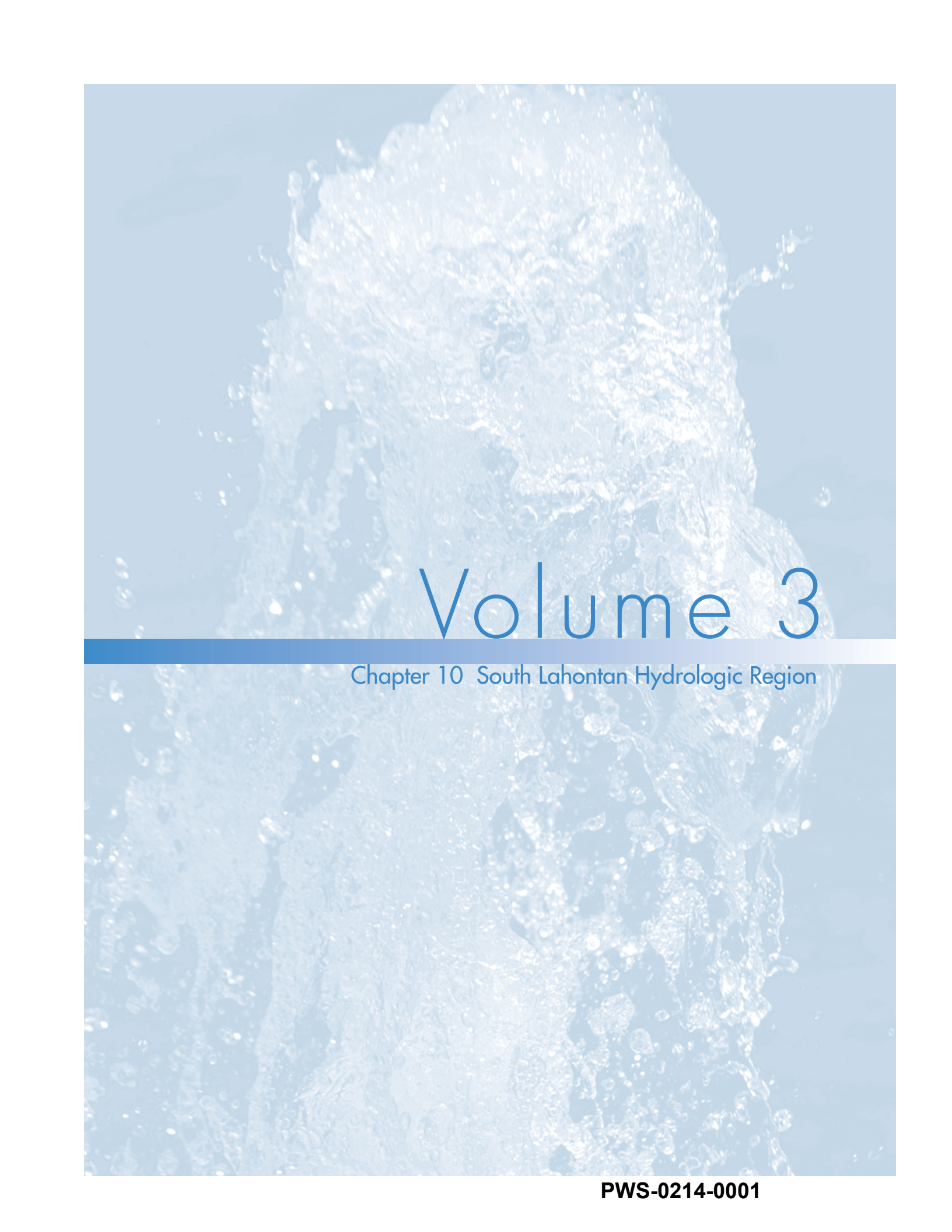


The background of the entire page is a high-speed photograph of water splashing, creating a dense field of white bubbles and droplets against a light blue background. The splash is centered and extends from the top to the bottom of the frame.

Volume 3

Chapter 10 South Lahontan Hydrologic Region

Chapter 10 South Lahontan Hydrologic Region

Contents

Chapter 10 South Lahontan Hydrologic Region	10-1
Setting	10-1
Climate	10-1
Population	10-2
Land Use	10-2
Water Supply and Use	10-2
State of the Region	10-5
Challenges	10-5
Accomplishments	10-8
Relationship with Other Regions	10-9
Looking to the Future	10-9
Regional Planning	10-9
Water Portfolios for Water Years 1998, 2000, and 2001	10-11
Water Year 1998	10-11
Water Year 2000	10-11
Water Year 2001	10-11
Selected References	10-12

Boxes

Box 10-1 Death Valley Temperatures	10-1
Box 10-2 Mojave River Adjudication	10-9

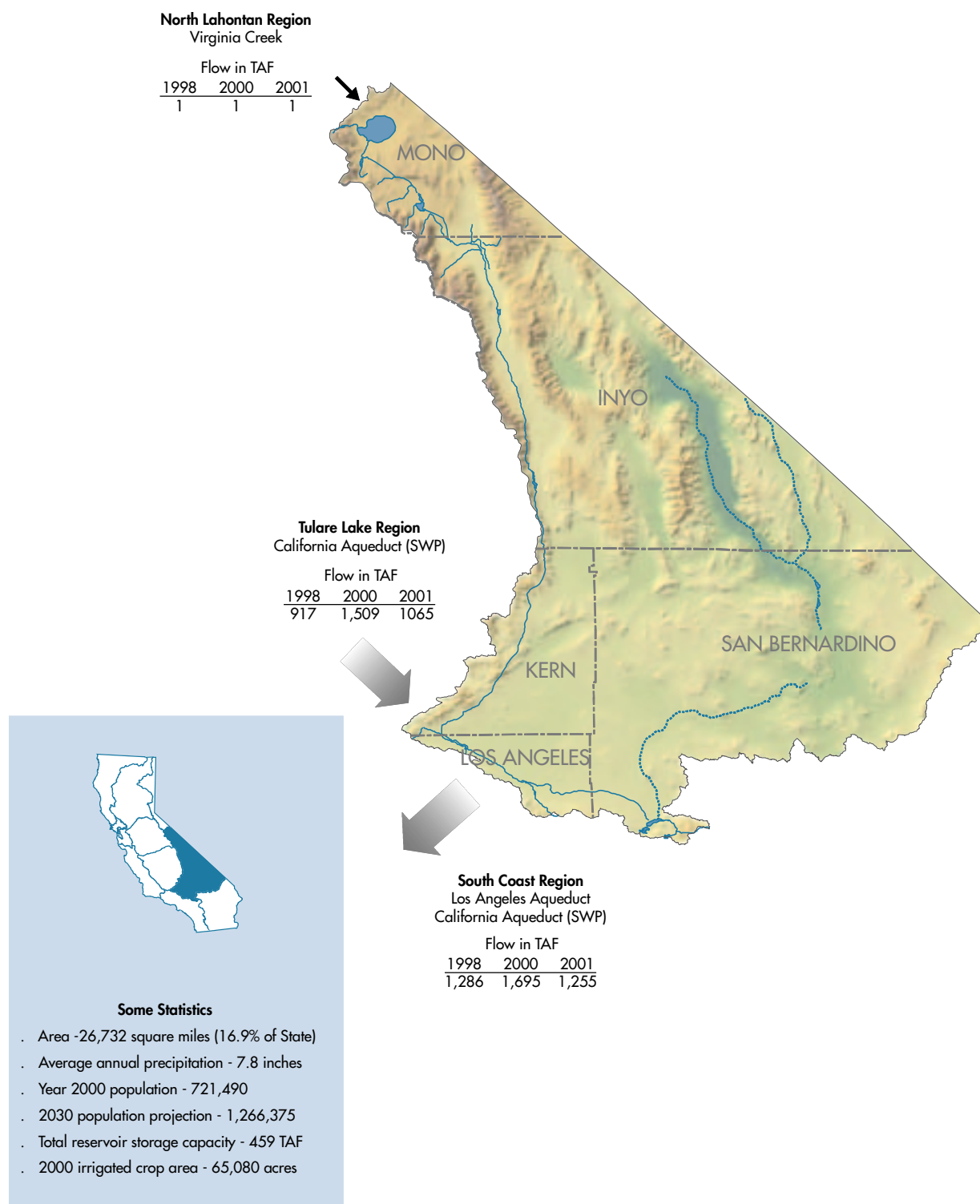
Figures

Figure 10-1 South Lahontan Hydrologic Region (map)	10-ii
Figure 10-2 South Lahontan Hydrologic Region population	10-4
Figure 10-3 South Lahontan region water balance for water years 1998, 2000, 2001 (2 bar charts)	10-6
Figure 10-4 South Lahontan region - illustrated water flow diagram	10-15
Figure 10-5 South Lahontan region - schematic flow diagram	10-16

Tables

Table 10-1 South Lahontan Hydrologic Region water balance summary	10-3
Table 10-2 South Lahontan Hydrologic Region water use and distribution of dedicated supplies	10-7
Table 10-3 South Lahontan region water portfolios	10-14

Figure 10-1 South Lahontan Hydrologic Region



The South Lahontan Hydrologic Region contains the Eastern Sierra and the Mojave Desert and includes both the highest point (Mount Whitney) and lowest point (Death Valley) in the lower 48 states. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

Chapter 10 *South Lahontan Hydrologic Region*

Setting

Although the South Lahontan hydrologic region brings to mind images of desert with Joshua trees, sand dunes, and dry lakes, it also contains the glacier-carved topography of the eastern slopes of the Sierra Nevada and the eastern slopes of the San Gabriel and San Bernardino mountains. The northern half of the region includes Mono Lake, Owens Valley, Panamint Valley, Death Valley, and the Amargosa River Valley. The Mojave Desert occupies the southern half of the region, and is characterized by many small mountain ranges and valleys with playas, or dry lakes. 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. The region includes all of Inyo County and parts of Mono, San Bernardino, Kern, and Los Angeles counties (Figure 10-1).¹

The South Lahontan region has fewer permanent rivers and streams due to the dryer hydrology on the east side of the Sierra Nevada. The largest river in this region is the Owens River, which flows from north to south over the length of Owens Valley. This river drains both the east side of the Sierra Nevada and the western slopes of the White Mountain range, and flowed into Owens Lake until 1913, when most of its flow was diverted for use in Los Angeles. Another important river in the region is the Mojave River. Although seldom seen flowing on the surface, it has significant underground flow that supports nearly all the groundwater-supplied agriculture and urban population in the Mojave River Valley. The Amargosa River is the only other significant river in the region, but it only generates surface flows during flash floods and does not serve

any significant agricultural areas. The floodwaters eventually flow south to a low-lying area near Silver Lake and Soda Lake, which is also the terminus for the Mojave River.

Climate

The climate of the South Lahontan region is generally arid. Annual average precipitation is less than 10 inches, except for the higher mountains. Annual average precipitation in the higher elevations of the Sierra Nevada ranges from 25 to 50 inches, which can generate significant snow accumulations for spring runoff. Some of the central and eastern portions of the Mojave Desert average 4 inches of precipitation annually. Death Valley receives a little less than 2 inches of rain on the average, but just a few tenths of an inch falls in some years (see Box 10-1). Daytime temperatures in the winter are generally cold in the mountains and mild in the desert valleys.

Precipitation for the region is summarized as part of regional water uses and supplies for recent years 1998, 2000 and 2001 in Table 10-1. Year 1998 was a very wet year in the South Lahontan region with 188 percent of normal precipitation (compared to 171 percent statewide). For year 2000 statewide precipitation was average (97 percent of normal), but the South Lahontan region was very dry with only 66 percent of normal precipitation. In the generally dry year 2001, the annual precipitation in this region was 91 percent of normal, while the statewide amounts averaged 72 percent of normal precipitation.

Box 10-1 Death Valley Temperatures

Death Valley experiences an oven-hot environment in the summer, when daytime maximum temperatures routinely reach the 110s and low 120s. Most seasons even see a few searing days with temperatures reaching the middle and upper 120s. A reading of 134 degrees was attained on a July day in 1913, the record for the western hemisphere.



The northern half of the South Lahontan region includes Mono Lake (in photo), Owens Valley, Panamint Valley, Death Valley, and the Amargosa River Valley. The Mojave Desert occupies the southern half of the region. (DWR photo)

Population

Although the South Lahontan region covers 16.9 percent of the land mass of the state, its year 2000 population was 721,490, roughly 2 percent of California's total population. Nearly 450,000 people now live in the southern portion of the region, in the areas of Antelope, Apple, and Victor valleys. The cities of Palmdale and Lancaster were among the fastest-growing cities in the state in the 1990s. Rapid population growth is projected to continue over the next 25 years, based on projections from the State department of Finance. Figure 10-2 provides a graphical depiction of the South Lahontan region's total population from 1960 through 2000, with current projections to 2030.

Land Use

The region supports a variety of urban and agricultural uses, including a moderate amount of agricultural acreage and several growing cities. Much of the land in the region remains undeveloped and is under protected or managed

status for recreational, scenic, environmental, or military purposes. Even though 18,000 acres in the Antelope Valley remain agriculturally productive, that area and Victor Valley have now become highly urbanized. Other than these two valleys and the cities of Barstow and Ridgecrest, the rest of the region is rural and generally consists of widely scattered small towns with populations of less than 8,000. Agricultural land uses are concentrated in the Antelope and Owens valleys and along the Mojave River. Of the 65,000 acres of crops harvested in 2000, alfalfa and pasture grass constituted about 75 percent of the total acreage, while truck crops, mostly carrots and onions, represent about 12 percent.

Water Supply and Use

The Los Angeles Aqueduct is the region's major water development feature. In 1913, the initial 223-mile-long aqueduct was completed by the Los Angeles Department of Water and Power (LADWP) and began transporting water from Owens Valley to the city of Los Angeles. The aqueduct was extended 115 miles

Table 10 -1 South Lahontan Hydrologic Region water balance summary - TAF

Water Entering the Region – Water Leaving the Region = Storage Changes in Region

	Water Year (Percent of Normal Precipitation)		
	1998 (188%)	2000 (66%)	2001 (91%)
Water Entering the Region			
Precipitation	20,409	7,476	9,741
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions	918	1,510	1,066
Total	21,327	8,986	10,807
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	259	321	316
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	1,286	1,695	1,255
Statutory Required Outflow to Salt Sink	80	67	58
Additional Outflow to Salt Sink	111	150	126
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	19,745	7,055	9,352
Total	21,481	9,288	11,107
Storage Changes in the Region			
[+] Water added to storage			
[-] Water removed from storage			
Change in Surface Reservoir Storage	72	-8	-1
Change in Groundwater Storage **	-226	-294	-299
Total	-154	-302	-300
Applied Water * (compare with Consumptive Use)	480	612	570

***Footnote for applied water**

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.

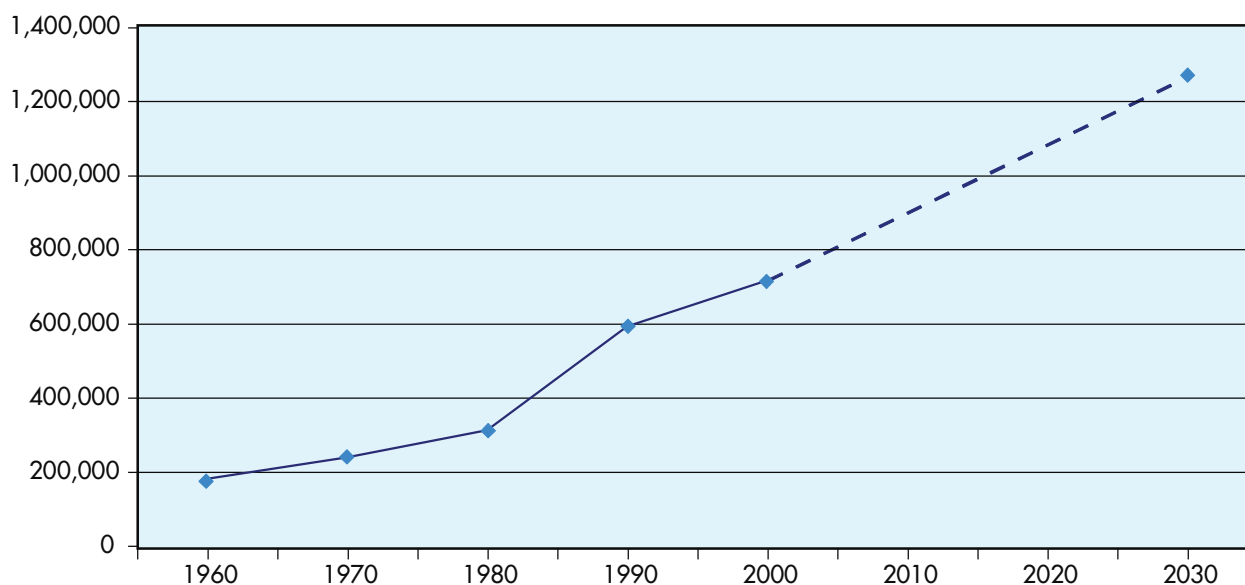
****Footnote for change in Groundwater Storage**

Change in Groundwater Storage is based upon best available information. Basins in the north part of the state (North Coast, San Francisco, Sacramento River and North Lahontan regions and parts of Central Coast and San Joaquin River regions) have been modeled – spring 1997 to spring 1998 for the 1998 water year and spring 1999 to spring 2000 for the 2000 water year. All other regions and year 2001 were calculated using the following equation:

GW change in storage =
intentional recharge + deep percolation of applied water + conveyance deep percolation - withdrawals

This equation does not include the unknown factors such as natural recharge and subsurface inflow and outflow.

Figure 10-2 South Lahontan Hydrologic Region population



Data from California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for South Lahontan region.

north into the Mono Basin in 1940 and additional water was diverted. 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 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 acre-feet. 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. 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.

The only dam on the Mojave River, at the base of the San Bernardino Mountains, is the Mojave River Forks Dam. This U.S. Corps of Engineers flood control facility provides a maximum reservoir storage capacity of 179,400 acre-feet. The lower Mojave River is seldom seen flowing on the earth's surface. Instead it exists as groundwater underflow which supports much of the agriculture crops and urban population in the Mojave River Valley.

Groundwater provides about 41 percent of the average annual water supply in the region. Groundwater 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 239,000 acre-feet, according to the 2003 update of DWR Bulletin 118 California's Groundwater. 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 such, many of the groundwater basins have not been significantly used, and there is thus little data available about groundwater volume and quality.

Five water agencies in the southwest portion of this region have contracts with the State Water Project for a total of about 250,000 acre-feet of surface water annually. The East Branch of the SWP California Aqueduct brings imported water into the region. Some of this SWP water is used to recharge groundwater in the Mojave River Valley. The Mojave Water Agency (MWA) has taken little of its SWP contract entitlement to date, although that may change in the near future as the water agency seeks ways to reduce the over-pumping of the groundwater basin.

The Mojave Water Agency is developing a Regional Water Management Plan Update that will provide a regional framework for managing water resources and ensuring reliable water for the future of the MWA desert region. While MWA relies predominately on groundwater, it also receives water from the California Aqueduct as one of 29 SWP contractors. The RWMP Update will address population growth, water demand projections, stakeholder needs and issues, facilities needed to replenish groundwater supplies, and revenue alternatives.

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, and the U.S. Borax and Chemical Facilities. AVEK was formed to bring imported surface water from the SWP into this region.

The 2,700 acre-feet capacity Littlerock Reservoir provides water to Littlerock Creek Irrigation District and to Palmdale Water District (PWD). 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 Lake Palmdale, a 42,000 acre-foot storage reservoir.

In the San Bernardino Mountains, Lake Arrowhead, owned by the Arrowhead Lake Association, is a 48,000 acre-foot reservoir providing recreational opportunities and water for Arrowhead Woods property owners. Figure 10-3 provides a graphical summary of all the water supply sources that are used to meet the developed water uses in this hydrologic region for years 1998, 2000, and 2001.

In the northern part of the South Lahontan region, the town of Mammoth Lakes provides water from surface and groundwater sources to a permanent population of about 5,000, an average daily population of about 13,000, and a peak weekend and holiday period population of up to 30,000 people per day. In communities that are 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.

Most of the quantified environmental water demands (listed in Table 10-3) 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. Another identified environmental

water demand involves current and proposed, releases into the Owens River to restore flows that were previously intercepted for use in Los Angeles after 1913, and for use in restoring surface water to Owens Lake.

Alfalfa produced in the region uses groundwater as the primary source of irrigation water. In the Mono and Owens valleys, water supplies from the Los Angeles Aqueduct are sometimes used for flood irrigation of fields for improved production of native pasture grass. Ground and surface water is not the only source of water available to grow alfalfa. In the Antelope Valley region of Los Angeles County, 680 acres of alfalfa have been irrigated for the past 14 years with municipal effluent water. The treated water comes from the Lancaster Water Reclamation Plant owned and operated by County Sanitation District No. 14 of Los Angeles County.

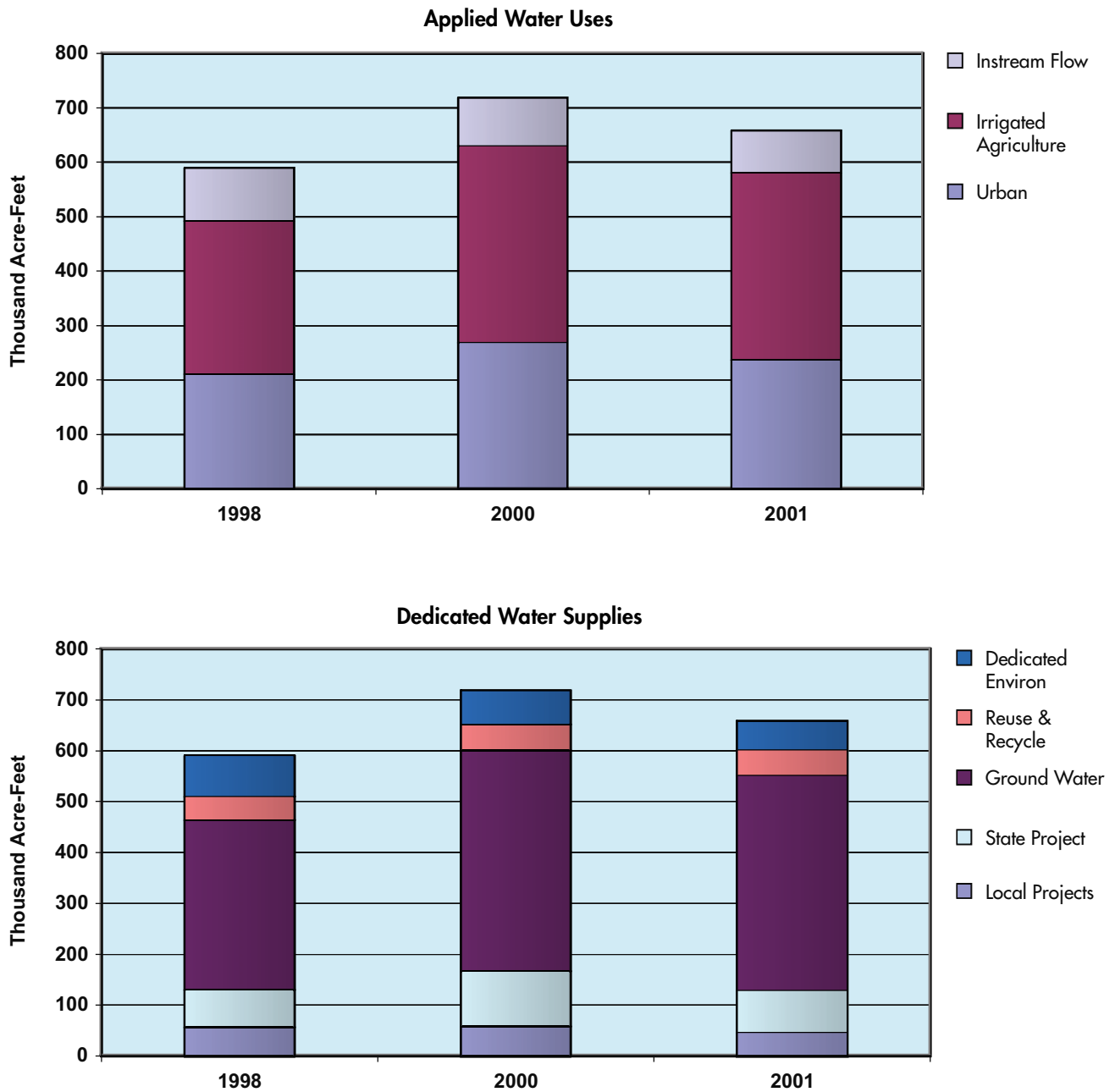
The water balance data shown in Table 10-1 and Table 10-2 summarize the detailed regional water accounting contained in the water portfolio data sets for years 1998, 2000 and 2001. These tabulated water supplies and uses provide a comparison of how the patterns of water use and distribution can change from a very wet year (1998) to a dryer year (2000), and for an average water year such as 2001.

State of the Region Challenges

Many of the rapidly developing urban parts of this region are susceptible to shortfalls in available water supplies. For example, a recent study by the Antelope Valley Water Group concluded that the valley has low reliability to meet demands from existing and future groundwater supplies, the SWP, Littlerock Reservoir, and recycling. The report further stated that the region could only expect to meet full 1998 water demands about half the time without overdrafting the groundwater resources. The capability to meet water demands for projected growth and development is a concern for many water agencies in the southern portions of the South Lahontan region. There is concern that overdrafting the groundwater resources will generate adverse environmental impacts, such as diminished flows in springs and surface streams that support wildlife.

The quality of the limited surface water resources is excellent in the region, and is greatly influenced by snowmelt from the eastern Sierra Nevada. However at lower elevations, groundwater and surface water quality can be degraded, both naturally from geothermal activity, and as a result of activities such as recreational uses and cattle grazing. Nutrients entering

Figure 10-3 South Lahontan region water balance for water years 1998, 2000, 2001



Three years show a marked change in the amount and relative proportions of water delivered to South Lahontan region's urban and agricultural sectors and water dedicated to the environment (applied water, top chart), where the water came from, and how much water was reused among sectors (dedicated water supplies, bottom chart).

Table 10-2 South Lahontan Hydrologic Region Water Use and Distribution of Dedicated Supplies (TAF)

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	8.4			6.6			5.3		
Commercial	27.8			19.0			20.1		
Industrial	8.1			4.7			5.6		
Energy Production	6.3			6.3			6.3		
Residential - Interior	86.4			137.0			113.5		
Residential - Exterior	62.9			77.2			75.3		
Evapotranspiration of Applied Water		71.3	71.3		83.8	83.8		80.6	80.6
E&ET and Deep Perc to Salt Sink		30.5	30.5		40.4	40.4		34.5	34.5
Outflow		32.0	32.0		49.5	49.5		35.6	35.6
Conveyance Applied Water	4.9			5.1			4.8		
Conveyance Evaporation & ETAW		4.9	4.9		5.1	5.1		4.8	4.8
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	6.4			12.9			5.6		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	211.2	138.7	138.7	268.8	178.8	178.8	236.5	155.5	155.5
Agriculture									
On-Farm Applied Water	280.6			361.0			344.0		
Evapotranspiration of Applied Water		187.8	187.8		237.7	237.7		235.0	235.0
E&ET and Deep Perc to Salt Sink		5.7	5.7		7.3	7.3		6.7	6.7
Outflow		51.7	51.7		65.4	65.4		60.0	60.0
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	280.6	245.2	245.2	361.0	310.4	310.4	344.0	301.7	301.7
Environmental									
Instream									
Applied Water	98.4			88.8			78.4		
Outflow		79.8	79.8		67.4	67.4		57.8	57.8
Wild & Scenic									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	0.0			0.0			0.0		
Evapotranspiration of Applied Water		0.0	0.0		0.0	0.0		0.0	0.0
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Environmental Use	98.4	79.8	79.8	88.8	67.4	67.4	78.4	57.8	57.8
TOTAL USE AND OUTFLOW	590.2	463.7	463.7	718.6	556.6	556.6	658.9	515.0	515.0
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	56.6	56.6	56.6	58.1	58.1	58.1	46.8	46.8	46.8
Local Imported Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Federal Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWP Deliveries	73.1	73.1	73.1	108.0	108.0	108.0	81.9	81.9	81.9
Required Environmental Instream Flow	79.8	79.8	79.8	67.4	67.4	67.4	57.8	57.8	57.8
Groundwater									
Net Withdrawal	226.2	226.2	226.2	294.1	294.1	294.1	299.0	299.0	299.0
Deep Percolation of Surface and GW	107.9			140.6			123.3		
Reuse/Recycle									
Reuse Surface Water	18.6			21.4			20.6		
Recycled Water	28.0	28.0	28.0	29.0	29.0	29.0	29.5	29.5	29.5
TOTAL SUPPLIES	590.2	463.7	463.7	718.6	556.6	556.6	658.9	515.0	515.0
Balance = Use - Supplies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Crowley Reservoir, on Owens River south of Mono Lake, have contributed to low dissolved oxygen levels in the reservoir. Water quality and quantity are inherently related in the Owens River watershed because of the large exports of surface and groundwater to the city of Los Angeles. Arsenic, a known human carcinogen, is a health concern in the basin, and therefore, in Los Angeles as well, especially with the recently proposed lower drinking water standard for this chemical. The vast majority of public water supply wells do meet drinking water standards. However, in places where these standards are exceeded, it is most often for TDS, fluoride, or boron. Several domestic water supply wells in the Barstow area have been closed due to historical contamination from industrial and domestic wastewater. Three military installations in the southwestern part of the region are on the federal Superfund National Priorities List because of volatile organic compounds and other hazardous contaminants, and the PG&E chromium groundwater contamination site in Hinkley is also within this region. In its triennial review, the Lahontan Regional Water Quality Control Board identified the need for site-specific ammonia objectives for Paiute Ponds and Amargosa Creek in Los Angeles County. Also, the monitoring and cleanup of chromium in groundwater and the cleanup of sites contaminated by mining wastes are additional water quality needs for this region.

In the Owens Valley, a restoration project is in operation to mitigate for dust generated as a result of the City of Los Angeles diverting water from the Owens Lake into its aqueduct. The barren playa on Owens Lake at one time regularly exceeded federal standards for airborne particulate pollution due to the prevailing winds moving across the dry lakebed. After years of litigation, the Los Angeles Department of Water and Power is using water from the aqueduct to irrigate large tracts of lakebed to reduce the dust hazard in the area. To date significant reductions in airborne pollution have dramatically improved conditions at Owens Lake. The full implementation measures are expected to occur by January 2007.

In the vicinity of Ridgecrest, the Indian Wells Valley Water District has been involved in a cooperative study and project to alleviate declining groundwater levels and to manage water quality problems. The proposal is evaluating the availability and use of imported water for groundwater recharge. Studies are being conducted to determine where recharge would be most feasible. Additional studies will also attempt to determine the age and source of deep groundwater aquifers, which may contain higher levels of minerals and potential water quality issues.

Accomplishments

The region has developed solutions to two major water issues during the past 10 years, which are the overuse of the Mojave River Valley groundwater basin and changes to water diversions from the Owens River/Mono Basin by the city of Los Angeles. The Mojave River groundwater basin was in overdraft since the early 1950s, which led to court adjudication in 1996 and the appointment of the Mojave Water Agency as the basin water-master (see Box 3-2). The Los Angeles Department of Water and Power is involved with many restoration projects for the Owens River and Mono Basin. 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 acre-feet per year. LADWP has developed plans to help ranchers manage grazing practices in the Crowley Lake tributary area. The Owens Gorge Rewatering Project and the Lower Owens River Project are two other significant restoration programs being implemented by LADWP to restore the river after 50 years of dewatering.

In 1994, Mojave Water Agency completed its Morongo Basin project, which is a 70-mile pipeline from the East Branch of the SWP to the Morongo Basin. This system has a capacity of 100 cubic feet per second or nearly 72,300 acre-feet per year to the Mojave River, and then reduces to a capacity of 15,700 acre-feet per year to Morongo Basin and Johnson Valley. The pipeline allows MWA to bring SWP water into part of its almost 5,000-square-mile service area. MWA has been delivering about 3,500 acre-feet per year to the Hi-Desert Water District since completion of the Morongo Basin Pipeline. In 1997, MWA began construction of another 61-mile Mojave River Pipeline with 67,900 acre-feet per year capacity to bring imported water to the Barstow area and neighboring communities downstream to the Newberry Springs area. This 61-mile pipeline has been built to a recharge facility along the river near the community of Daggett. Recharge facilities have also been built along the river near the communities of Hodge and Lenwood. When completed, the final reaches of the pipeline will extend to a groundwater recharge facility in the Newberry Springs area.

Mojave Water Agency has entered into a creative multiyear groundwater banking and exchange agreement with the Solano County Water Agency in northern California. During any wet year, SCWA can bank up to 10,000 acre-feet of its annual SWP water in MWA's groundwater basin, not to exceed a total balance of 20,000 acre-feet. During droughts, SCWA can take part of MWA's SWP water by exchange, using the North Bay Aqueduct to divert the water from the Sacramento-San Joaquin Delta. MWA has developed the ability to store

more imported supplies in the Mojave River Basin at MWA's Rock Springs groundwater recharge facility and is considering more recharge facilities in other areas. Several other districts are also studying potential groundwater recharge and exchange projects. Funds from loan and grant programs, especially for drought relief, will play an important role in the continued development of water projects for this region.

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 community of Yucca Valley, which has an allocation for up to 7,200 acre-feet of MWA's surface water from the SWP.

As described in previous sections, imported State Water Project water is used to recharge groundwater supplies in the Mojave River Valley basins. Some of these surface water and groundwater supplies are also exported from the Owens and Mono portions of South Lahontan Hydrologic Region to the South Coast Hydrologic Region by the Los Angeles Department of Water and Power, using the Los Angeles

Aqueduct. Recent exports through these facilities to the South Coast region were 442,000 acre-feet in 1998, 294,000 acre-feet in year 2000, and 272,000 acre-feet in 2001.

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.

Regional Planning

Mojave Water Agency is updating its previous 1994 Regional Water Management Plan, which will allow it to identify and prioritize future water supply projects. This update process began in 2002 and is expected to be completed in 2005. As an example of regional planning, MWA has initiated a

Box 10-2 Mojave River Adjudication

The Mojave River Groundwater basin has experienced overdraft since the early 1950s, with the largest increase in groundwater overdraft occurring in the 1980s. In January 1996, the Riverside County Superior Court issued a final ruling on the adjudication of this basin (the case having been transferred out of San Bernardino County). The court ruling confirmed that the area had been in overdraft for decades, and directed that the Mojave Water Agency must alleviate overdraft through conservation and the purchase of supplemental water. MWA was appointed as the basin watermaster. Some parties challenged the Stipulated Judgment in the 4th District Court of Appeal, which partially overturned the Superior Court's decision. The MWA petitioned the California Supreme Court to accept review of the Court of Appeal's decision, which resulted in the case being heard by the California Supreme Court in August 2000. The higher court affirmed the stipulated judgment with regard to the parties involved, but determined that some of the appellants held overlying water rights that are not subject to the judgment. Consequently, this final judgment has been implemented in the Mojave Basin Area.

The adjudication stipulated that any party pumping more than 10 acre-feet per year of groundwater must become a party to the judgment and be bound by it. The judgment stated that each party has a right to its base annual groundwater production, which was determined from the highest usage between 1986 and 1990. The judgment also required the watermaster to initially reduce this amount by at least 5 percent each year for four years as one way to achieve a physical solution to the longstanding overdraft. Any party exceeding its annual allotment must purchase replenishment water from MWA or from other parties to the judgment. If there is still overdraft after the end of the first five years of the judgment, water use in overdrafted subareas will be further reduced. The judgment recognized five basin subareas and required that if an upstream subarea does not meet its water obligation to a downstream subarea, then the upstream area must pay for supplemental water.

demonstration project in the Oro Grande Wash south of the city of Victorville to evaluate the effectiveness of off-river artificial groundwater recharge using State Water Project water. The project site is located several miles away from the main stem of the Mojave River and intends to supply imported surface water for groundwater recharge. When needed, the local water purveyors would subsequently pump this stored groundwater for use in the rapidly growing urban areas. This project is the first of several off-river recharge projects that the agency considers as the next major phase in water supply infrastructure development.

With a growing population and increasing demands on the limited supplies of fresh water for its service area, Victor Valley Wastewater Reclamation Authority (VWVRA) has been planning a program with new facilities that would recycle millions of gallons of wastewater daily. The current wastewater flows are about 9 MGD from more than 100,000 residents, and are expected to increase to more than 18.7 MGD by the year 2020. In 1997, the VWVRA completed a feasibility study that projected population growth and wastewater treatment requirements, and identified potential reclamation strategies and costs through 2020. These strategies included potential uses of the fully-treated effluent for beneficial purposes such as landscape irrigation and industrial process water. In 2000, VWVRA adopted amendments to the plan, which projected future wastewater flows within its service area with greater accuracy, and recommended the completion of four sub-regional wastewater reclamation facilities by the year 2010. In 2002 VWVRA also completed an interim expansion of its treatment plant to accommodate wasteflows of up to 11 million gallons-per-day.

The VWVRA Board of Commissioners also approved a draft policy to sell the recycled water at the current river discharge location to stipulated parties from the Mojave Adjudication, and held a public hearing on the policy in 2001. Under the proposed policy, recycled water would be sold and credited to individual parties for use in meeting makeup water or replacement water requirements as specified by the Mojave River adjudication. However, the board has delayed approval of this proposed policy until legal challenges to the Mojave Adjudication are settled by the Superior Court.

The Antelope Valley Water Group (AVWG) was formed in 1991 to provide coordination among valley water agencies and other planning groups. AVWG members include the cities of Palmdale and Lancaster, Edwards Air Force Base, AVEK, Antelope Valley United Water Purveyors Association, Los Angeles County Waterworks Districts, PWD, Rosamond Community Services District, and Los Angeles County. AVWG then completed the Antelope Valley Water Resource Study in

1995 to address regional water management issues. That study evaluated the valley's existing and future water supplies from groundwater, the SWP, Littlerock Reservoir, and recycling, and then compared those supplies with projected water demands. The study concluded that there is a low level of water supply reliability in the study area, and concluded that full 1998 water demands could only be met half of the time without overdrafting groundwater resources. The report recommended water conservation, recycling, and conjunctive use as strategies to reduce expected water shortages, and identified three potential sites (two on Amargosa Creek and one on Littlerock Creek) with high potential as groundwater recharge spreading ponds. The study also identified several potential groundwater injection sites within existing Los Angeles County Waterworks and PWD municipal well fields, and treated SWP water was identified as a potential recharge source. AVWG agencies are now developing individual programs and projects based on the recommendations from that 1995 water resource study.

In 2001, Palmdale Water District adopted a water facilities master plan for its service area, which updated previous 1989 and 1996 master plans. PWD relies on three water sources: Littlerock Reservoir, local groundwater, and SWP surface water. The master plan highlights PWD's desire to maintain the capability to obtain 40 percent of its water supply from groundwater. However, because declining groundwater levels are an ongoing concern in the Palmdale area, there is uncertainty about whether the groundwater basin's perennial yield could support the desired level of pumping. In addition, this plan indicated that existing supplies would not be insufficient to meet demands in drought periods, and projected possible water supply shortfalls during normal years by 2010.

To help meet future demands, the PWD plan recommended building up to six new wells and modifications to four existing cased wells, so that they could be used to help meet potable water demands. The Draft Environmental Impact Report for the plan identified a continuing decline in groundwater levels as an unavoidable effect from building new wells and pumping additional groundwater, as desired to maintain groundwater as 40 percent of PWD's total supply. Mitigation measures have been developed which recommend more water conservation, drought-year reductions in water demands, more conjunctive use programs, the acquisition of additional SWP surface water, participation in water marketing and transfers, and the expansion of available uses for recycled water.

In 2002, the Quartz Hill Water District constructed six wells in order to develop the capability to participate in future conjunctive use projects. Only four of these wells were equipped

with groundwater pumps because the water yield from the other two wells was too small. Quartz Hill WD is also planning to add groundwater injection equipment to some of its wells, so that recharge of the groundwater basin can occur whenever surplus SWP water supplies are available.

Water Portfolios for Water Years 1998, 2000, and 2001

Water Year 1998

Water year 1998 was a wet year for this region, with annual precipitation at 188 percent of normal, while the statewide annual precipitation was 171 percent of average. The reservoirs in the region increased storage by about 72,000 acre-feet as a result of the additional rainfall and runoff, but the regions groundwater basins were drawn down by about 226,000 acre-feet. The expanding urban developments in the southern portion of this region have become dependent on the use of groundwater to meet water demands, because significant surface water resources and facilities do not exist. As a result more groundwater is pumped and used annually than can be recharged, even during the wetter years.

The primary agricultural water use in the region is irrigation of alfalfa and pasture grass for raising beef. Smaller amounts of land are dedicated to truck crops, such as carrots and onions, and still less is used for grain crops and orchards. As shown in Table 10-3 the total agricultural applied water use for 1998 in this region was 280,600 acre-feet, which is about 48 percent of the total developed use of 590,200 acre-feet. Agricultural water use in 1998 was less than in years 2000 and 2001 because the significant amount of rainfall in this wet year reduced the need for irrigation.

Total urban applied water use for the region was 211,200 acre-feet in 1998, which represents about 36 percent of all water use. The wet winter of 1998 also reduced the amount of urban water use compared to years 2000 and 2001 (as shown in Table 10-3), because this category also includes outdoor landscape, parks and recreation facilities which generally require less water in a wetter year. Total environmental water use for this region was 98,400 acre-feet, primarily for uses related to the preservation of Mono Lake and Owens River flows.

In 1998 about 442,000 acre-feet of surface water was exported from this region to the South Coast through the Los Angeles Aqueduct, as a result of the wet winter and abundant water supplies. SWP water deliveries into the South Lahontan region were 73,000 acre-feet from the California Aqueduct. An addi-

tional 844,000 acre-feet of SWP surface water flowed through this region in the California Aqueduct, passing from the Tulare Lake region for deliveries to the South Coast region. These regional imports and exports are summarized on the regional map in Figure 10-1.

Water Year 2000

Year 2000 was dry in the South Lahontan region with annual precipitation at 66 percent of average, while the state as a whole received near normal rainfall. The lack of rainfall increased the need to apply water to crops, resulting in a total agricultural applied water use of about 361,000 acre-feet, which is about 50 percent of the total developed use of 718,600 acre-feet. As shown in Table 10-3, urban water use also increased in year 2000 (compared to 1998), and the 269,000 acre-feet of urban use represented about 37 percent of total applied water uses. Dedicated environmental water uses in the region declined slightly in year 2000 compared to 1998, and represent about 13 of the total applied water uses.

During year 2000, total storage in the surface reservoirs decreased by 8,000 acre-feet as more water was released for use than was available for storage. Net groundwater storage declined by roughly 294,000 acre-feet, as more water is pumped to meet demands in a dryer water year. Only 294,000 acre-feet of surface water was diverted from the South Lahontan region through the LA Aqueduct to the South Coast region, which is significantly less than the 1998 amount. However more SWP water from the California Aqueduct flowed through the region, with 108,000 acre-feet diverted to meet local uses and 1,401,000 passed to the South Coast region (see Figure 10-1).

Water Year 2001

Year 2001 produced slightly below normal water supply conditions in the South Lahontan region with annual precipitation at 91 percent of average. For comparison, statewide average precipitation in year 2001 was only 72 percent of normal. Because the South Lahontan region is a relatively arid part of the State (average annual precipitation is less than 10 inches), a single storm event can significantly alter the regional average in comparison to statewide precipitation. The reduced amounts of rainfall in other regions of the State resulted in lower SWP deliveries to water contractors, and SWP imports to the South Lahontan region were about 82,000 acre-feet. As shown in Table 10-3, urban, agricultural and environmental water uses were all slightly less than in year 2000, and accounted for roughly the same percentages of the total developed water supply.

About 272,000 acre-feet of surface water was exported through the L.A. Aqueduct to the South Coast region in 2001, which is slightly less than in year 2000. An additional 983,000 acre-feet of SWP surface water flowed through this region in the California Aqueduct, passing from the Tulare Lake region for deliveries in the South Coast region. As shown in Table 10-1, the region's surface reservoir storage in 2001 remained nearly the same as in year 2000, but the amount of groundwater in storage continued to decline, by 299,000 acre-feet during this year.

A more detailed tabulation of the developed urban, agricultural and environmental water uses and water depletion is presented in Table 10-3. This table also provides details about the sources of the developed water supplies, which include surface water, groundwater and some SWP water imports from other regions. The three water portfolio data sets included in Table 10-3 and the companion water portfolio flow diagrams (Figures 10-4 and 10-5) provide more detailed information about how the available water is routed, distributed and used throughout this region.

Technical Memorandum, Description of Existing Investigations and Data Relevant to the Owens Lake Groundwater Evaluation, Inyo County CA, Camp, Dresser & McKee, March 29, 1999

Water Quality Control Plan, Regional Water Quality Control Board Watershed Management Initiative Chapter, Regional Water Quality Control

Selected References

- 2002 California 305(b) Report on Water Quality, State Water Resources Control Board
- Antelope Valley Water Resource Study by Kennedy/Jenks Consultants Engineers and Scientists for Antelope Valley Water Group, November 1995
- California's Groundwater Bulletin 118-05, Update 2003, California Department of Water Resources
- Draft Environmental Impact Report and Statement for the West Mojave Plan, Bureau of Land Management, May 2003
- Lancaster Water Reclamation Plant 2020 Plan EIR, District 14, Antelope Valley Los Angeles County, September 2003
- Nonpoint Source Program Strategy and Implementation Plan, 1998-2013, State Water Resources Control Board, California Coastal Commission, January 2000
- Mojave Water Agency Regional Water Management Plan, June 1994, Bookman-Edmonston Engineering, Inc., Glendale California
- Palmdale Water District Final Water System Master Plan Update, March 2001, Montgomery Watson
- Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001
- Technical Memorandum, Establishing Objectives and Standards based on Existing Management Framework Owens Lake Groundwater Evaluation, Inyo County, CA, December 1998