the aqueduct. The northernmost reservoir is Grant Lake in Mono County. Seven of the nine reservoirs are in the South Lahontan region; the Bouquet and Drinkwater reservoirs are in the South Coast Hydrologic Region. Water from the aqueduct system passes through 12 hydropower plants on its way to Los Angeles. The annual energy generated is more than 1 billion kilowatt-hours, enough to supply the needs of 220,000 homes.

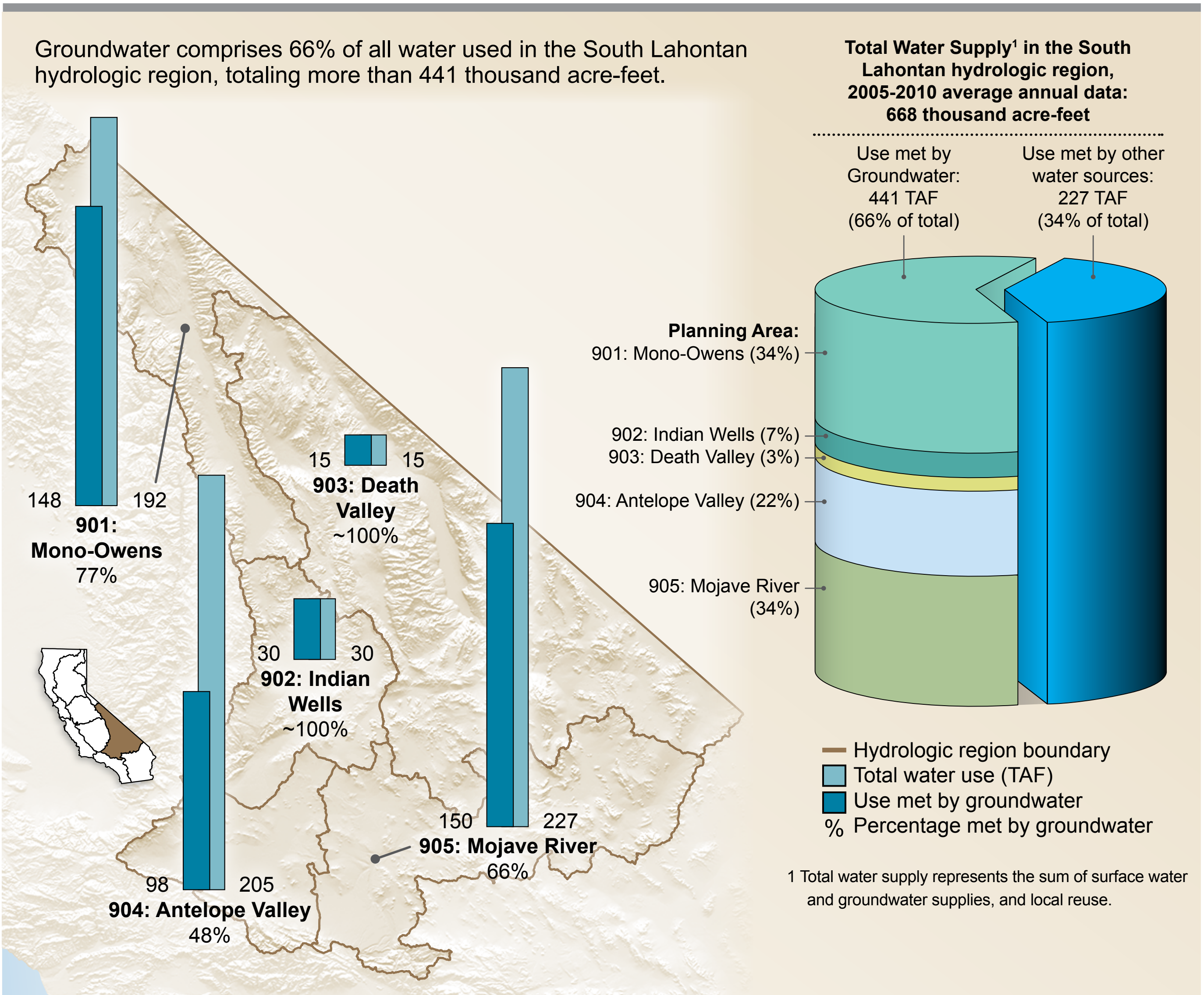
Most of the LAA infrastructure is in the South Lahontan region; however, most of the water supplies conveyed by the project are used in the South Coast Hydrologic Region. In the South Lahontan region, water supplies from the LAA are used for the irrigation of some of the native pasture grass fields and environmental enhancement projects identified in the 1991 EIR and for the vegetation to mitigate the dust problem on Owens Lake.

Groundwater

Groundwater supply estimates are based on water supply and balance information derived from DWR land use surveys, and from groundwater supply information that water purveyors or other State agencies voluntarily provide to DWR. Groundwater supply is reported by water year (October 1 through September 30) and is categorized according to agriculture, urban, and managed wetland uses. The groundwater information is presented by planning area, county, and type of use. Groundwater accounts for about two-thirds of the region's total water supply, with the majority of groundwater supplies (61 percent) being used to meet agricultural use and the rest (39 percent) going to urban use. Groundwater supply is not used to meet any managed wetlands use in the region.

Figure SL-10 depicts the planning area locations and the associated 2005-2010 groundwater supply in the region. The estimated average annual 2005-2010 total water supply for the region is 668 taf, of which 441 taf is from groundwater supply (66 percent). (Reference to total water supply represents the sum of surface water and groundwater supplies in the region and local reuse.) The figure also shows that Mono-Owens and Mojave River planning areas are the largest

Figure SL-10 **Contribution of Groundwater to the South Lahontan Hydrologic Region Water Supply by Planning Area (2005-2010)**



users of groundwater in the region: an average annual supply of 150 taf each and 300 taf together (68 percent of the total groundwater supply for the region). The third biggest user of groundwater is Antelope Valley planning area, being supplied with an average of about 100 taf (22 percent of the total groundwater supply for the region).

Table SL-7 provides the 2005-2010 average annual groundwater supply by planning area and by type of use. Groundwater supplies meet 72 percent (271 taf) of the overall agricultural water use and 58 percent (170 taf) of the overall urban water use in the region. No groundwater resources are used for meeting managed wetland uses in the region. The table also shows that the various planning areas meet between 60 and 100 percent of the agricultural water use and between 30 and 100 percent of the urban water use with groundwater supply.

Table SL-7 South Lahontan Hydrologic Region Average Annual Groundwater Supply by Planning Area (PA) and by Type of Use (2005-2010)

South Lahontan Hydrologic Region		Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
PA NUMBER	PA NAME	TAF	%	TAF	%	TAF	%	TAF	%
901	Mono-Owens	137.4	76	10.5	90	0	0	147.9	77
902	Indian Wells	10.3	100	19.4	98	0	0	29.7	99
903	Death Valley	10.6	100	4.0	100	0	0	14.7	100
904	Antelope Valley	57.6	73	40.7	32	0	0	98.3	48
905	Mojave River	54.7	57	95.7	73	0	0	150.4	66
2005-10 annual average hydrologic region total		**270.6**	**72**	**170.3**	**58**	**0**	**0**	**440.9**	**66**

Notes:

TAF = thousand acre-feet

Percent use is the percent of the total water supply that is met by groundwater, by type of use.

2005-2010 precipitation equals 92 percent of the 30-year average for the South Lahontan Hydrologic Region.

Although groundwater extraction in the region accounts for only about 3 percent of California's 2005-2010 average annual groundwater supply, it accounts for the majority of the domestic supply for many of the region's rural communities and is also heavily relied upon to meet local agricultural uses. For example, the Indian Wells Valley Groundwater Basin is the sole source of water for the city of Ridgecrest, the communities of Inyokern and Trona, and the China Lake Naval Weapons Center. It is also the only supply for many private domestic, small water systems, and a small number of agricultural well owners.

Regional totals for groundwater based on county area will vary from the planning area estimates because county boundaries do not necessarily align with planning areas or hydrologic region boundaries.

For the South Lahontan Hydrologic Region, county groundwater supply is reported for Mono, Inyo, and San Bernardino counties; groundwater supply for Kern and Los Angeles counties are reported in the Tulare Lake and South Coast hydrologic regions, respectively. Table SL-8 shows that groundwater contributes up to 62 percent of the total water supply for the three-county area, ranging from 37 to 70 percent for individual counties. Groundwater supplies in the three-county area are used to about 52 percent of the agricultural water use and 70 percent of the urban water use.

Changes in annual groundwater supply and type of use may be related to a number of factors, such as changes in surface water availability, urban and agricultural growth, market fluctuations, and water use efficiency practices. Figures SL-11 and SL-12 summarize the 2002 through 2010 groundwater supply trends for the region.

The right side of Figure SL-11 illustrates the annual amount of groundwater versus other water supplies, while the left side identifies the percent of the overall water supply provided by groundwater relative to other water supplies. The center column in the figure identifies the water year along with the corresponding amount of precipitation, as a percentage of the 30-year running average for the region. The figure indicates that the annual water supply for the region has fluctuated between 590 taf and 730 taf. The annual groundwater supply has fluctuated between 380 taf and 490 taf, providing between 60 and 70 percent of the total water supply.

Figure SL-12 shows the annual amount and percentage of groundwater supply to meet urban and agricultural uses. The figure indicates that about 60 to 70 percent of the annual groundwater supply met agricultural use, while the remaining groundwater supply met urban use.

More detailed information regarding groundwater water supply and use analysis is available online from Update 2013, Volume 4, *Reference Guide,* the article, "California's Groundwater Update 2013."

Water Uses

From 2006 through 2010, annual applied water demands for urban and agricultural water users in the South Lahontan region ranged from 659 taf to 742 taf; peak demands were achieved in 2007. Agricultural applied water demands ranged from 385 taf to 425 taf; also peaking in 2007. The higher uses probably reflect the drier hydrology and slightly warmer temperatures which occurred that year. For the region's urban users, annual applied water demands ranged from 273 taf to 317 taf. Urban demands declined during the 2008–2010 period. Statewide and local precipitation totals were below average, and the decreased demands were probably responses to the implementation of voluntary and involuntary water use efficiency programs and policies by the water agencies and their customers. Negative impacts from the recent recession cannot be discounted as factors in the decline.

Most of the urban applied water demands in the region were met with groundwater supplies during the period. As mentioned previously, surface water supplies were utilized to meet some of urban water user demands in the northern Owens-Mono PA. Supplies from Mary and June lakes, located in the eastern slopes of the Sierra Nevada, were conveyed to customers of the Mammoth Community Water District (MCWD) and June Lake Public Utilities District. In the Antelope Valley PA, SWP and surface water from Littlerock Reservoir are used to augment groundwater supplies. In the Mojave River PA, urban and agricultural demands are exclusively met by groundwater. SWP for the Mojave River PA is primarily used for groundwater recharge of the now adjudicated basins and some limited direct use.

Despite having less than 5 percent of the population in the hydrologic region, per capita water demands continue to be high in the Owens-Mono PA. For 2006 through 2010, the annual gallons per capita (gpc) values ranged from 312 to 373 gallons per capita per day (gpcd). This is because of the influx of travelers and recreational enthusiasts seeking to take advantage of winter (skiing) and summer (fishing, hiking, and camping) outdoor activities present in the area. The MCWD

Table SL-8 South Lahontan Hydrologic Region Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

South Lahontan Hydrologic Region	Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
COUNTY	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT
Mono	82.9	36	3.3	67	0.0	0	86.2	37
Inyo	59.4	67	11.1	100	0.0	0	70.5	70
San Bernardino	116.9	85	423.3	69	0.0	0	540.1	68
2005-10 annual average total	**259.1**	**52**	**437.7**	**70**	**0.0**	**0**	**696.8**	**62**

Notes:

TAF = thousand acre-feet

Percent use is the percent of the total water supply that is met by groundwater, by type of use.

2005-2010 precipitation equals 92% of the 30-yr average for the South Lahontan Hydrologic Region

provides water service to a permanent population of about 7,000. However, this is somewhat misleading as the daily population could increase to as much as 13,000 people per day during the week and swell to as much as 30,000 on weekends and holidays because of the activities. This also occurs in the city of Bishop and communities of Big Pine, Independence, and Lone Pine in the Owens Valley. In the southern areas, Antelope Valley and Mojave River, the urban uses are influenced by the higher outside demands.

The conditions are just too arid in the region to grow crops without irrigation water. Most of the agricultural demands are met with groundwater supplies. However, there are exceptions. As noted earlier, in the Owens-Mono PA, diversions from the LAA are used to irrigate many of the native and improved native pasture grass fields. In the Antelope Valley PA, some deciduous fruit orchards in the western half of the valley are irrigated with water from the SWP.

Most of the crop irrigations in the South Lahontan are handled by a variety of sprinkler systems. Center pivot sprinkler systems are used to irrigate many of the alfalfa and field crop fields. Self-propelled side roll systems are common as well. Hand-move sprinklers are usually employed for vegetables, especially when the land is prepared for planting and during the earlier growth stages of the crop. Many farmers transition from sprinklers to furrow-flow irrigation as the crops mature. Tree crops are irrigated primarily with mini jet systems and permanent sprinklers.

Recycled water supplies, used mostly in the Antelope Valley PA, are utilized for local recreation and landscape irrigation needs. Some acres of forage crops cultivated in the planning area are irrigated with recycled water supplies.

Many of the moderate and large urban water agencies are implementing some or all of the urban best management practices in their respective water service areas. The agencies are also implementing other new programs that target exterior water demands. Rebate programs now exist that encourage the use of weather-based irrigation controllers and upgrades of older irrigation

Figure SL-11 South Lahontan Region Annual Groundwater Supply Trend (2002-2010)

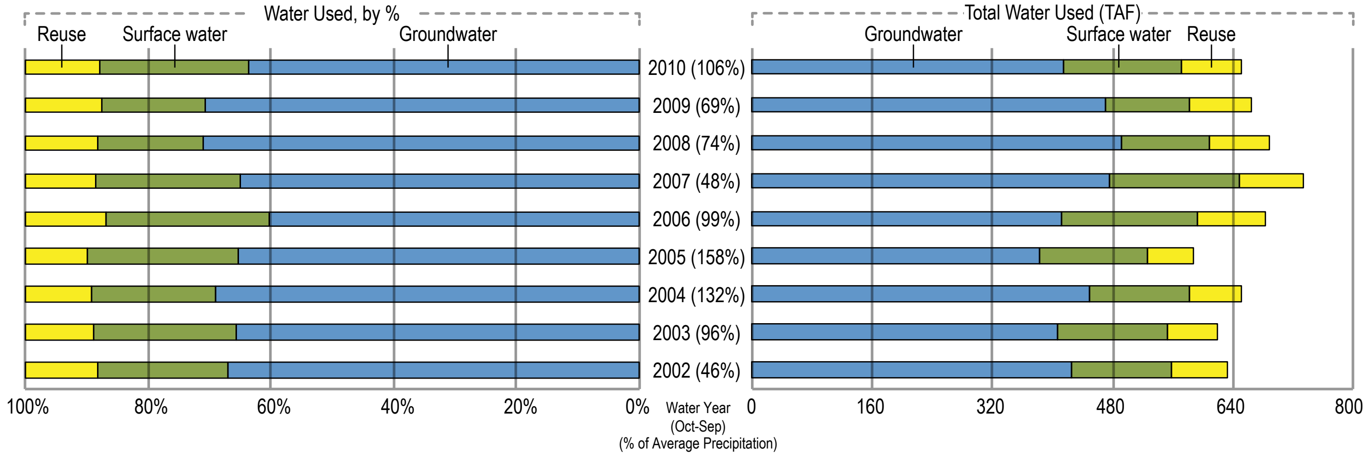
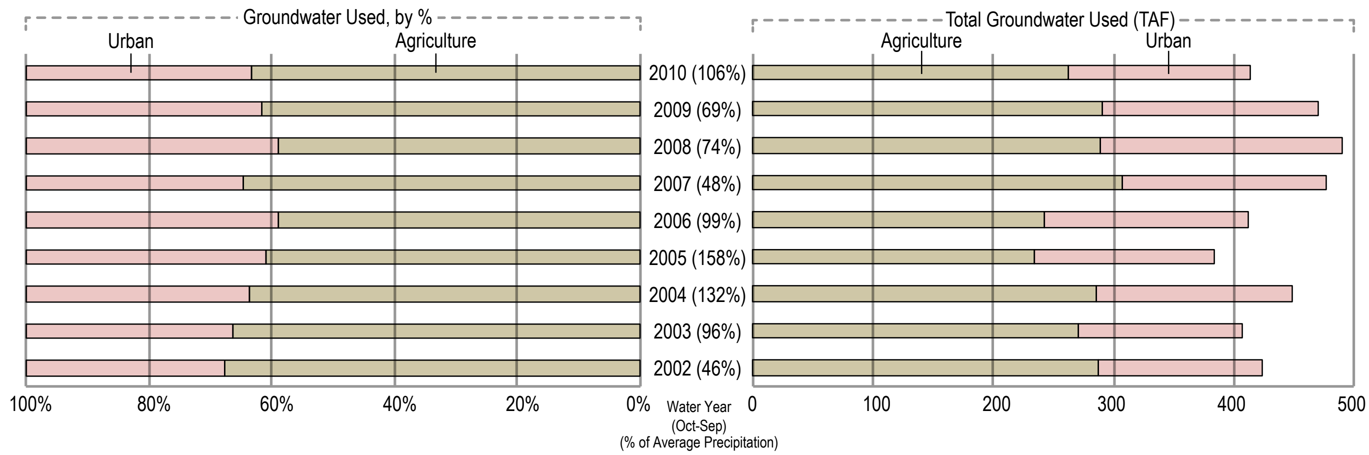


Figure SL-12 South Lahontan Region Annual Groundwater Supply Trend by Type of Use (2002-2010)



systems. Turf removal programs are also being implemented. Residential customers receive financial assistance for removal of turf grass from around their homes and the installation of plants which are more suitable for the hot, dry conditions. Conservation efforts in the Mojave PA have resulted in a decrease in urban per-capita use from 284 gpcd in 2000 to 163 gpcd in 2012. A majority of this decrease in per-capita use is from a reduction in exterior water use for landscape irrigation. The MWA's turf removal program began in 2008. As of early 2013 the program had over 3,500 participants and over 5 million square feet of turf had been removed.

Farmers are continuing to improve the efficiencies of their irrigation operations. Actions that have been implemented since the first energy crisis in the early 1980s include operating irrigation pumps during off-peak hours to lower energy costs. On the water side, data being collected by CIMIS weather stations in the major agricultural areas are being accessed with greater frequencies, presumably by farmers, and landscape managers, seeking to monitor evapotranspiration rates and schedule future irrigations for their crops. This is being done for the

Owens Lake project. CIMIS stations on the north and south shores of the lake are monitored daily to determine when to irrigate the salt-tolerant native grasses and plants planted on the lakebed.

Drinking Water

The region has an estimated 187 community drinking water systems. The majority (over 80 percent) of these community drinking water systems are considered small (serving fewer than 3,300 people) with most small water systems serving fewer than 500 people (Table SL-9). Small water systems face unique financial and operational challenges in providing safe drinking water. Given their small customer base, many small water systems cannot develop or access the technical, managerial, and financial resources needed to comply with new and existing regulations. These water systems may be geographically isolated, and their staff often lacks the time or expertise to make needed infrastructure repairs; install or operate treatment; or develop comprehensive source water protection plans, financial plans or asset management plans (U.S. Environmental Protection Agency 2012).

In contrast, medium and large water systems account for less than 20 percent of region's drinking water systems; however, these systems deliver drinking water to over 90 percent of the region's population . These water systems generally have financial resources to hire staff to oversee daily operations and maintenance needs, and hire staff to plan for future infrastructure replacement and capital improvements. This helps to ensure that existing and future drinking water standards can be met.

Water Conservation Act of 2009 (SB X7-7) Implementation Status and Issues

Seventeen South Lahontan urban water suppliers have submitted 2010 urban water management plans to DWR. The Water Conservation Act of 2009 (SB X7-7) required urban water suppliers to calculate baseline water use and set 2015 and 2020 water use targets. Based on data reported in the 2010 urban water management plans, the South Lahontan Hydrologic Region had a population-weighted baseline average water use of 258 gpcd with an average population-weighted 2020 target of 207 gpcd. The Baseline and Target Data for individual South Lahontan urban water suppliers is available on the DWR Urban Water Use Efficiency Web site (http://www.water.ca.gov/wateruseefficiency/).

The Water Conservation Act of 2009 required agricultural water suppliers who supply more than 25,000 irrigated acres to prepare and adopt agricultural water management plans by December 31, 2012, and update those plans by December 31, 2015, and every five years thereafter. No plans were submitted from the South Lahontan region. The region has no agricultural suppliers over the 25,000 acreage threshold.

Water Balance Summary

South Lahontan Hydrologic Region consists of five planning areas. The environmental water use in these planning areas is limited to instream requirements in Mono-Owens (PA 901) and wild and scenic rivers in PA 901 (Owens River and Cottonwood Creek) and Death Valley (PA 903) (Amargosa River). There are no managed wetlands in South Lahontan region. Table SL-10 provides a hydrologic water balance summary for the South Lahontan region. Figure SL-13 illustrates a water balance for dedicated and developed supply by year. For more information on the water balances and portfolios, go to Volume 5, *Technical Guide*.

Table SL-9 Summary of Large, Medium, Small, and Very Small Community Drinking Water Systems in South Lahontan Hydrologic Region

Water System Size by Population	Community Water Systems (CWS)		Population Served	
	SYSTEMS	PERCENT	POPULATION	PERCENT
Large >10,000	18	10	762,492	84
Medium 3,301 - 10,000	13	7	80,670	9
Small 500 – 3,300	49	26	54,629	6
Very small < 500	105	56	14,069	2
CWS that primarily provide wholesale water	2	1	---	---
Total:	**187**	**---**	**911,860**	**---**

Source: California Department of Public Health (CDPH) Permits, Inspection, Compliance, Monitoring, and Enforcement database as of June 2012.

Note: Population estimates for community drinking water systems are from CDPH and may include seasonal visitors.

In PA 901, urban use is primarily residential and averages about 12 taf per year. Agriculture applied water is about 175 to 200 taf annually. The aforementioned instream use varies from about 65 to 100 taf. The 2010 wild and scenic applied water added 42 taf to the environmental use.

Local surface water provides one-half to one-third of the supplies, with the rest being groundwater extraction. Some of the instream requirement is reused downstream.

Indian Wells (PA 902) has a higher urban use than agricultural, averaging about 20 taf per year urban and 10 to 11 taf agricultural applied water. Supplies are primarily from groundwater, with 200 to 400 af of SWP deliveries.

Urban use in PA 903 averages 4 taf, with agricultural use about 11 taf annually. These demands were met with groundwater supplies. The wild and scenic applied water demand was about 1,400 af in 2010, which was met with surface water supplies.

Antelope Valley (PA 904) and Mojave River (PA 905) are the most urbanized areas in South Lahontan region. Urban use in both planning areas is primarily residential and ranges from about 120 to 140 taf annually in each planning area. In PA 904, agricultural applied water ranges from 88 to 98 taf per year. Agricultural use in PA 905 is a little higher, averaging about 100 taf.

One-half to one-third of the supply in PA 904 comes from SWP deliveries and a little local supply in wetter years, with the rest being groundwater. There are also about 200 af of reclaimed wastewater being used each year.

In PA 905, water supply consists of less SWP water and more groundwater, with a substantial amount of reuse and a little more reclaimed water than PA 904.

Table SL-10 South Lahontan Hydrologic Region Water Balance for 2001-2010 (in taf)

South Lahontan (taf)	Water Year (Percent of Normal Precipitation)									
	2001 (91%)	**2002** (46%)	**2003** (96%)	**2004** (132%)	**2005** (158%)	**2006** (99%)	**2007** (48%)	**2008** (74%)	**2009** (69%)	**2010** (106%**)**
WATER ENTERING THE REGION										
Precipitation	9,741	4,964	10,416	14,371	17,255	10,905	5,303	8,209	7,626	11,727
Inflow from Oregon/Mexico	0	0	0	0	0	0	0	0	0	0
Inflow from Colorado River	0	0	0	0	0	0	0	0	0	0
Imports from Other Regions	1,066	1	1,865	1,928	1,632	1,933	2,021	1,193	1,185	1,481
Total	**10,807**	**4,965**	**12,281**	**16,299**	**18,887**	**12,838**	**7,324**	**9,402**	**8,811**	**13,208**
WATER LEAVING THE REGION										
Consumptive use of applied water[a] (Ag, M&I, Wetlands)	331	347	332	346	301	347	381	360	353	339
Outflow to Oregon/Nevada/ Mexico	0	0	0	0	0	0	0	0	0	0
Exports to other regions	1,255	1,174	2,009	2,037	1,673	1,786	1,940	1,199	1,136	1,533
Statutory required outflow to salt sink	58	71	68	56	73	84	52	47	49	59
Additional outflow to salt sink	126	76	61	69	60	71	70	82	75	72
Evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, natural and incidental runoff, ag effective precipitation & other outflows	9,337	3,622	10,044	14,096	16,915	10,755	5,266	8,048	7,456	11,471
Total	**11,107**	**5,290**	**12,514**	**16,604**	**19,022**	**13,043**	**7,709**	**9,736**	**9,069**	**13,474**
CHANGE IN SUPPLY										
[+] Water added to storage [-] Water removed from storage										
Surface reservoirs	-1	-37	16	-23	83	31	-105	-10	57	-14
Groundwater[b]	-299	-288	-249	-282	-218	-236	-280	-324	-315	-252
Total	**-300**	**-325**	**-233**	**-305**	**-135**	**-205**	**-385**	**-334**	**-258**	**-266**
Applied water[a] (ag, urban, wetlands) (compare with consumptive use)	581	649	632	665	594	689	747	704	679	665

Notes:

taf = thousand acre-feet, M&I = municipal and industrial

[a] Definition: Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

[b] Definition: Change in Supply: Groundwater — The difference between water extracted from and water recharged into groundwater basins in a region. All regions and years were calculated using the following equation: change in supply: groundwater = intentional recharge + deep percolation of applied water + conveyance deep percolation and seepage - withdrawals.

This equation does not include unknown factors such as natural recharge and subsurface inflow and outflow. For further details, refer to Volume 4, *Reference Guide*, the article "California's Groundwater Update 2013" and Volume 5, *Technical Guide*.

Project Operations

The major water supply projects in the region move SWP to areas with need for supplemental water supplies. The Mojave River and Morongo Basin Pipelines deliver SWP water primarily to groundwater recharge sites throughout the region, with a few direct delivery connections. The R^3 Project was completed in 2012 as a conjunctive use project that banks SWP water in the ground in the Mojave River floodplain and later recovers the water via production wells and delivers to retail water systems in Adelanto, Apple Valley, Hesperia, and Victorville. Most of the SWP delivery infrastructure is designed to recharge SWP water to groundwater along the Mojave River floodplain. This can be a challenge when the Mojave River is flowing and there is no available ground surface for recharge operations. Also, not all demands for groundwater occur along the floodplain, and there is still a need to alleviate pumping stresses that occur away from the floodplain. The region is able to withstand local and statewide droughts, including periods of low SWP water availability, thanks to most demands being met with groundwater; the groundwater basin functions as a buffer against extended periods of drought.

Cadiz Valley Water Conservation, Recovery, and Storage Project

Cadiz Inc. is a private corporation that owns approximately 34,000 mostly contiguous acres in the Cadiz and Fenner valleys, which are located in the Mojave Desert in eastern San Bernardino County. In December 2011, the Cadiz Inc., in collaboration with the Santa Margarita Water District and other water providers participating in the Cadiz Valley Water Conservation, Recovery, and Storage Project, collaboratively developed a draft EIR for the project. According to the applicant, underlying the Cadiz and Fenner valleys and the adjacent Bristol Valley is a vast groundwater basin that holds an estimated 17 million to 34 million acre-feet (maf) of fresh groundwater. According to the draft EIR, Southern California water providers could use water from this groundwater basin to replace or augment current supplies and enhance dry-year supply reliability. The project has met with opposition over the possibility that it will mine groundwater and dry up desert springs. The draft EIR can be found at: http://www.smwd.com/operations/cadiz-project-draft-eir.html.

Water Quality

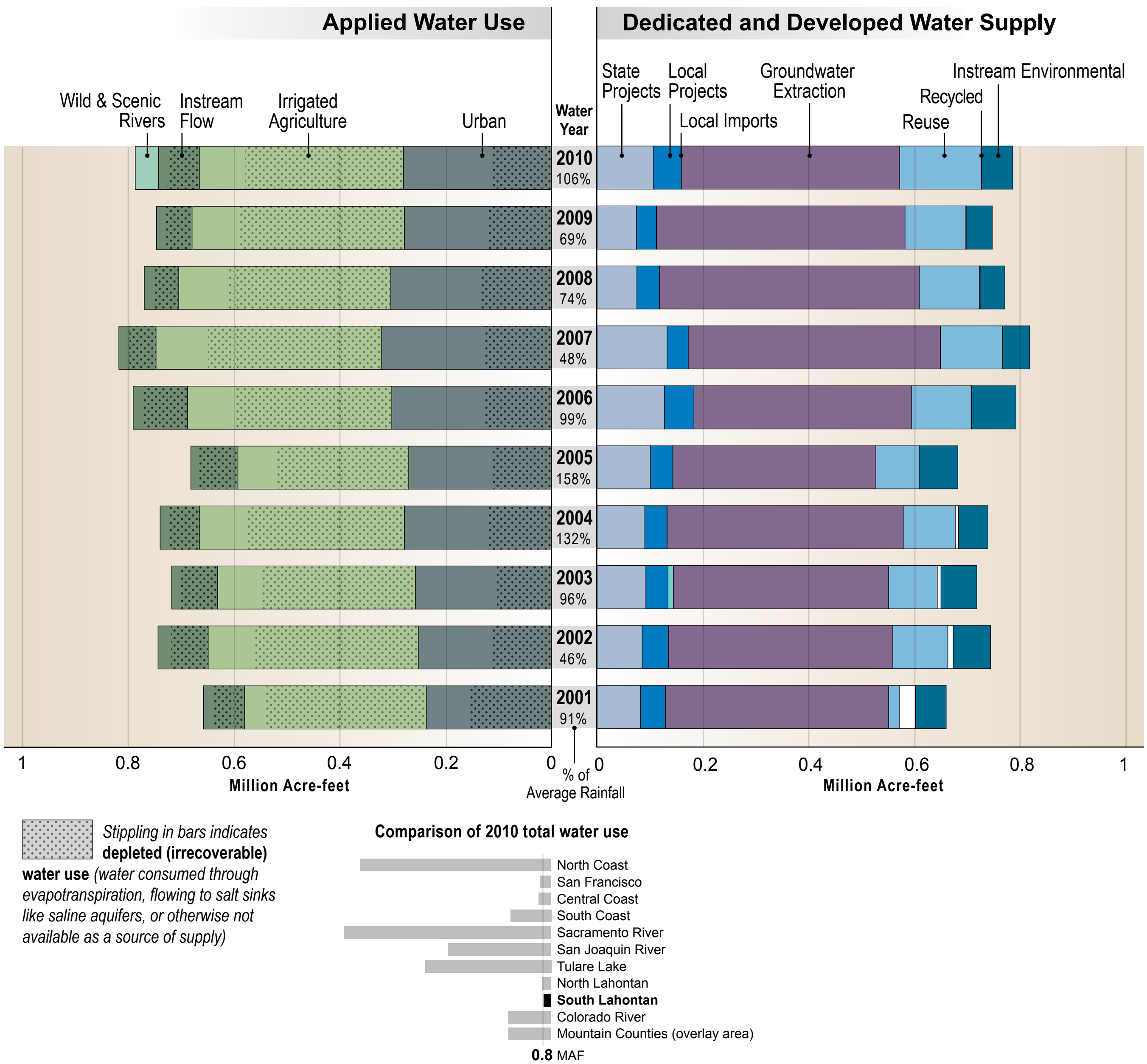
The region's surface water, although limited, is of excellent quality. It is greatly influenced by snowmelt and runoff from the eastern Sierra Nevada and the San Gabriel and San Bernardino mountains. Groundwater quality is also excellent in aquifers recharged by streams receiving mountain runoff.

However, at lower elevations, groundwater and surface water is degraded in localized areas. This degradation occurs both naturally (from geothermal activity and from closed groundwater water basins that accumulate and increase salt concentration from evapotranspiration losses) and through human activities (for example, agricultural operations, treated municipal sewage disposal, and improper industrial waste disposal). The highest priority water quality issues in the region are listed below:

- Elevated concentrations of nitrates and total dissolved solids in groundwater from sewage treatment plants, septic systems, and dairy operations.
- Groundwater overdraft, which causes pumping of older waters that have elevated levels of minerals (for example, total dissolved solids [TDS], arsenic, or fluoride).

Figure SL-13 South Lahontan Water Balance by Water Year, 2001-2010

California's water resources vary significantly from year to year. Ten recent years show this variability for water use and water supply. Applied Water Use shows how water is applied to urban and agricultural sectors and dedicated to the environment and the Dedicated and Developed Water Supply shows where the water came from each year to meet those uses. Dedicated and Developed Water Supply does not include the approximately 125 million acre-feet (MAF) of statewide precipitation and inflow in an average year that either evaporates, are used by native vegetation, provides rainfall for agriculture and managed wetlands, or flow out of the state or to salt sinks like saline aquifers (see Table SL-10). Groundwater extraction includes annually about 2 MAF more groundwater used statewide than what naturally recharges – called groundwater overdraft. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years.



For further details, refer to Vol. 5, *Technical Guide*, and the Volume 4 article, "California's Groundwater Update 2013."

Key Water Supply and Water Use Definitions

Applied water. The total amount of water that is diverted from any source to meet the demands of water users without adjusting for water that is depleted, returned to the developed supply or considered irrecoverable (see water balance figure).

Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

Instream environmental. Instream flows used only for environmental purposes.

Instream flow. The use of water within its natural watercourse as specified in an agreement, water rights permit, court order, FERC license, etc.

Groundwater Extraction. An annual estimate of water withdrawn from banked, adjudicated, and unadjudicated groundwater basins.

Recycled water. Municipal water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource.

Reused water. The application of previously used water to meet a beneficial use, whether treated or not prior to the subsequent use.

Urban water use. The use of water for urban purposes, including residential, commercial, industrial, recreation, energy production, military, and institutional classes. The term is applied in the sense that it is a kind of use rather than a place of use.

Water balance. An analysis of the total developed/dedicated supplies, uses, and operational characteristics for a region. It shows what water was applied to actual uses so that use equals supply.

South Lahontan Water Balance by Water Year Data Table (TAF)

	2001 (91%)	2002 (46%)	2003 (96%)	2004 (132%)	2005 (158%)	2006 (99%)	2007 (48%)	2008 (74%)	2009 (69%)	2010 (106%)
APPLIED WATER USE										
Urban	236	251	257	278	270	302	322	305	278	280
Irrigated Agriculture	344	398	374	387	323	386	425	400	401	385
Managed Wetlands	0	0	0	0	0	0	0	0	0	0
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	78	95	87	75	89	103	71	65	68	78
Wild & Scenic R.	0	0	0	0	0	0	0	0	0	44
Total Uses	**659**	**744**	**719**	**741**	**682**	**791**	**818**	**770**	**747**	**786**
DEPLETED WATER USE (STIPPLING)										
Urban	156	114	102	117	114	125	124	135	117	114
Irrigated Agriculture	302	308	291	299	248	293	327	307	310	298
Managed Wetlands	0	0	0	0	0	0	0	0	0	0
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	58	71	68	56	73	84	52	47	49	59
Wild & Scenic R.	0	0	0	0	0	0	0	0	0	0
Total Uses	**515**	**493**	**461**	**472**	**434**	**502**	**503**	**488**	**476**	**470**
DEDICATED AND DEVELOPED WATER SUPPLY										
Instream	58	71	68	56	73	84	52	47	49	59
Local Projects	47	50	42	42	42	56	40	43	38	53
Local Imported Deliveries	0	0	10	0	0	0	0	0	0	0
Colorado Project	0	0	0	0	0	0	0	0	0	0
Federal Projects	0	0	0	0	0	0	0	0	0	0
State Project	82	85	92	90	101	127	132	75	74	106
Groundwater Extraction	422	424	407	448	384	411	477	491	470	413
Inflow & Storage	0	0	0	1	0	0	0	0	0	0
Reuse & Seepage	21	104	92	97	82	113	117	114	115	154
Recycled Water	30	10	7	6	0	1	0	1	1	1
Total Supplies	**659**	**744**	**719**	**741**	**682**	**791**	**818**	**770**	**747**	**786**

- Effects of hydromodification, including sedimentation, erosion, and loss of riparian areas.
- Prevention of future groundwater degradation by managing increasing recycled water applications.
- Long-term management of groundwater polluted with industrial wastes at Department of Defense sites and with mining wastes at mine sites (groundwater contamination zones at Edwards Air Force Base and the former George Air Force Base will require groundwater monitoring for many decades or centuries).
- Minimizing the loss of assimilative capacity in aquifers affected by multiple land uses.
- Dissolved metals in groundwater (e.g., hexavalent chromium in the Hinkley area).
- Dissolved industrial salts (e.g., perchlorate in the Barstow area).
- Increased soil loss and deposition associated with land disturbance from development activities.

Groundwater Quality

Antelope Valley

The quality of the groundwater supplies from the Antelope Valley Groundwater Basin is good. The concentration of TDS averages 300 milligrams per liter and ranges from 200 to 800 mg/L. There are some concerns about arsenic and nitrates in the groundwater.

Arsenic concentrations above 10 milligrams per liter have forced the Los Angeles County Waterworks District (Lancaster) to put six wells on inactive status. Nitrate levels above 10 mg/L have been detected in the valley. Nitrates are also present in the groundwater near the community of Littlerock. This is directly because of the agricultural operations in the area.

Mojave River Valley

Water quality conditions are generally good throughout groundwater basins in the Mojave River Valley. However, as is common in arid basins of the southwest, there are localized issues associated with naturally occurring constituents such as arsenic, chromium, TDS, fluoride, boron, iron, and manganese. Additional information is available on the MWA Web site at http://www.mojavewater.org.

Elevated nitrate concentrations and TDS have been measured in the groundwater beneath some dairy waste disposal operations and sewage effluent disposal sites in the region. Fertilizers have been measured in wells and reservoirs near these operations.

Southeastern Inyo County

In southeastern Inyo County, the groundwater basin has TDS, fluoride, and arsenic levels that exceed the drinking water standards. That basin is the only source of potable water supplies for residents of the communities of Tecopa and Tecopa Hot Springs; and existing water treatment facilities are inadequate to treat these contaminants. Local residents are faced with the problem of either driving to other urban centers to purchase drinking water or to use those supplies and face the increased potential for health problems later.

Drinking Water Quality

In general, drinking water systems in the region deliver to their customers' water that meets federal and State drinking water standards. Recently, the State Water Resources Control Board completed a statewide assessment of community water systems that rely on a contaminated groundwater source for drinking water (State Water Resources Control Board 2013). Contamination of local groundwater resources results in higher costs for rate-payers and consumers due to the need for additional water treatment. This report identified 73 community drinking water systems in the region that rely on at least one contaminated groundwater well as a source of supply (Table SL-11). A total of 180 community drinking water wells are affected by groundwater contamination; and the most prevalent contaminants are arsenic, gross alpha particle activity, uranium, and fluoride — all naturally occurring contaminants. The majority of the affected systems are small community water systems, which often need financial assistance to construct a water treatment plant or alternate solution to meet drinking water standards.

Groundwater Conditions and Issues

Groundwater Occurrence and Movement

Aquifer conditions and groundwater levels change in response to varying supply, demand, and climate conditions. During dry years or periods of increased groundwater use, seasonal groundwater levels tend to fluctuate more widely and, depending on annual recharge conditions, may result in a long-term decline in groundwater levels, both locally and regionally. Depending on the amount, timing, and duration of groundwater level decline, nearby well owners may need to deepen wells or lower pumps to regain access to groundwater.

As groundwater levels fall, they can impact the surface water-groundwater interaction by inducing additional infiltration and recharge from surface water systems, which reduce groundwater discharge to surface water baseflow and wetlands areas. Extensive lowering of groundwater levels also can cause land subsidence due to the dewatering, compaction, and loss of storage within finer grained aquifer systems.

During years of average and above average, or during periods of low groundwater use, aquifer systems tend to recharge and respond with rising groundwater levels. As groundwater levels rise, they reconnect to surface water systems, contributing to surface water base flow or wetlands, seeps, and springs.

The movement of groundwater is typically from higher elevations to lower elevations. The direction of groundwater movement can also be influenced by groundwater extractions. Where groundwater extractions are significant, groundwater may flow toward the extraction point. Rocks with low permeability can restrict groundwater flow through a basin.

Depth to Groundwater and Groundwater Elevation Contours

Groundwater monitoring makes data available to prepare the depth to groundwater and groundwater elevation contours. The depth to groundwater has a direct bearing on the costs associated with well installation and groundwater extraction operations. Knowing the local depth to groundwater can also provide a better understanding of the interaction between the

Table SL-11 Summary of Community Drinking Water Systems in the South Lahontan Hydrologic Region that Rely on One or More Contaminated Groundwater Wells that Exceed a Primary Drinking Water Standard

Community Drinking Water Systems and Groundwater Wells Grouped by Water System Population	Number of Affected Community Drinking Water Systems	Number of Affected Community Drinking Water Wells
Small Systems (≤ 3,300)	54	86
Medium Systems (3,301 – 10,000)	10	30
Large Systems (> 10,000)	9	64
Total	73	180

Source: *Communities That Rely on a Contaminated Groundwater Source for Drinking Water*. State Water Resources Control Board 2013.

groundwater table and the surface water systems, and the contribution of groundwater aquifers to the local ecosystem.

The South Lahontan Hydrologic Region is an extensive region and is characterized by many mountains and valleys. Some of the valleys are filled with thousands of feet of alluvial deposits derived from the surrounding mountains. The resulting geography is diverse and influences the depth to groundwater. Depending on the local geology, the proximity to a river, and the amount of groundwater production, groundwater can flow to the surface as springs, be within a few feet of the ground surface, or many hundreds of feet deep. Generally, the depth to groundwater in the valley fill material is related to topography, with the shallowest groundwater levels occurring in the lower elevations of the valley and greater depths to groundwater at higher elevations on alluvial fans.

Depth-to-groundwater data for some of the groundwater basins in the region are available online via DWR's Water Data Library (http://www.water.ca.gov/waterdatalibrary/), DWR's CASGEM system (http://www.water.ca.gov/groundwater/casgem/), and the USGS National Water Information System (http://waterdata.usgs.gov/nwis).

Much of the land in the region is designated as public lands, including National Forests, National Parks, State Parks, and military bases. As such, the population density is low in much of the region. The hydrogeology of many of the basins is not well understood due to the lack of development and infrastructure in the region. Some local agencies independently or cooperatively monitor depth-to-groundwater data and produce groundwater elevation contour maps. (Groundwater elevation contours can help estimate the direction, gradient, and the rate of groundwater flow.) For example, the Mojave Water Agency 2004 Regional Water Management Plan (Mojave Water Agency 2005) and USGS reports (2011 and 2007) contain depth-to-groundwater data for basins in the region within the MWA boundary. The Antelope Valley Integrated Regional Water Management Plan contains depth-to-groundwater data for portions of their planning area (Antelope Valley Regional Water Management Group 2007).

Groundwater Level Trends

Groundwater levels within groundwater basins in the region are highly variable because of the physical variability of aquifer systems, the variability of surrounding land use practices, and the variability of groundwater availability and recharge. Plots of depth-to-water measurements in wells over time (groundwater level hydrographs) allow analysis of seasonal and long-term groundwater level variability and trends. The hydrographs presented in Figures SL-14A to SL-14D help explain how local aquifer systems respond to changing groundwater pumping quantities and to resource management practices. The hydrograph name refers to the well location (township, range, section, and tract).

Figure SL-14A shows hydrograph 10N09W04D001S, which is from a well located to the north of Rogers Lake and within the Edwards Air Force Base boundary, and overlying the northeastern portion of the Antelope Valley Groundwater Basin in Kern County, a CASGEM high priority basin. The well is approximately 500 feet deep and is constructed within alluvial sediments derived from the San Gabriel and Tehachapi Mountain. Groundwater is likely confined by lacustrine deposits exposed at the land surface near Rogers Lake (Leighton and Phillips 2003). Groundwater level steadily declined from 1960 to 1992 due to a heavy reliance on groundwater in the Antelope Valley to meet increased water use resulting from rapid urban growth. Seasonal fluctuations can be observed until 1992 but are almost indiscernible after that. From 1993 to 1996, groundwater level appears to rise slightly, followed again by a gradual and steady decline from 1997 to 2010. The groundwater levels in the well do not appear to be affected by climate variations such as droughts or wet cycles; annual groundwater level decline, however, continues regardless. The long-term decline in groundwater levels has resulted in more than 6 feet of land subsidence and permanent loss of groundwater storage in some areas. The long-term decline of groundwater levels in portions of the region has also led to litigation. The groundwater rights of residents and purveyors within the Antelope Valley region are currently undergoing an adjudication process overseen by the Superior Court of California. If the groundwater rights become adjudicated, the groundwater levels and extraction limits will be managed in a court-appointed manner with the goal of stabilizing groundwater levels (Antelope Valley Regional Water Management Group 2007).

Figure SL-14B shows hydrograph 09N03W23C001S, which is from a well located in the Middle Mojave River Valley Groundwater Basin, a CASGEM low priority basin. The well is constructed near agricultural developments along the Mojave River between the communities of Helendale and Lenwood.

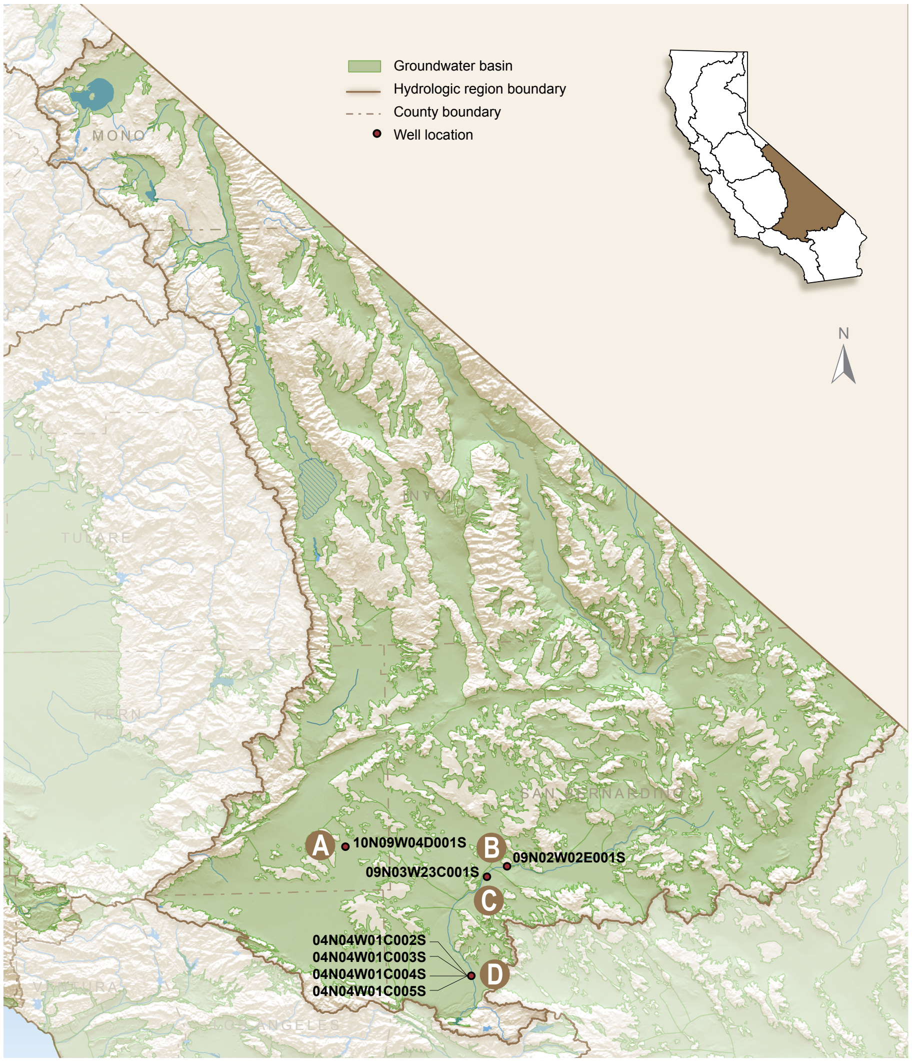
Figure SL14-C shows hydrograph 09N02W02E001S, which is from a well located in the Lower Mojave River Valley Groundwater Basin, a CASGEM medium priority basin. The well is constructed adjacent to the Mojave River, near residential and industrial developments immediately down-gradient from recharge ponds in Lenwood. The recharge ponds replenish the underlying aquifers with water from the SWP.

Figure SL-14D shows hydrograph 04N04W01C005S, which is from a well located in the Upper Mojave River Valley Groundwater Basin, a CASGEM high priority basin. The well is constructed in a residential and commercial area adjacent to the Mojave River in the City of Apple Valley.

The groundwater levels in all three wells (Figures SL-14B, SL-14C, and SL-14D) display seasonal fluctuations in response to variations in the hydrology. The spikes in the hydrographs correlate to periods of heavy precipitation that recharge the underlying aquifers and cause

Figure SL-14 Groundwater Level Trends in Selected Wells in the South Lahontan Hydrologic Region

Regional locator map

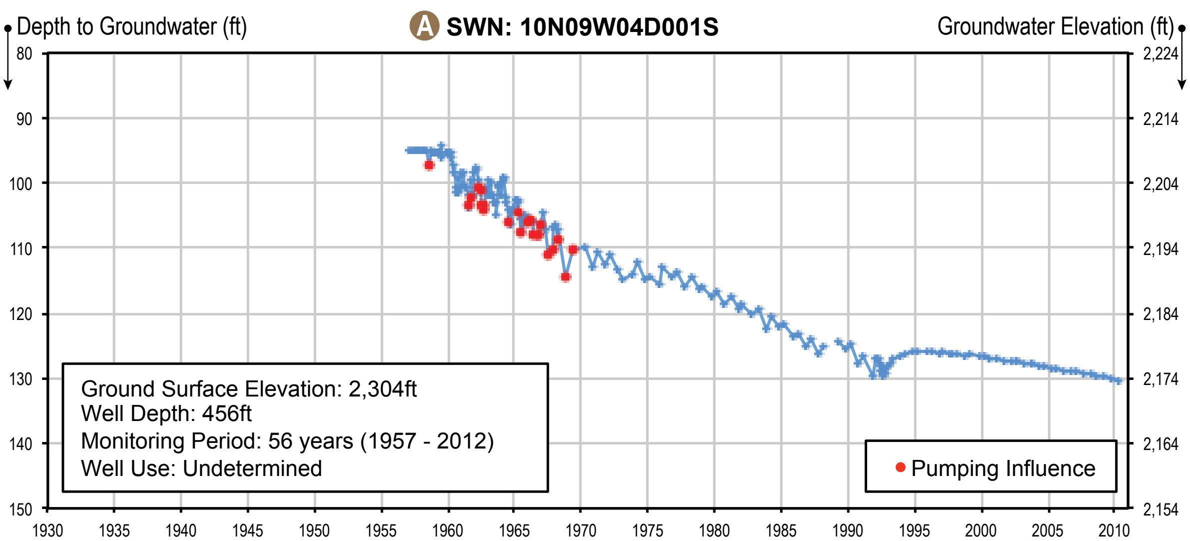


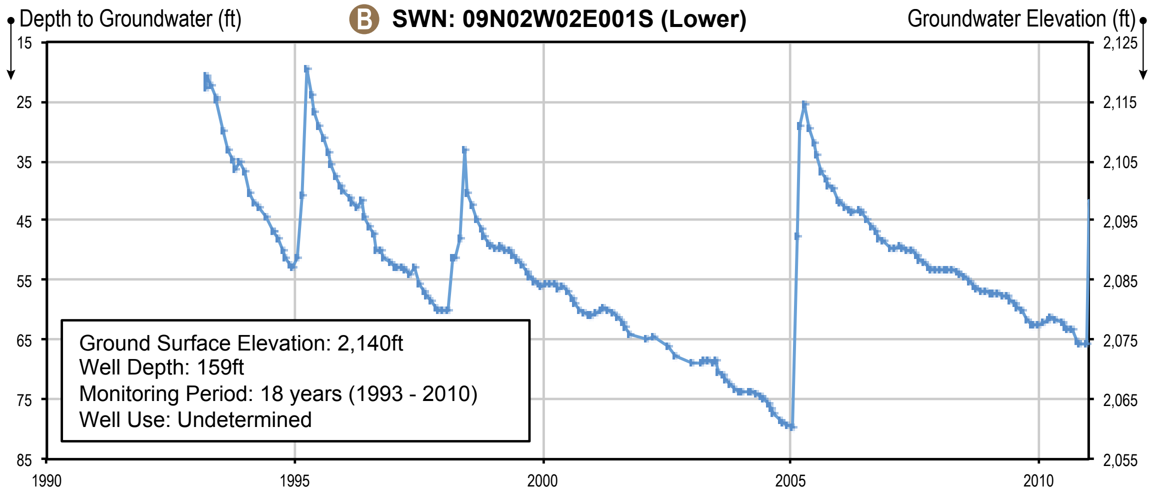
Aquifer response to changing demand and management practices

Hydrographs were selected to help tell a story of how local aquifer systems respond to changing groundwater demand and resource management practices. Additional detail is provided within the main text of the report.

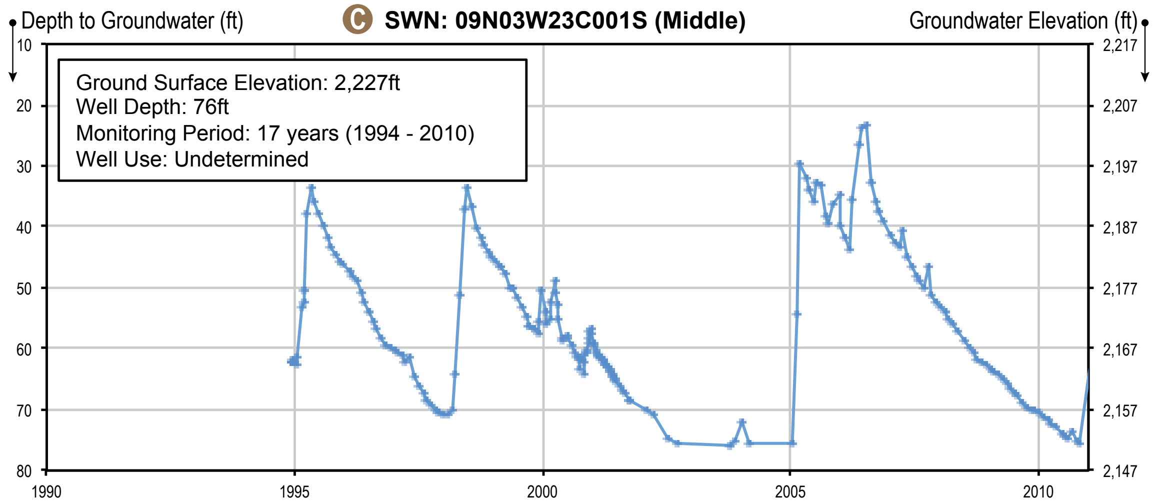
(A) Hydrograph 10N09W04D001S: illustrates the stabilization of declining groundwater levels through increased pumping costs and introduction of SWP water in 1970s. The rapid urban growth of 1980s, however, offset the recovery and resumed the downward trend in the groundwater levels.

(B) (C) (D) Hydrograph 09N02W02E001S, 09N03W23C001S, and 04N04W01C002S-5S: highlights the inter-connected aquifer response to the precipitation conditions in the Lower, Middle and Upper Mojave River Valley Groundwater Basins, respectively. The aquifers underlying the three basins consist of very porous sediments which allow rapid water infiltration resulting in rapid increase in groundwater elevations during periods of heavy precipitation. The delayed recharge response in Middle and Lower Mojave River Groundwater Basins is most likely due the fact that the Mojave River is an ephemeral river and does not have water flow along its entire reach except during very large wet cycles. With the exception of notably large wet cycles, the majority of the aquifer recharge within the Mojave River drainage system occurs along the upper reaches of the Mojave River and is less pronounced in the middle and lower reaches of the drainage system.

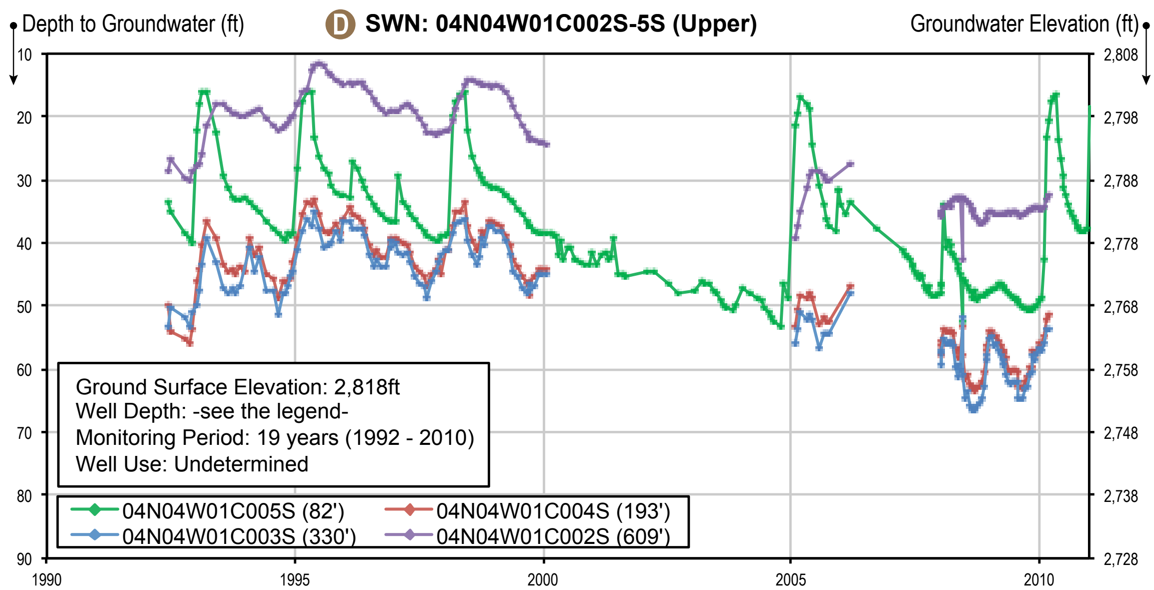




Depth to Groundwater (ft)
B SWN: 09N02W02E001S (Lower)
Groundwater Elevation (ft)
15
25
35
45
55
65
75
85
2,125
2,115
2,105
2,095
2,085
2,075
2,065
2,055
1990
1995
2000
2005
2010
Ground Surface Elevation: 2,140ft
Well Depth: 159ft
Monitoring Period: 18 years (1993 - 2010)
Well Use: Undetermined



Depth to Groundwater (ft)
C SWN: 09N03W23C001S (Middle)
Groundwater Elevation (ft)
10
20
30
40
50
60
70
80
2,217
2,207
2,197
2,187
2,177
2,167
2,157
2,147
1990
1995
2000
2005
2010
Ground Surface Elevation: 2,227ft
Well Depth: 76ft
Monitoring Period: 17 years (1994 - 2010)
Well Use: Undetermined



Depth to Groundwater (ft)
D SWN: 04N04W01C002S-5S (Upper)
Groundwater Elevation (ft)
10
20
30
40
50
60
70
80
90
2,808
2,798
2,788
2,778
2,768
2,758
2,748
2,738
2,728
1990
1995
2000
2005
2010
Ground Surface Elevation: 2,818ft
Well Depth: -see the legend-
Monitoring Period: 19 years (1992 - 2010)
Well Use: Undetermined
04N04W01C005S (82')
04N04W01C004S (193')
04N04W01C003S (330')
04N04W01C002S (609')

groundwater levels to rise. As displayed in these hydrographs, the years with relatively abundant precipitation include 1993, 1995, 1998, 2005, and 2010. The Mojave River channel and its underlying aquifer systems contain very porous sediments, which allow rapid water infiltration.

The troughs in the hydrographs correlate with droughts or periods of low precipitation. Notable droughts during the time span of the hydrographs include the 1999-2004 and 2007-2009 droughts. Although minor seasonal fluctuations can be seen, all three hydrographs display sharp downward trends during these droughts. Groundwater levels decrease rapidly during dry years as groundwater is extracted.

Figure SL-14D also depicts a nested well cluster that shows groundwater levels at four depths and how they relate to periods of high and low precipitation. The nested well has a total construction depth of 620 feet and consists of four wells — Well 04N04W01C002S (609 feet below ground surface [bgs]), Well 04N04W01C003S (330 feet bgs), Well 04N04W01C004S (193 feet bgs), and Well 04N04W01C005S (82 feet bgs). Well 04N04W01C005S displays the most groundwater level fluctuation and the largest response to the recharge and drawdown events. The groundwater levels in well 04N04W01C003S and 04N04W01C004S coincide closely and measure groundwater levels from the same aquifer. The shallow depth-to-water observed in Well 04N04W01C002S is a result of the hydraulic head caused by the reduced permeability of the deeper deposits and most likely represents localized semi-confined to confined conditions (California Department of Water Resources 2003).

Change in Groundwater Storage

Change in groundwater storage is the difference in stored groundwater volume between two time periods. Examining the annual change in groundwater storage over a series of years helps identify the aquifer response to changes in climate, land use, or groundwater management over time. If the change in storage is negligible over a period represented by average hydrologic and land use conditions, the basin is considered to be in equilibrium under the existing water use scenario and current management practices. However, declining storage over a relatively short period characterized by average hydrologic and land use conditions does not necessarily mean that the basin is being managed unsustainably or 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.

Additional information regarding the risks and benefits of conjunctive management can be found online from Update 2013, Volume 3, *Resource Management Strategies,* Chapter 9, "Conjunctive Management and Groundwater."

Because of resource and time constraints, changes in groundwater storage estimates for basins within the region were not developed as part of the groundwater content enhancement for Update 2013. Some local groundwater agencies within the South Lahontan region, including the MWA, periodically develop change-in-groundwater-storage estimates for basins within their service area.

Land Subsidence

In the South Lahontan region, researchers have investigated the occurrence of land subsidence in the Mojave Desert and in the Antelope Valley.

Groundwater is the primary source of water supply in the Mojave Desert. The MWA is the largest local groundwater management agency in the Mojave Desert and serves as watermaster for the areas specified in the 1996 Mojave Basin Area judgment. Groundwater production initially developed along the Mojave River in the early 1900s. As a result of that, since the 1930s, groundwater levels have declined by about 40 feet to more than 100 feet in some areas (Smith et al. 2011). The USGS and the MWA worked cooperatively to investigate the occurrence of land subsidence in four areas of the MWA management area (Sneed et al. 2003). The resulting investigation concluded that subsidence ranging from 0.15 to 0.3 feet occurred in four areas of the Mojave Desert — El Mirage, Lockhart-Harper Lake, Newberry Springs, and Lucerne Valley. The MWA recognizes the potential for future land subsidence and has developed water management objectives to reduce the potential for land subsidence. The objectives include balancing water demand and supply and stabilizing groundwater storage (Mojave Water Agency 2005).

The Antelope Valley has had a long history of groundwater production. Due to unreliable and unstable surface water sources, agricultural developments began relying on groundwater in 1912. Agricultural developments continued to increase and peaked during the 1950s. In the early 1960s, the predominant water demand began to shift from agriculture to municipal and industrial developments (Galloway et al. 1998). The water demand in Antelope Valley was met almost entirely by groundwater until 1972, when water transported by the SWP became available for import. During the 1980s, the Antelope Valley experienced rapid urban growth, which resulted in a high water demand and subsequent decline in groundwater levels. Groundwater levels have declined at least 100 feet in most of the Antelope Valley region and resulted in land subsidence in some areas (Antelope Valley Regional Water Management Group 2007). Land subsidence has been a known occurrence in the Antelope Valley area since the 1950s (Antelope Valley Regional Water Management Group 2007). The City of Lancaster is the largest city in Antelope Valley, with an estimated population of 157,700 (U.S. Census Bureau 2010). Phillips et al. (2003) investigated the amount of land subsidence in the Lancaster area using GPS surveys, tilt-meters, and a dual borehole extensometer. The study indicates that more than 6 feet of land subsidence in Lancaster is the result of a groundwater level decline of more than 200 feet since the 1920s (Phillips et al. 2003). Sneed and Galloway (2000) investigated land subsidence at the Edwards Air Force Base, north of Lancaster. The study shows that long-term groundwater extractions have resulted in nearly 4 feet of land subsidence between 1926 and 1992 at the Edwards Air Force Base. From 1990 to 2000, nearly 0.4 feet of subsidence occurred.

The population growth in Antelope Valley is expected to continue, and the forecasted water demand is expected to exceed currently available water supplies (Antelope Valley Regional Water Management Group 2007). Groundwater modeling by Phillips et al. (2003) suggests that land subsidence would likely continue if groundwater levels continue to decline.

Current water management efforts in the Antelope Valley to offset groundwater level decline and land subsidence include the use of imported surface water from the SWP, the storage of local runoff in Little Rock Reservoir, artificial recharge, the use of recycled water, and conservation. The Antelope Valley region is undergoing an adjudication process that began in 1999. If the

California Superior Court adjudicates the groundwater rights in the area, the judgment will likely stipulate groundwater extraction rights and limits.

Additional information regarding land subsidence is available online from Update 2013, Volume 4, *Reference Guide,* the article, "California's Groundwater Update 2013."

Flood Management

The Inyo/Mono Watersheds Invasive Weed Control Program is an example of integrated water management (IWM) in the South Lahontan region. This is a three-phase project that will include flood management, creek restoration, and agricultural irrigation. Phase One is the study and engineering of up to three flood diversions, two reservoirs, 3 miles of creek restoration, and up to 500 acres of irrigation system.

Another example of an IWM project with a flood management component and ecosystem restoration is the West Walker River Restoration Plan. The goal of this project is develop a restoration plan via the completion of an assessment of the riverine and riparian conditions associated with approximately 3 miles of the West Walker River located within the area of Antelope Valley that is designated as an economically disadvantaged community. This area has experienced significant damage from stormwater events and flooding of the Walker River that have, in turn, resulted in significant impacts, including loss of productive farmlands.

Risk Characterization

Winter storms can create the greatest potential for flood damage in the region. Historically in the South Lahontan Hydrologic Region, flooding originates principally from melting of the Sierra snowpack (in the northern portion of region) and from rainfall. Flooding from snowmelt typically occurs in the spring and has a lengthy runoff period. Floods adjacent to the large rivers in the region can be caused by either the overtopping of embankments by slow-rising floodwaters or flash-flooding from high-intensity rainfall. As mentioned earlier, many streams in the region have intermittent flows, especially in their lower reaches. This can leave steep channel bed slopes and negatively impact vegetation cover. Surface runoff from severe summer thunderstorms can cause damage downstream if channelized in these dry streambeds and pass through urban areas. Some of the urban and agricultural areas of the region are located on gently sloping terrain, which makes them vulnerable to flooding from large-scale rain events.

In the region, more than 150,000 people and nearly $12 billion in assets are exposed to the 500-year flood event. Figures SL-15 and SL-16 provide a snapshot of people, structures, crops, and infrastructure exposed to flooding in the region. Over 210 threatened, endangered, listed, or rare plant and animal species exposed to flood hazards are distributed throughout the South Lahontan Hydrologic Region.

Flood management agencies are responsible for operating and maintaining 244 miles of levees, 49 dams and reservoirs, 270 debris basins, and other facilities within the South Lahontan Hydrologic Region.

In the South Lahontan Hydrologic Region, 33 local flood management projects or planned improvements were identified. Of these projects, 29 have costs totaling approximately $173 million; and 21 local planned projects use an IWM approach to flood management, including the Oak Creek Watershed Fire/Flood Restoration Phase I Project and the Amethyst Detention Basin Project. These identified projects and improvements are summarized in DWR's State Flood Management Planning Program (SFMP) *California's Flood Future: Recommendations for Managing the State's Flood Risk Report.*

Water Governance

IWM planning activities in two heavily urbanized areas of the South Lahontan region have and will be impacted by groundwater adjudication judgments. In the Mojave River area, parties to the stipulated judgment for the Mojave River Groundwater Basin must comply with decisions handed down in the September 1993 Stipulated Judgment by the Superior Court and the California Supreme Court reaffirmation of the Appellate Court's decision in August 2000 regarding the Stipulated Judgment and the exclusion of the appealing parties from the judgment. In addition to impacting the demands in the valley, the judgment impacted urban and agricultural uses and resulted in the completion of several groundwater recharge facilities. Additional information is available on the MWA Web site at http://www.mojavewater.org.

Litigation continues in the case, which will result in the adjudication of the Antelope Valley Groundwater Basin in northern Los Angeles County. As reported in *California Water Plan Update 2009*, the legal boundary for the groundwater basin to be adjudicated has been established. Among the current activities, parties are stepping forward for consideration in the final judgment. Yet to be litigated are the historical groundwater extraction quantities for all of the parties.

In addition to the Mono Lake requirements, the LADWP provides the water supplies for environmental projects that are jointly agreed to by the agency and the County of Inyo. Impacts to the environment from the pumping of groundwater supplies for these projects are also closely monitored.

California's water resource development has resulted in a complex, fragmented, and intertwined physical and governmental infrastructure. Although primary responsibility for flood management might be assigned to a specific local entity, aggregate responsibilities are spread among more than 75 agencies in the South Lahontan Hydrologic Region with many different governance structures. A list of agencies can be found in the *California's Flood Future Report Attachment E: Information Gathering Technical Memorandum* (California Department of Water Resources and U.S. Army Corps of Engineers 2013b). Agency roles and responsibilities can be limited by how the agency was formed, which might include enabling legislation, a charter, a memorandum of understanding with other agencies, or facility ownership.

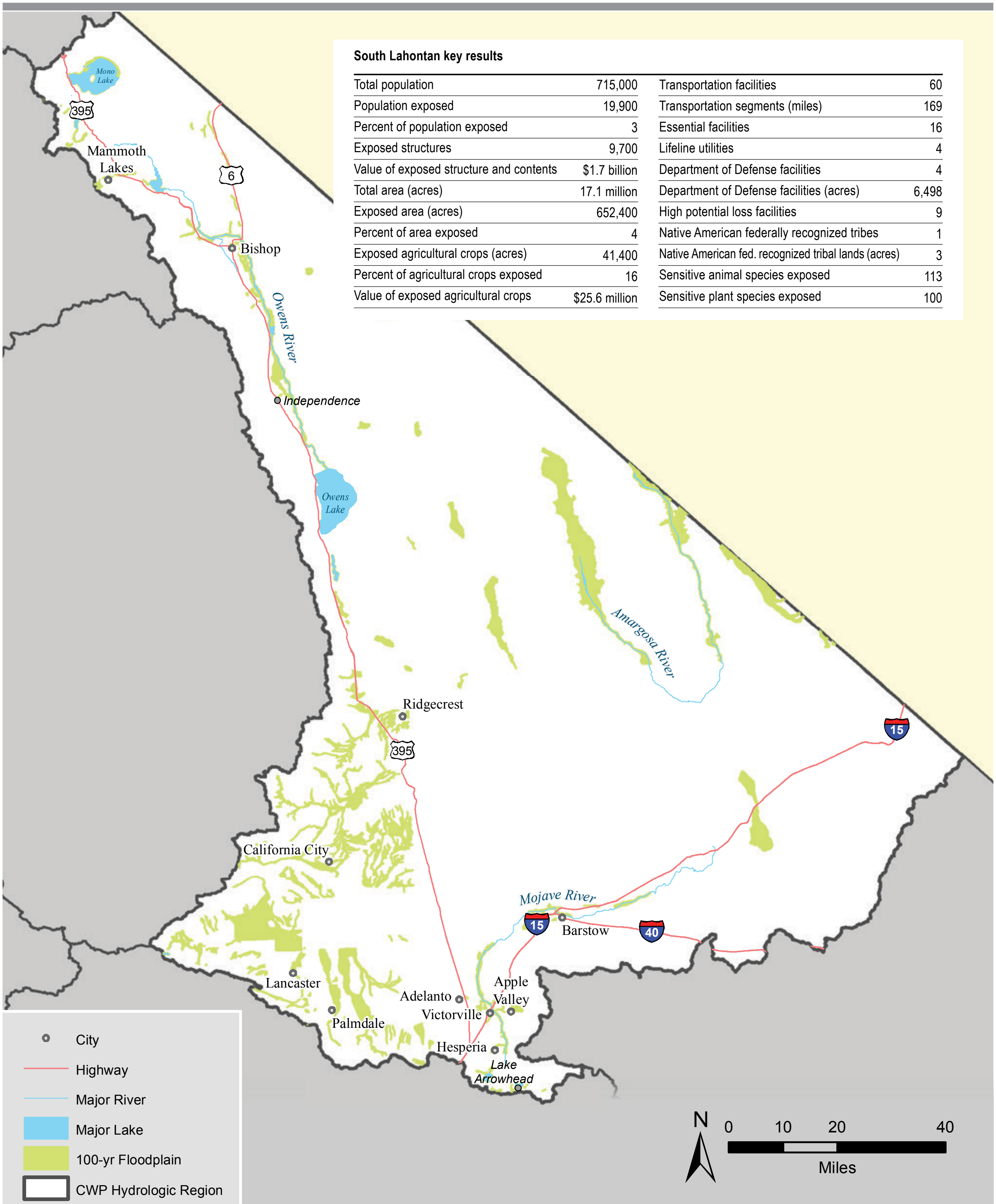
Groundwater Governance

California does not have a statewide management program or statutory permitting system for groundwater. However, one of the primary vehicles for implementing local groundwater management in California is a groundwater management plan (GWMP). Some local agencies manage groundwater through adoption of groundwater ordinances, and others manage groundwater through authorities granted by special acts of the Legislature. Additional avenues types of groundwater management include basin adjudication, IRWM plans, urban water management plans, and agricultural water management plans.

Figure SL-15 Flood Exposure to the 100-Year Floodplain, South Lahontan Hydrologic Region

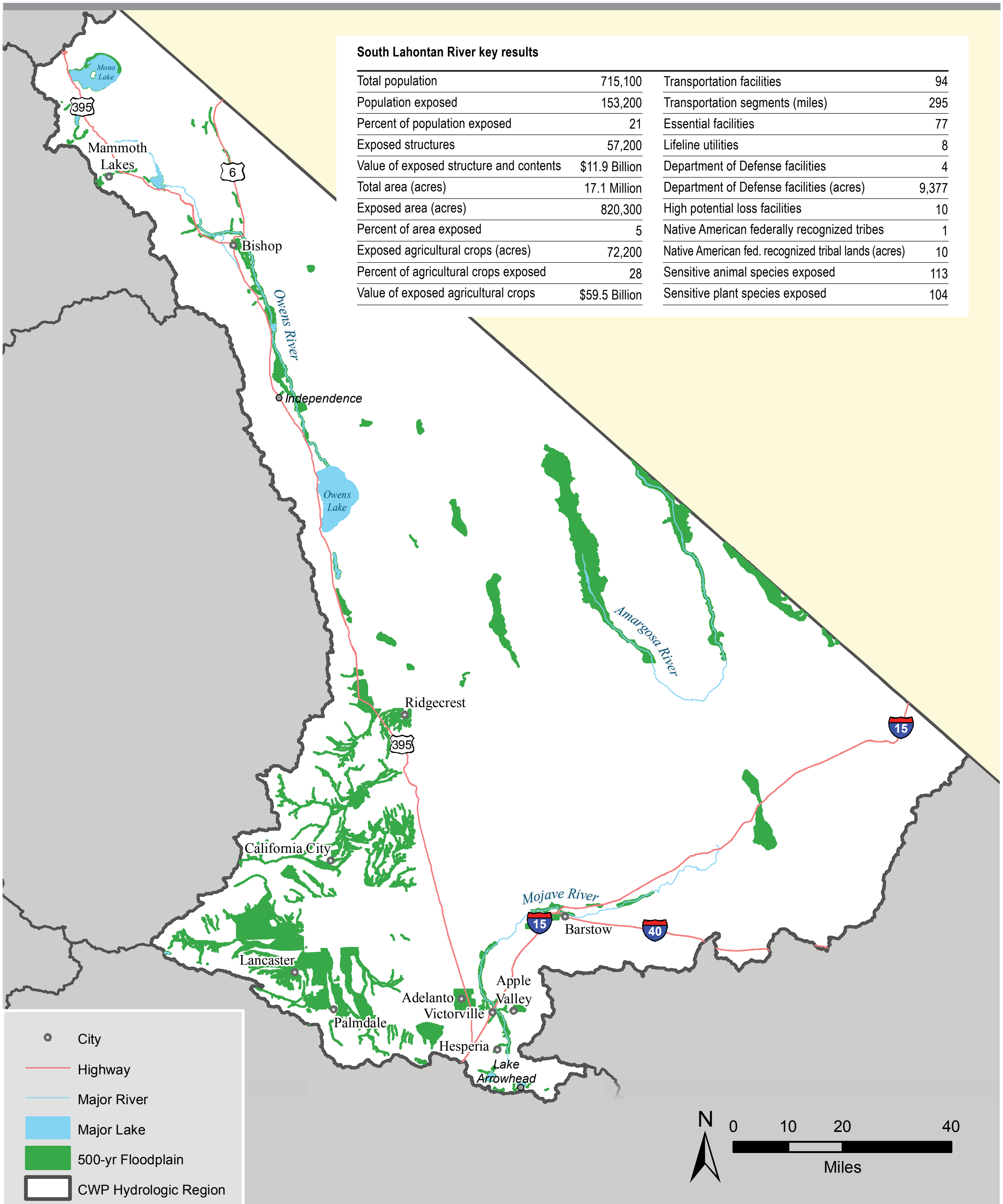
South Lahontan key results

Total population	715,000	Transportation facilities	60
Population exposed	19,900	Transportation segments (miles)	169
Percent of population exposed	3	Essential facilities	16
Exposed structures	9,700	Lifeline utilities	4
Value of exposed structure and contents	$1.7 billion	Department of Defense facilities	4
Total area (acres)	17.1 million	Department of Defense facilities (acres)	6,498
Exposed area (acres)	652,400	High potential loss facilities	9
Percent of area exposed	4	Native American federally recognized tribes	1
Exposed agricultural crops (acres)	41,400	Native American fed. recognized tribal lands (acres)	3
Percent of agricultural crops exposed	16	Sensitive animal species exposed	113
Value of exposed agricultural crops	$25.6 million	Sensitive plant species exposed	100



Source: California's Flood Future Report 2013

Figure SL-16 Flood Exposure to the 500-Year Floodplain, South Lahontan Hydrologic Region



South Lahontan River key results

Total population	715,100	Transportation facilities	94
Population exposed	153,200	Transportation segments (miles)	295
Percent of population exposed	21	Essential facilities	77
Exposed structures	57,200	Lifeline utilities	8
Value of exposed structure and contents	$11.9 Billion	Department of Defense facilities	4
Total area (acres)	17.1 Million	Department of Defense facilities (acres)	9,377
Exposed area (acres)	820,300	High potential loss facilities	10
Percent of area exposed	5	Native American federally recognized tribes	1
Exposed agricultural crops (acres)	72,200	Native American fed. recognized tribal lands (acres)	10
Percent of agricultural crops exposed	28	Sensitive animal species exposed	113
Value of exposed agricultural crops	$59.5 Billion	Sensitive plant species exposed	104

Source: California's Flood Future Report 2013

A summary assessment of some of the GWMPs in the region is provided below, while a detailed assessment is available online from Update 2013, Volume 4, *Reference Guide,* the article, "California's Groundwater Update 2013." The assessment was based on a GWMP inventory developed through a joint DWR/Association of California Water Agencies (ACWA) online survey and follow-up communication by DWR in 2011 and 2012.

Groundwater Management Assessment

Table SL-12 lists the GWMPs in the region, while Figure SL-17 shows the location and distribution of the GWMPs. GWMPs prepared in accordance with the 1992 Assembly Bill (AB) 3030 legislation, as well as those prepared with the additional required components listed in the 2002 SB 1938 legislation are shown.

The GWMP inventory shows four GWMPs exist within the South Lahontan region, three of which are fully contained within the region. The other plan includes portions of the adjacent Colorado River Hydrologic Region. Three of the four GWMPs were developed or updated to include SB 1938 requirements and are considered active for the purposes of the GWMP assessment. As of August 2012, four of the five basins identified as high or medium under the CASGEM Basin Prioritization are covered by active GWMPs.

The CWC Section 10753.7 requires that six components be included in a groundwater management plan for an agency to be eligible for State funding administered by DWR for groundwater projects. The requirement associated with the 2011 AB 359 (Huffman) legislation, applicable to groundwater recharge mapping and reporting, did not take effect until January 2013 and was not included in the current assessment. In addition, the requirement for local agencies outside of recognized groundwater basins was not applicable to any of the GWMPs in the region.

In addition to the six required components, CWC Section 10753.8 provides a list of 12 voluntary components that may be included in a groundwater management plan. DWR *Bulletin 118-2003*, Appendix C "Required and Recommended Components of Local Groundwater Management Plans" provides a list of seven recommended components related to management development, implementation, and evaluation of a GWMP, which should be considered to help ensure effective and sustainable groundwater management.

As a result, the GWMP assessment was conducted using the following criteria:

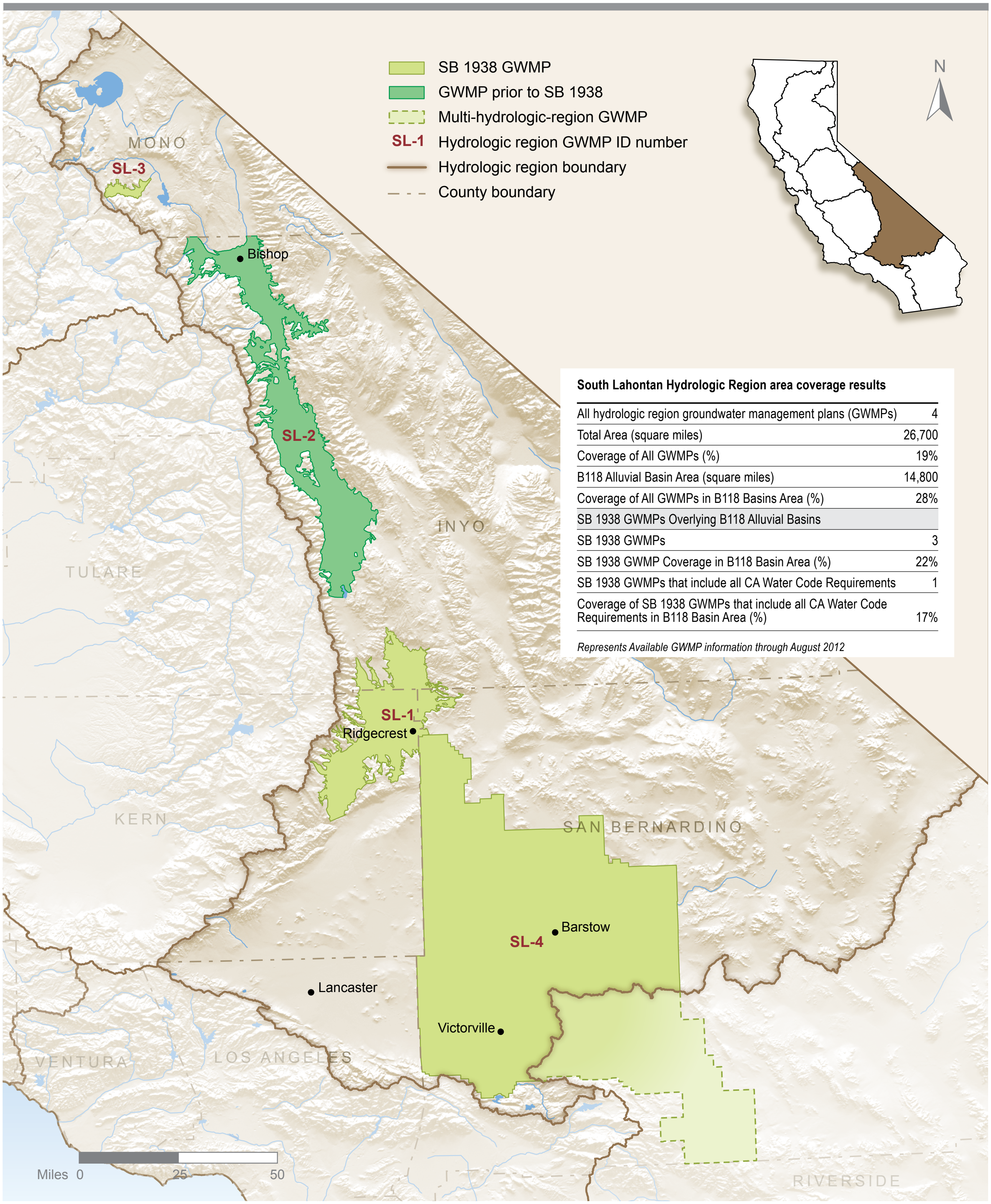
- How many of the post SB 1938 GWMPs meet the six required components included in SB 1938 and incorporated into CWC Section 10753.7?
- How many of the post SB 1938 GWMPs include the 12 voluntary components included in CWC Section 10753.8?
- How many of the implementing or signatory GWMP agencies are actively implementing the seven recommended components listed in DWR *Bulletin 118-2003*?

A summary of the GWMP assessment is provided in Table SL-13.

Factors Contributing to Success and Impediment to Groundwater Management

The survey participants were also asked to identify key factors that promoted or impeded successful groundwater management.

Figure SL-17 Location of Groundwater Management Plans in the South Lahontan Hydrologic Region



South Lahontan Hydrologic Region area coverage results

All hydrologic region groundwater management plans (GWMPs)	4
Total Area (square miles)	26,700
Coverage of All GWMPs (%)	19%
B118 Alluvial Basin Area (square miles)	14,800
Coverage of All GWMPs in B118 Basins Area (%)	28%
SB 1938 GWMPs Overlying B118 Alluvial Basins	
SB 1938 GWMPs	3
SB 1938 GWMP Coverage in B118 Basin Area (%)	22%
SB 1938 GWMPs that include all CA Water Code Requirements	1
Coverage of SB 1938 GWMPs that include all CA Water Code Requirements in B118 Basin Area (%)	17%

Represents Available GWMP information through August 2012

Table SL-12 Groundwater Management Plans in the South Lahontan Hydrologic Region

Map Label	Agency Name	Date	County	Basin Number	Basin Name
SL-1	Indian Wells Valley Water District	2006	Kern, Inyo, San Bernardino	6-53	Coso Valley
	Naval Air Weapons Station / China Lake			6-54	Indian Wells Valley
	North American Chemical Company				
	City of Ridgecrest				
	Kern County Water Agency				
	Inyokern Community Services District				
	Indian Wells Valley Airport District				
	Eastern Kern County Resources Conservation District				
	Ridgecrest Resource Area Bureau of Land Management				
	Quist Farms				
SL-2	Inyo County and City of Los Angeles	1990	Inyo	6-12	Owens Valley
	No signatories on file				
SL-3	Mammoth Community Water District	2005	Mono	6-11	Long Valley
	No signatories on file				
SL-4 (CR-4)	Mojave Water Agency	2004	Kern, Los Angeles, San Bernardino	6-35	Cronise Valley
	No signatories on file			6-38	Caves Canyon Valley
				6-40	Lower Mojave River Valley
				6-41	Middle Mojave River Valley
				6-42	Upper Mojave River Valley
				6-44	Antelope Valley
				6-46	Fremont Valley
				6-48	Goldstone Valley
	Mojave Water Agency (Continued)			6-49	Superior Valley
				6-50	Cuddeback Valley
				6-51	Pilot Knob Valley
				6-52	Searles Valley
				6-53	Salt Wells Valley
				6-54	Indian Wells Valley
				6-77	Grass Valley

Map Label	Agency Name	Date	County	Basin Number	Basin Name
				6-89	Kane Wash Area
				7-11	Copper Mountain Valley
				7-12	Warren Valley
				7-13.01	Deadman Lake Subbasin
				7-13.02	Surprise Spring Subbasin
				7-15	Bessemer Valley
				7-16	Ames Valley
				7-18.01	Soggy Lake Subbasin
				7-18.02	Upper Johnson Valley Subbasin
				7-19	Lucerne Valley
				7-20	Morongo Valley
				7-50	Iron Ridge Area
				7-51	Lost Horse Valley
				7-62	Joshua Tree

Note: Table represents information as of August, 2012.

Four agencies from the region participated in the survey. Three or more responding agencies identified data collection and sharing, outreach and education, developing an understanding of common interest, sharing of ideas and information, using a water budget, and adequate funding as key factors for successful GWMP implementation. Broad stakeholder participation, having adequate time, and having adequate surface water supplies and surface storage and conveyance systems were also identified as important factors.

Respondents pointed to a lack of adequate funding as the greatest impediment to GWMP implementation. Funding is a challenging factor for many agencies because the implementation and the operation of groundwater management projects are generally expensive and because funding typically is limited to locally raised money or to State and federal grants. Unregulated groundwater pumping, lack of broad stakeholder participation, lack of governance, lack of surface storage and conveyance, and a lack of knowledge regarding local issues were also identified as factors that impede successful implementation of GWMPs.

All four survey respondents felt long-term sustainability of their groundwater supply was possible.

More detailed information on the survey and assessment of the GWMPs are available online from Update 2013, Volume 4, *Reference Guide*, the article, “California’s Groundwater Update 2013.”

Table SL-13 Assessment of Groundwater Management Plans Components

SB 1938 GWMP Required Components	Percent of Plans that Meet Requirement
Basin Management Objectives	33
BMO: Monitoring/Management Groundwater Levels	100
BMO: Monitoring Groundwater Quality	100
BMO: Inelastic Subsidence	33
BMO: SW/GW Interaction and Affects to Groundwater Levels and Quality	67
Agency Cooperation	100
Map	67
Map: Groundwater basin area	100
Map: Area of local agency	100
Map: Boundaries of other local agencies	67
Recharge Areas (1/1/2013)	Not Assessed
Monitoring Protocols	33
MP: Changes in groundwater levels	100
MP: Changes in groundwater quality	100
MP: Subsidence	33
MP: SW/GW Interaction and Affects to Groundwater Levels and Quality	67
SB 1938 GWMP Voluntary Components	**Percent of Plans that Include Component**
Saline Intrusion	33
Wellhead Protection and Recharge	67
Groundwater Contamination	67
Well Abandonment and Destruction	67
Overdraft	100
Groundwater Extraction and Replenishment	100
Monitoring Groundwater Levels and Storage	100
Conjunctive Use Operations	100
Well Construction Policies	67
Construction and Operation	67

SB 1938 GWMP Voluntary Components	Percent of Plans that Include Component
Regulatory Agencies	100
Land Use	67
Bulletin 118-03 Recommended Components	**Percent of Plans that Include Component**
GWMP Guidance	100
Management Area	67
BMOs, Goals, and Actions	67
Monitoring Plan Description	33
IRWM Planning	100
GWMP Implementation	67
GWMP Evaluation	100
Notes: BMO = basin management objective, IRWM = integrated regional water management, GWMP = groundwater management plan, MP = monitoring rotocols, SW/GW = surface water/groundwater	

Groundwater Ordinances

Groundwater ordinances are laws adopted by local authorities, such as cities or counties, to manage groundwater. In 1995, the California Supreme Court declined to review a lower court decision (*Baldwin v. Tehama County*) that says that State law does not occupy the field of groundwater management and does not prevent cities and counties from adopting ordinances to manage groundwater under their police powers. Since 1995, the *Baldwin v. Tehama County* decision has remained untested; thus the precise nature and extent of the police power of cities and counties to regulate groundwater is still uncertain.

A number of counties in the region have adopted groundwater ordinances. The most common ordinances regulate well construction, abandonment, and destruction. However, none of the ordinances provide for comprehensive groundwater management.

Special Act Districts

Special acts of the Legislature have granted greater authority to manage groundwater to a few local agencies or districts. These agencies generally have authority to (1) limit groundwater export and extraction (upon evidence of overdraft or threat of overdraft) or (2) require reporting of extraction and to levy replenishment fees.

There are many Special Act Districts established by the California State Legislature consisting of different authorities that may or may not have groundwater management authority. It is not part of the scope for Update 2013 to identify Special Act Districts in the region or the established agencies. This report includes the GWMPs that were prepared by these agencies and submitted to DWR, as discussed in the preceding section.

Court Adjudication of Groundwater Rights

Another form of groundwater management in California is through the courts. There are currently 24 groundwater adjudications in California. The South Lahontan Hydrologic Region contains two of those adjudications (Table SL-14).

The Mojave Groundwater Basin adjudication judgment was finalized in 1996. The Superior Court appointed the MWA to serve as watermaster to ensure that the conditions set forth in the adjudication are followed. The judgment established Free Production Allowance (FPA) for the water producers, which is the amount of water that a producer can pump for free during a year without having to pay for replacement water. A producer who needs more FPA than its assigned value must pay for the excess water used either by arranging to transfer the desired amount from another producer or by buying the amount required from the watermaster.

The judgment for Tehachapi basin adjudication was filed in 1971 by the California Superior Court, Kern County. By 1972, the Tehachapi Basin was severely depleted. In 1973, the amended judgment was filed and included the following provisions: safe yield, 5,500 af/yr.; initial base water right, 8,200 af; established an annual allowed pumping allocation, 5,524 af; provided for domestic users to pump up to 3 af/yr.; appointed Tehachapi-Cummings County Water District as watermaster; and placed injunction against exporting water.

Although currently not adjudicated, groundwater rights of residents and purveyors within the Antelope Valley Groundwater Basin are going through an adjudication process overseen by the Superior Court of California. The adjudication process was initiated because of the long-term decline in groundwater levels in the basin. If groundwater rights become adjudicated, groundwater extractions in the basin will be managed in a court-appointed manner with the goal of stabilizing groundwater levels and preventing further damage to the basin from long-term decline of groundwater levels (Antelope Valley Regional Water Management Group 2007).

Other Groundwater Management Planning Efforts

Groundwater management also occurs through other avenues such as IRWM plans, urban water management plans, and agricultural water management plans. Box SL-1 summarizes groundwater management aspects included in these planning efforts.

Current Relationships with Other Regions and States

Although most the MWA service area is in the South Lahontan Hydrologic Region, a portion of its service area does extend into the Colorado River Hydrologic Region (Lucerne and Johnson valleys and the Morongo basin). This includes the communities of Yucca Valley (Hi-Desert Water District), which has an allocation of up to 4,282 af of MWA's surface water from the SWP;

Table SL-14 Groundwater Adjudications in the South Lahontan Hydrologic Region

Court Judgment	Basin Number	County	Judgment Date
Tehachapi Basin	6-45	Kern	1973
Mojave Basin Area	6-37, 6-40, 6-41, 6-42, 6-43, 6-47, 6-89	San Bernardino	1996

Note: Table represents information as of April, 2013.

Joshua Tree (Joshua Basin Water District), an allocation up to 1,959 af; a County Service Area, an allocation of 73 af; and the Bighorn-Desert View Water Agency, an allocation up to 653 af.

Surface water is exported from the Owens and Mono portions of the South Lahontan Hydrologic Region to the South Coast Hydrologic Region by LADWP using the LAA. Recent exports through these facilities to the South Coast region were 148 taf in 2008, 137 taf in year 2009, 251 taf in 2010, and 358 taf in 2011.

MWA, in its effort to prepare for increased demands in the future and mitigate the overdraft conditions of the Mojave River Groundwater Basin, has entered into agreements with water agencies outside of the region for additional supplies. One significant step was taken in 1997 when it purchased 25 taf from the Berenda Mesa Water District Table A allocation of SWP water supplies. The actual transfer took place in 1998. In 2009, MWA executed a new agreement with the Dudley Ridge Water District for the permanent transfer of 14 taf from that agency's Table A allocation of SWP water supplies. The water supplies would be transferred in stages: 7 taf in 2010, 3 taf in 2015, and 4 taf in 2020. MWA's SWP Table A water supplies now total 89,800 af.

Regional Water Planning and Management

Integrated Regional Water Management Coordination and Planning

The IRWM Planning Act, signed by former Governor Schwarzenegger as part of SB 1 in 2008 (CWC Section 10530 et seq.), provides a general definition of an IRWM plan as well as guidance to DWR as to what IRWM program guidelines must contain. The act states that the guidelines shall include standards for identifying a region for the purpose of developing or modifying an IRWM plan. The first Regional Acceptance Process (RAP) spanned 2008-2009 and the second RAP was in 2011. Final decisions were released in fall 2009 and fall 2011. The RAP is used to evaluate and accept an IRWM region into the IRWM grant program.

Most of the population for the South Lahontan region has been represented by four IRWM planning regions: Antelope Valley, Fremont Basin, Inyo-Mono, and Mojave. Because these plans are living documents, new regions may be formed or existing regions may be modified.

Some regional projects in the South Lahontan region are highlighted here.

Box SL-1 Other Groundwater Management Planning Efforts in the South Lahontan Hydrologic Region

The integrated regional water management plans, urban water management plans, and agricultural water management plans in the South Lahontan Hydrologic Region that also include components related to groundwater management are briefly discussed below.

Integrated Regional Water Management Plans

There are five integrated regional water management (IRWM) regions covering a portion of the South Lahontan Hydrologic Region. Four regions have adopted IRWM plans, and one region is currently developing an IRWM plan. The Mojave Water Agency IRWM Plan crosses into the adjacent Colorado River Hydrologic Region providing guidance on water management and water supply sustainability. The plan discusses objectives and management strategies related to stabilizing groundwater storage, protecting and restoring riparian habitat, and preventing groundwater quality degradation.

The objectives of the Inyo-Mono IRWM plan are to ensure sustainable and reliable water supplies, improved water quality, efficient urban development, flood management, and ecosystem protection. The primary water issues in the area include threats to water quality caused by naturally occurring contaminants such as arsenic and uranium. A widespread concern in the area is a lack of infrastructure, which results in water loss and inability to store water. In addition to developing better infrastructure, the IRWM plan also aims at expanding water recycling programs and participation of and support for small and disadvantaged communities.

The objective of the Antelope Valley IRWM plan is to meet the expected demands for water and other resources within the area for the next few decades. Strategies for achieving the long-term goal include conducting groundwater supply studies; management actions; identifying financial resources to implement water management efforts; establishing cooperative stakeholder relationships; conjunctive use of surface water, imported water, and groundwater; public education regarding water conservation and awareness; and protecting groundwater quality.

The Kern IRWM plan was developed to provide guidance on water management and water supply sustainability within the agency's service area. The planning area is primarily in the Tulare Lake Hydrologic Region, but encompasses a small area in the southwestern portion of the South Lahontan Hydrologic Region. The plan discusses objectives and management strategies related to stabilizing groundwater storage, protecting and restoring riparian habitat, and preventing groundwater quality degradation.

Urban Water Management Plans

Urban water management plans are prepared by California's urban water suppliers to support their long-term resource planning and to ensure adequate water supplies are available to meet existing and future water uses. Urban use of groundwater is one of the few uses that meter and report annual groundwater extraction volumes. The groundwater extraction data is currently submitted with the urban water management plan and then manually translated by California Department of Water Resources staff into a database. Online methods for urban water managers to directly enter their water use along with their plan updates is currently under evaluation and review by DWR. Because of the time-line, the plans could not be reviewed for assessment for California Water Plan Update 2013.

Agricultural Water Management Plans

Agricultural water management plans are developed by water and irrigation districts to advance the efficiency of farm water management while benefitting the environment. No suppliers in the region were required to submit an agricultural water management plan as they did not meet the criteria. See the "Water Conservation Act of 2009" section for more information.

- **Upper Amargosa Creek Recharge and Nature Park Project** — The Upper Amargosa Creek Recharge Project will provide the Antelope Valley with increased groundwater supplies and give local citizens a creekside nature park. The recharge facility is envisioned to capture water supplies available from the SWP (aqueduct) and storm flows originating from the Amargosa Creek watershed and to percolate these waters into the Antelope Valley aquifer so the water may be extracted for beneficial use.
- **Antelope Valley Water Supply Stabilization Project Number 2** — The Water Supply Stabilization Project No. 2 (WSSP2) is a groundwater banking project that will increase the reliability of the Antelope Valley Region's water supplies by storing excess water available from the (SWP) during wet periods and recovering it to serve it to customers during dry and high demand periods or during a disruption in deliveries from the SWP. By "banking" excess water for future use, the WSSP2 will significantly reduce the region's dependence on constant water deliveries from the Delta. The WSSP2 will also help to stabilize the groundwater basin and preserve agricultural land and open space.
- **Regional Recharge and Recovery Project** — Known as "R³," this is a conjunctive use project currently under construction that will be a sustainable source of water supply for the Mojave region. R³ will store SWP water underground in the local aquifer and later recover and distribute the water to local retail water purveyors. It is an integral part of the regional water management portfolio identified in MWA's 2004 Regional Water Management Plan.
- **Inyo-Mono IRWM Planning Effort** — Since its inception, the Inyo-Mono Regional Water Management Group has made great strides in developing an IRWM Plan for the eastern portions of California that conforms to the IRWM program. Open to the public and with a governance structure formally adopted by the Inyo-Mono group, an extensive array of stakeholders numbering over 40 entities are actively involved with developing highest priorities and strategies to address such priorities in the Inyo-Mono IRWM Plan.

Accomplishments

Environmental Restoration

Owens Valley and Mono Basin

The LADWP continues to implement restoration projects for the Owens River and Mono Basin. The agency continues to release runoff from the eastern Sierra Nevada into the major streams draining into Mono Lake to restore Mono Lake to a water surface elevation of 6,391 feet above sea level. The current elevation of the water surface is 6,384 feet (2012). Projects continue to be implemented for the floodplains around Rush and Lee Vining creeks to restore the fisheries in each creek and riparian vegetation on the embankments.

In the Owens River, implementation of the environmental restoration projects continues to be a collaborative effort between the LADWP, Inyo County, and other parties. The largest of the projects continues to be LORP. Permanent flow is maintained in the historic 62-mile southern portion of the Owens River resulting in the establishment of the lush riparian habitat and providing a suitable environment for warm water fishery. The flow is maintained at 40 cfs, and the supplies are provided from the LAA. In fiscal year 2011-12, almost 20 taf was required for the LORP and several nearby projects. About 2,000 acres of wetland and riparian habitat has been established on the floodplain of the river.

Other re-vegetation projects are continuing in the Owens Valley in response to the 1991 settlement between LADWP and Inyo County on the EIR regarding the operations of the LADWP's second aqueduct. Several of the enhancement\mitigation projects were already being implemented prior to the settlement. Others were implemented in response to the impacts identified in the EIR. Slightly less than 12 taf were utilized for the irrigation of these projects.

Further to the north, the Owens Gorge Re-watering Project is re-establishing the ecosystem in the Owens River between Crowley Lake and Pleasant Valley. In addition to the fishery, the project has created riparian habitat for birds and other wildlife. As part of the project, LADWP designated a reach of the Owens River immediately below Long Valley Dam as a sanctuary for threatened and endangered Owens Tui Chub fish.

Dust Control Measures

Since 2001, LADWP has diverted water from the LAA for the Owens Lake Dust Mitigation Program. The dust control measures have improved habitat for shorebirds and water fowl. As of April 2010, LADWP had completed approximately 36 square miles of shallow flooding, 4 square miles of managed vegetation, 0.4 square miles of sand fence, and 2.2 square miles of gravel, which totals to approximately 42 square miles.

In January 2013, LADWP proposed Phase 7a to meet regulatory requirements without increasing water commitments while maintaining existing habitat, improving aesthetics, providing safe limited access, preserving cultural resources, and utilizing existing infrastructure and vegetation. The proposed project consists of 3.1 square-miles of dust control and 3.4 square miles of transitioned dust control for a total project area of 6.5 square-miles. LADWP's proposed project will implement current best available control measures including gravel cover, shallow flooding, and managed vegetation.

The Phase 7a project also includes construction of three new turnout facilities and modification to four existing turnout facilities; irrigation and drainage systems and other infrastructure to support shallow flooding, managed vegetation and tillage; construction of public amenities such as trails, boardwalks, and visitor outlooks; installation or reconfiguration of dust control area berms; improvement and re-routing of roads; and construction of a new water supply pipeline.

Water Supply

Mojave River

Strategic planning and construction continue to increase the reliability of water supplies from the Mojave River groundwater basin, which has been in overdraft since the early 1950s. The basin became adjudicated in 1996 with the appointment of the MWA as the basin watermaster. Implementation of the judgment has resulted in the purchase of replacement water imported from the SWP and the construction of groundwater recharge facilities to offset overdraft, primarily in the Victor Valley area. Thanks to these activities, most of the Mojave River groundwater basin is no longer in overdraft.

MWA has built the Morongo Basin and Mojave River pipelines, which bring SWP water supplies to groundwater recharge facilities in the Morongo and Yucca valleys and near the communities of Newberry Springs, Hodge, Lenwood, and Daggett. The agency continues work on the Oro

Grande Wash Recharge project, which delivers SWP water to a groundwater recharge site in Victorville. Up to 8 taf of SWP supply will be recharged at this facility once it is completed.

Construction was also completed in 2012 for another groundwater recharge project, the R^3 Project. SWP supplies will be spread at recharge basins in the floodplain of the Mojave River groundwater basin and in southern Apple Valley. MWA-owned production wells, located downstream of the basins, will pump out and deliver these supplies to several local retail water agencies. The beneficiaries include the cities of Adelanto and Hesperia, the Apple Valley Ranchos Water Company, Victorville Water District, and systems operated by the Golden State Water Company and San Bernardino County. Construction operations are divided into two phases with the yield of the first phase, completed in 2012, being 15 taf.

Yucca Valley

MWA is also collaborating with water agencies in the Twentynine Palms-Lanfair PA for the construction of additional groundwater recharge projects. The Big Horn Desert View Water Agency is the co-lead agency on the Ames Valley Recharge Project, which is in San Bernardino County and north of the City of Yucca Valley. The project will recharge the groundwater basin of the same name with SWP supplies. It will include a pipeline intertie with the Morongo Pipeline, recharge facilities at Pipes Wash, and monitoring wells. Construction has commenced for a similar project to recharge the Joshua Tree groundwater basin. The lead agency for this project is the Joshua Basin Water District. A third project involves the City of Hesperia, which has identified a site for the construction of a stormwater detention basin. The site is near the Morongo Pipeline and could also be utilized for the recharge of SWP supplies.

Antelope Valley

The County of Los Angeles continues to make progress on its groundwater conjunctive use project in the Antelope Valley. The project was granted a waiver from the Lahontan RWQCB in 2010. Using 17 wells, the county plans to inject a maximum of 6,843 af of SWP water annually into the groundwater basin. Injection operations will occur only during wet hydrologic conditions when additional SWP supplies would be available. During dry conditions, the stored supplies could then be pumped by the local retail water agencies when less SWP supplies would be available.

Recycled Water

Recycled water use is increasing in the South Lahontan region. Uses are reported in the service area of the MCWD, in Victor Valley, Owens Valley, and Antelope Valley. Over 26,000 af of recycled water use was reported for 2009, according to the Municipal Wastewater Recycling Survey, conducted by the SWRCB and DWR. This represents almost 4 percent of the 668 taf hydrologic region's total water use.

Agricultural irrigation is the single largest use of recycled water in the South Lahontan region. Recycled water supplied by the Los Angeles County Sanitation Department (LACSD) (Palmdale and Lancaster facilities) provided over 14,000 af of recycled water for agricultural irrigation. Recycled water was also provided to Piute Ponds by LACSD's Lancaster facility.

Golf course and landscape irrigation accounted for most of the remainder of the recycled water use in 2009 within the South Lahontan region. The cities of Ridgecrest and California City, Edwards Air Force Base, Fort Irwin, MCWD, and the VVWRA (for the cities of Barstow and Victorville) all provided recycled water for these uses.

Long-range planning indicates the continued expansion of recycled water use in the South Lahontan region to meet future water demands.

Additional information on statewide municipal recycled water is included in Volume 3, *Resource Management Strategies,* Chapter 12,"Municipal Recycled Water." Additional information on specific recycled water uses in the South Lahontan Hydrologic Region can be found in Volume 4.

Water Conservation

Even before the passage of the Water Conservation Act of 2009, many urban water agencies in the South Lahontan region were engaged in the planning and implementation of water conservation programs and activities within their respective service areas. In the Mojave River PA, 28 water and governmental agencies in 2003 formed the Alliance for Water Awareness and Conservation (AWAC). Goals of the alliance are to (1) educate the local communities on the importance of water conservation, (2) provide the necessary tools to the local communities to enable them to achieve specific water conservation targets, and in response to SB X7-7, (3) attempt to achieve water savings of 10 percent by 2010 and 20 percent by 2020. As of 2010, the 20 percent goal had already been achieved.

Of the list of urban best management practices, residential home audits and high efficiency clothes washing machine rebates are being implemented with greater frequency. This includes the MCWD, PWD, Los Angeles County Waterworks District, and the Victorville Water District. Water agencies in the region continue to offer rebates on the purchase of ultra-low flush toilets (1.6 gallons per flush), but have begun to offer the rebates for the high efficiency toilets (1.2 gallons per flush). Sometimes, rebates may be offer for both toilets. Public information programs implemented by the agencies are beginning to target exterior water uses. This includes conducting free workshops and providing published literature on landscaping and irrigation tips. This is being done in conjunction with the modifications to local building codes brought on by the Model Water Efficient Landscape Ordinance legislation.

New conservation programs are being implemented as well. The MCWD now offers rebates to its customers for irrigation system upgrades and for the purchase of weather-based irrigation controllers. The MWA is among several agencies now offering financial incentives for landscape conversions which include the removal of turf grass. This is an activity covered by the regional Water Conservation Incentive Program (WCIP). Since the program's inception in February 2008, over 5 million square feet of turf have been removed and 1,200 af/yr. of water saved. The WCIP was designed for water agencies that did not have financial incentive programs for their customers. Through partnership with MWA, it became possible for them to implement a program. It was also designed to augment the programs for water agencies that offered conservation incentives.

The PWD has been implementing its "HydroPoint Weather Trak Irrigation Audit and Smart Controller Installation" program, which provides technical assistance to farmers and landscape managers in the form of audits on their irrigation systems and operations and the installation of new weather-based controllers.

Challenges

Flood Challenges

Flood management challenges exist in the Antelope and Mojave River valleys. Key issues include the following.

- Levee portions of the Mojave River in Victorville require continuous maintenance to remove sand buildups.
- The loss of the Mojave River floodplain results in stream channelization, and groundwater pumping results in the loss of riparian habitat.
- Increasing urbanization of the watershed in the Victor Valley is increasing peak storm flow velocities resulting in increased sediment loads and losses of riparian habitat.
- Improvements in coordination are needed in the Antelope Valley.
- Flood control measures are often in conflict with groundwater recharge requirements.
- Edwards Air Force Base requires delivery of sediments into the dry lakes to maintain its operations area.

Mojave River Area

The SWP is the region’s only source of imported supplemental water supply. MWA has made forward-looking investments in SWP “Table A” water supplies that are in excess of the region’s current demands, but the vulnerability of those supplies due to environmental, regulatory, and policy activities related to the Delta and management of the SWP may put the region at risk, depending upon the outcome of those activities (i.e., reduced SWP supply is a risk to MWA). The Mojave region is a high-growth area (population grew about 40 percent between 2000 and 2010), with increasing water demands and a finite water supply. Balancing growth, water conservation, and acquisition of new water supplies will continue to be challenges as the area expands.

Antelope Valley

The continued urbanization in Antelope Valley and the increases in demand that accompany it require local water managers to seek and obtain additional and higher quality water supplies. This has been a challenge to the managers and stakeholders in the region. Much of the water used within the Antelope Valley region is extracted from groundwater aquifers. Over the years, excessive pumping has put many of the groundwater basins in the region in states of overdraft. Water providers and managers within the region recognize the need to balance the water being pumped from the aquifers with the water being put back in; thus, adjudication is currently under way.

Water Quality Challenges

Some areas in the region continue to have issues meeting federal and State drinking water standards in their groundwater basins. In the Inyo-Mono region, water from wells in Tecopa and Tecopa Hot Springs does not meet the State's safe drinking water standards for dissolved solids, fluoride, and arsenic. A feasibility study is to be conducted to determine whether safe drinking water and fire flow storage facilities can be provided in these two communities.

Closed basins in the region struggle with increases in salinity in groundwater as use of recycled water increases. As a result, IRWM groups in the region are developing Salt Nutrient Management Plans that will provide guidance on meeting objectives to manage salts, nutrients, and other possible constituents of concern from all sources within the basin to maintain water quality objectives and support beneficial uses.

Hazard Mitigation Planning

Water districts in the region have water supply shortage contingency plans that can be implemented to mitigate the effects of short- and long-term water shortages. In the event of an emergency, the water agencies will immediately coordinate with personnel in the appropriate local governmental agencies to implement actions to mitigate the impacts and resolve the emergency as rapidly as possible. The MCWD has a specific plan that includes coordination procedures with local law enforcement, fire, medical, and other services; communications procedures; and stages of action.

The Disaster Mitigation Act of 2000 (DMA) required local governments to develop hazard mitigation plans in order to qualify for additional disaster mitigation funding through Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The DMA also provided monies for developing the plans, which have emphasized community partnerships in planning for and responding to disasters; assessed and posited strategies for reducing risks; and identified capabilities and resources of local agencies for addressing various hazards. Kern, Los Angeles, San Bernardino, and Mono counties have written hazard mitigation plans. These plans discuss and offer methods for reducing flood risks in their respective boundaries.

Drought Contingency Plans

With a heavy reliance on groundwater supplies, most all water agencies have been able to get through dry hydrologic conditions with little or no impacts. However, in response to the Urban Water Management Planning Act, these agencies have been able to develop water shortage contingency plans that can be activated in response to natural or human-made supply shortages. These plans identify the actions that should be taken by agencies to mitigate the impacts, if any, for the different levels of shortages. The actions include (1) water conservation measures that can be utilized to decrease demands at different supply shortage stages; (2) restrictions on certain kinds of water uses (landscape irrigations only on certain days); (3) emergency responses to sudden shortages caused by earthquakes, flooding, regional power outages, contamination, and terrorist acts; and (4) strategies to replace imported water supplies if reductions are imposed because of dry hydrologic conditions.

The implementation of groundwater recharge projects by the MWA, which includes water supply transfer agreements with agencies outside of the South Lahontan region, is providing additional water supplies that will help mitigate the impacts of droughts or other human-made supply shortages. As of the publication of its 2010 Urban Water Management Plan, MWA had banked enough groundwater storage to fully meet local demands during a 6-year drought or a 3-year complete outage of the SWP.

Wildfire

There are many areas within the region that are susceptible to damage from wildfires, including much of the eastern Sierra and Owens Valley, the relatively more heavily vegetated high desert, and the mountains to the south, including the San Gabriel and San Bernardino mountains. The region has been hit by several notable wildfires, including a fire in October 2003 that burned 1,000 acres of Silverwood Lake State Recreation Area — the park was nearly engulfed. Impacts to the SWP, including to the reservoir's future water quality, are still being evaluated.

Looking to the Future

To address the needs of expanding urban area in the southern portion of the region, many water districts have taken a proactive approach to the water reliability problems by initiating studies and projects that could provide partial or complete solutions. These include water conservation programs, water recycling projects, groundwater exchanges and recovery, water marketing, and other water supply augmentation strategies. Agricultural practices and water uses in rural areas are anticipated to remain at current levels for the near future.

The region also has vast amounts of undeveloped land, particularly the Mojave and Antelope Valley PAs; and growth projections indicate substantial population increases will occur in these areas over the next several decades. Five water agencies have contracts for SWP water supplies, some of which have made forward-looking investments in surplus SWP "Table A" supplies in order to meet future increases in water needs based upon growth projections. These agencies have historically not taken delivery of their full SWP allocations because in some cases their SWP supplies are much greater than their current water demands, but were purchased to meet future growth projections. Protecting the reliability of SWP water supplies from the Sacramento-San Joaquin River Delta (the Delta) is very important to these agencies in order to maintain their ability to make use of these investments in the future.

MWA and AVEK have several projects under way or completed that achieve some of water management objectives identified in their respective IRWM plans. MWA has completed Oro Grande Wash Recharge Project. Also, the Mojave River Well Field and Water Supply Pipeline Project (locally referred to as the R^3 Project) will deliver SWP water to the Mojave River as well as direct pipeline connections to the water systems of major purveyors in the Victor Valley. The project was completed in 2012 and is to be operational in 2013. Through a partnership with over 25 regional entities, AWAC provides MWA a network with a common vision to be a collaborative alliance providing leadership, education, resources, support, ideas, and solutions to agencies region-wide to conserve and protect our water supplies. By consistently developing and disseminating materials to increase the public awareness about water use efficiency, the regional per capita water use continues to drop, achieving regional water supply savings in the last 10 years of over 20 percent, despite population increase of about 40 percent during the same period.

The MWA has SWP entitlement exchange agreements with both Solano County Water Agency (SCWA) and Metropolitan Water District of Southern California (MWD). The program with MWD is similar to the program with SCWA, but it is a one-for-one exchange program, meaning that for every af MWD stores with MWA, one af will be returned. Between 2003 and 2010 about 45,000 af were stored in MWA and returned to MWD via the program. In 2011, MWA and MWD extended the term of the program to accommodate up to 390,000 af to be stored and returned between 2011 and 2035.

Between 2004 and 2006, the cities of Adelanto, Apple Valley, Hesperia, and Victorville passed landscape ordinances requiring new development to include water conserving desert-friendly landscaping.

The following lists some of the priority areas and needs specific to the South Lahontan Hydrologic Region from a DFW perspective for California, in relation to California water supply.

- Acquire conservation easements on lands.
- Improve the coordination, management and implementation of groundwater management.
- Prevent or reduce negative impacts from invasive non-native species including those associated with water supply and conveyance projects such as quagga and zebra mussels, *Egeria densa*, water hyacinth, and others.
- Protect or restore fish habitat through the improvement of fish passage conditions, gravel augmentation, hydrology, fish screens, and min/max flow.
- Restore riparian habitat, including conservation of riparian corridors.
- Improve water quality (sediment, oxygen saturation, pollution, and temperature) to support healthy ecosystems.
- Improve existing wetlands or create new wetlands in appropriate areas.

Future Conditions

Future Scenarios

Update 2013 evaluates different ways of managing water in California depending on alternative future conditions and different regions of the state. The ultimate goal is to evaluate how different regional response packages, or combinations of resource management strategies from Volume 3, perform under alternative possible future conditions. The alternative future conditions are described as future scenarios. Together the response packages and future scenarios show what management options could provide for sustainability of resources and ways to manage uncertainty and risk at a regional level. The future scenarios are composed of factors related to future population growth climate change. Growth factors for the South Lahontan Hydrologic Region are described below. Climate change factors are described in general terms in Update 2013, Volume 1, *The Strategic Plan*, Chapter 5, “Managing an Uncertain Future.”

Water Conservation

Update 2013 scenario narratives include two types of water use conservation. The first is conservation that occurs without policy intervention (called background conservation). This includes upgrades in plumbing codes and end user actions such as purchases of new appliances and shifts to more water efficient landscape absent a specific government incentive. The second type of conservation expressed in the scenarios is through efficiency measures under continued implementation of existing best management practices California Urban Water Conservation Council's Memorandum of Understanding Regarding Urban Water Conservation in California (last amended in September 2011). These are specific measures that have been agreed upon by urban water users and are being implemented over time. Any other water conservation measures that require additional action on the part of water management agencies are not included in the scenarios, and would be represented as a water management response.

South Lahontan Growth Scenarios

Future water demand in the South Lahontan Hydrologic Region is affected by a number of growth and land use factors, including population growth, planting decisions by farmers, and size and type of urban landscapes. See Table SL-15 for a conceptual description of the growth scenarios used in Update 2013. Update 2013 quantifies several factors that together provide a description of future growth and how growth could affect water demand for the urban and agricultural sectors in South Lahontan region. Growth factors are varied between the scenarios to describe some of the uncertainty faced by water managers. For example, it is impossible to predict future population growth accurately so Update 2013 uses three different, but plausible population growth estimates when determining future urban water demands. In addition, Update 2013 considers up to three different alternative views of future development density. Population growth and development density will reflect how large the urban landscape will become in 2050 and are used by Update 2013 to quantify encroachment into agricultural lands by 2050 in South Lahontan Hydrologic Region.

For Update 2013, DWR worked with researchers at the University of California, Davis, to quantify how much growth might occur in South Lahontan Hydrologic Region through 2050. The "UPlan Urban Growth Model" was used to estimate a year 2050 urban footprint under the scenarios of alternative population growth and development density (see http://ice.ucdavis.edu/project/uplan for information on the UPlan model). UPlan is a simple rule-based urban growth model intended for regional or county-level modeling. The needed space for each land use type is calculated from simple demographics and is assigned based on the net attractiveness of locations to that land use (based on user input), locations unsuitable for any development, and a general plan that determines where specific types of development are permitted. Table SL-16 describes the amount of land devoted to urban use for 2006 and 2050, and the change in the urban footprint under each scenario. As shown in the table, the urban footprint grew by about 75,000 acres under low-population growth scenario (LOP) by 2050 relative to 2006 base-year footprint of about 270,000 acres. The urban footprint under the high population scenario (HIP), however, grew by about 260,000 acres. The effect of varying housing density on the urban footprint is also shown.

Table SL-17 describes how future urban growth could affect the land devoted to agriculture in 2050. Irrigated land area is the total agricultural footprint. Irrigated crop area is the cumulative area of agriculture, including multi-crop area, where more than one crop is planted and harvested each year. The low-population growth scenarios show an increase in irrigated acreage over existing conditions, even though the urban footprint increases while the high population growth shows a decline in irrigated crop acreages. As shown in the table, irrigated crop acreage increases on average by about 2,000 acres by year 2050 as a result of low population growth, but the decline under high population growth is about 5,000 acres.

Table SL-15 Conceptual Growth Scenarios

Scenario	Population Growth	Development Density
LOP-HID	Lower than Current Trends	Higher than Current Trends
LOP-CTD	Lower than Current Trends	Current Trends
LOP-LOD	Lower than Current Trends	Lower than Current Trends
CTP-HID	Current Trends	Higher than Current Trends
CTP-CTD	Current Trends	Current Trends
CTP-LOD	Current Trends	Lower than Current Trends
HIP-HID	Higher than Current Trends	Higher than Current Trends
HIP-CTD	Higher than Current Trends	Current Trends
HIP-LOD	Higher than Current Trends	Lower than Current Trends

South Lahontan 2050 Water Demands

This section provides a description for how future water demands might change under scenarios organized around themes of growth and climate change described earlier in this chapter. The change in water demand from 2006 to 2050 is estimated for the South Lahontan Hydrologic Region for the agriculture and urban sectors under 9 growth scenarios and 13 scenarios of future climate change. The climate change scenarios included the 12 Climate Action Team scenarios described in Update 2013, Volume 1, Chapter 5, “Managing an Uncertain Future,” and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a “without climate change” condition.

Figure SL-18 shows the change in water demands for the urban and agricultural sectors under 9 growth scenarios, with variation shown across 13 climate scenarios. The nine growth scenarios include three alternative population growth projections and three alternative urban land development densities, as shown in Table SL-15. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050. Urban demand is the sum of indoor and outdoor water demand where indoor demand is assumed not to be affected by climate. Outdoor demand, however, depends on such climate factors as the amount of precipitation falling and the average air temperature. Change in water demand is shown under a repeat of historical climate conditions and for 12 scenarios of future climate change.

Urban water demand increases under all 9 growth scenarios tracking with population growth. On average, it increases by about 140 taf under the three low population scenarios, 200 taf under the three current trend population scenarios, and about 390 taf under the three high population scenarios when compared to historical average of about 230 taf. The results show change in future urban water demands are less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

Agricultural water demand decreases under most future scenarios due to reduction in irrigated lands as a result of urbanization and background water conservation when compared with historical average water demand of about 350 taf. Under the low-population and current trend population scenarios, the average reduction in water demand is about 30 taf while it is about

Table SL-16 Growth Scenarios (Urban) — South Lahontan Hydrologic Region

Scenario[a]	2050 Population (thousand)	Population Change (thousand) 2006[b] to 2050	Development Density	2050 Urban Footprint (thousand acres)	Urban Footprint Increase (thousand acres) 2006[c] to 2050
LOP-HID	1,374.7[d]	501.4	High	333.4	67.3
LOP-CTD	1,374.7	501.4	Current Trends	341.6	75.5
LOP-LOD	1,374.7	501.4	Low	348.4	82.3
CTP-HID	1,592.5[e]	719.2	High	398.3	132.1
CTP-CTD	1,592.5	719.2	Current Trends	408.1	142.0
CTP-LOD	1,592.5	719.2	Low	420.0	153.9
HIP-HID	2,293.0[f]	1,419.7	High	497.5	231.4
HIP-CTD	2,293.0	1,419.7	Current Trends	527.2	261.1
HIP-LOD	2,293.0	1,419.7	Low	556.9	290.8

Notes:

[a] See Table SL-15 for scenario definitions.

[b] 2006 population was 873.3 thousand.

[c] 2006 urban footprint was 266.1 thousand acres.

[d] Values modified by the California Department of Water Resources from the Public Policy Institute of California.

[e] Values provided by the California Department of Finance.

[f] Values modified by California Department of Water Resources from the Public Policy Institute of California.

50 taf for the three high population scenarios. The results show agricultural water demands are sensitive to assumptions about population growth and housing density by reducing the amount of lands for irrigated agriculture.

Integrated Regional Water Management Plan Summaries

Inclusion of the information contained in IRWM plans into Update 2013 regional reports has been a common suggestion by regional stakeholders at the regional outreach meetings since the inception of the IRWM program. To this end, Update 2013 has taken on the task of summarizing readily available IRWM plans in a consistent format for each of the regional reports. (This collection of information will not be used to determine IRWM grant eligibility.)

All IRWM plans are different in how they are organized. Therefore, finding and summarizing the content in a consistent way proved difficult. It became clear through these efforts that a process is needed to allow those with the most knowledge of the IRWM plans, those that were involved in the preparation, to have input on the summary. It is the intention that this process be initiated following release of Update 2013 and continue to be part of the process of the update process for Update 2018. This process will also allow for continuous updating of the content of the "atlas" (described below) as new IRWM plans are released or existing IRWM plans are updated.

Table SL-17 Growth Scenarios (Agriculture) — South Lahontan Hydrologic Region

Scenario[a]	2050 Irrigated Land Area[b] (thousand acres)	2050 Irrigated Crop Area[c] (thousand acres)	2050 Multiple Crop Area[d] (thousand acres)	Change in Irrigated Crop Area (thousand acres) 2006 to 2050
LOP-HID	64.4	64.4	0.0	+1.8
LOP-CTD	64.4	64.4	0.0	+1.8
LOP-LOD	64.3	64.3	0.0	+1.7
CTP-HID	62.7	62.7	0.0	+0.1
CTP-CTD	62.6	62.6	0.0	+0.0
CTP-LOD	62.2	62.2	0.0	+0.4
HIP-HID	57.7	57.7	0.0	-4.9
HIP-CTD	57.4	57.4	0.0	-5.2
HIP-LOD	56.7	56.7	0.0	-5.9

Notes:

[a] See Table SL-15 for scenario definitions.

[b] 2006 irrigated land area was estimated by the California Department of Water Resources (DWR) to be 62.5 thousand acres.

[c] 2006 irrigated crop area was estimated by DWR to be 62.6 thousand acres.

[d] 2006 multiple crop area was estimated by DWR to be 0.1 thousand acres.

In addition to these summaries, all summary sheets will be provided in one IRWM Plan Summary "Atlas" as an article included in Volume 4, *Reference Guide*. This atlas will, under one cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management accomplishments and challenges. The atlas will showcase how the dedicated efforts of regional water management groups (RWMGs) have individually and cumulatively transformed water management in California.

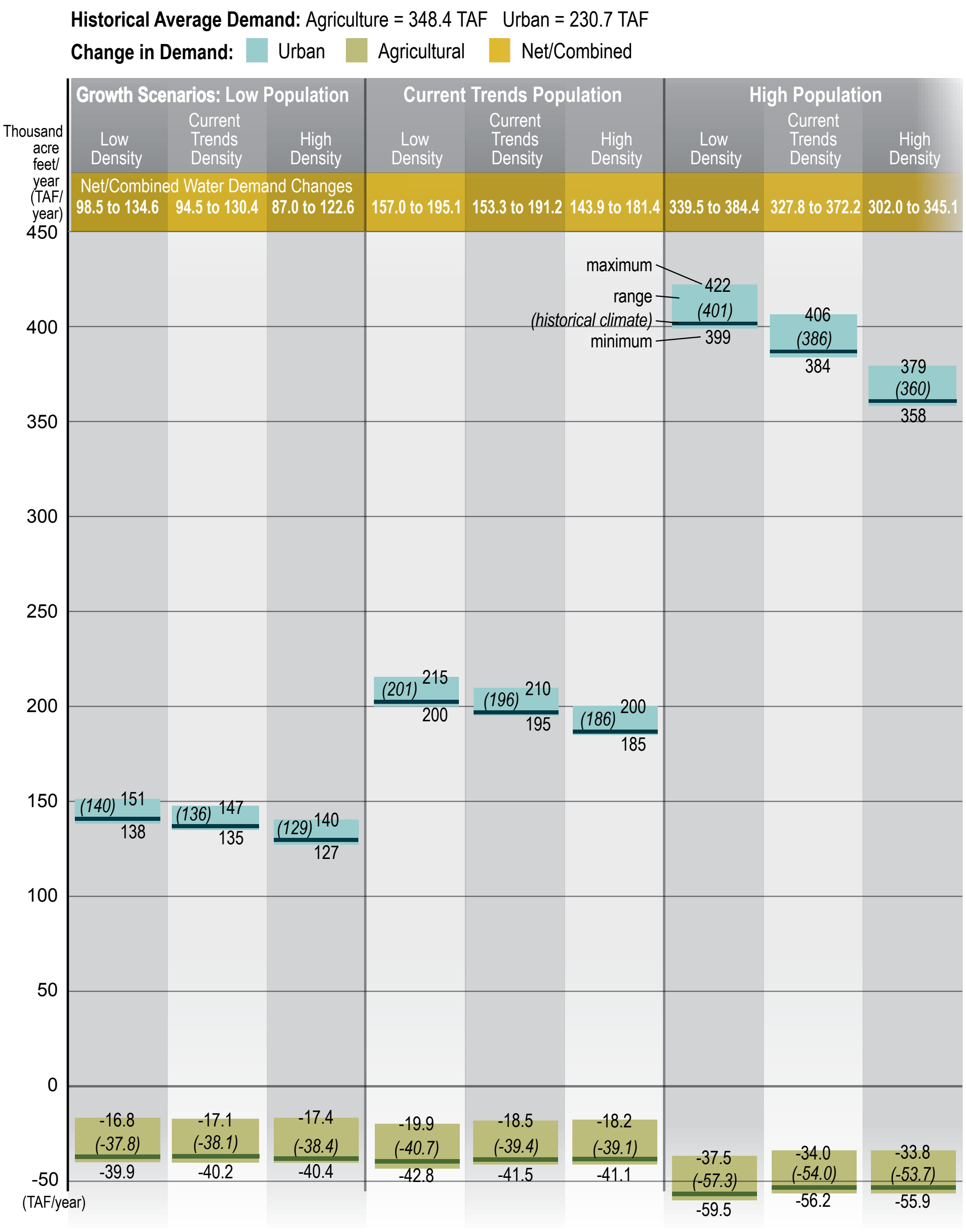
As can be seen in Figure SL-19, there are four regional water management planning groups in the South Lahontan Hydrologic Region. (Information for the Kern County RWMG is presented in the Tulare Lake Hydrologic region report.)

Region Description

As of late 2013, the regional water management planning groups in the South Lahontan Hydrologic Region have received a total of about $124.7 million in funding from both State and non-State sources: $52,422,284 from the State and $72,283,069 from non-State sources. Table SL-18 provides a funding source breakdown for the region. (These grant figures only reflect funding provided for Antelope Valley, Inyo-Mono, and Mojave RWMGs.) No information was available for Fremont Basin for Update 2013.

The following are short descriptions of the regional water management planning groups and the areas they serve within the South Lahontan region.

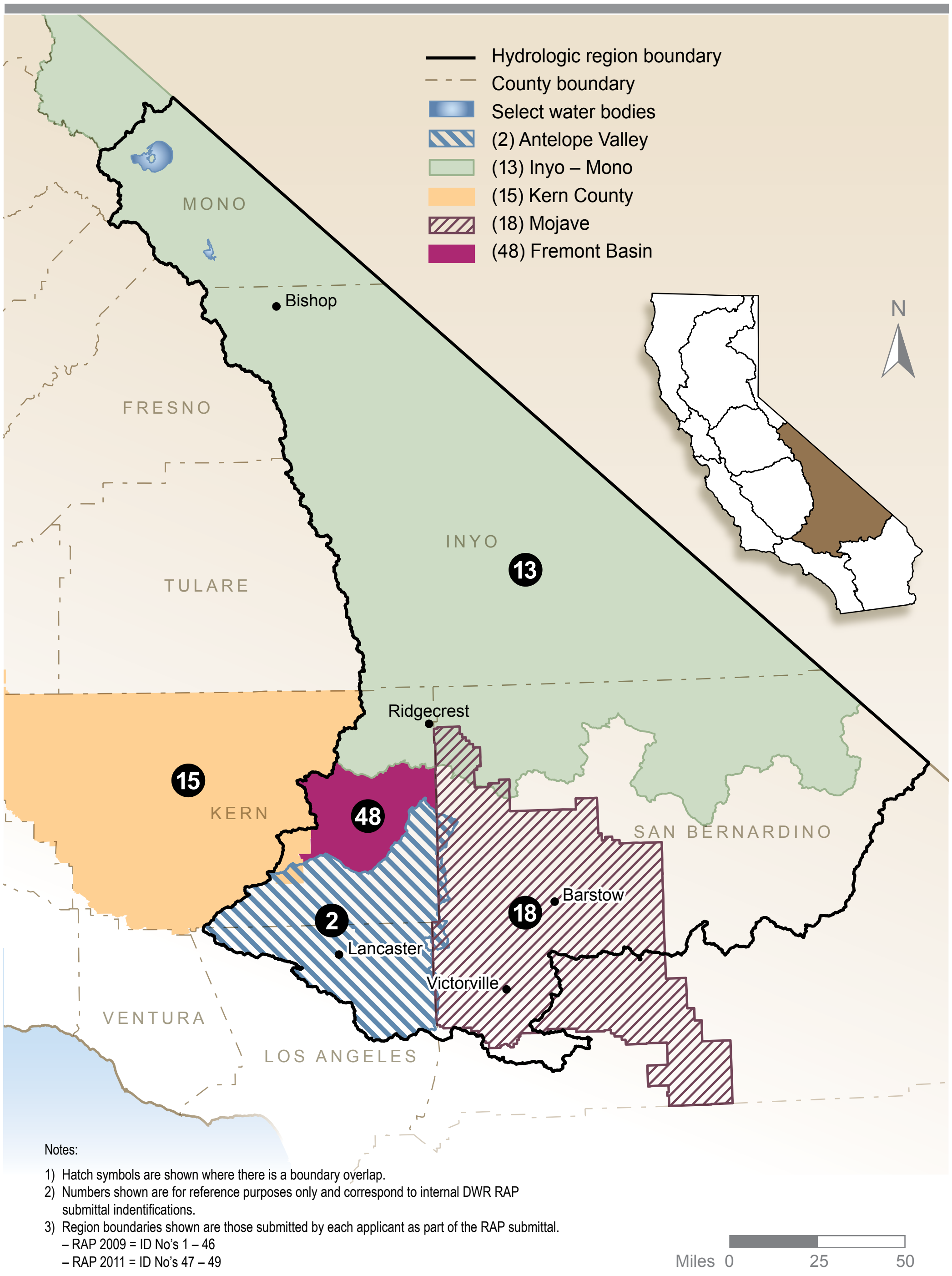
Figure SL-18 Change in South Lahontan Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050 (taf per year)



Antelope Valley

The Antelope Valley region encompasses portions of northern Los Angeles County, southern Kern County, and western San Bernardino County. It is bounded by the San Gabriel Mountains to the south and southwest, the Tehachapi Mountains to the northwest, and a series of hills and buttes that generally follow the San Bernardino County Line to the east. Major communities

Figure SL-19 **Regional Water Management Groups in the South Lahontan Hydrologic Region**



Notes:
1) Hatch symbols are shown where there is a boundary overlap.
2) Numbers shown are for reference purposes only and correspond to internal DWR RAP submittal identifications.
3) Region boundaries shown are those submitted by each applicant as part of the RAP submittal.
– RAP 2009 = ID No's 1 – 46
– RAP 2011 = ID No's 47 – 49

within the region include California City, Edwards Air Force Base, Lancaster, Mojave, Palmdale, and Rosamond. The region boundary overlaps slightly with both the Mojave IRWM region and the Kern County IRWM region.

Table SL-18 South Lahontan IRWM Plan Funding

IRWM Region	Prop. 50 Planning Grant	Prop. 50 Implementation Grant	Prop. 84 Planning Grant	Prop. 84 Implementation Grant[a]	Prop. 1E Stormwater Grant	Regional Totals
Antelope Valley			**$472,919** $334,772	**$5,400,000** $18,746,000	**$6,500,000** $6,983,322	$38,437,013
Inyo-Mono			**$719,885** $657,493	**$1,075,000** $213,559		$2,665,937
Mojave		**$25,000,000** $23,594,500		**$8,000,000** $16,498,944	**$5,254,480** $5,254,479	$83,602,403
Total per grant:		$48,594,500	$2,185,069	$49,933,503	$23,992,281	
Grand Total $124,705,353						

Notes:

IRWM = integrated regional water management

This table is up-to-date as of late 2013. Information on Fremont Basin IRWM plan was not available for Update 2013.

Grant figures in **bold** are State funded. Grant figures in regular type are non-State funded.

[a] Does not include Proposition 84 Implementation Grant Round 2 Awards.

Inyo-Mono

The Inyo-Mono region is located east of the Sierra Nevada and is characterized by very low population densities and vast open spaces. The region includes Inyo and Mono counties, northern portions of San Bernardino County, and the northeastern corner of Kern County. It is generally bounded by the Sierra Nevada to the west, the state of Nevada to the east, and follows watershed boundaries in the north and south. The principal watersheds within the region include West Walker River, East Walker River, Mono Basin, Owens River, Amargosa River, and Death Valley. The region has no natural outlet to the ocean.

Mojave

The Mojave region lies in the California High Desert, located on the northeastern flanks of the San Bernardino and San Gabriel mountains in Southern California. The Mojave River is the main surface water drainage feature within the region and is fed by rainfall and snowpack from the San Bernardino Mountains. In addition to the Mojave River, the region has a number of terminal dry lakes, which are lakebeds that collect water only during periods when there is sufficient runoff, have no outlet, and lose all their water to evaporation. The region is made up of relatively small urban centers with low population densities, including Barstow, Victorville, and Yucca Valley.

Key Challenges and Goals

Antelope Valley

The Antelope Valley region faces the following challenges:

- Reliance on imported water.
- Groundwater management.
- Gap between supplies and demand for some users.
- Existing facility limitations.
- Land subsidence.

To address the challenges, the Antelope Valley has identified the following goals/objectives:

- Ensure that municipal and industrial purveyors can reliably provide the quantity and quality of water that will be demanded by a growing population.
- Develop options to satisfy agricultural users' demand for reliable irrigation water supplies at reasonable costs.
- Maximize opportunities to protect and enhance current water resources (including groundwater) and the other environmental resources within the Antelope Valley region.

Inyo-Mono

The Inyo-Mono region faces the following challenges:

- Water quality.
- Water infrastructure.
- Institutional/human capacity.

To address the challenges, the Inyo-Mono region has identified the following goals/objectives:

- Protect, conserve, optimize, and/or augment water supply.
- Protect, restore, and/or enhance water quality.
- Provide stewardship of our natural resources.
- Maintain and/or enhance water, wastewater, and power generation infrastructure efficiency and reliability.
- Address climate variability and/or reduce greenhouse gas emissions.
- Increase participation of small and disadvantaged communities in the IRWM process.

Mojave

Mojave faces the following challenges:

- Balancing future water demands with limited available supplies.
- Maximizing the overall beneficial use of water throughout the region.
- Managing groundwater basins to no longer be in overdraft.
- Protecting ecosystem health.

To address the challenges, the Mojave region has identified the following goals/objectives:

- Balance future water demands with available water supplies.
- Maximize beneficial uses of water throughout the region.
- Stabilize the long-term groundwater basin storage balance.

Water Supply and Demand

Antelope Valley

The main sources of water supply for the region are imported water, recycled water, groundwater, and local surface water. In 2010, average year imported water supply was 98,100 af/yr., which is expected to decrease to 96,500 af/yr. by 2035. The region has roughly 7,000 af/yr. of local surface water supplies. Urban demand is expected to increase from 87,000 af/yr. in 2010 to 118,000 af/yr. by 2035. Agricultural demand is projected to increase from 174,000 af/yr. in 2010 to 205,000 af/yr. by 2035. While water supply is projected to be sufficient for demands into the future, unused supply is projected to decrease from 43,400 af/yr. in 2010 to 10,800 af/yr. by 2035.

Inyo-Mono

Much of the water supplies within the region are exported to the City of Los Angeles, which began in the early 1900s. By the 1930s, Owens Lake was completely dry due to diversions. Water use varies within the region, but is relatively low. It is estimated that agriculture in the region uses a little below 200,000 af/yr. The MCWD supplied 2,691 af in 2010. It is projected that demand will reach 4,200 af/yr. by 2030.

Mojave

Water supplies within the region are primarily imported from the SWP or obtained locally through natural surface flows or return flow from pumped groundwater. Surface water supplies are not directly used for potable use but are used to recharge the groundwater basin, which is then extracted for drinking water. In 2010, roughly 179,000 af/yr. of water was supplied to the region. Supplies are expected to increase to around 197,000 af/yr. by 2035. Total water demand in 2010 was around 146,000 af/yr., which is projected to grow to roughly 180,000 af/yr. by 2035.

Water Quality

Antelope Valley

Groundwater quality within the region is excellent within the upper aquifer, but degrades toward the northern portion of the dry lake areas. TDS, fluoride, boron, and nitrate levels within the lower portions of the aquifer are high. Portions of the basin have experienced nitrate levels above the maximum contaminant level. Arsenic is also an emerging concern. But due to its location in the deep aquifer, it is not anticipated to lead to future loss of groundwater as a supply source. The only source of surface water within the region is Lake Palmdale, which is considered to be of good quality. Amargosa Creek does suffer from high pH and inconsistent temperature downstream of a wastewater treatment plant discharge point.

Inyo-Mono

Water quality throughout the region is generally of very high quality, with the only quality issues resulting from natural contaminants and processes such as arsenic, uranium, sedimentation, and erosion. Several water bodies within the region exceed State and federal maximum contaminant levels. Because of the limited resources of many of the communities within the region, they are unable to bring their potable water resources into compliance. Several communities rely on bottled water as their primary source of drinking water.

Mojave

Surface water quality within the region suffers from a number of constituents including TDS, fluoride, sulfates, and nitrate. Impaired surface water bodies within the region include Crab Creek, Sheep Creek, and portions of the Mojave River. Surface water, while not used as potable water, is used to recharge groundwater which is then used for drinking water. Groundwater within the region suffers from arsenic, nitrates, iron, and hexavalent chromium. Some of these, like arsenic, are naturally occurring; others, like hexavalent chromium, are associated with human activities.

Flood Management

Antelope Valley

Portions of the region are subject to flooding due to uncontrolled runoff from the nearby foothills, which average more than 12 inches of rain a year. Flooding is aggravated by lack of proper drainage facilities and defined flood channels in the Antelope Valley region. The Antelope Valley Comprehensive Plan of Flood Control and Water Conservation addresses flooding by proposing floodplain management strategies for hillside areas, urban and urbanizing areas, and rural areas. Lack of coordination between flood management entities has been identified as a regional issue that should be addressed.

Inyo-Mono

Flooding within the region occurs when snowmelt from the Sierra Nevada overflows the river channels and spills into the floodplains or when heavy winter rains inundate low-lying lands. The region addresses flood management by promoting sustainable stormwater and floodplain management that enhances flood protection. Specifically, the region has committed to characterizing current situations and challenges, improving existing infrastructure and operational techniques/strategies, and integrating drainage control and natural recharge into construction projects.

Mojave

Reducing flood risk in these flood-prone areas is a significant challenge for the region. The region contains several areas designated to be within the 100-year and 500-year floodplains as defined by the Federal Emergency Management Agency (FEMA). Historically, the most severe floods have occurred along the Mojave River near Victorville, but localized flooding does occur throughout the region. Flood management within the region is provided by a number of local agencies, including the San Bernardino County Flood Control District. The region has a flood management infrastructure, which provides valuable flood protection to residents and farmland throughout the region. Basins, spreading grounds, channels, and flood control systems within the region have been constructed by multiple private, local, State, and federal agencies.

Groundwater Management

Antelope Valley

The Antelope Valley Groundwater Basin underlies the IRWM region and has a reported total storage capacity of about 70 maf. Groundwater extractions exceed the estimated natural recharge rates of the basin. This overdraft has caused water levels to decline by more than 200 feet in some areas and by at least 100 feet in most of the region. Although the groundwater basin is not currently adjudicated, an adjudication process has begun and is in the early stages of development. While there are currently no restrictions on groundwater pumping, pumping may be altered or reduced as a result of the adjudication process.

Inyo-Mono

Numerous groundwater basins underlie the region including Antelope Valley, Mono Basin, Owens Valley, and Long Valley. While Inyo and Mono counties have not adopted GWMPs, they have groundwater ordinances in place that employ land-use planning and police powers of locally elected county boards to manage groundwater resources. Many communities within the region primarily depend on groundwater despite contaminants like arsenic and uranium exceeding compliance limits.

Mojave

The Mojave region overlies all or a portion of 36 groundwater basins and subbasins, which can be grouped into the Mojave River Groundwater Basin and the Morongo Basin/Johnson Valley Area. These two groundwater basins are adjudicated and managed by appointed watermasters to prevent overdraft. Due to these adjudications, groundwater levels are stable, with the exception of two subbasins. Groundwater is an important resource within the region, as almost all of the water use is supplied by pumped groundwater. The groundwater is generally of good quality, but can suffer from several constituents.

Environmental Stewardship

Antelope Valley

The region has many unique environmental features, and several plant and animal species are endemic to the desert area that characterizes the region. Habitat conservation activities in the region include the establishment of SEAs and the development of habitat conservation plans (HCPs) such as the Antelope Valley Areawide General Plan and the West Mojave HCP. SEAs are defined by Los Angeles County and generally encompass ecologically important or fragile areas that are valuable as plant or animal communities. The three SEAs within the region are the Antelope Valley SEA, the Joshua Tree Woodland SEA, and the San Andreas SEA.

Inyo-Mono

The region can generally be split into two zones: the eastern Sierra Nevada and the northern Mojave Desert. Each of these zones has unique wildlife, vegetation, and environmental challenges. The region is committed to environmental stewardship by providing stewardship of water-dependent natural resources and protecting, conserving, optimizing, and augmenting supply while maintaining ecosystem health. Identified strategies to support the region's stewardship include supporting research; identifying efforts to control invasive species; and protecting, restoring, and enhancing natural processes, habitats, and threatened and endangered species.

Mojave

Various environmental stewardship efforts are in place to protect the environmental resources of the region, including efforts led by the BLM and biological resource mitigation requirements as identified in the Mojave Basin Judgment. In addition, the 2010 Morongo Basin Conservation Priorities Report serves as a resource guide to help inform and support conservation activities and to balance environmental protection with the enhancement of social and economic well-being. Moving forward, the region is committed to wildlife connectivity and habitat, establishing conservation easements and purchasing land for conservation purposes, and enacting incentives and regulation for wildlife-sensitive development.

Climate Change

Climate change is already affecting these IRWM regions and will have significant impacts on their water and other resources in the future. Changes in timing, amount, and type of precipitation and surface runoff affect the availability of local and imported water supplies.

Antelope Valley

With declining snowpacks and increasing temperatures, precipitation extremes, flooding, and wildfire risks, the Antelope Valley IRWM region is taking action to mitigate and adapt to a changing climate. The region is incorporating salt management and regional flood management plans into its IRWM plan and was awarded funds to develop an operational groundwater bank through a groundwater recharge and recovery project. The region also is implementing through the City of Palmdale a flood control, recharge, and habitat restoration project in the Upper Amargosa Creek. Through its various conservation efforts, the Antelope Valley IRWM region has been able to get retail water demands down by over 20 percent. The region is continuing with its climate change work by completing a vulnerabilities assessment and taking other actions.

Inyo-Mono

Snowpack levels are projected to decline by over 50 percent, which will impact mountain communities dependent on tourism, such as Mammoth Lakes. Sensitive habitats, such as Mono Lake, are already competing for water used by urban populations elsewhere. With declining snowpacks and increasing temperatures, precipitation extremes, flooding, and wildfire risks, the region is taking action to mitigate and adapt to a changing climate. The Inyo-Mono IRWM region has initiated work on determining regional vulnerabilities and adaptation strategies and on incorporating climate change into its IRWM planning processes. One of the objectives for the Inyo-Mono IRWM plan is to address climate variability and reduce emissions of greenhouse gases. The region is continuing with its climate change work under way for updating its IRWM plan.

Mojave

With declining snowpacks and increasing temperatures, precipitation extremes, flooding, and wildfire risks, the region is taking action to mitigate and adapt to a changing climate within the low and high desert areas of its region. The region has facilitated water conservation projects, is completing a recharge project in the Joshua Basin and several recharge projects in the Oro Grande Wash, and is eradicating non-native species from the Mojave River within its jurisdictional boundary, all of which assist in adapting to climate change. USBR also is providing technical support in addressing climate change in updating the region's IRWM plan currently under way.

Tribal Communities

Antelope Valley

There are no formal Native American reservations or rancherias identified within the Antelope Valley IRWM region. However, invitations were extended to those Native Americans who did express interest in the Antelope Valley IRWM planning efforts.

Inyo-Mono

There are several federally and non-federally recognized tribes in the region that contribute significantly to the economy and culture of the region. These groups have also been involved in regional water issues for centuries. As such, it was recognized early in the IRWM planning process that tribal involvement in the RWMG is imperative. Targeted outreach efforts yielded good results; all but two tribes in the region are signatories to the Inyo-Mono Memorandum of Understanding.

Mojave

There are no tribal reservations or lands identified in the region; however, artifacts relating to the San Manuel Band of Mission Indians have previously been encountered in project work within the region. The region intends to include this tribe in its stakeholder outreach as part of the ongoing IRWM plan update process.

Disadvantaged Communities

Antelope Valley

Identified DACs in the region include the unincorporated communities of Boron, Lake Los Angeles, Littlerock, Mojave, and Roosevelt, as well as portions of the City of Lancaster and City of Palmdale. A DAC outreach committee was formed as part of the IRWM plan update. The purpose of the DAC outreach committee was to assist with data collection, outreach efforts, education of target audiences in DAC regions, and project solicitation in DAC areas. Additional outreach efforts were made in the region to rural and isolated communities, regardless of DAC status.

Inyo-Mono

All of Inyo County is classified as a DAC. The Inyo-Mono RWMG has prioritized outreach to and engagement of DACs and tribes since its inception in 2008. The DACs in the Inyo-Mono planning region include unincorporated communities in Inyo, Mono, San Bernardino, and Kern counties, as well as federally recognized and non-federally recognized Native American tribes. Throughout the pre-planning and planning phases, effort has been made to reach out to DACs; share information about IRWM program activities, objectives, and funding opportunities; and, more importantly, listen to their water-related needs and concerns. Program office staff has targeted outreach to DACs both with individual meetings/ presentations and through the larger outreach campaign initiated in 2010.

Mojave

The inclusion and participation of DACs is considered essential to the Mojave IRWM plan process, as more than half of the region qualifies as a DAC. Those identified in the region include Adelanto, Barstow, Daggett, El Mirage, Hinkley, Johnson Valley, Joshua Tree, Kramer Junction, Landers, Lenwood, Lucerne Valley, Newberry Springs, Oro Grande, Pinon Hills, Pioneertown, Yermo, Yucca Valley, and portions of Apple Valley, Hesperia, Phelan, and Victorville. Numerous efforts have been conducted to identify needs of, seek input from, and communicate with DACs in the region. The region held three DAC-specific public meetings in different locations as part of the IRWM plan update process. The region also outreached to DACs through informational invitations mailed and e-mailed to individuals and water agencies servicing known DACs.

Governance

Antelope Valley

The RWMG, composed of 11 organizations, was developed through a memorandum of understanding. The RWMG is responsible for developing the IRWM plan, providing and sharing information, reviewing and commenting on the draft plan, adopting final plan, and assisting with future project grant applications. An advisory team supports the RWMG by providing focused initiative and effort to implement the IRWM plan. Several subcommittees also support the RWMG and are responsible for addressing specific aspects including flood management, DAC involvement, and climate change.

Inyo-Mono

The region is currently governed by the 32-member RWMG. The RWMG is organized by a memorandum of understanding. The region has an IRWM program office that provides overall coordination and manages day-to-day operations of the RWMG. The administrative committee, formed in 2010, is tasked with providing advice and guidance to the program office and guiding the decisions and process of the RWMG.

Mojave

The Mojave RWMG was formed through a memorandum of understanding between the MWA, the VVWRA, the MWA Technical Advisory Committee, the Mojave Desert Resource Conservation District, and the Morongo Basin Pipeline Commission. The RWMG is responsible for the development of the region’s IRWM plan. The coordinating committee, consisting of one staff member and an alternate from each of the RWMG agencies, is tasked with overseeing the plan through its adoption, including reviewing drafts of the plan.

Resource Management Strategies

Volume 3, *Resource Management Strategies* contains detailed information on the various strategies that can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in available IRWM plans for the South Lahontan Hydrologic Region is summarized in Table SL-19.

Conjunctive Management and Groundwater Storage

Conjunctive management, or conjunctive use, refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Managing both resources together, rather than in isolation, allows water managers to use the advantages of both resources for maximum benefit. Conjunctive use of surface water and groundwater has been utilized by AVEK and the MWA in the South Lahontan Hydrologic Region.

A DWR/ACWA survey was undertaken in 2011 and 2012 to inventory and assess conjunctive management projects in California. Box SL-2 is a summary of the inventory effort. More detailed information about the survey results and a statewide map of the conjunctive management projects and operational information is available online from Update 2013, Volume 4, *Reference Guide*, the article, “California’s Groundwater Update 2013.”

Although 89 conjunctive management programs were identified in California as part of the DWR/ACWA survey, the MWA was the only one in the region that responded to the survey. The MWA reports that the annual recharge and extraction capacities are each 50,000 af. However, the annual recharge and extraction amounts vary from year to year, depending on various factors. The cumulative recharge for the conjunctive management program is estimated to be 390,000 af.

The survey results, a statewide map of the conjunctive management projects, and details are available online from Update 2013, Volume 4, *Reference Guide,* the article, “California’s Groundwater Update 2013.” Also, information on conjunctive management in California including benefits, costs, and issues can be found online from Update 2013, Volume 3, *Resource Management Strategies*, Chapter 9, “Conjunctive Management and Groundwater.”

Regional Resource Management Strategies

In the northern part of the South Lahontan region, the Sierra Nevada Conservancy is very active on issues about the eastern flank of the Sierra Nevada. The conservancy has granted funds to support the purchase of forest lands, which are placed under conservation easements to allow for selective timber harvesting in order to preserve the health of the forest. Placing forest lands under conservation easements is an example of forest and watershed management and recharge area protection strategies. In addition the conservancy has funded habitat preservation projects that produce benefits under these same strategies. The conservancy has also undertake fuel reduction projects, which in the long term support the pollution protection strategy by preventing extreme wildfire events that have devastating impacts on water quality.

Table SL-19 Resource Management Strategies Addressed in IRWM Plans in the South Lahontan Hydrologic Region

Resource Management Strategy	Antelope Valley	Inyo-Mono	Mojave
Agricultural Water Use Efficiency	X	X	
Urban Water Use Efficiency	X	X	X
Flood Management		X	
Conveyance – Delta			X
Conveyance – Regional/Local	X	X	
System Reoperation	X	X	
Water Transfers	X	X	
Conjunctive Management and Groundwater	X	X	X
Desalination – Brackish Water and Seawater		X	
Precipitation Enhancement		X	
Recycled Municipal Water	X	X	
Surface Storage – CALFED			
Surface Storage – Regional/Local		X	
Drinking Water Treatment and Distribution	X	X	
Groundwater/Aquifer Remediation	X	X	
Match Water Quality to Use	X	X	
Pollution Prevention	X	X	X
Salt and Salinity Management	X	X	
Urban Stromwater Runoff Management	X	X	
Agricultural Lands Stewardship	X	X	
Ecosystem Restoration	X	X	X
Forest Management	X	X	
Land Use Planning and Management	X	X	X
Recharge Area Protection	X	X	X
Watershed Management		X	
Economic Incentives - Loans, Grants, and Water Pricing	X	X	
Water-Dependent Recreation	X	X	

Note: Information for the Fremont Basin IRWM Plan was not available for Update 2013.

Box SL-2 Statewide Conjunctive Management Inventory Effort in California

The effort to inventory and assess conjunctive management projects in California was conducted through literature research, personal communication, and documented summary of the conjunctive management projects. The information obtained was validated through a joint survey by the California Department of Water Resources (DWR) and Association of California Water Agencies (ACWA). The survey requested the following conjunctive use program information:

1. Location of conjunctive use project;
2. Year project was developed;
3. Capital cost to develop the project;
4. Annual operating cost of the project;
5. Administrator/operator of the project; and
6. Capacity of the project in units of acre-feet.

To build on the DWR/ACWA survey, DWR staff contacted by telephone and e-mail the entities identified to gather the following additional information:

1. Source of water received;
2. Put and take capacity of the groundwater bank or conjunctive use project;
3. Type of groundwater bank or conjunctive use project;
4. Program goals and objectives; and
5. Constraints on development of conjunctive management or groundwater banking (recharge) program.

Statewide, a total of 89 conjunctive management and groundwater recharge programs were identified. Conjunctive management and groundwater recharge programs that are in the planning and feasibility stage are not included in the inventory.

Climate Change

For over two decades, the State and federal governments have been preparing for climate change effects on natural and built systems with a strong emphasis on water supply. Climate change is already affecting many resource sectors in California, including public health, water, agriculture, biodiversity, and transportation and energy infrastructure (California Natural Resources Agency 2009; U.S. Global Change Research Program 2009). Climate model simulations, using the Intergovernmental Panel on Climate Change's 21st century climate scenarios, project increasing temperatures in California, with greater increases in the summer (Intergovernmental Panel on Climate Change 2013). Projected changes in annual precipitation patterns across California will result in changes to surface runoff timing, volume, and type (Cayan et al. 2008). Recently developed computer downscaling techniques (model simulations that refine computer projections to a scale smaller than global models) indicate that California flood risks from warm-wet, atmospheric river-type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011).

Currently, enough data exist to warrant development of contingency plans, mitigation (i.e., reduction) of greenhouse gas (GHG) emissions, and incorporation of adaptation strategies (i.e., methodologies and infrastructure improvements that benefit the region at present and into the future). Although the State of California is taking aggressive action to mitigate climate change through reducing emissions from GHGs and implementing other measures (California Air Resources Board 2008, 2013), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to affect climate through the rest of the century (Intergovernmental Panel on Climate Change 2013).

Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Because of the economic, geographical, and biological diversity of California, vulnerabilities and risks from current and future anticipated changes are best assessed on a regional basis. Many resources are available to assist water managers and others in evaluating their region-specific vulnerabilities and identifying appropriate adaptive actions (U.S. Environmental Protection Agency and California Department of Water Resources 2011; California Emergency Management Agency and California Natural Resources Agency 2012a). The most comprehensive report to date on climate change observations, impacts, and projections for the southwestern United States, including California, is the *Assessment of Climate Change in the Southwest United States* (Garfin et al. 2013).

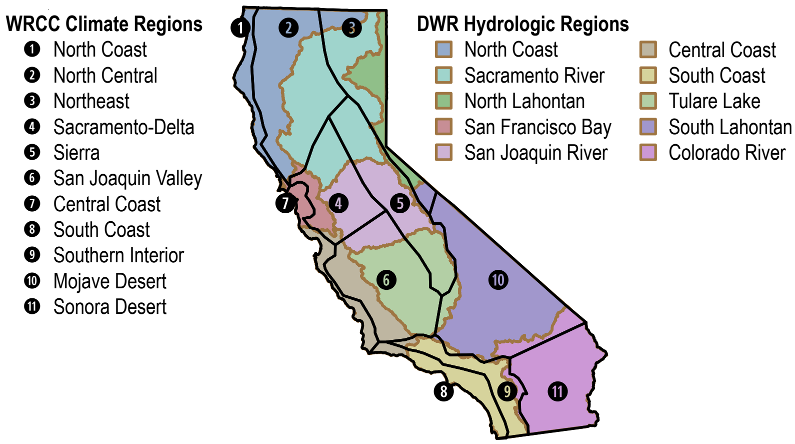
Observations

The region's observed temperature and precipitation vary greatly owing to complex topography, geography, and relation to the Pacific Ocean. Regionally specific air temperature trends for the past century are available from the Western Regional Climate Center (2013). The WRCC serves as a repository of historical climate data and information. Air temperature records for the past century are summarized by the WRCC into distinct climate regions (Abatzoglou et al. 2009), which are geographically different from hydrologic regions. DWR's hydrologic regions do not correspond directly to WRCC's climate regions. A particular hydrologic region may overlap more than one climate region and thus have different climate trends in different areas. For the purposes of this regional report, however, climate trends within climate regions are considered to be relevant trends for respective portions of this hydrologic region (see Figure SL-20).

Statewide, California's air temperature already has risen by 1 °F (0.6 °C), mostly at night and during the winter, with higher elevations experiencing the highest increase (California Department of Water Resources 2008). In the South Lahontan Hydrologic Region within the WRCC Mojave Desert climate region, mean temperatures have increased 1.3 to 2.5 °F (0.7 to 1.4 °C) in the past century, with minimum and maximum temperatures increasing 1.6 to 2.7 °F (0.9 to 1.5 °C) and 1.0 to 2.4 °F (0.6 to 1.3 °C), respectively (Western Regional Climate Center 2013). Within the WRCC Northeast climate region, mean temperatures have increased 0.8 to 2.0 °F (0.5 to 1.1 °C) in the past century, with minimum and maximum temperatures increasing 0.9 to 2.2 °F (0.5 to 1.2 °C) and 0.5 to 2.1 °F (0.3 to 1.2 °C), respectively (Western Regional Climate Center 2013).

The South Lahontan region also is experiencing impacts from climate change through changes in precipitation patterns, surface runoff volumes and timing, and streamflow timing, which in turn affect availability of local and imported water supplies. During the last century, the average early snowpack in the Sierra Nevada, which is an important source of both local and imported water for the South Lahontan region, decreased by about 10 percent, which equates to a loss of 1.5 maf of snowpack storage (California Department of Water Resources 2008). Long-term shifts in streamflow timing have been observed for snowmelt-dominated basins throughout western North America since the late 1940s, and that the primary cause for the regional trends toward earlier snowmelt and streamflow timing is a broad-scale increase of winter and spring temperatures (Stewart et al. 2005).

Figure SL-20 DWR Hydrologic and Western Regional Climate Center Climate Regions



The Western Region Climate Center (WRCC) divides California into 11 separate climate regions, and generates historic temperature time-series and trends for these regions (http://www.wrcc.dri.edu/monitor/cal-mon/frames_version.html). DWR maintains 10 hydrologic regions, with the Delta and Mountain Counties being overlays of other DWR hydrologic regions. Each DWR hydrologic region spans one or more of the WRCC climate regions.

Sea level rise, although not a direct impact to the South Lahontan region, degrades the quality of the region's imported water from the Delta, as well as increases salinity intrusion and affects the Delta levee infrastructure, requiring substantial capital investments by the public. According to the California Climate Change Center, sea level rose 7 inches (18 cm) along California's coast during the past century (California Department of Water Resources 2008; California Natural Resources Agency 2009).

Projections and Impacts

While historical data are directly observed indicators of how the climate is changing, they cannot by themselves project what future conditions may be like under different GHG emissions scenarios. Current climate science uses computer modeling to simulate and develop future climate projections. A recent study by the Scripps Institution of Oceanography uses the most sophisticated methodology to date and indicates that between 2060 and 2069 annual mean temperatures would be 3.4 to 4.9 °F (1.9 to 2.7 °C) higher across the state than they were between 1985 and 1994 (Pierce et al. 2012). Between 2060 and 2069, annual mean temperature is projected to increase by 4.9 °F (2.7 °C) for the WRCC Mojave Desert climate region, with increases of 3.6 °F (2.0 °C) during the winter months and 5.9 °F (3.3 °C) during summer. The WRCC Northeast climate region has similar projections with annual mean temperatures increasing by 4.7 °F (2.6 °C), winter temperatures increasing by 3.4 °F (1.9 °C), and summer temperatures increasing by 6.5 °F (3.6 °C). Climate projections from Cal-Adapt indicate that the mean temperatures between 1990 and 2100 would increase about 5 to 10 °F (2.8 to 5.6 °C) during winter and 8 to 10 °F (4.4 to 5.6 °C) during summer (California Emergency Management Agency and California Natural Resources Agency 2012b).

Changes in precipitation across California due to climate change could result in changes in type of precipitation (rain or snow) in a given area, in timing or total amount, and in surface runoff timing and volume. Precipitation projections from climate models for the state are not all in agreement, but most anticipate drier conditions in the southern part of California, with heavier and warmer winter precipitation in the north (Pierce et al. 2012). Because there is a lower model resolution of localized precipitation changes, there is a need to adapt to this uncertainty at the regional level (Qian et al. 2010).

Although annual precipitation will vary by area, decreasing precipitation in the South Lahontan region would affect local reservoirs and the replenishment of the region's groundwater. Projections for the South Lahontan region indicate that precipitation could decline by as much as 15 inches (38 cm) depending on the location and emissions scenario (California Emergency Management Agency and California Natural Resources Agency 2012b). In areas that receive less than 6 inches (15 cm) of rain, total precipitation could be reduced to less than 4 inches (10 cm) annually, while in other areas where rainfall exceeds 45 inches per year (114 cm/yr.) precipitation could decrease by 15 inches (38 cm) (California Emergency Management Agency and California Natural Resources Agency 2012b).

On the other hand, extremes in California's precipitation are projected to increase with climate change. As stated above, recent computer downscaling techniques indicate that California flood risks from warm-wet, atmospheric river-type storms may increase beyond those we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011). Increased winter runoff could result in increased flood hazards, with flows potentially exceeding reservoir storage capacities. Higher flow volumes could scour stream and flood control channels, degrading aquatic and riparian habitats already affected by shifts in climate and placing additional stress on special-status species.

Sierra Nevada snowpack volume is projected to continue to decline as warmer temperatures raise the elevation of snow levels, reduce spring snowmelt, and increase winter runoff. Rising temperatures from downscaled models produce reduced snowpack in the Sierra, with impacts on winter recreation, streamflow, and water storage and supply (Hayhoe et al. 2004). Based on historical data and modeling, researchers at the Scripps Institution of Oceanography project that, by the end of this century, the Sierra Nevada snowpack would experience a 48 to 65 percent loss from its average at the end of the previous century (Pierce and Cayan 2013). Reduced snow and precipitation in the Sierra Nevada range could affect the imported water supply for the South Lahontan region and could cause potential overdrafting of the region's groundwater basins. In addition, earlier peak streamflows would reduce the flexibility in how the state manages its reservoirs to protect downstream communities from flooding while ensuring a reliable water supply.

Locally in the South Lahontan region, snowpack amounts are projected to decline by over 50 percent by 2100 (California Emergency Management Agency and California Natural Resources Agency 2012b). Such a decline in snowpack would affect mountain communities dependent on snow-based tourism, such as the ski resorts of Mammoth Lakes and June Lake, where the winter population substantially increases with ski season (California Emergency Management Agency and California Natural Resources Agency 2012b).

The hydrology and geomorphology of streams draining the northern slopes of the San Bernardino and San Gabriel mountains are similar to those for watercourses emanating from the eastern Sierra Nevada. The snowpack in these mountains is smaller because of their southern locations and lower peak elevations; however, the population and urbanized area are greater. Though hydrograph changes due to the reduced snowpack are projected to be smaller, relative to those in the Sierra Nevada, impacts on these urban areas could be equally or more severe in the San Bernardino and San Gabriel ranges.

Water supplies within California are already stressed because of current demand and expected population growth. Even though the South Lahontan region represents about 2 percent of the state's population, it grew by 14 percent between 2000 and 2005 (California Department of Water Resources 2009). The uncertainty regarding the extent of these environmental changes will reduce the ability of local agencies to meet the water demand for the South Lahontan region if these agencies are not adequately prepared.

Changes in climate and runoff patterns may create competition among sectors that utilize water. The agricultural water demand and demand for landscape irrigation within the region could increase as a result of higher evapotranspiration rates and potentially longer growing seasons caused by increased temperatures. Demand for water exported through the LAA also could increase and affect the resources at Mammoth Creek, Owens Valley, and other areas. Prolonged drought and decreased water quality could diminish water-based recreational opportunities at South Lahontan reservoirs and streams. Environmental water supplies would need to be retained in reservoirs for managing instream flows to maintain habitat for aquatic and migratory species throughout the dry season not only within the region (such as for Mono Lake, a prominent stop for migrating birds), but also for the region's imported source water.

Currently, Delta pumping restrictions are in place to protect endangered aquatic species. Climate change is likely to further constrain the management of these endangered species and the state's ability to provide water for other uses. For some areas of the South Lahontan region, this could further reduce supplies available for import through the SWP during the non-winter months. SWP operators already must balance between preventing winter floods with maintaining water storage for summer dry periods, a balance that could be disrupted by earlier runoff (Cayan et al. 2008; Hayhoe et al. 2004). Reductions in the quantity of available SWP water would force local water agencies in the Antelope Valley (AVEK and PWD) to rely more heavily on local groundwater and local surface flows, or on other sources of imported water.

Besides earlier runoff, reservoir managers and SWP operators also are challenged by other factors. With increasing temperatures, net evaporation from reservoirs is projected to increase by 15 to 37 percent (Medellin-Azuara et al. 2009; California Natural Resources Agency 2009). In addition, prolonged drought events are likely to continue and further affect the availability of local and imported surface water and contribute to the depletion of groundwater supplies. Currently, groundwater supplies the water for more than 65 percent of urban, agricultural, and environmental water demands in the South Lahontan region because much of the surface water is not locally available due to historical water appropriation rights (California Emergency Management Agency and California Natural Resources Agency 2012b).

Higher temperatures and decreased moisture during the summer and fall seasons would increase the South Lahontan region's vulnerability to wildfire hazards and impact local watersheds. The extent to which climate change will alter the existing risk to wildfires is variable (Westerling and Bryant 2006). However, by 2085, the risk is projected to increase up to 19.1 times that of historical risk in the northern part of Mono County, while the rest of Mono County and Inyo County can anticipate a wildfire risk between 1.1 to 4.8 times greater than current levels (California Emergency Management Agency and California Natural Resources Agency 2012b). Earlier snowmelt and drier conditions have been correlated with an increase in the size and intensity of these fires (Westerling 2012).

Some models using vegetation distribution and productivity have projected that, by the end of the century, the total annual area burned could range from 9 percent to 15 percent greater than normal and that the greatest increases in annual area burned were simulated along the eastern edge of Sierra Nevada and other areas (Lenihen et al. 2006). More frequent fires and/or higher fire intensity would mean less native vegetation to capture and reduce the velocities of surface runoff and maintain soil integrity. Erosion rates would increase, which could increase the destructive force of debris flows and sedimentation rates for flood control channels and reservoirs. Furthermore, wildfires have historically been linked to debris-flow flooding in vulnerable communities within the South Lahontan region. The highly unpredictable nature of alluvial fans within the region has created flooding situations dependent on rain, vegetation, and wildfires (Stuart 2012).

A recent study that explores future climate change and flood risk in the Sierra indicates a tendency toward increased three-day flood magnitude. The study used downscaled simulations from three global climate models (GCMs) under an accelerating GHG emissions scenario that is more reflective of current trends. By the end of the 21st century, all three projections yield larger floods for both the moderate elevation northern Sierra Nevada watershed and for the high elevation southern Sierra Nevada watershed on the western side, even for GCM simulations with 8 to 15 percent declines in overall precipitation. The increases in flood magnitude are statistically significant for all three GCMs for the period 2051 to 2099. By the end of the 21st century, the magnitudes of the largest floods increase to 110 to 150 percent of historical magnitudes. These increases appear to derive jointly from increases in heavy precipitation amount, storm frequencies, and days with more precipitation falling as rain and less as snow (Das et al. 2011).

Even though this study focused on the western side of the Sierra Nevada, these scenarios could potentially be indicative of other regional settings already experiencing flooding risks. Sparse development in the region, however, precludes catastrophic flood damage over a widespread area. Nevertheless, it is essential for local agencies to take action and be ready to adapt to climate change to protect the well-being of their communities.

Adaptation

Changes in climate have the potential to affect the water resources of the South Lahontan region, upon which the state depends for economic and environmental benefits. These changes would increase the vulnerability of natural and built systems in the region. Impacts on natural systems would challenge aquatic and terrestrial species by diminishing water quantity and quality and shifting ecoregions. Built systems would be affected by changing hydrology, shifts in runoff timing, and loss of natural snowpack storage, making the region more dependent on surface storage in reservoirs and groundwater sources. Preparing for increased future water demand for both natural and built systems may be particularly challenging to meet with less natural storage and less overall supply.

The South Lahontan region contains a diverse landscape with different climate zones and complex topographic and hydrogeologic systems, making it difficult to find one-size-fits-all adaptation strategies. Water managers and local agencies must work together to determine the appropriate planning approach for their operations and communities. Although climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (U.S. Environmental Protection Agency and California Department of Water Resources 2011). However, stationarity (the idea that natural systems fluctuate within an unchanging envelope of variability) can no longer be assumed, so new approaches will likely be required (Milly et al. 2008). Whatever planning approach is used, it is necessary for water managers and communities to start implementing adaptation measures sooner than later so as to be prepared for current and future changes.

IRWM planning is a framework that allows water managers to address climate change on a smaller, more regional scale. Climate change now is a required component of all IRWM plans (California Department of Water Resources 2010, 2012). IRWM regions must identify and prioritize their specific vulnerabilities to climate change and identify the adaptation strategies that are most appropriate. Planning and adaptation strategies that address vulnerabilities should be proactive and flexible, starting with proven strategies that will benefit the region today and adding new strategies that will be resilient to the uncertainty of the degree of climate change.

In partnership with DWR, the California State University at San Bernardino – Water Resources Institute has developed a Web-based portal for land use planning in alluvial fans, which uses an integrated approach in assessing hazards and resources (California State University, San Bernardino 2012; Lien-Longville 2012). Other adaptation strategies to consider for managing water in a changing climate include developing coordinated plans for mitigating future flood, landslide, and related impacts; implementing activities to minimize and avoid development in flood hazard areas; restoring existing flood control and riparian and stream corridors; implementing tiered pricing to reduce water consumption and demand; increasing regional natural water storage systems; encouraging low-impact development to reduce stormwater flows; promoting economic diversity; and supporting alternative irrigation techniques within the agriculture industry. To further safeguard water supplies, other promising strategies include adopting more water-efficient cropping systems, investing in water-saving technologies, and developing conjunctive use strategies. In addition, tracking forest health in the mountain areas and reducing accumulated fuel load would provide a more resilient watershed ecosystem that can mitigate for floods, droughts, and fires (California Department of Water Resources 2008; Hanak and Lund 2011; California Emergency Management Agency and California Natural Resources Agency 2012c; Jackson et al. 2012).

Local, State, and federal agencies face the challenge of interpreting new information and determining which methods and approaches are appropriate for their planning needs. The *Climate Change Handbook for Regional Water Planning* provides an analytical framework for incorporating climate change impacts into regional and watershed planning processes and considers adaptation to climate change (U.S. Environmental Protection Agency and California Department of Water Resources 2011). This handbook provides guidance for assessing the vulnerabilities of California's watersheds and regions to climate change impacts and prioritizing these vulnerabilities.

Strategies to manage local water supplies must be developed with the input of multiple stakeholders (Jackson et al. 2012). While both adaptation and mitigation are needed to manage risks and are often complementary and overlapping, there may be unintended consequences if efforts are not coordinated (California Natural Resources Agency 2009). Central to adaptation in water management is full implementation of IRWM plans that address regionally appropriate practices that incorporate climate change information. These IRWM plans, along with regional flood management plans, can integrate water management activities that connect corridors and restore native aquatic and terrestrial habitats to support the increase in biodiversity and resilience for adapting to changes in climate (California Natural Resources Agency 2009). However, with limited funds RWMGs must prioritize their investments.

Already RWMGs in the South Lahontan region are taking action. The Inyo-Mono RWMG has initiated work on determining regional vulnerabilities and adaptation strategies and incorporating climate change into its IRWM planning processes. One of the objectives for the Inyo-Mono IRWM plan is to address climate variability and reduce GHG emissions. The Mojave RWMG is implementing projects that assist in adapting to climate change, such as water conservation, groundwater recharge in the Oro Grande Wash, and eradication of non-native species from the Mojave River within its jurisdictional boundary. The Mojave RWMG will be evaluating climate change impacts to its water supplies and infrastructure as part of updating its IRWM Plan, as well as planning for salt and nutrient management and flood management. The Antelope Valley RWMG also is incorporating salt management and regional flood management plans into its IRWM plan and was awarded funds to develop an operational groundwater bank through a groundwater recharge and recovery project and to implement through the City of Palmdale a flood control, recharge, and habitat restoration project in Upper Amargosa Creek. Through its various conservation efforts, the Antelope Valley RWMG has been able to reduce retail water demands by over 20 percent throughout its IRWM region.

Individual communities and utilities also are taking action. In preparing for climate change, LADWP completed a study to evaluate the effects of climate change on the LAA's eastern Sierra watershed. The LAA system is vulnerable to disruption from earlier snowmelt runoff because it has smaller surface water storage compared to other large conveyance systems in California (Harrington pers. comm. April 3, 2012). The LADWP study identified possible adaptation measures that could be implemented to mitigate the potential negative effects of climate change on the hydrology of the region over the next century, as well as the potential negative impact on water quality. These adaptation measures include creating new storage downgradient of Owens Valley to capture and store wet year flows for use during dry years and pursuing water transfers delivered from the SWP into the LAA (American Geophysical Union 2011; Pettijohn and Hsu pers. comm. 2013). In addition, the Sierra Nevada Alliance developed a climate change toolkit for Sierra mountain communities (Sierra Nevada Alliance 2010). In the Victor Valley area, the Town of Apple Valley has adopted a climate action plan, in addition to developing targets and GHG inventories; Victorville has a GHG inventory and included climate change in its adopted general plan (DeShazo and Matute 2012). According to the Luskin Center for Innovation report, roughly one-third of Southern California cities have taken steps toward reducing GHG emissions, but more work needs to be done, not only in mitigating for but also in adapting to climate change (DeShazo and Matute 2012).

The State of California has developed additional online tools and resources to assist water managers, land use planners, and local agencies in adapting to climate change. These tools and resources include the following:

- *Safeguarding California: Reducing Climate Risk* (http://resources.ca.gov/climate_adaptation/docs/Safeguarding_California_Public_Draft_Dec-10.pdf), which identifies a variety of strategies across multiple sectors (other resources can be found at http://www.climatechange.ca.gov/adaptation/strategy/index.html).
- *California Adaptation Planning Guide* (http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html) developed into four complementary documents by the California Emergency Management Agency and the California Natural Resources Agency to assist local agencies in climate change adaptation planning.
- Cal-Adapt (http://cal-adapt.org/), an online tool designed to provide access to data and information produced by California's scientific and research community.

- *Urban Forest Management Plan Toolkit* (http://www.ufmptoolkit.com/), sponsored by the California Department of Forestry and Fire Management to help local communities manage urban forests to deliver multiple benefits, such as cleaner water, energy conservation, and reduced heat-island effects.
- California Climate Change Portal (http://www.climatechange.ca.gov/).
- DWR Climate Change Web site (http://www.water.ca.gov/climatechange/resources.cfm).
- The Governor's Office of Planning and Research Web site (http://www.opr.ca.gov/m_climatechange.php).

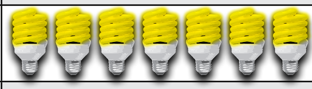
Several of the resource management strategies in Volume 3 of Update 2013 can be singled out as providing benefits for adapting to climate change in addition to meeting water management objectives in the South Lahontan Hydrologic Region. These include:

- Chapter 2, "Agricultural Water Use Efficiency."
- Chapter 3, "Urban Water Use Efficiency."
- Chapter 4, "Flood Management."
- Chapter 8, "Water Transfers."
- Chapter 9, "Conjunctive Management and Groundwater Storage."
- Chapter 11, "Precipitation Enhancement."
- Chapter 12, "Municipal Recycled Water."
- Chapter 14, "Surface Storage — Regional/Local."
- Chapter 15, "Drinking Water Treatment and Distribution."
- Chapter 16, "Groundwater/Aquifer Remediation."
- Chapter 18, "Pollution Prevention."
- Chapter 19, "Salt and Salinity Management."
- Chapter 21, "Agricultural Land Stewardship."
- Chapter 22, "Ecosystem Restoration."
- Chapter 23, "Forest Management."
- Chapter 24, "Land Use Planning and Management."
- Chapter 25, "Recharge Area Protection."
- Chapter 27, "Watershed Management."
- Chapter 28, "Economic Incentives — Loans, Grants, and Water Pricing."
- Chapter 31, "Water-Dependent Recreation."

The myriad of resources and choices available to managers can seem overwhelming, and the need to take action given uncertain future conditions is daunting. There are many low-regret actions that water managers in the South Lahontan region can take to prepare for climate change, regardless of the magnitude of future warming. These low-regret actions involve adaptation options where moderate levels of investment increase the capacity to cope with future climate risks (The World Bank 2012).

Water managers and others will need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for

Figure SL-21 Energy Intensity per Acre-Foot of Water

Type of Water	Energy Intensity ( = 1-250 kWh/AF  = 251-500 kWh/AF)	Percent of Regional Water Supply*
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	*This type of water not available*	0%
State (Project)		14%
Local (Project)	 <250 kWh/AF	7%
Local Imports	*This type of water not available*	0%
Groundwater		64%

Energy intensity (EI) in this figure is the estimated energy required for the extraction and conveyance of one acre-foot of water. These figures reflect only the amount of energy needed to move from a supply source to a centralized delivery location (not all the way to the point of use). Small light bulbs are for EI greater than zero, and less than 250 kilowatt hours per acre- foot (kWh/af). Large light bulbs represent 251-500 kWh/af of water (e.g., four light bulbs indicate that the water source has EI between 1,501-2,000 kWh/af).

*The percent of regional water supply may not add up to 100 percent because not all water types are shown in this figure EI values of Desalinated and Recycled Water are covered in Volume 3, *Resource Management Strategies*. For detailed descriptions of the methodology used to calculate EI in this figure, see Volume 5, *Technical Guide*.

maintaining ecosystem services important for human society, such as flood management, carbon sequestration, pollution remediation, and recreation. Land use decisions are central components in preparing for and minimizing the impacts from climate change (California Natural Resources Agency 2009). Increased cross-sector collaboration among water managers, land use planners, and ecosystem managers provides opportunities for identifying common goals and actions needed to achieve resilience to climate change and other stressors.

Mitigation

California's water sector consumes about 12 percent of total statewide energy (19 percent of statewide electricity, and about 32 percent of statewide natural gas, and negligible amounts of crude oil). As shown in Volume 1, Figure 3-28, "Energy Use Related to Water," water conveyance and extraction accounts for about 2 percent of energy consumption in the state, with 10 percent of total statewide energy use attributable to end-users of water (California Energy Commission 2005, 2013; California Public Utilities Commission 2010). Energy is used in the water sector to extract, convey, treat, distribute, use, condition, and dispose of water and wastewater. Figure 3-29, "Water and Energy Connection" (Volume 1), shows all of the connections between water and energy in the water sector — both water use for energy generation and energy use for water supply activities. The regional reports in *Update 2013* are the first to provide detailed information on the water-energy connection, including energy intensity (EI) information at the regional level. EI information is designed to help inform the public and water utility managers about the relative energy requirements of the major water supplies used to meet demand. Since energy usage is closely related to GHG emissions, this information can support measures to reduce GHGs as mandated by the State. (Energy intensity is discussed in Box SL-3.)

Figure SL-21, "Energy Intensity per Acre-Foot of Water" (above), shows the amount of energy associated with the extraction and conveyance of one af of water for each of the major water sources in this region. The quantity of each water source used in the region is also included, as a percentage. For reference, only extraction and conveyance of raw water in Figure 3-29 "The Water-Energy Connection," in Volume 1, Chapter 3, "California Water Today" are illustrated in

Box SL-3 Energy Intensity

Energy Intensity (EI), as defined in *California Water Plan Update 2013*, is the amount of energy needed to extract and convey an acre-foot (af) of water from its source to a delivery location. Extraction refers to the process of moving water from its source to the ground surface. Many water sources are already at ground surface and require little or no energy for extraction, whereas others, such as groundwater or seawater for desalination, require energy to move the water to the surface. Conveyance refers to the process of moving water from a location at the ground surface to a different location. Conveyance can include pumping of water up and over hills and mountains or can occur via gravity. EI should not be confused with total energy — that is, the *amount* of energy (e.g., kilowatt hours [kWh]) required to deliver all of the water from a water source to customers within the region. EI focuses not on the total amount of energy used to deliver water to customers, but instead the portion of energy required to extract and convey a single unit of water (in kWh/af). In this way, EI gives a normalized metric that can be used to compare alternative water sources. (For detailed descriptions of the EI methodology and the delivery locations assumed for the water types presented, see Volume 5, *Technical Guide*).

In most cases, this information will not have sufficient detail for actual project-level analysis. However, these generalized, region-specific metrics provide a range in which energy requirements fall. The information can also be used in more detailed evaluations by using tools such as WeSim (http://www.pacinst.org/publication/wesim/), which allows modeling of water systems to simulate outcomes for energy, emissions, and other aspects of water supply selection.

Although not identical, EI is closely related to greenhouse gas (GHG) emissions (for more information, see "Climate Change and the Water-Energy Nexus" in Volume 1, Chapter 3, "California Water Today"). On average in California, generation of 1 megawatt-hour (MWh) of electricity results in the emission of about one-third of a metric ton of GHG (eGrid 2012). This estimate takes into account all types of energy generation throughout the state and electricity imported to the state.

Reducing GHG emissions is a State mandate. Water managers can support this effort by considering EI in their decision-making process. It's important to note that water supply planning must take into consideration myriad different factors in addition to energy impacts, such as public safety, water quality, firefighting, ecosystems, reliability, energy generation, recreation, and costs.

Accounting for Hydroelectric Energy

Generation of hydroelectricity is an integral part of many of the state's large water projects. The State Water Project (SWP), Central Valley Project (CVP), Los Angeles Aqueduct, Mokelumne Aqueduct, and Hetch Hetchy Aqueduct all generate large amounts of hydroelectricity at large multi-purpose reservoirs at the heads of each system. In addition to hydroelectricity generation at head reservoirs, several of these systems also generate hydroelectric energy by capturing the power of water falling through pipelines at in-conduit generating facilities. In-conduit generating facilities refer to hydroelectric turbines placed along pipelines to capture energy as water runs downhill in a pipeline (conduit). Hydroelectricity is also generated at hundreds of smaller reservoirs and run-of-the-river turbine facilities.

Because of the many ways hydroelectric generation is integrated into water systems, accounting for hydroelectric generation in EI calculations is complex. In some systems, such as the SWP and CVP, water generates electricity and then flows back into the natural river channel after passing through the turbines. In other systems, such as the Mokelumne Aqueduct, water can leave the reservoir by two distinct outflows, one that generates electricity and flows back into the natural river channel, and one that does not generate electricity and flows into a pipeline leading to water users. In both situations, experts have argued that hydroelectricity should be excluded from EI calculations because the energy generation system and the water delivery system are, in essence, separate (Wilkinson 2000).

DWR has adopted this convention for its EI calculations. All hydroelectric generation at head reservoirs has been excluded. Consistent with Wilkinson (2000) and others, DWR has included in-conduit and other hydroelectric generation that occurs as a consequence of water deliveries, such as the Los Angeles Aqueduct's hydroelectric generation at plants on the system downstream of the Owen's River diversion gates. The California Department of Water Resources has made one modification to this methodology to simplify the display of results: energy intensity has been calculated at each main delivery point in the systems. If the hydroelectric generation in the conveyance system exceeds the energy needed for extraction and conveyance, the EI is reported as zero. That means no water system is reported as a net producer of electricity, even though several systems (e.g., Los Angeles Aqueduct, Hetch Hetchy Aqueduct) produce more electricity in the conveyance system than is used.

Figure SL-21. Energy required for water treatment, distribution, and end uses of the water are not included. Not all water types are available in this region. Some water types flow mostly by gravity to the delivery location and may require little or no energy to extract and convey. As a default assumption, a minimum EI of less than 250 kilowatt hours per acre-foot (kWh/af) was assumed for all water types).

Recycled water and water from desalination used within the region are not show in Figure SL-21 because their EI differs in important ways from those water sources. The EI of both recycled and desalinated water depend not on regional factors but rather on much more localized-, site-, and application-specific factors. Additionally, the water produced from recycling and desalination is typically of much higher quality than the raw (untreated) water supplies evaluated in Figure SL-21. For these reasons, discussion of the EI of recycled and desalinated water are found separately in Volume 3, *Resource Management Strategies*.

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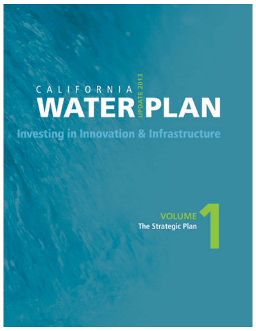

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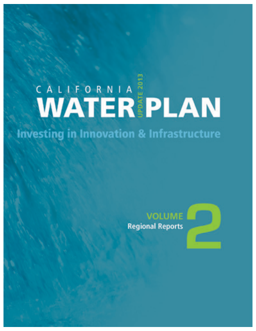

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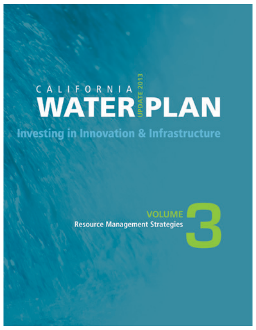

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