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Chapter 10  South Lahontan Hydrologic Region

Setting
The South Lahontan Hydrologic Region represents about 17 percent of the land area in California. 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, and San Bernardino mountains; and to the east by the state of Nevada. (Figure 10-1).

PLACEHOLDER Figure 10-1 South Lahontan Hydrologic Region (map)

The region is dominated by parallel northwest-southeast trending mountain ranges separated by broad alluvial valleys. In addition to these mountain ranges, other prominent features include the Mono Basin, Owens Valley, Panamint Valley, Death Valley, Amargosa River Valley, the Mojave Desert, and Antelope Valley. The region has the highest and lowest elevation points in the continental United States: Mount Whitney with an elevation of 14,495 feet and Death Valley at 282 feet below sea level.

Major lakes and reservoirs in the region include Mono Lake, June Lake, Convict Lake, Crawley Lake, and Tinemaha Reservoir in the north and Lake Arrowhead, Silverwood Lake, and Lake Palmdale in the south. Most of the perennial rivers are in the north. This includes the Owens River and Rush Creek. In the south, the Mojave and Amargosa rivers are typically dry for most of the year. Water flows in the channels of both rivers after heavy rainfall events. In addition, there are two locations on the Mojave River where groundwater is forced to the surface of channel by geologic conditions.

PLACEHOLDER Box 10-1 Acronyms and Abbreviations Used in this Chapter

Watersheds
Four major watershed areas have been identified for the South Lahontan Region (Figure 10-2). These are the Antelope Valley, Mojave, Mono Basin, and Owens River watersheds.

PLACEHOLDER Figure 10-2 Watersheds and ecosystems in the South Lahontan Hydrologic Region (map)

Antelope Valley Watershed
The Antelope Valley watershed is in northern Los Angeles County and covers an area of about 2,400 square miles (see Figure 10-2). It also includes portions of Kern and San Bernardino counties. 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 within the watershed 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 for storm runoff (LADPW 1987).
The watershed has undergone rapid urbanization for the past two decades, specifically for the cities of Lancaster and Palmdale. This development has occurred on land that had been previously farmed or undeveloped. Agricultural activities, although smaller than two decades ago, have remained quite steady.

All of the important streams of the watershed 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.

Numerous streams originating in the mountains surrounding the Antelope Valley carry highly erodible soils toward the valley floor. Streams meander across the alluvial fans in paths subject to change. Precipitation ranges on average from less than 10 inches per year on the valley floor to more than 12 inches in the surrounding mountains (Rantz 1969 as cited in USGS 1995). Portions of the valley floor are subject to flooding due to uncontrolled runoff from these nearby foothills (City of Lancaster 1997), and this situation is aggravated by the lack of drainage facilities and defined flood channels. Heavy discharge and flooding is prevalent along Big Rock, Little Rock, Amargosa, and Anaverde creeks. Heavy rainfall and summer thunderstorms increase the potential for flash floods.

Storm water runoff that does not percolate into the ground eventually ponds and evaporates in the impermeable dry lake beds at Edwards Air Force Base (LADPW 1987). Totaling about 60 square miles, these playas are generally dry, but are likely to be flooded following prolonged precipitation. Fine sediments carried by the storm water inhibit percolation as do the impermeable playa soils (LADPW 1987). Surface water can remain on the playa for up to five months until the water evaporates (LADPW 2006).

**Mojave Watershed**

The Mojave watershed in San Bernardino County covers an area of 4,500 square miles (see Figure 10-2). It includes the Mojave River and its associated floodplain. It is bounded to the south by the San Bernardino and San Gabriel Mountains. The Bristol, Calico, Granite, and Providence mountains provide portions of the boundary. From the San Bernardino Mountains, the watershed extends northward to the City of Barstow before turning to the northeast. It terminates at Silver Lake, a dry lake bed near the community of Baker. In addition to Silver Lake, other dry lake beds include 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. Snowpack melt provides most of water for the river and provides an estimated 65,000 af of average annual recharge. The river is impounded behind the Mojave River Dam in the Mojave River Forks Reservoir, which is a multipurpose facility operated for water supply, flood management, water conservation, and recreation. The Mojave River descends from the dam and meanders approximately 120 miles to its terminus at Silver Dry Lake. For most of the year, the Mojave River channel is typically dry downstream of the dam except in the Narrows near Victor Valley and Afton Canyon where groundwater is forced to the surface by geologic structures.

The watershed has a combination of urban, agricultural, and environmental land and water uses. The urban area in the Victor Valley, which includes the City of Victorville, has been undergoing rapid expansion. Urban growth has significantly modified the amount of waste discharges that could potentially affect water quality, including storm water and wastewater treatment.
Typical of southwestern arid environments, the Mojave watershed has limited water resources. Surface water from the headwaters in the San Bernardino Mountains quickly percolates into the porous sands of the young Mojave River alluvium. Thus, groundwater is the primary source of water supply in most of the watershed. In a constant state of overdraft since the 1950s, the groundwater resources of the Mojave watershed were formally adjudicated in 1996 through a stipulated judgment, which was appealed shortly thereafter. The California Supreme Court issued a decision in the case on August 22, 2000, that affirmed water rights priority in cases of competing water apportionment (Box 10-2 Mojave River Adjudication).

**PLACEHOLDER Box 10-2 Mojave River Adjudication**

**Mono Basin**

The Mono Basin watershed is located on the eastern slope of the Sierra Nevada in southern Mono County (see Figure 10-2). The watershed encompasses more than 800 square miles and is bounded by the Bodie Hills, Cowtrack Mountain, and Long Valley Caldera. The watershed extends to the crest of the Sierra Nevada. Mono Lake is the main feature of the watershed. The surface area of the lake is about 71 square miles with a total volume of water of about 2.6 maf (in 2003). The major streams that originate in the Sierra Nevada range are 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 at Mono Lake to almost 12,000 feet near the crest of the Sierra Nevada. Climate zones range from the Lower to Upper Boreal classifications. Summers range from mild to cool, while 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 continues to be an important location 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, no agricultural activities are presently occurring. Work is underway on projects to restore the fishery and riparian vegetation for Rush and Lee Vining creeks. All activities are being monitored to track improvements.

**Owens River**

The Owens River watershed is in the northern quarter of the South Lahontan Hydrologic Region (see Fig. 10-2). It extends from just north of the City 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. Total area is ___ square miles. The main natural feature of the watershed is the Owens River. Important tributaries to this river include Fish Slough and Convict, Horton, Rock, Bishop, Big Pine, Independence, and Lone Pine creeks.

The Los Angeles Aqueduct (LAA) is the major man-made feature in the watershed. Other important natural and man-made water bodies include Crowley Lake, Convict Lake, Pleasant Valley Reservoir, Haiwee Reservoir, and Tinemaha Reservoir. Hot Creek Hatchery, operated by the Department of Fish and Game (DFG), supports a large regional recreational fishery by providing fish stock for planting in other rivers and lakes. Other private hatcheries also provide
excellent stock for planting. Crowley Lake is one of the largest and most used trout fisheries in California.

Urban and agricultural land uses within the watershed are small. Population is concentrated in small cities and communities. With the exception of Mammoth Lakes, populations in these urban areas are stable. The largest of the cities is Mammoth Lakes, followed by Bishop. Agriculture operations are located near the City of Bishop and communities of Big Pine and Lone Pine. The main crop is alfalfa with some improved pastures. Livestock grazing occurs on both public and private lands. Diversions from the Los Angeles Aqueduct are used to irrigate the improved native pasture grasses in some of these areas.

The economy of the watershed is sustained by tourism throughout the year. The Inyo National Forest includes the John Muir trail and several federal wilderness areas. The LADWP owns several reservoirs, which also receive heavy recreational use.

The Long Hydrologic Area is in Mono County and encompasses approximately 380 square miles. It includes the upper reaches of the Owens River above Crowley Reservoir. Within the watershed are numerous alpine lakes at the higher elevations of the eastern Sierra Mountains. A few peaks in this watershed are at elevations of over 12,000 feet above mean sea level. Within the watershed, numerous streams flow eastward to the Owens River; the principal of which are Mammoth, Deadman, Glass, Hot, McGee, Convict and Hilton creeks. The headwaters of the Owens River are considered the “Big Springs.” An ancient volcano, known as the Long Valley Caldera, forms the topographical shape of the Long Hydrologic Unit into an elongated oval. Volcanic activity in the area is recent. Crowley Reservoir, constructed in 1941, forms the low point in the watershed. Its spillway elevation is 8,781 feet above mean sea level.

The following major landowners within the watershed manage more than 90 percent of the land area:

- US Forest Service (USFS), Inyo National Forest;
- US Bureau of Land Management (BLM), Bishop Resources Area; and
- City of Los Angeles, Department of Water and Power (LADWP).

LADWP, in consultation with the parties to the MOU and others, is identifying areas of Los Angeles-owned land, which are not included in the LORP planning area, and is developing plans to remedy problems caused by livestock grazing and other uses of the land. Priority is being given to riparian areas, irrigated meadows and sensitive plant and animal habitats. The plans 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. Each plan will contain an implementation compliance with CEQA. As plans become final, they will be presented to the Board of Water and Power Commissioners for approval and implementation.

Some of these projects are underway. At Convict Lake, a program that incorporates land management and livestock grazing activities has shown good results in establishing riparian vegetation communities to mitigate erosion and sediment runoff into Crowley Lake. Other revegetation projects are under way in Bishop, Laws, Big Pine, and Owens Lake.
**Amargosa River**

The Amargosa River watershed is in one of the driest areas of California and Nevada. Although its area is 3,000 square miles at Tecopa and about 5,000 square miles at its sink in Death Valley, it is not a major runoff-producing watershed; its mean annual runoff (at Tecopa) is only 3,000 af. The headwaters of the Amargosa River lie in the Black and Timber Mountains near Yucca in Nevada.

**Ecosystems**

**Antelope Valley**

Los Angeles County has identified several Significant Ecological Areas (SEAs) in the Antelope Valley that have unique plant communities and serve as habitat for threatened or endangered species. The areas included are 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 IRWM study area.

The US Bureau of Land Management--in conjunction with the US Fish and Wildlife Service, California Department of Fish and Game, and the cities of Lancaster and Palmdale--has 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.

**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, Harper Dry Lake, portions of Sheep Creek, and other drainages in the region.

On the Mojave River, a Cottonwood Willow habitat area is located in an area known as the Upper and Lower Narrows, which is maintained by DFG.

Near the terminus of the Mojave River, an area known as Camp Cady had thriving mesquite trees and three ponds. However, groundwater tables have fallen and the mesquite groves are drying out. DFG has purchased land on the western boundary and has initiated efforts to maintain channel flows and possibly reestablish surface ponding to maintain habitat for animals.

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

A federally designated wetland area exists at Harper Dry Lake. Tailwater from a nearby farming operation had sustained the area but that has replaced surface runoff from a solar power plant operated by FPL Energy Operating Services, for some of the marshes only. The Bureau of Land Management is considering purchasing additional land to expand the wetland area.
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 American Indian tribes.

Climate
Topography greatly impacts the climate of the South Lahontan Hydrologic Region. Due to the rain shadow-effect of the Sierra Nevada, climates in the areas east of the mountains range from hot desert to steppe. Summers are usually hot and dry and the winters are mild with very little precipitation. The foothills of the Sierra Nevada benefit from the orographic lift of storms. The summers are generally mild and the winters can be quite cold with rain and snowfall. In the south, which includes the Antelope and Mojave River valleys, summer months are hot with little or no precipitation. The winters are mild with moderate to small amounts of precipitation. All areas of the South Lahontan can be impacted by summer monsoonal thunderstorms.

Average annual rainfall amounts vary. In the valleys and hills, the annual amounts are generally less than 10 inches. In the mountains, the annual rainfall amounts range from 25 to 50 inches. Snowfall in the higher elevations is important for the runoff in the spring. Portions of the central and eastern Mojave Desert average 4 inches of precipitation annually. Death Valley receives a little less than 2 inches of rain on the average, but occasionally it can receive just a few tenths of an inch. Precipitation for the region is summarized as part of regional water uses and supplies for recent years 1998 through 2005 (see Table 10-1).

PLACEHOLDER: Table 10-1 Selected temperatures and precipitations for the South Lahontan

When compared with the long-term averages for several NWS stations in the region, annual maximum and minimum temperatures were higher between 2000 and 2005. In addition, the period was marked by several below average as well as above average precipitation years. Precipitation, mainly rainfall, was below average in 2000, 2002, and 2003, with ____ being the driest. Above-average rainfall occurred in 2001, 2004, and 2005, with totals in 2005 being the highest.

Demographics
Although the South Lahontan Region covers 16.9 percent of the land mass of the state, its total population in 2005 was 810,000, or approximately ____ percent of California’s total population. Nearly 90 percent of the population resides in the southern portion, which includes the Antelope, Apple, and Victor valleys. Urban development in these areas continues at a rapid pace. In 2007, Victorville was the second-fastest growing city in the nation. Based on projections from the Department of Finance, populations for these areas are expected to increase at the same swift pace for the next 25 years. For the remainder of the region, populations are projected to remain level or increase only slightly over the same period. Figure 10-3 provides a graphical depiction of the South Lahontan Region’s total population from 1960 through 2005, with current projections to 2050.

PLACEHOLDER Figure 10-3 Population for the South Lahontan Hydrologic Region, 1960 through projected 2050
Senate Bill 18 (Chapter 905, Statutes of 2004) requires cities and counties to consult with Native American Indian Tribes during the adoption or amendment of local general plans or specific plans. A contact list of appropriate Tribes and representatives within a region is maintained by the Native American Heritage Commission. The following is a list of the Tribes in this region, according to the commission. A Tribal Consultation Guideline, prepared by the Governor’s Office of Planning and Research, is available online at http://www.opr.ca.gov/programs/docs/09_14_05%20Updated%20Guidelines%20(922).pdf.

- Big Pine Rancheria
- Bishop Indian Reservation
- Benton Paiute Reservation
- Bridgeport Reservation (Bridgeport Indian Colony)
- Chemehuevi Reservation
- Chumash Council of Bakersfield
- Fernandeno Tataviam Band of Mission Indians
- Fort Independence Community of Paiute
- Fort Mojave Indian Tribe
- Kern Valley Indian Council
- Kern Valley Indian Council
- La Jolla Band of Mission Indians
- Lone Pine Paiute-Shoshone Reservation
- Pechanga Band of Mission Indians
- Ramona Band of Cahuilla Mission Indians
- San Luis Rey Band of Mission Indians
- Serrano Nation of Indians
- Soboba Band of Mission Indians
- Tehachapi Indian Tribe
- Timbisha Shoshone Tribe
- Twenty-Nine Palms Band of Mission Indians
- Walker River Reservation

**Land Use Patterns**

The South Lahontan region is largely desert and mountain with a history of ranching and some irrigated agriculture. In the last three decades, however, two of the region’s valleys nearest the urban population centers of Southern California have experienced accelerated growth with affordable residential housing. Otherwise, most of the region seems to have changed little in the last several decades, for the most part retaining its mix of agriculture, publicly managed parks and military bases, and occasional high-desert small towns and hamlets.

There were approximately 66,000 acres of irrigated agriculture in the South Lahontan Region in 2005, about 1,000 more than in 2000. This region’s agricultural acreage has remained fairly steady in recent years.
Figure 10-4 shows irrigated crop acres by selected categories for the South Lahontan region from 1998 through 2005.

**PLACEHOLDER Figure 10-4 Irrigated crop acres for selected categories for the South Lahontan Hydrologic Region, 1998 through 2005**

The outward expansion of the perimeters for the cities of Lancaster and Palmdale in Antelope Valley and for the cities of Hesperia, Victorville, and Apple Valley in Victor Valley continues. Agricultural land uses that existed in Victor Valley in decades past have now been replaced by urban expansion. However, the agricultural activity in Antelope Valley has continued at the same level for the past decade.

Approximately 30,000 of the region’s irrigated crop acres are located in the Owens and adjacent Eastern Sierra valleys, including Chalfant, Hammil, and Fish Lake valleys. Most acreage is alfalfa and range pasture irrigated through an arrangement with the Los Angeles Department of Water and Power. Crop acreage varies little from year to year in these valleys. With approximately 18,600 acres of irrigated crops, Antelope Valley contains a little more than a quarter of the region’s agricultural acreage. Vegetables are the number one crop in the valley, dominated by carrots, onions, and some potatoes. The valley still has 1,400 acres of deciduous orchards, most of which are peaches. Grain and alfalfa round out the valley’s crop portfolio.

The other important production area in the region is along the Mojave River. From Victorville in the south to Barstow in the north and on to Newberry Springs in the east, growers along the river have persisted in the production of 11,500 acres of alfalfa, much of it irrigated with center pivot systems.

Agricultural activities are still present in the Indian Wells Valley, although the total acres of crops continue to decline. The main area for agriculture now is north of the community of Inyokern. Many of the farms that traditionally grew alfalfa in the area south and east of Red Rock Canyon State Park have remained idle in recent years. Several hundred acres of apple orchards remain in the Tehachapi Valley, and about 1,000 acres of vegetable crops were brought into production lately.

Much of the land within the South Lahontan Region is publicly managed, including numerous parks, preserves, and recreation areas. The major public land managers are Death Valley National Park, Mojave National Preserve, Bureau of Land Management, and the Angeles, Inyo, and San Bernardino National Forests. Among several smaller park and preserve units, two of the more notable are the Mono Lake Tufa State Reserve and Red Rock Canyon State Park. The military manages some large land areas within the region, including the Naval Weapons Center China Lake, Fort Irwin National Training Center, and Edwards Air Force Base.

There are many areas within the region that are susceptible to damage from wildfires, including much of the Eastern Sierra and Owens Valley area, the relatively more heavily vegetated high desert, and the mountains to the south, including the San Gabriel and San Bernardino mountains. A number of notable conflagrations have visited the region in the recent past, including a fire in October 2003 that burned 1,000 acres of Silverwood Lake State Recreation Area, nearly the entire park. Impacts to the SWP, including to the reservoir’s future water quality are still being evaluated.
Many communities in the San Bernardino Mountains, including Lake Arrowhead, were hit by fire in October 2007. More than 12,000 acres were burned and more than 400 homes and structures were destroyed.

**Tribal Lands**

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<th>Tribal owner(s)</th>
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<td>Owens Valley Paiute and Shoshone Indians</td>
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<td>Bridgeport Reservation (Bridgeport Indian Colony)</td>
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<td>Paiute Indians</td>
</tr>
</tbody>
</table>

**Regional Water Conditions**

**Environmental Water**

Most of the environmental water demands are in the northern part of this hydrologic region and involve the restoration of the water surface elevation for Mono Lake. The required inflows are the result of several years of court litigation and have resulted in improving water surface elevations in recent years. Other demands are the current and proposed releases into the Owens River to restore flows that were previously intercepted for use in Los Angeles after 1913; the releases would also help restore surface water to Owens Lake. Environmental water use for 2005 is about ___ taf.

Some environmental water demands are met with recycled water supplies. The Piute Ponds near the Lancaster Water Reclamation Plant receive about 3,000 af annually. Victor Valley Regional Wastewater Reclamation Plant discharges about 9,000 af of recycled water supplies into the Mojave River channel to support riparian vegetation and habitat for an area managed by DFG.

**Water Supplies**

Most of the urban and agricultural water demands in the South Lahontan Region are met adequately with groundwater supplies. Water supplies are also imported into the region through the SWP; local surface water supplies such as Lake Arrowhead and Littlerock Reservoir are equally important. There are minor diversions from the Los Angeles Aqueduct in the Owens-Mono Planning Area (PA) to irrigate some of the native pasture; recycled water is utilized for agriculture and specific urban uses.

Groundwater provides about ___ percent of the average annual water supply in the region. It is used conjunctively with surface water in the more heavily pumped basins. Seventy-six
groundwater basins underlie about 55 percent of this hydrologic region. The total estimated demand met by groundwater in the region is about ______ af. Most of the groundwater production is concentrated, along with the population, in basins in the southern and western parts of this hydrologic region. Many other areas of this hydrologic region are designated as public land and have low population density. As a result, many of the groundwater basins have not been used significantly, which is why there is little data available about groundwater volume and quality.

Direct precipitation, ephemeral stream flow, infrequent surface flow of the Mojave River, and underflow of the Mojave River into the basin from the southwest recharge the Mojave River Valley basin naturally (Eccles 1981; Stamos and Predmore 1995; Lines 1996). In addition, the SWP water supplies, treated wastewater effluent, septic tank effluent, effluent from two fish hatchery operations, and irrigation waters are allowed to percolate into the ground and recharge the groundwater system. The combined storage capacity of the basins is estimated to be 25.3 maf.

The Mojave River Valley basin is included in the Mojave Basin Area adjudication. The Superior Court bound the stipulated parties to the Stipulated Judgment in 1993. Non-stipulated parties, such as the Lucerne and El Mirage basins, were bound to the judgment in 1996.

The total storage capacity of the Antelope Valley basin has been reported at 68 maf (Planert and Williams 1995) and 70 maf. For the part of the basin between 20 and 220 feet in depth, the storage capacity has been reported to be 5.4 maf (Bader 1969).

Groundwater quality is excellent within most of the principal aquifer but degrades toward the northern portion of the dry lakes areas. High levels of arsenic, fluoride, boron, and nitrates are a problem in some areas of the basin.

Ongoing court proceedings will result in a final adjudication judgment for Antelope Valley Groundwater Basin. Although there are no existing restrictions on groundwater pumping, pumping may be altered or reduced as part of the adjudication process.

The Owens Valley groundwater basin underlies Benton, Hammil, and Chalfant valleys in Mono County and Round and Owens valleys in Inyo County. The principal source of replenishment for this basin is percolation of stream flow from the surrounding mountains. Lesser sources of recharge include infiltration of excess irrigation waters and of precipitation to the valley floor, as well as underflow from Long Valley. Total storage capacity of the basin is estimated to be 30 maf and 35 maf.

The Indian Wells Valley basin is the sole source of water for the City of Ridgecrest, the communities of Inyokern and Trona, the Naval Air Weapons Station, Searles Valley Minerals, and China Lake as well as many private domestic, small water systems, and a small number of agricultural well owners.

SWP supplies for the region are used to satisfy urban and agricultural demands and for groundwater recharge. Five water agencies in the southwest portion of this region have contracts with the SWP for a total of about 250 taf of surface water annually.

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.
Antelope Valley-East Kern Water Agency (AVEK) is the largest SWP water contractor in this region and one of the largest in the state. AVEK provides water to five major municipal agencies, 16 smaller water service agencies, Edwards Air Force Base, Palmdale Air Force Plant 42, the US Borax and Chemical Facilities, and some agricultural customers. AVEK was formed to bring imported surface water from the SWP into this region.

SWP water supplies recharge the groundwater basin in the Mojave River Valley. The Mojave Water Agency (MWA) has been taking increasing amounts of its SWP contract entitlement in recent years 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 component of the water supply for the Lake Arrowhead Community Services District, which provides retail water and sewer services to the Lake Arrowhead area. In addition, Crestline-Lake Arrowhead Water Agency, a State Water Project contractor, pumps water from Silverwood Lake.

The Littlerock Reservoir has a 3,500 af capacity, provides water to Littlerock Creek Irrigation District and to Palmdale Water District (PWD), and serves urban users. PWD recently funded most of a seismic rehabilitation of the original dam (constructed in 1924) in exchange for control of the water supply for the next 50 years. Water from Littlerock Reservoir is released into a canal that conveys flows to PWD’s Palmdale Lake, which has a capacity of approximately 4,129 af.

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 City of Mammoth Lakes), which are both in Mono County.

The Los Angeles Aqueduct (LAA) is the region’s other major water infrastructure. In 1913, the initial 223-mile-long aqueduct was completed by the Los Angeles Division of Water and Power (LADWP) and began transporting water from Owens Valley to 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 modified and reduced as a result of litigation to preserve Mono Lake, to restore the lower Owens River, and to mitigate the dust problems that resulted from the diversion of water from Owens Lake.

There are eight small reservoirs in the Los Angeles Aqueduct system with a combined storage capacity of about 323,000 af. These reservoirs were built to store and regulate flows in the aqueduct. The northernmost reservoir is Grant Lake in Mono County. Six of the eight reservoirs are in the South Lahontan region; the Bouquet and Los Angeles reservoirs are in the South Coast 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.

Although most of the infrastructure of the LAA is in the region, the water supplies are mostly used in the South Coast Hydrologic Region. Small quantities from the LAA are used to irrigate some of the improved native pasture fields in the Mono-Owens area.

Figure 10-5 provides a graphical summary of all the water supply sources that are used to meet the developed water resources in this hydrologic region for years 1998 through 2005. The water balance data shown in Table 10-3 summarizes the detailed regional water accounting contained in the water portfolio data sets for years 1998 through 2005. These tabulated water supplies and uses
provide a comparison of how the patterns of water use and distribution can change from a very wet year to a dryer year, and for an average water year.

**PLACEHOLDER Figure 10-5 Water supplies for the South Lahontan Hydrologic Region water balance for water years 1998–2005**

**PLACEHOLDER Table 10-3 South Lahontan Hydrologic Region water use and distribution of dedicated supplies (taf), 1998–2005**

**Water Uses**

Total applied water demands in the South Lahontan Region were __________ taf in 2005. About ______% of this demand occurred in the Antelope Valley and Mojave River Planning Areas. This is a slight increase in demands from 2000 which was ______ taf.

The total applied water demands for urban, agriculture, and the environment were met separately with groundwater, SWP, surface, and recycled water supplies, or through a combination. Groundwater supplies met ____ percent of the demands in 2005, while SWP met ____ percent, surface water met ____ percent, and recycled water met ____ percent.

The water supply sources that are used to meet these urban demands are different in parts of the region. In the northern portions of the region, some water agencies located in the foothills of the Sierra Nevada utilize surface (or 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 Antelope Valley, water agencies are using groundwater, SWP water supplies, or a blend. In many of the small urban areas scattered throughout the region, demands are met with groundwater.

The use of recycled water supplies to meet urban demands is limited. Recycled water is used in human-made lakes at Apollo Park in the City of Lancaster.

Agricultural water demands for the region were _____ taf in 2005. This is a slight increase from 2000, which had demands of ______ taf. Almost half of the demands occurred in the Owens-Mono Planning Area.

Groundwater supplies are used to meet most of the agricultural demands. In the Mono and Owens valleys, water supplies from the Los Angeles Aqueduct are sometimes used for flood irrigation of fields of improved production of native pasture grass. In the Antelope Valley region of Los Angeles County, AVEK delivers SWP water supplies to some of the farms adjacent to the aqueduct. In addition, treated water from the Palmdale Water Reclamation Plant and Lancaster Water Reclamation Plant, owned and operated by County Sanitation Districts of Los Angeles County, supplies recycled water for 3,230 acres of feed and fodder crops.

In the northern part of the South Lahontan region, the town of Mammoth Lakes provides surface and groundwater sources to a permanent population of about 5,000. However, this is somewhat misleading in that the city may have a daily population of about 13,000 and peak weekend and holiday period population of up to 30,000 people per day due to the influx of travelers and recreational enthusiasts. In popular tourist destinations, this pattern of peak population and water use that is several times the permanent base level is a common water supply and distribution problem.
Water use efficiency programs are equally important for the urban users in the region. Many of the water districts are implementing or have plans to implement water use efficiency programs.

The kinds of conservation programs fall into the categories of public information and customer assistance. Many of the water districts serve as a source of information on the management and issues regarding statewide and local water resources. This includes published literature on landscape and general conservation tips, homeowner workshops, and demonstration gardens.

Many of the local water agencies are either implementing or planning to implement customer assistance programs in their service areas. These include residential home audits, large landscape programs, and rebates for ultra-low-flow toilets (ULFT), high efficiency toilets (HET), and water and energy efficient washing machines. The Rosamond Community Services District offers comprehensive water audit services for single and multi-family dwellings and for facilities with large landscape (greater than 3 acres) areas. During audits of large landscape areas, the district checks for leaks and broken sprinklers in the irrigation system, measures system uniformity, and evaluates automatic control settings.

Some water use efficiency has been achieved through compliance with local building codes. With the construction of new residential and commercial continuing in the southern half of the region, water efficient fixtures have been and are being installed in each building. These include ULFTs and water efficient faucets and showerheads. Landscaping is also required to comply with local building codes.

For this region, the predominant crops are alfalfa and irrigated improved and native pastures. Sprinkler systems are commonly used to deliver the water supplies to these crops. Flood irrigation is used for the improved and native pasture grass fields in the Owens Valley and Mono Basins. The kinds of sprinkler systems range from the hand move, side-roll, linear-move to center-pivots with the latter two systems possessing the potential for high water application efficiency. Growers in these counties usually schedule spring and summer irrigations during early morning or evening to avoid high surface evaporation from high daytime temperatures and high wind conditions. This procedure also saves some energy.

The remaining harvested crops in the Antelope and Owens valleys and along the Mojave River are mainly truck crops (such as carrots and onions). These crops are usually irrigated by hand move sprinklers, which are more efficient than the traditional furrow irrigation.

**Water Quality**

The quality of the limited surface water is excellent in the South Lahontan Region and 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 closed groundwater basin environments) 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:

- 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 contain elevated levels of minerals (for example, total dissolved solids, arsenic, or fluoride).
• 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. A very large groundwater containment zone at Edwards Air Force Base (AFB) will require groundwater monitoring for many decades, or centuries.
• Minimizing the loss of assimilative capacity in aquifers affected by multiple land uses.

**Antelope Valley**

The quality of the groundwater supplies from the Antelope Valley groundwater basin is good. The concentration of total dissolved solids ranges from 200 to [ ] mg/L. There are some concerns about arsenic and nitrates in the groundwater.

Arsenic concentrations above 10 mg/L have forced the Los Angeles County Waterworks District (Lancaster) to put 6 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 due to the agricultural operations in the area.

**Mojave River Valley**

Arsenic, nitrates, iron, manganese, chromium VI, petroleum hydrocarbons, and volatile organic compounds have been detected in the groundwater supplies in the Upper, Middle, and Lower Mojave River Valley groundwater basins. Salt concentrations have also been observed.

Elevated nitrate concentrations and TDS have been measured in the groundwater beneath dairy waste disposal operations in the region. Water supply reservoirs were also constructed adjacent to the older operations. Fertilizers have been measured in the wells and reservoirs near these operations.

**Water Governance**

**Adjudication**

The adjudication judgment for the Mojave Basin governs the pumping of groundwater in the Mojave River Valley. Groundwater basins bound by the judgment include the Upper Mojave River, Middle Mojave River, Lower Mojave River, and El Mirage.

The judgment assigns base annual productions for each groundwater producer using 10 or more acre-feet annually. The allocations were based on historical production. The users are assigned a variable free-production allowance, which is a uniform percentage of the base annual production. The percentage decreases over time until the free production allowance is equivalent to the available groundwater supplies. Any producers that pump more than their share of the free production allowance are obligated to purchase replenishment water from the Mojave Water Agency equal to the over-pumping.

**Source: Mojave Water Agency – 2005 Urban Water Management Plan.**

The Antelope Valley groundwater basin continues to move towards a final judgment order. The Superior Court recently ruled on the boundaries of the basin bound by its adjudication judgment.
Flood Management

Historic Floods
In the South Lahontan region, winter storms generally create the greatest flood damage. Most streams in the region are intermittent in their lower reaches, which have steep channel bed slopes and little vegetation. Sediment loads are often dominated by coarse-grained materials. These often result in flash floods and dangerous debris flows. Severe local damage may be sustained when thunderstorms generate floods upstream of an urban development.

The region’s more flood-significant streams are the Mojave and Amargosa rivers and Bishop and Deep creeks. The flood parameters for each are presented in Table 10-x Flood parameters for principal streams in Appendix 10A.

No records of flow and damage exist for floods in the South Lahontan Region before 1938; however, significant floods occurred in 1938, 1943, 1959, 1969, 1989, and 2008. For more information on these floods see Appendix 10A Flood Management.

Flood Hazards
Storms in the South Lahontan region tend to be intense. Streambeds are rocky with little vegetative cover, causing runoff to peak and recede quickly. Flash floods can surprise unwary visitors and residents. Intermittent water erosion, as well as more continuous wind erosion, takes a heavy toll on the topsoil throughout the area. Some land treatment measures have been implemented in the Antelope Valley, where limited irrigation water is available.

Flood Governance
Flood management is a cooperative effort for which federal, state, and local agencies all play significant parts. The principal participants are listed in Box 10-3 Flood Management Agencies. For more information on the agencies’ roles, see Table 10A-2 Flood management participants in Appendix 10A.

<table>
<thead>
<tr>
<th>Federal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Emergency Management Agency</td>
</tr>
<tr>
<td>US Geological Survey</td>
</tr>
<tr>
<td>US Army Corps of Engineers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>California Conservation Corps</td>
</tr>
<tr>
<td>Department of Corrections</td>
</tr>
<tr>
<td>Department of Forestry and Fire Protection</td>
</tr>
<tr>
<td>Department of Water Resources</td>
</tr>
<tr>
<td>Office of Emergency Services</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>County emergency services units</td>
</tr>
<tr>
<td>County planning departments</td>
</tr>
</tbody>
</table>
Flood Risk Management

Flood protection in the region is provided by structures, emergency response systems, land use regulations, and flood insurance programs.

**Structural Approaches**

**Constructed Facilities**—The Oro Grande Wash Channel Project (1969) consists of inlet levees and a concrete channel extending from the southeast limits of Victorville to the Mojave River. It protects Victorville from all but very large floods.

The Mojave River Dam (1971) is a multipurpose project about 14 miles upstream from Victorville on the Mojave River. It can impound 89,700 af. The dam protects about 19,000 acres of agricultural lands, as well as Barstow and Victorville, from floods; conserves water by recharging downstream groundwater basins; and provides recreational facilities.

Engineered channels and retention basins on Amargosa Creek and a flood retention basin along Anaverde Creek protect Palmdale and Lancaster from floods up to a 20-year frequency.

**Coordination of Flood Operations**—Mojave River Dam is an ungated flood control structure operated and maintained by the USACE. It is designed to moderate an inflow of 94,000 cfs to a maximum outflow of about 23,500 cfs. All inflows are released from the reservoir through the outlet tunnel. The outlet works do not include any mechanical equipment that would permit adjustment to outflows.

During heavy rains or high discharges from the Mojave Dam, USACE is in continuous communication with the San Bernardino County Flood Control District and the San Bernardino County Emergency Services is on continuous alert. The county may warn and evacuate people located in hazardous areas.

**Maintenance**—[Placeholder]

**Land Use Management**

**Floodplain Function Restoration**—[Placeholder]

**Regulation**—In 1966, San Bernardino County adopted an ordinance to regulate development in Swarthout Creek, Mojave River and Forks Reservoir, Silverwood, and Green Valley. In 1974, Kern County adopted general floodplain zoning ordinances and a review system for building permits.

Following severe flooding in Antelope Valley in 1980, 1983, and 1987, the LADPW prepared a comprehensive plan of flood control for the valley. The plan proposed floodplain management in the hillside areas; structural improvements in the urbanizing areas, including open channel conveyances and storm drains through communities, and detention and retention basins at the...
mouths of the large canyons; and non-structural management approaches in the rural areas (LADPW 1987). However, the county has limited revenue to fund the construction. Both the City of Palmdale and the City of Lancaster have incorporated major elements of the LADPW plan into their own planning efforts.

Regulated floodways are listed in Table 10x (Regulated floodways in the South Lahontan Hydrologic Region) in Appendix 10A.

**Flood Insurance**—The quality of available floodplain mapping is critical to administering an effective flood insurance program. DWR’s Awareness Floodplain Mapping project provides a simplified way to view flood-prone areas. Currently, floodplains have been delineated for several areas in Inyo, Mono, and Los Angeles counties; all remaining areas both lacking maps and expected to develop in the next 25 years will have floodplains demarcated by 2012.

FEMA has drawn Flood Insurance Rate Maps (FIRMs) for the entire hydrologic region. Most FIRMs for Inyo, Kern, and Los Angeles counties became effective in the 1980s; maps for the portions of Mono and San Bernardino counties within the South Lahontan area became available in the 1990s. Updated FIRMs should become effective for Los Angeles, Kern, and San Bernardino counties by the end of 2008.

There are five counties or partial counties and 12 cities in the South Lahontan region. Counties participating in the National Flood Insurance Program Community Rating System are ___, with a rating of ___, etc. Currently, none of the cities participate.

**Disaster Preparation, Response, and Recovery**

**Information and Education**—Accurate hydrologic and hydraulic models support the design of effective flood control structures and emergency actions before, during, and after floods. To forecast river flows, NWS’s Advanced Hydrologic Prediction Service uses historical data current river and watershed conditions, as well as near-term meteorological outlooks. The service is publicly available for a number of locations within the Mojave River watershed as shown in Table 10-x Advanced hydraulic prediction service stream forecast points in Appendix 10A.

**Event Management**—Routine flood forecasting is considered impractical in the South Lahontan Hydrologic Region because floods are generally produced by thunderstorms that cause almost instantaneous rainfall over isolated watersheds. Runoff from this type of storm can be devastating for a short period of time; however, the National Weather Service distributes flash flood warnings when region-wide internal storm patterns or thunderstorm activity warrants.

In general, flood emergency response begins with the local level and then escalates through the county (Operational Area), OES region, and OES headquarters DWR and USACE provide support throughout the event. Details of the procedures for flood preparedness, emergency response, and recovery are discussed in Volume 2 Resource Management Strategy on Flood Risk Management. Table 10A-x Flood emergency response organizations in Appendix 10A lists specific response organizations.

Recovery after a moderate flood event may involve the funding and construction services of USACE if the facilities are parts of federal projects. The severity of the event and the allocation of event-specific federal or State funds determines the availability of resources to repair local and private facilities; remove flood waters; and restore housing, business, and infrastructure.
**Relationship with Other Regions**

While most of Mojave Water Agency’s service area is in the South Lahontan 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, which has an allocation of up to 4,282 af of MWA’s surface water from the SWP; Joshua Tree (Joshua Basin Water District) which has an allocation up to 1,959 af; a County Service Area with an allocation of 73 af; and the Bighorn-Desert View Water Agency with an allocation up to 653 af.

Surface water is exported from the Owens and Mono portions of South Lahontan Hydrologic Region to the South Coast Hydrologic Region by LADWP using the Los Angeles Aqueduct. Recent exports through these facilities to the South Coast region were __________ taf in 2002, __________ taf in year 2003, __________ taf in 2004, and __________ taf in 2005.

**Regional Water and Flood Planning and Management**

**Integrated Regional Water Management**

Most of the population for the South Lahontan Region is represented by two IRWM planning regions: Antelope Valley and Mojave Water Agency. The area outside of the regions represents opportunities for additional planning efforts. Because these plans are living documents, new regions may be formed or existing regions may be modified. Table 10-4 and Figure 10-6 present the current IRWM planning regions within the hydrologic region.
## Table 10-4 Strategies of Integrated Regional Water Management efforts, South Lahontan Hydrologic Region

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Antelope Valley IRWMP Jan 2008</th>
<th>Mojave Water Agency IRWMP Feb 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conjunctive water use</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Desalination of Imported water</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Describe current and projected water demands</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Develop computer model for water management and watershed planning</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Ecosystem restoration</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Environment and habitat protection and improvement</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Flood management</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Implement groundwater management plan</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Implement urban water management plan</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Land use planning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonpoint source pollution control</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Recreation and public access</td>
<td></td>
<td></td>
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<tr>
<td>Storm water capture and management</td>
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<td></td>
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<tr>
<td>Study natural and imported water supplies</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Summarize water shortage contingency plan</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Surface storage</td>
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<td></td>
</tr>
<tr>
<td>Take 60 regional water management actions</td>
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<td>✓</td>
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<tr>
<td>Water and wastewater treatment</td>
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<td></td>
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<tr>
<td>Water conservation</td>
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<td>Water quality protection and improvement</td>
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<td>Water recycling</td>
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<td>Water supply reliability</td>
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<td>Water transfers</td>
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<tr>
<td>Watershed planning</td>
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<td></td>
</tr>
<tr>
<td>Wetlands enhancement and creation</td>
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</tr>
</tbody>
</table>
The Mono-Inyo IRWM Plan has been under development; when completed, it will cover the areas between the Antelope Valley IRWM Plan and the Tahoe Sierra IRWM Plan. Meanwhile, the Lower Owens River Project, Invasive Species Control, and Land Management Improvement Project in Owens Valley have been continued over the past years to deal with the water resources and environmental restoration in the region.
In the Indian Wells Valley, the Indian Well Valley Cooperative Groundwater Management Group (IWVCVMG) recently completed a second project funded by an AB303 grant. The primary objective of this project was to address data gaps in areas along the western and southwestern portions of the valley that were identified in the first AB303 report and to better quantify recharge into the basin in this area. A groundwater model of the basin is being developed through a cooperative effort of the Indian Wells Valley Water District, the Navy, and Searles Valley Minerals. The Indian Wells Valley Water District is currently conducting a reconnaissance level aquifer storage and recovery site evaluation and will soon begin a brackish water treatment pilot study in the Northwest Well Field.

Three partners are participating in the Rosamond-Semitropic Water Bank in the Antelope Valley: Rosamond Community Services District, Semitropic Water District, and Western Development. The water bank will be on property that was owned privately and will store an estimated 500,000 af of water that can be used if either Northern or Southern California experience a dry year. The bank will also serve as a backup if the Aqueduct supply is interrupted by something such as an earthquake on the San Andreas Fault or failure of the levees in the Sacramento-San Joaquin Bay Delta.

**Accomplishments**

The Los Angeles County All-Hazard Mitigation Plan was adopted in 2004, the Kern County California Multi-Hazard Mitigation Plan was adopted in 2005, the San Bernardino County Operational Area Multi-Jurisdictional Hazard Mitigation Plan in 2005, and the Mono County Multi-Jurisdictional Local Hazard Mitigation Plan in 2006.

**Owens River and Mono Basin.** The Los Angeles Department of Water and Power is involved with many restoration projects for the Owens River and Mono Basin. The agency continues in 1993, LADWP began final flow releases to restore Mono Lake to a water surface elevation of 6,392 feet. By 2003, Mono Lake elevation had reached 6,382, a level where LADWP can export 16,000 af per year. LADWP has developed plans to help ranchers manage grazing practices in the Crowley Lake tributary area.

The Lower Owens River Project (LORP) is 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 Inyo County's Owens River for export to Los Angeles, effectively drying up most of the 62 miles of the river below the LA Aqueduct intake. Now after 90 years, water once again has begun to flow. The LORP has reestablished a permanent river flow down the historic 62 mile channel, reviving its riparian habitat and providing a warm water fishery.

The 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 Owens Gorge Rewatering Project has been significant in the reestablishment of 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.

To mitigate the impacts on air quality in the lower Owens Valley, LADWP is shallow flooding approximately 15 square miles of the dry Owens Lake bed to help decrease the quantity of alkali
particles that could become entrained in the air during wind storms. In addition, about 3.5 square miles of managed vegetation (saltgrass) has been established on the lakebed for dust control. Additional areas will be flooded and ponds will be constructed to bring the project area to about 35 square miles.

**Mojave River.** The Mojave River groundwater basin has been in overdraft since the early 1950s, which led to entry of a court judgment in 1996 and the appointment of the Mojave Water Agency as the basin watermaster. Implementation of the judgment has resulted in the purchase of replacement water imported from the SWP to offset overdraft, primarily in the Victor Valley area.

In 1997, MWA began construction of the 75-mile Mojave River Pipeline, with 67,900 af per year capacity, to bring imported water to the Barstow area and neighboring communities downstream to the Newberry Springs area. In 2006 this 75-mile pipeline was completed and connected to a recharge facility near the community of Newberry Springs. Recharge facilities have also been built along the Mojave River near the communities of Hodge, Lenwood, and Daggett.

Additional studies on the condition of the groundwater basin in the MWA service area include the Transition Zone Final Report – Phases I and II, and the Este Sub-basin Hydrogeologic Investigation. MWA is also developing a geohydrologic model for the upper Mojave River Basin. The model will reflect regional geology and hydrology but will also provide more discrete modeling for the area to be used for the Regional Recharge and Recovery Project.

Eighteen water agencies have signed a memorandum of understanding with MWA to participate in the regional Water Conservation Incentive Program (WCIP) offered by MWA. The $500,000 program offers three incentives (high efficiency toilets, high efficiency washers, and cash-for-grass) to eligible customers. 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 one. It was also designed to augment the programs for water agencies that offered conservation incentives.

As part of the goal to improve the water infrastructure in its community, the Hi-Desert Water District is working on a groundwater recharge and reuse project. This project includes recharge sites recently constructed and the drilling of a new production well. This new well project will allow the district to increase water production capacity between 800 to 1,500 gallons per minute. In addition to the increased capacity, this well will increase reliability of water service for years to come.

In addition to the IRWM and urban water management plans, important planning studies in the Antelope Valley examined the feasibility on recycled water use and potential groundwater recharge sites. This includes a City of Lancaster study to determine the feasibility of recharging the groundwater basins with recycled water supplies.

The Los Angeles County Waterworks District has an aquifer storage and recovery project where they injected water supplies into the groundwater basin. In 2006, six wells were utilized and water was injected at a rate between 2,500 and 3,000 gpm. The project may expand to 15 wells in the future.

A groundwater-banking project that could store approximately 60,000 af has commenced on property owned by the Tejon Ranch in the Antelope Valley. The company is interested in signing agreements with water districts and other businesses that would like to bank water supplies.

[Source: Antelope IRWM Program. Prop. 50 Round 2 Step 1 Grant Application.]
Challenges

Flood Issues
Flood management challenges exist in the Antelope Valley. Key issues include:

- Leveed 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 and 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 operations area.

Water Quality
Runoff from agricultural fields and operations and agricultural return flows convey excess nutrients and pesticides to ground and surface waters. Elevated nitrate and TDS levels have been reported beneath dairy waste disposal operations. Excess nutrients in surface waters increase algal growth, which degrades water quality, while pesticides are known endocrine disrupters. Groundwater that has been contaminated requires expensive treatment before it can be used by municipalities.

Mojave River Valley
The continued urbanization of the Mojave River Valley is projected to create a deficit between existing water supplies and urban and agricultural uses by 2020. The IRWM planning process will need to provide strategies to develop alternative supplies that would bridge that gap.

The reliability of SWP supplies is important in the development of water management strategies for the region. Strategies would have to take into account system constraints such as short- and long-term limits to Delta exports and the competition for available supplies, as well as periodic dry hydrologic conditions.

Strategies are needed to stabilize the local groundwater tables. The lowering of the groundwater table in some areas has lead to the drying of wells and land subsidence. It is also impacting riparian vegetation along the Mojave River.

Groundwater quality issues need to be addressed. Key contaminants include arsenic, nitrates, iron, manganese, Chromium IV, petroleum hydrocarbons, and volatile organic compounds. In addition, TDS levels have become important issues. Salts are being added to the groundwater supplies when imported SWP water supplies are used to recharge basins and when treated urban wastewater is discharged and percolated.
**Antelope Valley**

Within the Antelope Valley, the recent acceleration of industrial and residential activity that has stimulated demand for both more water and higher quality water is a challenge to water managers and stakeholders in the Region. Complicating this challenge is the impact on water supply reliability in California that is being affected by both the 2007 ruling regarding the protection of delta smelt, and the effects of climate change.

Potential impacts of climate change are presented for the SWP and for the Sacramento-San Joaquin Delta, both of which are related to the Antelope Valley Region’s imported water supplies. Since much of the Antelope Valley relies on imported SWP supplies as part of its overall supply mix, any reduction or change in the timing of availability of those supplies could have negative impacts on the water supply of the region. Reductions in the quantity of SWP water available would force AVEK and Palmdale Water District to rely more heavily on local groundwater and local surface flows, or other sources of imported water. It is possible that local surface flows could also be reduced by changes in snowpack altitude levels and/or quantity of snowpack in the mountains from global warming, which would reduce natural recharge, thus exacerbating groundwater availability problems.

Another challenge, and potential obstacle to implementation of the Antelope Valley IRWM Plan, is the pending adjudication of the Antelope Valley Groundwater Basin. The IRWM Plan’s water supply analysis is based on assumptions about the availability and reliability of the groundwater supply; it was used to identify specific objectives and planning targets for the IRWM Plan. It is possible that the outcome of the adjudication may require a change in the assumptions as well as the objectives and planning targets, which may delay implementation of the IRWM Plan. Additionally, the adjudication may place limitations not currently considered on the groundwater banking and recharge projects included for implementation.

**Palmdale Water District**

Approximately 60 percent of the district’s supply comes from surface water and the rest from wells. In wet years, when supplies are plentiful, the water district can take 100 percent of its entitlement from the State Water Project, which amounts to 21,300 af. Water from the aqueduct is stored in Palmdale Lake.

Strategic planning is now under way by local agencies in the Antelope Valley to implement the recommendations identified in the Antelope Valley Integrated Regional Water Management Plan. The document proposes solutions to increase water supplies and strategies to increase water use efficiency.

Another project the MWA is funding is a pipeline and recharge basins for groundwater recharge in the Oro Grande Wash. The MWA is involved in the second year of a program to remove invasive non-native plant species from the Mojave River floodplain, and the second year of a water conservation incentive program.

The Mammoth Community Water District (MCWD) is collaborating with several organizations to finalize an EIR that recommends a preferred bypass flow alternative for Mammoth Creek. The bypass would permit the agency to continue to deliver water to several customers, preserve and protect the habitat and fishery of the Creek, and maintain the quality of the water.
Drought and Flood Planning

San Bernardino County Flood Planning Division’s main responsibilities are advance planning and preparing the flood control district’s budget. Planning items include investigations and project studies; preparing annual reports, special reports, and studies; preparing and reviewing Master Plans of Drainage; documenting flood overflows and damages; and preparing and updating district master planning maps, exhibit maps, and displays.

Because the flood control district is so large and many of the drainage issues are more localized, Master Plans of Drainage or Comprehensive Storm Drain Plans are created to evaluate the existing drainage systems, identify deficiencies, and recommend improvements and new facilities in an area. Maps are available for San Bernardino Valley, High Desert, Barstow, East Desert, and Needles.

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 proffer methods for reducing flood risks in their respective boundaries.

In addition, water districts in the region have water supply shortage contingency plans that can be implemented to mitigate the impacts of short- and long-term water shortages. The Palmdale Water District and Indian Wells Water District have specific plans that establish emergency command teams; coordination procedures with local law enforcement, fire, medical, and other services; communications procedures; and stages of action.

Quagga Mussels

Water supplies, especially the imported and local surface, in the region have not yet become infested with the quagga mussels, a non-native species that clogs water pipes and pumps. Increased costs will occur for the clean-up and more-frequent inspections of water supply facilities that do become infested and for public education on the problem.

Looking to the Future

To address the needs of expanding urban areas 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 Mojave Water Agency and Antelope Valley East Kern Water Agency have several projects underway that would achieve some of water management objectives identified in their respective IRWM plans. MWA is moving forward with the planning (including EIR preparation and approval) and administrative and legal exercises for two groundwater recharge projects: the Mojave River Well Field and Water Supply Pipeline Project and the Oro Grande Wash Recharge Ponds North of the Aqueduct.
In addition, MWA has partnered with other local entities to form the Alliance for Water Conservation and Awareness Urban Water Conservation Plan to increase the awareness of the public on water use efficiency and intensify water use efficiency program efforts to achieve regional water supply savings of 10 percent by 2010.

A SWP water exchange program between MWA and the Metropolitan Water District of Southern California is under consideration. MWA estimates that it may have as much as 400,000 af of unused SWP water supplies between now and 2020. In the proposal, MWD would deliver between 18,000 and 65,400 af annually to MWA. During the years that it needs supplies, MWD would utilize MWA’s SWP supplies for that year.

In the Antelope Valley, several projects that are a part of the overall objectives of the area’s IRWM will be completed in the near future. This includes the upgrades of two water reclamation plants, groundwater recharge, and ecosystem rehabilitation. The multi-phased upgrade of the Lancaster Water Reclamation Plant is underway and the Palmdale WRP upgrade is in the design phase. When complete, both plants will be able to treat more wastewater effluent flows, provide activated sludge treatment with tertiary filtration and disinfection of the effluent, and store and deliver recycled water supplies to local businesses and farming operations.

In addition, AVEK is moving forward with plans to build a groundwater recharge operation in the central portion of the Antelope Valley. Once completed and in operation, the project will help slow the decline of groundwater tables and will mitigate the impacts from short- and long-term decreases in SWP water supplies caused by dry hydrologic conditions, natural and man-made disasters, and regulations.

**Future Scenarios**

Models need to be developed for the impacts from short- and long-term reductions in SWP supplies caused by climate change, droughts, natural and human-made disasters, and regulations. These models will give water planners in AVEK and MWA extra tools and projections to help develop comprehensive and effective water management strategies for their service areas.

**Climate Change**

The SWP analysis presents potential impacts on SWP operations, including reservoir inflows, delivery reliability, and average annual carryover storage, as well as many other operational parameters. The analysis assumes forecast levels of climate change in year 2050, with 2020 land use levels. Some of the main impacts include changes to south of Delta Table A Amount deliveries (from an increase of about 1 percent in a wetter scenario to about a 10 percent reduction for a drier climate change scenario); increased winter runoff and lower Table A allocations in the three driest climate change scenarios; lower carryover storage in drier scenarios; and higher carryover storage in a wetter scenario.

Reductions in the quantity of SWP water available would force AVEK and Palmdale Water District to rely more heavily on local groundwater and local surface flows, or on other sources of imported water. It is possible that local surface flows could also be reduced by changes in snowpack altitude levels or quantity of snowpack in the mountains from global warming; this would reduce natural recharge and exacerbate problems with groundwater supplies.
Climate change may also impact the nature of brush fires in the region. Drier than average conditions may result in an increase in the frequency of fires and area consumed. Primary and secondary impacts caused by the fires include damage to an existing watershed, changes in surface runoff and percolation, and the economic impacts on the area.

The effects on floods in the South Lahontan region from climate change could be substantial. Hydrographs for streams and river that drain the eastern Sierra Nevada could exhibit shorter lag times and higher river stages due to a decrease in the snow-to-rain ratio. Consequently, exceedance probabilities would rise for given flows while summer base flows would decrease. Thus the probability of flooding in towns in the Owens Valley could be greater. However, sparse development in the region precludes catastrophic flood damage over a widespread area.

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 snowpacks in these mountains are smaller, due to their southern locations, and lower peak elevations; however, the population and urbanized area are greater. While hydrograph changes due to the reduced snowpacks are projected to be smaller, relative to those in the Sierra Nevada range, impacts from the higher exceedance probabilities on these urban areas could be equally or more severe in the San Bernardino and San Gabriel ranges.

Wildfires could have a significant role in the future. If annual precipitation and snowpacks decrease in the region, the likelihood of and destruction caused by wildfires could be more significant. Frequent fires 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. It could lead to greater channel incision by the debris-laden runoff, which would be detrimental to riparian communities, aquatic organisms, and flood control.

Response Strategies

MWA is actively engaged or studying proposals to replenish the groundwater supplies in the Mojave River Valley. The agency has an entitlement exchange agreement of SWP water supplies with the Solano County Water Agency. MWA will receive additional supplies during wet hydrologic conditions in the State when the SCWA has approved entitlement in excess of its needs. During dry conditions, the SCWA will be able to utilize some of MWA’s approved entitlement, but not more than half of the quantity delivered to MWA from SCWA.

Implementation Next Steps

Water Portfolios from 1998–2005

PLACEHOLDER: Table 10-5 South Lahontan Hydrologic Region water portfolio (taf)

PLACEHOLDER: Figure 10-7 South Lahontan Hydrologic Region—illustrated water flow diagram

PLACEHOLDER: Figure 10-8 South Lahontan Hydrologic Region —schematic flow diagram