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Acronyms and Abbreviations Used in This Report

AACLP	All-American Canal Lining Project
AB	Assembly Bill
ACWA	Association of California Water Agencies
af	acre-feet
af/yr.	acre-feet per year
BMO	basin management objectives
BMP	best management practices
Cal EPA	California Environmental Protection Agency
CASGEM	California Statewide Groundwater Elevation Monitoring
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CIMIS	California Irrigation Management Information System
CNRA	California Natural Resources Agency
CRA	Colorado River Aqueduct
CRWDA	2003 Colorado River Water Delivery Agreement
CVRWMG	Coachella Valley Region Water Management Group
CVWD	Coachella Valley Water District
CWC	California Water Code
DAC	disadvantaged community
DDT	dichlorodiphenyltrichloroethane
DFW	California Department of Fish and Wildlife
DO	dissolved oxygen
DPR	California Department of Pesticide Regulation
DPWSS	Dos Palmas Water Supply System
DWA	Desert Water Agency

DWR	California Department of Water Resources
EDP	equitable distribution plan
EI	energy intensity
EIS/EIR	environmental impact statement/environmental impact report
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
EWMP	efficiency water management practices
FAP	Financial Assistance Program
FEMA	Federal Emergency Management Agency
FPA	Free Production Allowance
GAMA	Groundwater Ambient Monitoring and Assessment
GCM	global climate model
GHG	greenhouse gas
gpm	gallons per minute
GPS	global positioning system
GWMP	groundwater management plan
HAL	health advisory level
HCB	hexaclorobenzene
HCP	habitat conservation plan
HIP	high population scenario
ICS	intentionally created surplus
IID	Imperial Irrigation District
IRWM	integrated regional water management
IRWMP	IRWM plan
IWA	Indio Water Authority
IWM	integrated water management
IWSP	Interim Water Supply Policy for Non-Agricultural Projects
kWh	kilowatt-hour

kWh/af	kilowatt hours per acre-foot
LCRMSCP	Lower Colorado River Multi-Species Conservation Program
LCRWSP	Lower Colorado River Water Supply Project
LOP	low-population growth scenario
maf	million acre-feet
MCL	maximum contaminant level
mg/L	milligrams per liter
MHI	median household income
MOU	memorandum of understanding
MSCP	Multi-Species Conservation Program
MSWD	Mission Springs Water District
MWD	Metropolitan Water District of Southern California
MWh	megawatts per hour
NCCP	Natural Communities Conservation Plan
NEPA	National Environmental Policy Act
NL	notification level
PA	planning area
PCB	polychlorinated byphenyl
PEIR	programmatic environmental impact report
ppt	parts per thousand
PVID	Palo Verde Irrigation District
RWMG	regional water management group
RWQCB	regional water quality control board
SGPWA	San Gorgonio Pass Water Agency
SB	Senate Bill
SCH	2009 Species Conservation Habitat
SDAC	severely disadvantaged community

SDCWA	San Diego County Water Authority
SMCL	secondary maximum contaminant level
SSA	Salton Sea Authority
SSAM	Salton Sea Accounting Model
SWN	State well number
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TDS	total dissolved solids
TMDL	total maximum daily load
Update 2013	California Water Plan Update 2013
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
WDR	waste discharge requirements
WRCC	Western Regional Climate Center
WUIWA	Wister Unit of the Imperial Wildlife Area

Salton Sea, CA. With an approximate surface area of more than 340 square miles, the Salton Sea is the largest lake in California and the only one created by accident, when a breach occurred in the Alamo Canal in 1905. The Salton Sea, at an elevation below sea level, receives inflow from agricultural lands and is the focus of efforts aimed at restoring the regional ecosystem.

Colorado River Hydrologic Region

Colorado River Hydrologic Region Summary

Despite the subtropical desert climate, reliable water supplies for the Colorado River Hydrologic Region have made it possible to establish, maintain, and even expand the key local industries — agriculture, recreation, and tourism. At the same time, the region's topographic landscape, shaped by tectonic and past volcanic activities, remains as scenic and beautiful. This includes the Salton Sea, which is sustained by agricultural tailwater, tile drain water, and treated and untreated urban wastewater flows. Water agencies in the region have not stopped planning and implementing programs and projects to maintain the quality and quantity of water supplies, particularly groundwater, for the future. This includes water use efficiency conservation and groundwater storage and conjunctive use programs and water supply transfers. Activities are also under way to protect and enhance the region's important environmental resources — in particular, the Salton Sea, which provides critical habitat for resident and migratory birds.

Current State of the Region

Setting

The Colorado River Hydrologic Region (region) is located in southeastern California and contains 12 percent of the state's land area. The Colorado River provides most of the eastern boundary, and the border with Mexico forms the southern boundary (Figure CR-1). The region includes Imperial County and portions of Riverside, San Bernardino, and San Diego counties.

Geology and climate shape the topography of the Colorado River region. Numerous faults exist, including the San Andreas fault; and they are responsible for the mountainous terrain in the north and the large valleys and plains in the south. The northern third of the region is part of the Mojave Desert and features small to moderate mountain ranges, dormant volcano cinder cones, hills, and narrow and U-shaped valleys. The San Bernardino and San Jacinto mountains in the north have peaks at or above 10,000 feet above sea level. The remainder of the region, which is part of the Sonoran Desert, is less mountainous and is dominated by the Salton Sea and the Imperial, Coachella, Palo Verde, and Bard valleys. The Salton Sea is the largest lake in California and is sustained mostly by agricultural runoff from the Imperial and Coachella valleys. The Salton Sea provides critical nesting habitat for migratory birds in the Pacific Flyway.

Coachella and Imperial valleys are to the north and south of the Salton Sea, respectively. Palo Verde and Bard valleys are on the western bank of the Colorado River. The surface of the Salton Sea and some of the land in the Coachella and Imperial valleys are as much as 230 feet below sea level. Most of the agricultural and urban land uses for the region are in these valleys. The Imperial Valley contains most of the agricultural area uses, and the Coachella Valley has most of the urban areas. Native vegetation in the creosote bush scrub classification is able to survive the hot summers and sparse rainfall common to the valleys and plains. In the mountains, the cooler and wetter climate supports vegetation in the pinyon-juniper woodland class. Major rivers in the region are the Colorado and Whitewater and the Alamo and New, which function as conduits for agriculture and urban runoff from the Imperial Valley in the United States and the Mexicali

Figure CR-1 **Colorado River Hydrologic Region**

Valley in Mexico. Most other rivers, streams, and washes — such as the Piute Wash and San Felipe Creek — are intermittent or dry. Playas, or dry lakebeds, are common in the eastern portions of the region. Major water conveyance facilities are the All-American and Coachella canals.

The Colorado River region has two of the state's largest public parks. The 600,000 acre Anza-Borrego Desert State Park is west of the Salton Sea in the Santa Rosa, Borrego, and Vallecitos mountains. Joshua Tree National Park is in the Little San Bernardino Mountains.

Watersheds

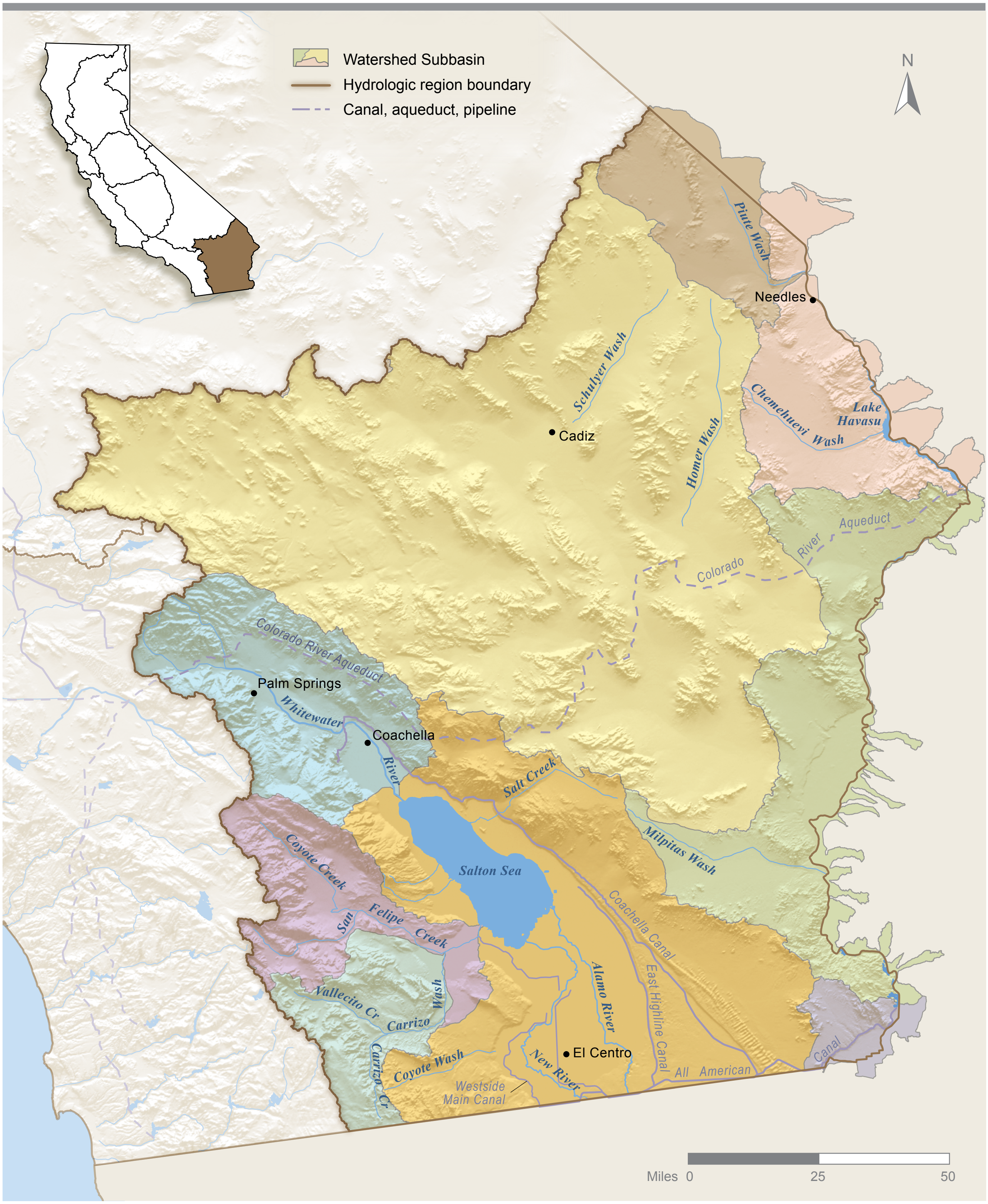
Many of the prominent watersheds in the Colorado River Hydrologic Region offer combinations of native vegetation and human-made environmental, urban, and agricultural land and water uses. Included are the Salton Sea Transboundary watershed, located in both the Coachella and Imperial Planning Areas (PAs); the Imperial Reservoir and Lower Colorado River watersheds in the Colorado River PA; and the watersheds for San Felipe, Fish, Vallecito, and Carrizo creeks in the Borrego PA. Other key watersheds, largely devoid of urban and agricultural uses, include the Havasu-Mojave Lakes and Piute in the Colorado River PA and the Southern Mojave in the Twentynine Palms-Lanfair PA (see Figure CR-2).

Salton Sea Transboundary Watershed

The Salton Sea Transboundary watershed stretches over two counties, Imperial and Riverside, and encompasses about one-third of the land area of the hydrologic region. It also includes most of the Coachella and Imperial Valley PAs. Key hydrologic features are the Salton Sea, the Whitewater River in the north, the Alamo and New rivers in the south, and San Felipe Creek in the west. The watershed has been designated as a Category 1 (impaired) watershed using the criteria in the 1997 California Unified Watershed Assessment.

The most prominent of the features is the Salton Sea. The lake was created more than 100 years ago by a levee break in the Colorado River. Find more information about the Salton Sea in its subsection below. To the north of the Salton Sea is the Coachella Valley, which has a blend of urban and agriculture land uses with a greater emphasis on the former. To the south is the Imperial Valley, which features major agricultural land uses and operations. More than 400,000 acres of land are utilized in crop production annually in the Imperial Valley. Two aqueducts are in operation; the All-American and Coachella canals transport Colorado River water supplies to both areas. Groundwater supplies are also important, especially in the Coachella Valley PA. Major cities include Indio, Palm Springs, Cathedral City, and Palm Desert in the Coachella Valley; El Centro, Brawley, and Calexico in the Imperial Valley. Water quality issues posed by the New and Alamo rivers were documented in *California Water Plan Update 2009*. The New River transports treated and untreated urban wastewater and untreated agricultural tailwater from the Mexicali Valley and treated urban wastewater, treated industrial and agricultural tail and drain water from the Imperial Valley to the Salton Sea. The Alamo River carries some treated urban wastewater but, as does the drainage systems in Imperial and Coachella valleys, carries mostly agricultural tail and drain water flows to the sea. Two important projects are under way to address the quality concerns in the rivers. The Imperial County Farm Bureau manages a voluntary TMDL Compliance program in Imperial Valley. The goal of the program is to decrease the sediment loads being transported into the Salton Sea from the fields. Interested farmers received information on best management practices that can be integrated into their farming

Figure CR-2 Watersheds of the Colorado River Hydrologic Region



operations to decrease sediment and nutrient runoffs from their fields. The second project is the New River Wetlands Project, which began in 2003. It is a collaborative project that includes U. S. Congressman Duncan Hunter (R-Alpine), Desert Wildlife Unlimited, the Imperial Irrigation District (IID), and the U.S. Bureau of Reclamation (USBR). Its goals are to construct aeration ponds and establish two small wetlands on the New River to help with the cleanup of the water downstream from the Mexico-United States border. These sites have been constructed. A third area was completed to the northeast of the City of Brawley on the Alamo River. A maximum of 12 wetland areas will be constructed with most for the New River.

The construction of the three areas was a collaboration between the USBR and IID and was made possible through federal funding. Many other agencies and organizations have participated in the project including Imperial County, U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (DFW), and Citizen Congressional Task force on the New River. The areas also have become small ecosystems attracting birds and fish as well as popular fishing spots for local area residents.

Salton Sea

The Salton Sea is the largest inland lake in California. Although its reputation for recreation and sports-fishing has diminished in recent years, the sea still provides critical habitat for migratory birds in the Pacific Flyway and is an important fishery, serving as a food source for the birds. The Sonny Bono Salton Sea National Wildlife Refuge is an important wetland area. The existing and restored wetlands on the shoreline of the sea provide habitat for Eared Grebes, White-faced Ibis, American White Pelicans, Yuma clapper rail, Black Skimmers, Double-breasted Cormorants, and Gull-billed Terns, just a few of the species of birds that can be found during winter-nesting. The population of the nesting birds is often in the hundreds and thousands.

The Salton Sea has no outlet to the Pacific Ocean or Gulf of California, and drainage of all surface water in the watershed flows to the Salton Sea. It has a surface area of 376 square miles and a shoreline of 105 miles. The elevation of the water surface is about 232 feet below sea level. One of the major functions of the Salton Sea is to serve as a sump for agricultural tailwater and for urban treated and untreated wastewater flows.

Although its physical characteristics have fluctuated over the years, the sea has remained relatively constant over the past two decades. Its size, shape, and volume has been sustained by annual inflow of 1.3 million acre-feet (maf) of agricultural tailwater and drain water; IID Federal Quantification Settlement Agreement (i.e., the 2003 Colorado River Water Delivery Agreement, referred to as CRWDA) mitigation discharges; surface runoff; treated and untreated urban wastewater flows from the Coachella Valley, Imperial Valley, and the Calexico Valley in Mexico; and a small amount of subsurface flow.

Runoff from precipitation also contributes 3 inches of direct rainfall over an area of 376 square miles. Because of the extremely arid climate, evaporation of water from the sea is about equivalent to the quantities of inflow water, 1.3 maf. Total volume of water in the sea is estimated at 7.5 maf. The only characteristic that has changed is the salinity and elevation of the water surface. At the end of the year 2012, the elevation of the surface was 231.72 feet below sea level, which is a decline of about 2.3 feet since 2008. The decline is the result of decreased flows from Mexico and below average precipitation. Average depth is slightly less than 30 feet, with its deepest spot determined to be 51 feet.

Salinity levels of the sea are critical issues. The inflows from the different sources identified above are contributing as much as 4.5 million tons of salts each year. In 2012, the level of salts was 53 parts per thousand (ppt); the Pacific Ocean's level is 35 ppt. Salinity levels are slightly higher because of the decrease in flows from Mexico and below-average precipitation. In 2017, the end of mitigation deliveries as specified in the 2003 Colorado River Water Delivery Agreement: Federal Quantification Settlement Agreement, Exhibit B, could exacerbate salinity levels. Local fish and invertebrate species will be impacted by the higher levels of salinity, which would then impact migratory and shore-line birds.

Water quality concerns stem from the presence of untreated and partially treated urban wastewater flows from the Mexicali Valley and the presence of pesticides, nutrients, selenium, and silt from the agricultural operations. From the north, the Whitewater River provides agricultural tailwater and tile drainage flows and urban runoff. Salt Creek, which drains portions of the Orocopia and Chuckwalla mountains to the east of the sea, and Whitewater River provide some freshwater inflows to the Salton Sea.

San Felipe Creek, Fish Creek, Vallecito Creek, and Carrizo Creek Watersheds

Watersheds associated with San Felipe, Fish, Vallecito, and Carrizo creeks are within and outside of the Anza-Borrego Desert State Park in eastern San Diego County with portions extending into Imperial County and north into Riverside County. These areas provide natural habitat for migratory birds and other wildlife, including 12 State- or federal-listed rare, threatened, or endangered species. Including land within the State park, the combined watersheds cover over 700,000 acres.

The riparian areas have been identified as key habitat for the birds and other wildlife. These include the natural groves of the California Fan Palms, mesquite woodland, and wet meadows or marshes. Management efforts are under way to preserve and improve the critical habitat areas, which include removal of invasive plant species (e.g., salt cedar) to allow the native plants and animals to redevelop.

In January 2013, the USFWS issued Rule No. FWS-R2-ES-2011-0053 that established the criteria for identifying and maintaining habitat for the Southwestern Willow Flycatcher, which is on the federal Endangered Species Act (ESA) list. Critical habitat for the Flycatcher was identified on segments of San Felipe Creek, a portion of which is located on land of the Iipay Nation of the Santa Ysabel Tribe. The USFWS is working with the tribe on maintenance operations for the habitat.

Other Watersheds

Colorado River, Twentynine Palms-Lanfair, and Chuckwalla PAs all have recognized watersheds. For the Colorado River PA, watersheds include Havasu-Mohave Lakes, Piute Wash, Imperial Reservoir, and the Lower Colorado River. These watersheds extend eastward into Nevada and Arizona. Scattered urban land uses exist in each watershed. Agricultural uses are prominent in the Imperial Reservoir and Lower Colorado River areas. Minor water quality concerns persist in the Havasu-Mohave Lakes and Piute Wash areas.

Southern Mojave watershed is in both the Twentynine Palms-Lanfair and Chuckwalla PAs. Portions of the San Bernardino and San Jacinto mountains and several smaller mountain ranges provide most of the boundaries for this watershed. Much of the watershed is devoid of urban and agricultural land uses. The exceptions are Lucerne Valley, which has urban areas and agriculture, and Yucca Valley, which has only urban areas.

Groundwater Aquifers and Wells

Groundwater resources in the Colorado River Hydrologic Region are supplied by both alluvial and fractured rock aquifers. Alluvial aquifers are composed of sand and gravel or finer grained sediments, with groundwater stored within the voids, or pore space, between the alluvial sediments. Fractured-rock aquifers consist of impermeable granitic, metamorphic, volcanic, and hard sedimentary rocks, with groundwater being stored within cracks, fractures, or other void spaces. The distribution and extent of alluvial and fractured-rock aquifers and water wells vary within the region. Many groundwater basins are bounded by faults that act as groundwater barriers. A brief description of the aquifers for the region is provided below.

Alluvial Aquifers

DWR *Bulletin 118-2003* recognizes 64 alluvial groundwater basins and subbasins, which underlie approximately 13,100 square miles, or 66 percent of the Colorado River Hydrologic Region (California Department of Water Resources 2003). The majority of the region's groundwater is stored in alluvial aquifers. Figure CR-3 shows the location of the alluvial groundwater basins and subbasins and Table CR-1 lists the associated names and numbers. The most heavily used groundwater basins in the region include Borrego Valley, Warren Valley, Lucerne Valley, and Coachella Valley groundwater basins.

Fractured-Rock Aquifers

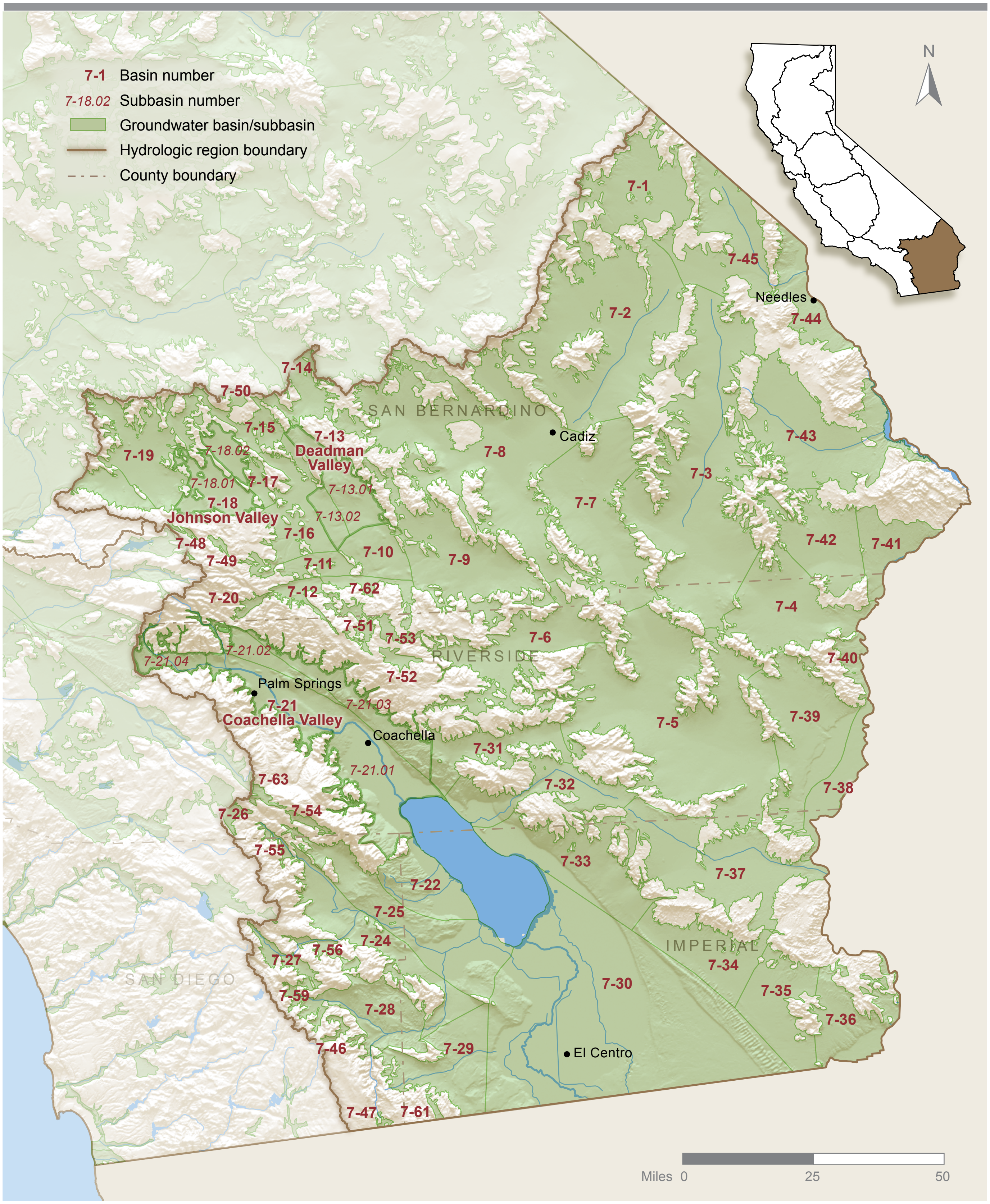
Groundwater extracted by wells located outside of the alluvial basins is supplied largely from fractured rock aquifers. Although fractured-rock aquifers are less productive with yield of 10 gallons per minute (gpm) or less compared to the alluvial aquifers in the region, they commonly serve as the sole source of water and a critically important water supply for many communities.

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

Well Infrastructure and Distribution

Well logs submitted to the California Department of Water Resources (DWR) for water supply wells completed during 1977 through 2010 were used to evaluate the distribution and uses of water wells in the Colorado River Hydrologic Region. Many wells could have been drilled prior to 1977 or without submitting well logs. As a result, the total number of wells in the region is probably higher than what is reported here. The number and distribution of wells in the region are grouped according to their location by county and according to the six most common well-use types: domestic, irrigation, public supply, industrial, monitoring, and other. Public supply wells include all wells identified in the well completion report as municipal or public. Wells identified as "other" include a combination of the less common well types, such as stock wells, test wells, or unidentified wells (no information listed on the well log).

Figure CR-3 **Alluvial Groundwater Basins and Subbasins within the Colorado River Hydrologic Region**



Well log data for counties that fall within multiple hydrologic regions were assigned to the hydrologic region containing the majority of alluvial groundwater basins within the county. Well log information listed in Table CR-2 and illustrated in Figure CR-4 show that the distribution and number of wells vary widely by county and by use.

The total number of wells installed in the region between 1977 and 2010 is approximately 13,200, with almost all the wells located in Riverside County. The low well count in Imperial County is due to the fact that its water use is mostly met by water from the Colorado River via the All-American Canal.

Figure CR-5 shows that domestic wells make up the majority of well logs (61 percent) for the region. The second most are monitoring wells, which account for about 17 percent of well logs. Although there is a large agricultural presence in portions of the region, irrigation wells only make up about 11 percent of well logs.

Figure CR-6 shows a cyclic pattern of well installation for the region, with new well construction ranging from about 200 to 700 wells per year. The large fluctuation of domestic well drilling is likely associated with population booms and residential housing construction. Between 1980 and 1990, Riverside County experienced about 75 percent increase in the number of residents and was the fastest-growing county in California. An economic downturn in the early 1990s resulted in a decline in the population growth and associated new well installation. Beginning in 2000, the rise in the number of domestic wells installed is likely attributed to the resurgence in residential housing construction. Similarly, the 2007 to 2010 decline in domestic well drilling is likely due to declining economic conditions and related drop in housing construction.

The onset of monitoring well installation in the mid- to late-1980s is likely associated with federal underground storage tank (UST) programs signed into law in the mid-1980s.

As Figure CR-6 shows, irrigation well installation is more closely related to hydrologic conditions, cropping trends, and surface water supply cutbacks. Most of the irrigation wells in the region are associated with Riverside County agricultural and golf course use.

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

Colorado River Hydrologic Region Groundwater Monitoring

Groundwater monitoring and evaluation is a key aspect to understanding groundwater conditions, identifying effective resource management strategies, and implementing sustainable resource management practices. California Water Code (CWC) Section 10753.7 requires local agencies seeking State funds administered by DWR to prepare and implement groundwater management plans that include monitoring of groundwater levels, groundwater quality, inelastic land subsidence, and changes in surface water flow and quality that directly affect groundwater levels or quality. This section summarizes some of the groundwater level, groundwater quality, and land subsidence monitoring efforts within the Colorado River Hydrologic Region. Additional information regarding the methods, assumptions, and data availability associated with the groundwater monitoring is available online from Update 2013, Volume 4, *Reference Guide*, the article, "California's Groundwater Update 2013."

Table CR-1 Alluvial Groundwater Basins and Subbasins within the Colorado River Hydrologic Region

Basin/Subbasin		Basin Name	Basin/Subbasin	Basin Name
7-1		Lanfair Valley	7-28	Vallecito-Carrizo Valley
7-2		Fenner Valley	7-29	Coyote Wells Valley
7-3		Ward Valley	7-30	Imperial Valley
7-4		Rice Valley	7-31	Orocopia Valley
7-5		Chuckwalla Valley	7-32	Chocolate Valley
7-6		Pinto Valley	7-33	East Salton Sea
7-7		Cadiz Valley	7-34	Amos Valley
7-8		Bristol Valley	7-35	Ogilby Valley
7-9		Dale Valley	7-36	Yuma Valley
7-10		Twentynine Palms Valley	7-37	Arroyo Seco Valley
7-11		Copper Mountain Valley	7-38	Palo Verde Valley
7-12		Warren Valley	7-39	Palo Verde Mesa
7-13		Deadman Valley	7-40	Quien Sabe Point Valley
	7-13.01	Deadman Lake	7-41	Calzona Valley
	7-13.02	Surprise Spring	7-42	Vidal Valley
7-14		Lavic Valley	7-43	Chemehuevi Valley
7-15		Bessemer Valley	7-44	Needles Valley
7-16		Ames Valley	7-45	Piute Valley
7-17		Means Valley	7-46	Canebrake Valley
7-18	7-18.01	Johnson Valley Area	7-47	Jacumba Valley
	7-18.01	Soggy Lake	7-48	Helendale Fault Valley
	7-18.02	Upper Johnson Valley	7-49	Pipes Canyon Fault Valley
7-19		Lucerne Valley	7-50	Iron Ridge Area
7-20		Morongo Valley	7-51	Lost Horse Valley
7-21		Coachella Valley	7-52	Pleasant Valley

Basin/Subbasin		Basin Name	Basin/Subbasin	Basin Name
	7-21.01	Indio	7-53	Hexie Mountain Area
	7-21.02	Mission Creek	7-54	Buck Ridge Fault Valley
	7-21.03	Desert Hot Springs	7-55	Collins Valley
	7-21.04	San Gorgonio Pass	7-56	Yaqui Well Area
7-22		West Salton Sea	7-59	Mason Valley
7-24		Borrego Valley	7-61	Davies Valley
7-25		Ocotillo-Clark Valley	7-62	Joshua Tree
7-26		Terwilliger Valley	7-63	Vandeventer Flat
7-27		San Felipe Valley		

Groundwater Level Monitoring

To strengthen existing groundwater level monitoring in the state by DWR, U.S. Geological Survey (USGS), USBR, local agencies and communities, the Legislature passed Senate Bill (SB) 7x-6 in 2009. The law requires that groundwater elevation data be collected in a systematic manner on a statewide basis and be made readily and widely available to the public. DWR was charged with administering the program, which is now known as California Statewide Groundwater Elevation Monitoring (CASGEM).

The location of monitoring wells by monitoring entity and monitoring well type in the Colorado River region are shown in Figure CR-7. Other wells account for 78 percent of the monitoring wells in the region, followed by observation wells with 12 percent and public wells with 7 percent of the monitoring wells, respectively.

A list of the number of monitoring wells in the region by monitoring agencies, cooperators, and CASGEM monitoring entities is provided in Table CR-3. Groundwater levels have been actively monitored in 512 wells in the region since 2010. The USGS monitors 360 wells in 26 basins, while four cooperators and five CASGEM monitoring entities monitor a combined 152 wells in six basins. DWR monitors an additional 70 wells in the region; however, those wells are not included in the monitoring well summary because the data are not publicly available due to privacy agreements with well owners or operators.

CASGEM Basin Prioritization

Figure CR-8 shows the groundwater basin prioritization for the Colorado River region. Of the 64 basins within the region, 2 basins were identified as high priority (Indio and San Gorgonio Pass subbasins of Coachella Groundwater Basin), 4 basins as medium priority, 9 basins as low priority; and the remaining 49 basins as very low priority. Table CR-4 lists the high and medium CASGEM priority groundwater basins for the region. The six basins designated as high or

Table CR-2 Number of Well Logs by County and Use for the Colorado River Hydrologic Region (1977-2010)

	Total Number of Well Logs by Well Use						
County	Domestic	Irrigation	Public Supply	Industrial	Monitoring	Other	Total Well Records
Riverside	8,048	1,421	466	74	2,086	758	12,853
Imperial	48	9	6	11	206	68	348
Total well records:	8,096	1,430	472	85	2,292	826	13,201

Note: Total well records represent total number of wells installed in the region between 1977 and 2010.

medium priority include 64 percent of the population and account for 76 percent of groundwater supply in the region. The basin prioritization could be a valuable tool to help evaluate, focus, and align limited resources for effective groundwater management, and reliable and sustainable groundwater resources.

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

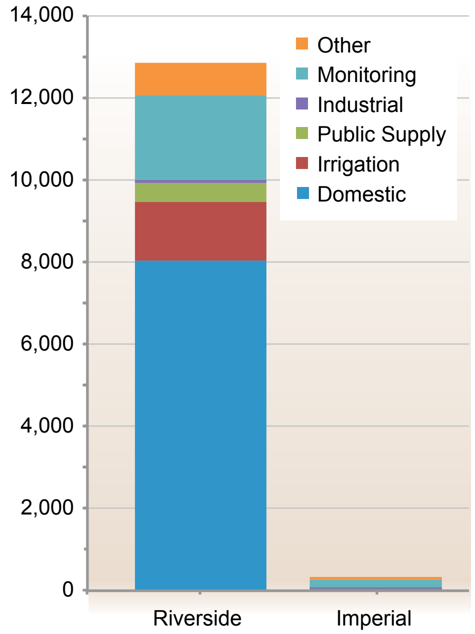
Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect to effective groundwater basin management and is one of the components that are required to be included in groundwater management planning in order for local agencies to be eligible for State funds. Numerous State, federal, and local agencies participate in groundwater quality monitoring efforts throughout California. Regional and statewide groundwater quality monitoring information and data are available on the State Water Resources Control Board's (SWRCB's) Groundwater Ambient Monitoring and Assessment (GAMA) Web site and the GeoTracker GAMA groundwater information system developed as part of the Groundwater Quality Monitoring Act of 2001. The GAMA Web site describes GAMA program and provides links to all published GAMA and related reports. The GeoTracker GAMA groundwater information system geographically displays information and includes analytical tools and reporting features to assess groundwater quality. This system currently includes groundwater data from the SWRCB, regional water quality control boards (RWQCBs), California Department of Public Health (CDPH), Department of Pesticide Regulation (DPR), DWR, USGS, and Lawrence Livermore National Laboratory. In addition to groundwater quality data, GeoTracker GAMA has more than 2.5 million depth to groundwater measurements from the Water Boards and DWR, and also has oil and gas hydraulically fractured well information from the California Division of Oil, Gas, and Geothermal Resources. Table CR-5 provides sources of groundwater quality information.

Land Subsidence Monitoring

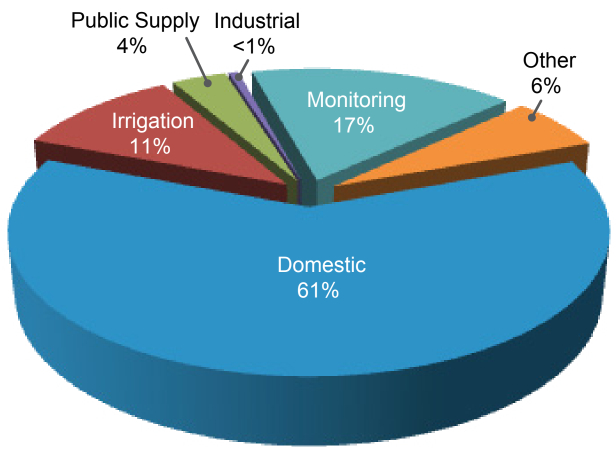
Land subsidence has been shown to occur in areas experiencing significant declines in groundwater levels. When groundwater is extracted from aquifers in sufficient quantity, the groundwater level is lowered and the water pressure, which supports the sediment grains structure, decreases. In unconsolidated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

Figure CR-4 Number of Well Logs by County and Use for the Colorado River Hydrologic Region (1977-2010)



The USGS and the Mojave Water Agency worked cooperatively to monitor and investigate the occurrence of land subsidence in the Mojave Water Agency portion of the Colorado River region. Additional land subsidence monitoring and reporting using a global positioning system (GPS) monitoring network and InSAR data have been conducted in Coachella Valley portion of the region by Ikehara in 1997, and by Sneed and Brandt in 2007. Results associated with these monitoring efforts are provided under subhead Land Subsidence later in the report.

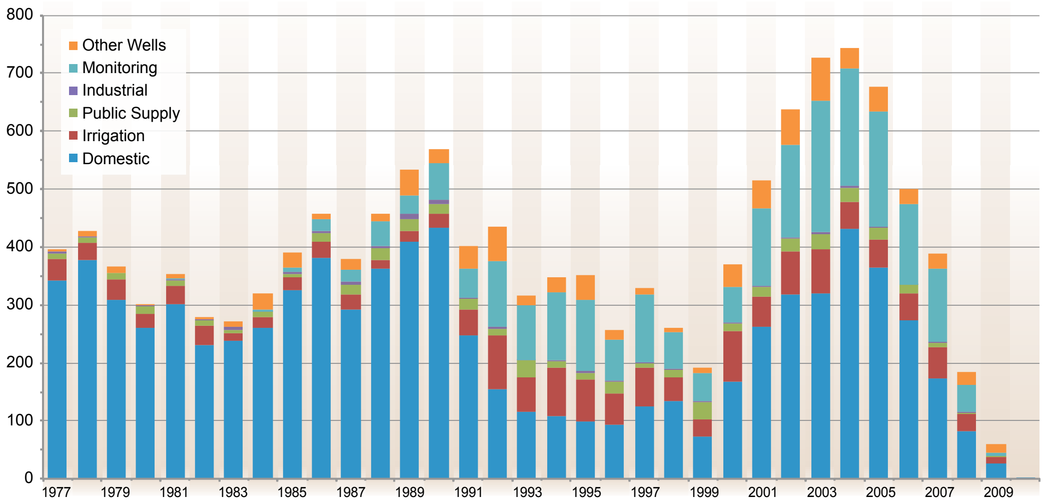
Figure CR-5 Percentage of Well Logs by Use for the Colorado River Hydrologic Region



Ecosystems

Several important ecosystems are in existence in the Colorado River Hydrologic Region. These are the Sonny Bono Salton Sea National Wildlife Refuge, the Wister Unit of the Imperial Wildlife Area, and a portion of the Mojave Desert Natural Reserve. These areas provide key habitat for both migratory and local birds and animals. Although progress has been slow, several environmental efforts related to the restoration of the Salton Sea are under way.

Figure CR-6 Number of Well Logs Filed per Year by Use for the Colorado River Hydrologic Region



Salton Sea

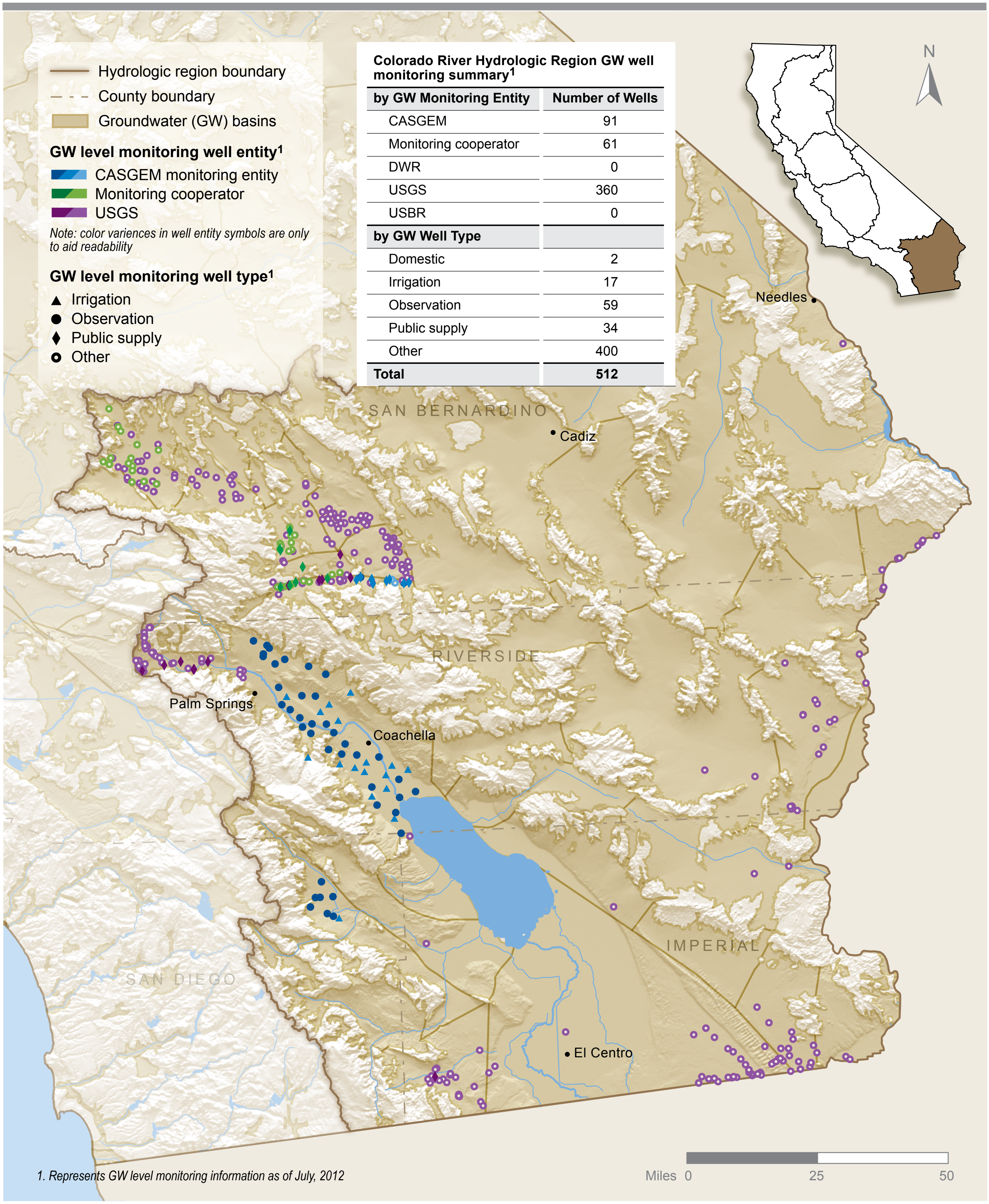
Serving as wintering habitat for migratory and shoreline birds, ranging in number from hundreds of thousands to the low one million, are the Sonny Bono Salton Sea National Wildlife Refuge and the Wister Unit of the Imperial Wildlife Area (WUIWA). The Sonny Bono refuge was established on the southern shores of the Salton Sea in 1998 in honor of the late U.S. Congressman's advocacy for environmental causes. It consists of 830 acres of land maintained as wetlands with an additional 870 acres planted to forage crops such as alfalfa, wheat, rye grass, and Sudan grass. The habitat was created for the endangered Yuma clapper rail and American Avocet. The WUIWA, located on the southeastern shore, occupies a little more than 7,900 acres of land. It includes salt marshes, freshwater ponds, and native, undeveloped lands.

Restoration activities for the Salton Sea continue to move forward. Progress is being made on the multi-agency The Salton Sea Species Habitat Conservation Project. This is a pilot study on 640 acres of land that will yield different options for aquatic habitat to sustain the sea's fish and wildlife populations as the surface area of the water decreases and salinity increases. The final environmental impact report/environmental impact statement (EIR/EIS) for the project was released in 2013, and project design is nearing completion. The project is scheduled to begin in 2014.

The Salton Sea Ecosystem Monitoring and Assessment Plan was released in 2013. The plan is a collaborative effort between DWR, DFW, USBR, and the USGS and provides guidelines for the analysis, management, and reporting of environmental data collected at the Salton Sea that would benefit restoration and management projects and activities.

Implementation will soon commence for three projects selected to receive grant funds through the Salton Sea Financial Assistance Program. The projects will establish a new wetland habitat on the Alamo River in Imperial County, evaluate the feasibility of on-site distillation of water from the Salton Sea for use in remotely located wetland areas, and expand an existing wetland area on the Torres-Martinez Indian Reservation.

Figure CR-7 **Monitoring Well Location by Agency, Monitoring Cooperator, and CASGEM Monitoring Entity in the Colorado River Hydrologic Region**



Colorado River Hydrologic Region GW well monitoring summary[1]

by GW Monitoring Entity	Number of Wells
CASGEM	91
Monitoring cooperator	61
DWR	0
USGS	360
USBR	0
by GW Well Type	
Domestic	2
Irrigation	17
Observation	59
Public supply	34
Other	400
Total	**512**

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

Table CR-3 Groundwater Level Monitoring Wells by Monitoring Entity in the Colorado River Hydrologic Region

State and Federal Agencies	Number of Wells
Department of Water Resources (DWR)	0[a]
U.S. Geological Survey	360
Total State and federal Wells	**360**
Monitoring Cooperators	**Number of Wells**
Bighorn-Desert View Water Agency	13
Hi Desert County Water District	15
Joshua Basin County Water District	3
Mojave Water Agency	30
Total Cooperator Wells	**61**
CASGEM Monitoring Entities	**Number of Wells**
Borrego Water District	8
Coachella Valley Water District	44
Mission Springs Water District	4
San Gorgonio Pass Water Agency	18
Twentynine Palms Water District	17
Total CASGEM Monitoring Wells	**91**
Grand total	**512**

Notes:

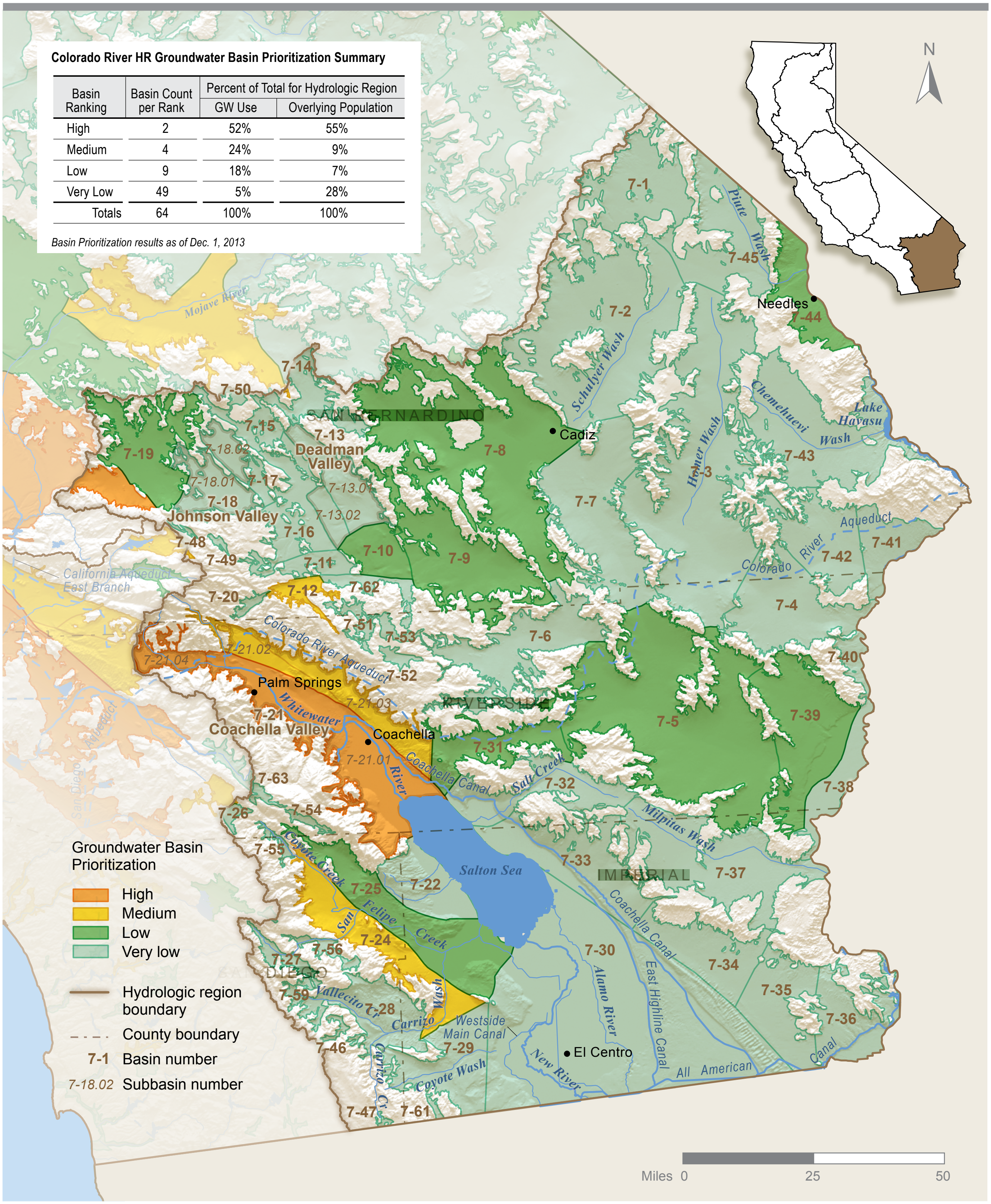
[a] Table includes groundwater level monitoring wells having publicly available online data. DWR currently monitors 70 wells in the Colorado River Hydrologic Region; however, not all of these data are publicly available due to privacy agreements with well owners or operators.

CASGEM = California Statewide Groundwater Elevation Monitoring

Table represents monitoring information as of July 2012

In 2013, Assembly Bill (AB) 71 (Perez) was signed into law by Governor Brown and requires the Secretary for the Natural Resources Agency and the Salton Sea Authority (SSA) to coordinate in the implementation of Salton Sea restoration projects. It also directs the SSA to be lead agency in a study of restoration funding and feasibility. In a related action, the County of Imperial, IID, and the Imperial County Air Pollution Control District entered into a memorandum of understanding (MOU) to work together and coordinate with the SSA to restore the Salton Sea. The MOU parties will develop the renewable energy resources at the Salton Sea, including the infrastructure, and use the revenues generated from the sales of the energy to assist the State with its obligation to fund restoration projects and activities. Alternative water supply sources for urban, agriculture, and the environment will be studied, and assistance will be provided to the SSA to update its 2006 restoration plan titled “Salton Sea Authority Plan for Multi-Purpose Project.” The IID will

Figure CR-8 CASGEM Groundwater Basin Prioritization for the Colorado River Hydrologic Region



Colorado River HR Groundwater Basin Prioritization Summary

Basin Ranking	Basin Count per Rank	Percent of Total for Hydrologic Region	
		GW Use	Overlying Population
High	2	52%	55%
Medium	4	24%	9%
Low	9	18%	7%
Very Low	49	5%	28%
Totals	64	100%	100%

Basin Prioritization results as of Dec. 1, 2013

Table CR-4 CASGEM Groundwater Basin Prioritization for the Colorado River Hydrologic Region

Basin Prioritization	Count	Basin/Subbasin Number	Basin Name	Subbasin Name	2010 Population
High	1	7-21.01	Coachella Valley	Indio	368,860
High	2	7-21.04	Coachella Valley	San Gorgonio Pass	29,550
Medium	1	7-12	Warren Valley		22,860
Medium	2	7-21.02	Coachella Valley	Mission Creek	18,974
Medium	3	7-21.03	Coachella Valley	Desert Hot Springs	22,568
Medium	4	7-24	Borrego Valley		3,853
Low	9	See *California Water Plan Update 2013*, Volume 4, *Reference Guide* article, "California's Groundwater Update 2013."			
Very Low	49	See *California Water Plan Update 2013*, Volume 4, *Reference Guide* article, "California's Groundwater Update 2013."			
Totals	**64**	**Population of groundwater basin area**			**723,100**

Notes:

Senate Bill 7x 6 (SBx7 6; Part 2.11 to Division 6 of the California Water Code Sections 10920 et seq.) requires, as part of the CASGEM program, DWR to prioritize groundwater basins to help identify, evaluate, and determine the need for additional groundwater level monitoring by considering available data that include the population overlying the basin, the rate of current and projected growth of the population overlying the basin, the number of public supply wells that draw from the basin, the total number of wells that draw from the basin, the irrigated acreage overlying the basin, the degree to which persons overlying the basin rely on groundwater as their primary source of water, any documented impacts on the groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation, and any other information determined to be relevant by the DWR.

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

not enter into any new water supply transfer agreements during the MOU and will withdraw its petition to the SWRCB asking for a modification of its 2002 order.

Mojave Desert Natural Reserve

The southeastern portion of the Mojave Natural Preserve is located in the Twentynine Palms-Lanfair PA. Despite arid conditions, a diverse collection of animals and plants have been able to settle and continue to flourish in the preserve. Natural seeps and springs are sufficient to support native vegetation, including yucca, creosote bush, cactus, relict white firs and chaparral, and the Joshua tree. The vegetation provides habitat to numerous animals and birds, including bighorn sheep, desert tortoises, hawks, and eagles.

Flood

Flooding is a significant issue in the Colorado River Hydrologic Region; and exposure to a 500-year flood event would threaten 38 percent of the population, more than $20 billion of assets (crops, buildings, and public infrastructure), and over 180 sensitive species. Even with this level of exposure, public awareness about flooding is inadequate because most events occur as a result of infrequent, high-intensity, summer storms. As a result of the terrain of this area, alluvial fan formations are common. An alluvial fan flooding can occur when a high intensity rainfall event washes sediment from sparsely vegetated steep slopes from mountains or valleys. The reminder of the hydrologic region is part of the Sonoran Desert, is less mountainous, and is dominated by the Salton Sea and the Imperial, Coachella, and Palo Verde valleys.

Major rivers in the hydrologic region are the Colorado, Alamo, New, and Whitewater. Most other rivers, streams, and washes, such Piute Wash and San Felipe Creek, are intermittent or normally dry. All other streams in the hydrologic region having significance to flood management terminate in the Salton Sea except Quail Wash, which ends at Coyote Lake.

In the Colorado River Hydrologic Region, 24 local flood management projects or planned improvements have been identified. Twenty-one projects have costs totaling $70 million while the remaining projects do not have costs associated with them at this time. There is one local planned project that implements an integrated water management (IWM) approach to flood management, the Cushenbury Flood Detention Basin and the San Jacinto River Gap Project. For a complete list of projects, refer to *California's Flood Future Report* Technical Attachment G: Risk Information Inventory (California Department of Water Resources and U.S. Army Corps of Engineers 2013c).

Floods can be caused by heavy rainfall; by dams, levees, or other engineered structures failing; or by extreme wet-weather patterns. Flooding from snowmelt typically occurs in the spring and has a lengthy runoff period. Flooding from rainfall occurs in the winter and early spring, particularly when storms arriving from the Gulf of Alaska draw moisture-laden air from the tropics.

Historic Floods

Damaging floods occurred in the region in 1916 when high water in the Colorado River caused flooding at Brawley, which was repeated in 1921. In 1927, flood-stage flows in the Whitewater River washed out roads and bridges in Thousand Palms and Palm Desert. The USGS estimated that the Whitewater River at White Water exceeded the 100-year flood stage in March 1938 when it isolated Palm Springs and caused several deaths.

In November of 1965 floods along the Whitewater River washed out 22 county roads. There were scour and damage to 13 miles of channel between Cathedral City and the Salton Sea. Two-thousand acres of agricultural lands were flooded with erosion or silting. Citrus and date groves suffered heavy damages. Whitewater River flooding caused three fatalities and $3 million in damages. Flooding of Tahquitz Creek washed out many roads and damaged bridge abutments on State Highway 111. Floodwaters swept 50 cars into streams and drainage channels of Tahquitz Creek and Whitewater River. Flooding of Big and Little Morongo washes eroded roads at dip crossings, damaged homes, and swept away several cars.

Table CR-5 Sources of Groundwater Quality Information for the Colorado River Hydrologic Region

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

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

In 1969, a flow of wet, tropical air from Hawaii to Southern California in January caused intense rainfall and consequent flooding in the Whitewater River basin, culminating in severe damage to roads and property in the Palm Springs area. In February, a flood struck Riverside County causing widespread inundation. Severe residential and highway damages occurred along the Whitewater River and the San Gorgonio River at Cabazon. Much agricultural damage was caused by flooding of the Whitewater River.

In September 1976, Tropical Storm Kathleen brought heavy rains of about 10 inches to some desert areas. San Felipe Creek overflowed and damaged 390 acres of agricultural land, irrigation works, and roads. Carrizo Wash washed out roads and rail lines. Ocotillo was flooded by Myer Creek, which left behind 1 to 3 feet of silt and mud damaging many homes and other structures. Three fatalities occurred in the Ocotillo area. Two people died on Interstate 8 when it washed out. Major flood damages occurred to Interstate 8, State Highway 98, and the San Diego and Arizona Eastern Railroad lines.

For a complete record of floods, refer to *California's Flood Future Report*, Technical Attachment C: History of Flood Management in California (California Department of Water Resources and U.S. Army Corps of Engineers 2013a).

Climate

Most of the Colorado River region has a subtropical desert climate with hot summers and short, mild winters. The mountain ranges on the northern and western borders, in particular the San Bernardino and San Jacinto mountains, create a rain shadow effect for most of the region. Annual average rainfall amounts range from a little over 6 inches to less than 3 inches. Most of the precipitation for the region occurs in the winter and spring. However, monsoonal thunderstorms, spawned by the movement of subtropical air from the south, do occur in the summer and can generate significant rainfall in some years. Higher annual rainfall amounts and milder summer temperatures occur in the mountains to the north and west. Clear and sunny conditions typically prevail, and the region receives 85 to 90 percent of the maximum possible sunshine each year: the highest value in the United States.

Table CR-6 presents annual averages of maximum and minimum temperatures and annual totals of precipitation as measured by five weather stations of the California Irrigation Management Information System (CIMIS) and historical information from the Western Regional Climate Center for 2005 through 2010 in the Colorado River region. Maximum and minimum temperatures and reference evapotranspiration values remained very stable during the period. Measured rainfall during 2006 through 2010 reflected the dry hydrologic conditions in the region and roughly corresponds with the conditions that were occurring statewide. Precipitation amounts rebounded in 2010. A little over 6 inches of rain was measured at the IID headquarters in Imperial in 2010. During the period, the region was not impacted by the normal frequency of summer monsoonal thunderstorms; it was unusually quiet. The lack of rainfall does not directly impact planting decisions by farmers in the region. However, drought on the Colorado River Upper Basin watershed will have future impacts, and Palo Verde Irrigation District (PVID) fallowing programs may grow in response to added water requirements in the South Coast should other supplies decrease.

Being dependent on the Colorado River for preponderance, if not all, of its water resource, the Colorado region is directly impacted by the hydrology of the Upper Basin Colorado River, which experienced a protracted multiyear drought that began in October 1999, ended in 2011, and resumed in 2012. In the summer of 1999, Lake Powell was essentially full with reservoir storage at 97 percent of capacity. However, it became evident with precipitation totals at only 30 percent of average for October, November, and December of that year that the stage was set for the low runoff that occurred in 2000 and has continued with the exception of 2010 through the end of 2012 and into 2013.

In the late 1990s, Lake Powell inflow was above average, and the lake stayed full from 1995 through 1999. However, from 2000 through 2004 Lake Powell inflow was about half of what is considered average. The 2002 inflow was the lowest recorded since Lake Powell began filling in 1963. By August 2011, unregulated inflow volume to Lake Powell increased to 120 percent of average; however, in 2012 the basin returned to drought conditions.

Annual water releases from Lakes Powell and Mead are currently based upon the 2007 Interim Guidelines for the Coordinated Operations of Lakes Powell and Mead. The interim guidelines are

Table CR-6 Colorado River Hydrologic Region Annual Averages of Temperatures and Precipitation

Year	Average Temperatures Maximum (°F)	Average Temperatures Minimum (°F)	Average Daily Temperatures (°F)	Average Annual Precipitation (inches)	Average ETo (inches)
2005	86.41	56.19	71.07	3.62	68.81
2006	87.11	55.79	71.21	0.95	71.66
2007	86.90	55.21	70.98	1.26	70.57
2008	87.19	55.86	71.56	1.77	70.71
2009	87.25	55.15	71.46	1.23	71.84
2010	86.02	55.61	70.97	3.42	71.13

Source: California Irrigation Management Information System and Western Regional Climate Center

Note: ETo = reference evapotranspiration.

intended to govern operations through 2026 and are being utilized to determine annual release volumes. The guidelines specify the critical water surface elevations in the two reservoirs, which govern the annual volumes released from Lake Powell; determine the need for equalization releases to balance the two reservoirs; and determine if Lake Mead will be operated in a surplus, normal, or shortage condition during the water-year. The USBR and seven Basin States use the criteria in the development of the "Annual Operating Plan for Colorado River Reservoirs."

In addition, the guidelines have provisions that can increase the management flexibility of the supplies for the Lower Colorado River Basin entitlement holders. The provisions encourage the efficient use and management of the water supplies. The USBR and the Basin States have entered into several agreements, which have procedures to account for the water supply savings that result from the implementation of water conservation programs and policies. The supply savings is identified as Intentionally Created Surplus (ICS). The creation, storage, and use of ICS supplies in the Lower Basin are intended to minimize the likelihood and severity of any potential future water supply shortages.

Table CR-7 presents unregulated inflow into Lake Powell as a percent of historical average inflow.

Demographics

Although the Colorado River Hydrologic Region is known for its beautiful natural desert landscapes and major agricultural operations, it does have major urban centers in the Coachella and Imperial valleys. These centers have expanded for the past several decades to provide housing for the growing local population and large number of part-time residents who reside outside of the region, but take advantage of the tourism and outdoor recreation industries.

Table CR-7 Unregulated Inflow into Lake Powell as a Percent of Historical Average Inflow for Water Years 2000-2001 through 2009-2010

Water Year	Unregulated Inflow Percent of Long-term Average[a]
2000-2001	65
2001-2002	24
2002-2003	57
2003-2004	54
2004-2005	118
2005-2006	80
2006-2007	81
2007-2008	116
2008-2009	94
2009-2010	78

Notes:

A water year period is from October1 to September 30 of the following year.

[a] Amounts are rounded to nearest percent.

Population

Colorado River Hydrologic Region population in 2010 was 747,100. This is a 23 percent increase in population from 2000, but only a 5 percent increase from 2005. Slower growth in the last 5 years is a reflection of the serious impacts of the recession that started in September 2008. In 2010, about 83 percent of the population in the region was located in the Coachella Valley PA (459,200 or 61 percent) and the Imperial Valley PA (165,600 or 22 percent). Of the remaining 122,300 residents, the Twentynine Palms-Lanfair PA had 73,100.

In the Coachella Valley, many of the residents reside in golf- and resort- cities in the northwest portion of the valley. These include Cathedral City (2010 population 51,200), Palm Desert (2010 population 48,400), Palm Springs (2010 population 44,600), and Desert Hot Springs (2010 population 25,900). In the southeast, the cities provide more service support for the surrounding agricultural operations; included are Indio (2010 population 76,000) and Coachella (2010 population 40,700). Just to the west of the Coachella Valley, in the San Gorgonio Pass, there is the City of Banning (2010 population 29,600).

In the Imperial Valley, cities and towns provide support for the major agricultural and some energy industries, State prison, and Homeland Security operations throughout the area. Consumer services are also provided for residents and businesses located in the Mexicali Valley across the international border. Important cities include El Centro (2010 population 42,600), Calexico (2010 population 38,600), Brawley (2010 population 24,950), and Imperial (2010 population 14,800); and across the border in Mexico, the municipality of Mexicali (2012 population 936,800).
The community of Ocotillo (population 266) obtains water from the Ocotillo-Coyote Wells

Groundwater Basin, an EPA-designated sole-source aquifer. Further development in that area is therefore not likely.

In Homestead and Coyote valleys in the Twentynine Palms-Lanfair PA, growing cities include Yucca Valley (2010 population 20,700) and Twentynine Palms (2010 population 25,068).

In the Colorado River PA, the City of Blythe (2010 population 20,800) provides support for agricultural operations in the Palo Verde Valley. To the north is the City of Needles (2010 population 4,800) in the Mohave Valley. Although there are no incorporated cities, the community of Winterhaven and widely dispersed residents in the Bard Valley, and west of Yuma, Arizona, represent about 3,200 permanent residents.

Tribal Communities

Native American tribes with territory in the Colorado River region include the Agua Caliente Band of Cahuilla Indians, Augustine Band of Mission Indians (Cahuilla), Cabazon Band of Mission Indians, Chemehuevi Tribal Council, Colorado River Indian Tribes, Fort Mojave Tribe, Morongo Band of Mission Indians, Torres-Martinez Band of Desert Cahuilla Indians, and the Twentynine Palms Band of Mission Indians. In the Coachella Valley, tribal land alternates with those that are publicly and privately owned. One-mile square tribal parcels alternate with one-mile square municipal parcels.

Disadvantaged Communities

The State defines a disadvantaged community (DAC) by using the median household income (MHI). A community is disadvantaged if MHI is less than 80 percent of the statewide median household income. A severely disadvantaged community (SDAC) is a community with a median household income less than 60 percent of the statewide median. According to the 2010 Census data, the California statewide MHI was $60,883. Thus, county subdivisions, census-designated places, and cities with an MHI of $48,706 or less are determined to be DACs. Those county subdivisions, census-designated places, and cities with an MHI of $36,530 or less are considered SDACs.

Imperial Valley Region

An evaluation of 2010 Census data determined the DACs within the Imperial Valley region. The MHI in the Imperial region was $36,202 according to U.S. Census Bureau estimates for 2010.

Although the City of Imperial does not meet the definition of a DAC, all other communities in this region have MHIs below the threshold of 80 percent of the statewide MHI ($48,706). Of the 19 locations in this region, 18 meet the definition of a DAC. Of those 18 DACs, 10 meet the definition of a SDAC.

Other than residents in Ocotillo, who access a sole source aquifer, virtually no one in the Imperial region has wells for domestic use. That is because of the high salinity of the groundwater. There are a few wells in the East Mesa that serve as sources for irrigation water.

Coachella Valley Region

In the Coachella Valley region, DAC issues are related to water, sewer and stormwater. Many rural mobile home communities that house the Coachella Valley's significant farm and service industry labor force do not have access to public water and sewer infrastructure. The cost to extend public infrastructure to these communities is estimated to be above the $20 million. Funding of that magnitude has been unavailable. The private sewer infrastructure serving these communities is often undersized or otherwise failing. The private wells serving these communities often lack treatment infrastructure needed for removal of naturally occurring contaminants like arsenic. Identifying the locations and magnitude of these communities is also challenging due to language barriers, fear of government, and access to private land. Regional flood control facilities are not in place because the cost to build them exceeds the monetary value of the community infrastructure needing protection. The Coachella Valley Regional Water Management Group is working to identify and implement lower-cost, near-term solutions that may be implemented with available grant funds thus improving these conditions in the interim period until permanent infrastructure can be funded.

Mojave Region

In the Mojave region, the MHI was $50,636 according to 2010 Census data. However, many areas within the region are disadvantaged. In the Colorado River Hydrologic Region-portion of the Mojave region, the MHI was $42,604; in the South Lahontan Hydrologic Region-portion of the Mojave region, the MHI was $52,021. Most of the rural, outlying areas in this region are considered DACs, but some of the more developed, urban areas are not. Four of the six incorporated cities in the region are DACs, but the City of Victorville and Town of Apple Valley are not.

Many of the small water systems serving rural disadvantage communities need improvements to increase their reliability, including ongoing maintenance and system deterioration problems, leak repairs, water storage reservoirs or other infrastructure to meet fire flow and outage needs, and other issues. Most of these systems do not have the staffing levels or expertise to pursue outside funding for projects that would address these problems. The region is developing a program that would help connect these systems with available State or federal funding.

Other Communities

The City of Blythe, by State standards, is a DAC. According to the 2010 Census, its MHI is $46,235, which is less than 75 percent of the California MHI. Because of the limited household income, the water-related rates, fees, and assessments are extremely difficult for individuals to absorb within their personal budgets. Water infrastructure is deteriorating to a point that could adversely affect public health. The city also suffers from the transient nature of its population, largely attributed to the State prisons within the community.

Other communities that have DACs are Borrego Springs, Salton City, Bombay Beach, Palo Verde, Blythe, and Winterhaven.

Land Use Patterns

Agriculture and Livestock

Despite the extremely arid conditions, three of Southern California's major agricultural areas are located in the Colorado River Hydrologic Region. These are Imperial Valley (Imperial PA), Coachella Valley (Coachella PA), and the Palo Verde and Bard valleys (Colorado River PA). The mild winters allow for an all-year regimen, and reliable water and good soils allow a wide range of permanent and annual crops, including table grapes, dates, citrus, vegetables of all kinds, and field crops — including alfalfa, wheat grain, Bermuda and Klein grass, and cotton. Multiple cropping is widely utilized. Even livestock is an important product, particularly cattle and sheep. The region, especially the Imperial Valley, is a valuable component in the nation's agricultural scheme.

Total irrigated land in the Colorado River region was 571,950 acres in 2010, and the total crop production was 645,970 acres. More than 73,000 acres of the land farmed was multicropped. By comparison, 587,000 acres of land were under cultivation in 2005, with 659,320 acres of total product (reductions of 2.5 percent and 2.0 percent, respectively). This change over the last five years is because of the implementation of land-fallowing programs in the Imperial and Palo Verde valleys. The land fallowing program in Imperial Valley helps IID meet water transfer obligations from the CRWDA and pay back Colorado River water supplies ordered above its allocation in 2011 and 2012. Land fallowing in Palo Verde Valley is a result of an agreement between the Metropolitan Water District of Southern California (MWD) and the PVID.

Table CR-8 shows the harvested acres of the top six crops in the Colorado River Hydrologic Region in 2010.

With more than 425,000 acres of farmland in production in 2010, Imperial Valley continued to be the most productive area in the region. It has been nicknamed as the nation's winter vegetable wonderland, producing a variety of vegetables between fall and spring each year. The crops include winter- and spring- harvested lettuce, broccoli, carrots, cantaloupes, and onions. In 2010, about 93,000 acres of vegetables were harvested in Imperial Valley.

Livestock forage and field crops are also very important in the Imperial Valley. Alfalfa continues to be the crop with the high acreage total for the valley with 138,000 acres in 2010. Other important field and forage crops include wheat and other grains, 55,600 in 2010, Bermuda, Klein, and other pasture grasses, 70,000 in 2010, Sudan grass, 52,800 acres in 2010. Classified as a field crop, valley farmers planted and harvested 26,100 acres of sugar beets for 2010, most of which is processed for sugar at a local refinery. Annual variations in the planted and harvested acreage for the various crops in the valley do occur, depending on anticipated and actual market conditions. Cotton was once very important in Imperial Valley in the 1980s; however, only 9,000 acres was planted in 2005 and less than 3,200 acres in 2010.

About 20 percent of the harvested alfalfa and forage crop acres was consumed locally by the 298,000 head of cattle corralled in the valley's feedlots in 2010. In fact, cattle was the second highest revenue-making agricultural commodity in the valley, with a gross value of $267 million in 2010. That year, head and leaf lettuce grossed a combined $290 million. Other important livestock raised in the valley was sheep, 140,000 head in 2010.

Table CR-8 Top Crops of the Colorado River Hydrologic Region, 2010

Crops	Acres
Alfalfa	193,400
Pasture Grass including Bermuda	80,820
Wheat and other Grains	62,120
Sudan Grass	54,430
Lettuce and Spinach[a]	36,350
Citrus and Subtropical Fruits[b]	33,000
Cole Crops[a,c]	23,500

Notes:

[a] The total of all truck and vegetables crops is 140,480 acres.

[b] Includes dates.

[c] Includes broccoli, cabbage, cauliflower, and allied cole vegetables.

To the north of the Imperial Valley lies another key agricultural operational center, the Coachella Valley (Coachella PA). Agriculture is quite different here. Although Imperial and Coachella valleys are similar climate-wise, less land is farmed in Coachella Valley. In 2010, approximately 48,000 acres of land were cultivated. The types of crops produced were also different — more permanent than row crops. Almost 75 percent of the farmed land in 2010 was planted to citrus and date orchards and vineyards. The harvested acres of field and forage crops was small. A variety of vegetables crops were grown, including peppers; but only a relatively small amount of lettuce. Dates are probably the most distinctive Coachella crop, with data palm orchards in operation on 8,100 acres in 2010. Gross revenue that year for date was $36 million. Equally important is the planning area's table grape vineyards, especially the Flame Seedless variety. In 2010, almost 12,000 acres of grape vineyards in production yielded $92 million in gross sales. Harvested citrus fruit netted $87 million in sales.

On the eastern border of the hydrologic region is the third key agricultural center in the region: the Colorado River PA. Agricultural operations occur mostly in the Palo Verde Valley (70,000 acres of irrigated land today in response to the land fallowing agreement between PVID and MWD. Over 100,000 acres were farmed before the agreement.). However, operations continue to exist in the Mohave Valley, which is north of the City of Needles (3,700 acres of irrigated land), and in the Bard Valley in the southeast corner of California, west of Yuma, Arizona (16,000 acres of irrigated land). Cropping patterns in each area are different. In the Palo Verde Valley, alfalfa was produced on over 43,000 acres which is more than half of the land under cultivation annually. Cotton remains important with more than 9,000 acres planted for 2010. In the Mohave Valley, alfalfa, cotton, and grain crops are the main crops produced. In the Bard Valley, it is winter vegetables, citrus fruit, and dates. In 2010, more than 13,000 acres of vegetable crops were produced on just 16,000 acres of land. The Bard Valley is also known for its date orchards with more than 1,000 acres of date orchards in production.

Two other smaller agricultural production centers in the region include the approximately 3,100 acres of citrus fruit orchards and nursery-grown palms in Borrego Valley in eastern San

Diego County, and the 1,000 acres of citrus and vineyards in Cadiz Valley in east-central San Bernardino County (County Agricultural Commissioner's Crop Report).

Urban and Industrial

Most of the urban land uses for the Colorado River region are in the Coachella, Imperial Valley, and Twentynine Palms-Lanfair PAs, with the heaviest concentration in Coachella PA. The uses include single-family and multi-family dwellings, strip malls and shopping centers, and more than 100 public and private country clubs and golf courses. In the Coachella Valley, most of the older uses are located on or near State Highway 111. The newer urban uses have continued to expand from this core to the north and southeast for more than two decades in support of recreation and tourism, particularly golf. However, that pace began to slow about 4 years ago in response to the recent recession. In the Imperial Valley and southeastern portion of the Coachella Valley, the commercial and industrial uses in the cities generally support local agricultural operations; packing houses and farm equipment sales and repairs. In addition, the residential and commercial lands in the Imperial Valley have undergone some expansion in support of new homeowners and consumers both locally and from the Mexicali Valley in Mexico.

Native American tribes and associated reservations also maintain a significant presence in the region. Native American-operated casinos and resorts along the Colorado River north of Needles, north of the City of Palm Springs, and near the community of Cabazon west of Palm Springs are a convenient alternative for Southern Californians who enjoy the attractions of Las Vegas.

Another area of urban development is in the San Gorgonio Pass. Between the cities of Banning and Beaumont (located outside of the Colorado River region). Residential and commercial development was occurring at a reasonably quick pace. The pace of that construction slowed because of the impacts of the recession.

Managed Public Lands

Naval and military training facilities and other preserved or managed public lands are everywhere in the region. This includes several large national and State parks, recreation and wilderness areas, and wildlife refuges.

Nationally known parks in the region include Joshua Tree National Park, the Mojave National Scenic Preserve, Anza-Borrego State Park, and the Salton Sea and Picacho State Recreation areas. Other lands are also set aside for preservation or other land management purposes, including national recreation and wilderness areas, wildlife refuges, tribal reservations, and U.S. Navy facilities.

Regional Resource Management Conditions

Water in the Environment

The largest water body in the region is the Salton Sea, a saline body of water with an area of about 376 square miles and maximum depth of about 51 feet. In 2010, the concentration of total dissolved solids in the sea was about 53,000 milligrams per liter, which is about 50 percent greater than that of ocean water. Under the terms of the CRWDA and related agreements, IID continues to operate a fallowing program to meet requirements for Salton Sea mitigation established by the SWRCB as part of its review and approval of the IID/San Diego County Water Authority (SDCWA) Water Transfer. In the remaining years of mitigation requirement, 2014-2017, IID will deliver 110, 130, and 150 thousand acre-feet (taf) of water, respectively. From 2003 to 2013, 320 taf of mitigation water have been delivered to the Salton Sea under this program.

Other than Salton Sea mitigation water, most of the environmental applied water demand in the region is for the Sonny Bono Salton Sea National Wildlife Refuge, DFW's Imperial Wildlife Area, wetland areas on the shore of the Salton Sea, including the 85-acre Desert Cahuilla Wetland on the northwestern tip of the sea.

The Salton Sea ecosystem remains a critical link on the international Pacific Flyway. It provides wintering habitat for migratory birds, including some species whose diets are based exclusively on fish. For the California Water Plan Update 2009, the expected average annual inflows to the Salton Sea for a 25-year time frame were about 962,000 acre-feet per year (af/yr.), based on estimates using the Salton Sea Accounting Model (SSAM).

The IID delivers water to the Sonny Bono Salton Sea National Wildlife Refuge Complex, the Imperial Wildlife Area, Wister Unit (no water is delivered to the Finney-Ramer Unit), IID's managed marsh, and some private wetlands in the Imperial Valley PA. For 2010, about 30 taf was delivered to these areas.

Water Supplies

The Colorado River and groundwater are the primary water supply sources for the Colorado River Hydrologic Region. Most of the agricultural, urban, and environmental water demands are met with them. Some supplies from the State Water Project (SWP) are delivered to the northern portion of the region through an exchange between the Coachella Valley Water District (CVWD), Desert Water Agency (DWA), and the MWD.

Colorado River Basin Water Supply and Demand Study

The Colorado River Basin Supply and Demand Study was completed in December 2012. Currently stakeholder groups are working on projects associated with "next steps" outlined in the study.

The Colorado River Basin Water Supply and Demand Study planning process has projected a likely imbalance in future supply and demand of just over 3 maf by 2060. The basin study report has identified a range of strategies including conservation, transfers, modification of operations, and mechanisms that facilitate implementation. The basin study report can be found online at http://www.usbr.gov/lc/region/programs/crbstudy.html.

Surface Water Supply

Urban, agricultural, environmental, and energy water demands in the Colorado River Hydrologic Region are met with surface water supplies from the Colorado River, groundwater, and recycled water. Water supplies from the Colorado River meet all or portions of the agricultural and urban water demands in the Imperial, Palo Verde, Coachella, and Bard valleys. The PVID operates facilities that divert water supplies from the Colorado River for its agricultural customers. For the Bard Valley, Colorado River water supplies are diverted to the area through the Yuma Project facilities, which are operated by the USBR. Colorado River water supplies are transported to the IID through the All-American Canal for its agricultural customers and for the urban customers of the public- and investor-owned water agencies in the valley. The Coachella Canal transports river water, taken at Drop 1 along the All-American Canal, into the Coachella Valley for agricultural and some urban uses. The Colorado River is an interstate and international river with use apportioned among the seven Colorado River Basin states and Mexico by a complex body of statutes, decrees, and court decisions known collectively as the “Law of the River” (find more information under the Water Governance section of this report).

Total annual water supplies required to meet the demands in the region between 2006 and 2010 ranged from 4,400 taf to 4,924 taf. Over 75 percent of the totals for each year were met by Colorado River supplies. These supplies were utilized in the following areas: Imperial Valley, Coachella Valley, Colorado River, and Borrego. (See Figure CR-9.)

The SWP and recycled and local surface water supplies provide the remainder of water to the region. SWP supplies are obtained through an exchange agreement between the CVWD, DWA, and MWD. No facilities exist today to deliver SWP supplies to the Coachella Valley contractors. However, through the agreement, the MWD releases the combined SWP allocations for the CVWD and DWA into the Whitewater River from its Colorado River Aqueduct. These releases recharge the upper groundwater basin of the Coachella Valley and the Slission Creek groundwater basin. In exchange, MWD receives the two agencies’ annual allocations through SWP facilities. The CVWD treats urban wastewater flows and makes the recycled water supplies available for non-potable uses such as irrigations of golf courses.

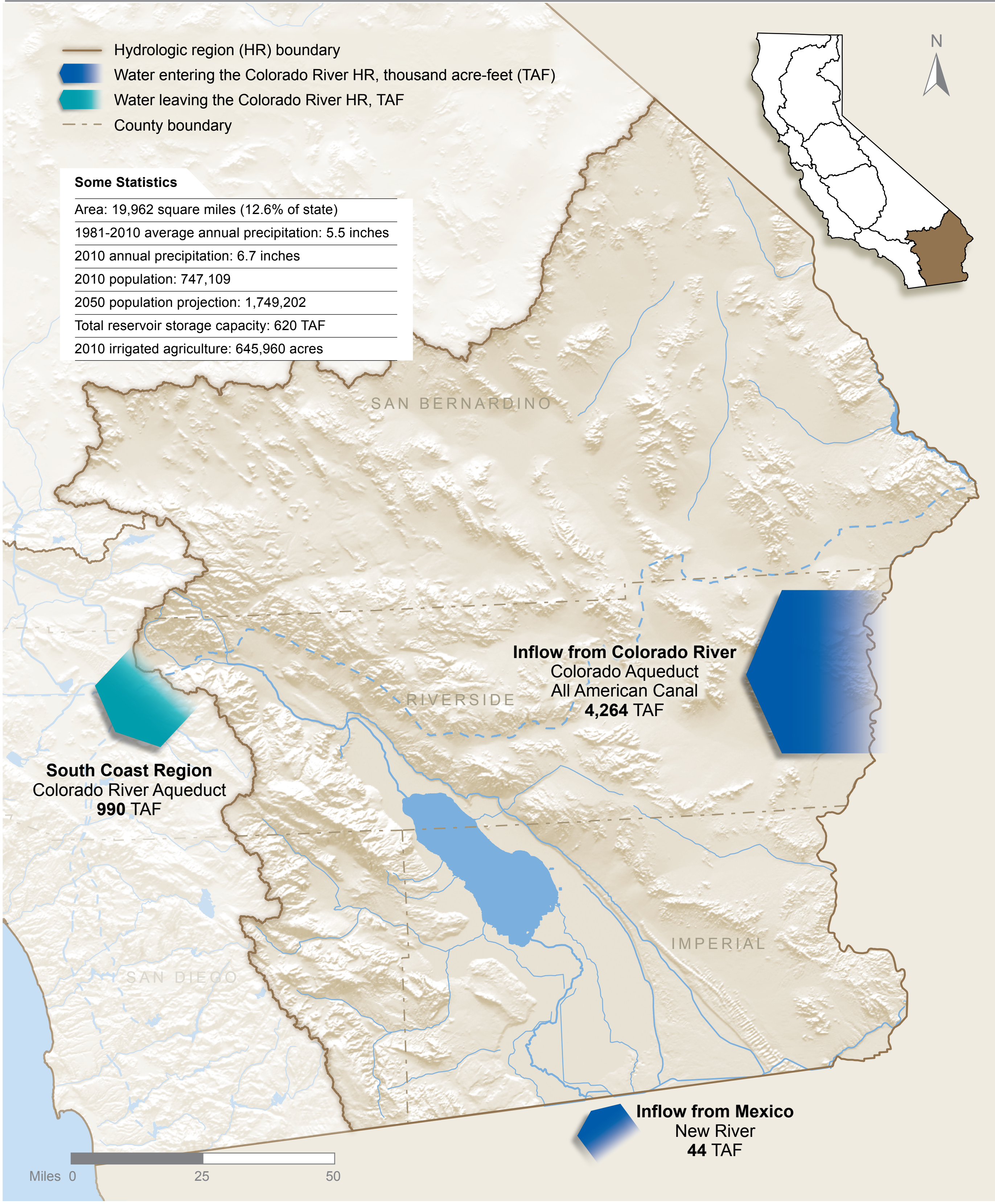
Although still under construction, a portion of the East Branch Extension of the SWP now delivers some water supplies into the Banning-Beaumont area for groundwater recharge. In 2010, the San Gorgonio Pass Water Agency (SGPWA) delivered 8.4 taf of SWP water for these operations; in 2011, it was 10.7 taf. However, when Phase II of the construction is complete, the SGPWA will be able to deliver 17.3 taf annually to the area for recharge operations.

The CVWD and DWA continue work with water agencies outside of the region to augment its SWP deliveries and assist with local groundwater management activities. In addition to the advanced delivery of Colorado River water, CVWD, DWA, and MWD agreed to the terms of a second agreement, the 2003 Exchange Agreement. MWD transferred 100 taf of its SWP allocation to both agencies: 89 taf to CVWD, and 11 taf to DWA. In 2007, the agencies agreed to transfer agreements with the Berenda Mesa Water District and the Tulare Lake Water Basin Storage District for the transfer of additional SWP supplies; for 16 taf and 7 taf respectively. CVWD has also entered into agreements for the one-time transfer of non-SWP water supplies to its service area with the Rosedale-Rio Bravo Water Storage District, for banked Kern River flood waters and DMB Pacific, Inc. for water from the Kern County Water Agency’s Kern River Restoration and Water Supply Program.

Groundwater Supply

Groundwater supply estimates are based on water supply and balance information derived from DWR land use surveys, and from groundwater supply information that water purveyors or other

Figure CR-9 Regional Inflows and Outflows, Colorado River Hydrologic Region



State agencies voluntarily provide DWR. Groundwater supply is reported by water year (October 1 through September 30) and is categorized according to agriculture, urban and managed wetland uses. The groundwater information is presented by planning area, county, and by the type of use. Although groundwater accounts for less than one-tenth of the region's total water supply, the majority of groundwater supplies (87 percent) are used to meet urban use while 13 percent goes to agricultural use. Groundwater supply is not used to meet any managed wetlands use in the region.

Figure CR-10 depicts the planning area locations and the associated 2005-2010 groundwater supply in the region. The estimated average annual 2005-2010 total water supply for the region is about 4.27 maf of which 380 taf is from groundwater supply (9 percent). (Reference to total water supply represents the sum of surface water and groundwater supplies in the region and local use). The figure also shows that Coachella planning area is the largest user of groundwater in the region: an average annual supply of 315 taf (83 percent of the total groundwater supply for the region).

Table CR-9 provides the 2005-2010 average annual groundwater supply by type of use, and by planning area and county. Groundwater supplies meet 53 percent of the overall urban use (330 taf), but only 1 percent of the overall agricultural use (50 taf). No groundwater resources are used for managed wetlands applications in the region.

Although groundwater extraction in the region accounts for only about 2 percent of California's 2005-2010 average annual groundwater supply, it contributes to 60 to 95 percent of the water supply for urban use in most planning areas in the region (Table CR-9). Regional totals for groundwater based on county area will vary from the planning area estimates because county boundaries do not necessarily align with planning area or hydrologic region boundaries.

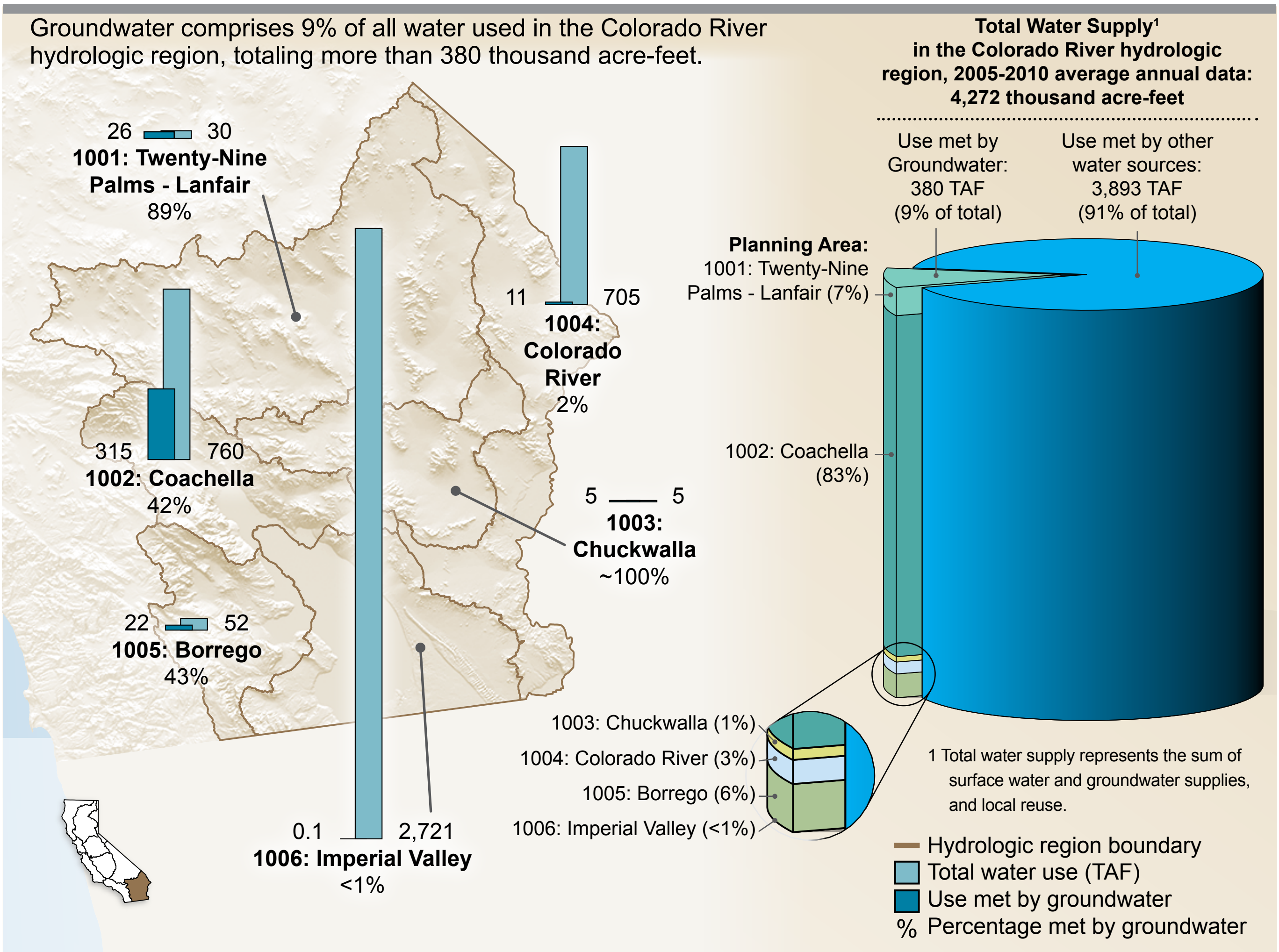
For the Colorado River Hydrologic Region, county groundwater supply is reported for Imperial and Riverside counties. Table CR-9 shows that groundwater contributes to approximately 13 percent of the total water supply for the two counties with almost all of the groundwater being used in Riverside County. Groundwater supplies in Riverside County are used to meet 54 percent of the urban water use and 15 percent of the agricultural water use.

The Colorado River is hydrologically connected to the groundwater basins adjacent to it. The water supplies in these basins are considered in the appropriation of the Colorado River water supplies. There are some urban and industrial groundwater users in the Colorado River floodplain that may not have valid rights to use these supplies. To resolve this issue, the U.S. Congress enacted the Lower Colorado River Water Supply Act of 1986 (Public Law 99-655). The law established the procedures for water users adjacent to the river to legally obtain water supplies to satisfy their respective domestic, municipal, industrial, and recreational demands.

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

The right side of Figure CR-11 illustrates the annual amount of groundwater versus other water supplies, while the left side identifies the percent of the overall water supply provided by groundwater relative to other water supplies. The center column in the figure identifies the

Figure CR-10 Contribution of Groundwater to the Colorado River Hydrologic Region Water Supply by Planning Area, 2005-2010



water year along with the corresponding amount of precipitation, as a percentage of the 30-year running average for the region. The figure indicates that the annual water supply for the region has remained relatively stable between 2002 and 2010 (ranges from 4.1 maf to 4.6 maf), which is likely due to a relatively stable surface water supply for the region. Between 2002 and 2010, groundwater supply has fluctuated between 340 taf and 500 taf per year, providing between 8 and 11 percent of the total water supply. Even during the dry years of 2006 and 2007, groundwater supply contributed to less than 10 percent of the total water supply.

Figure CR-12 shows the annual amount and percentage of groundwater supply to meet urban, agricultural, and managed wetlands uses. The figure indicates that 80 to 90 percent of the annual groundwater supply met urban use, while the remaining groundwater supply met agricultural use. Groundwater was not used for meeting any managed wetlands use.

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

Table CR-9 Colorado River Hydrologic Region Average Annual Groundwater Supply by Type of Use and by Planning Area (PA) and County (2005-2010)

Colorado River Hydrologic Region		Agriculture Water Use Met by Groundwater		Urban Water Use Met by Groundwater		Managed Wetlands Water Use Met by Groundwater		Total Water Use Met by Groundwater	
PA NUMBER	PA NAME	TAF	%	TAF	%	TAF	%	TAF	%
1001	Twenty-Nine Palms - Lanfair	11.1	100	15.3	82	0.0	0	26.4	89
1002	Coachella	21.0	8	294.4	60	0.0	0	315.4	42
1003	Chuckwalla	2.6	100	2.1	95	0.0	0	4.7	98
1004	Colorado River	0.4	100	10.4	78	0.0	0	10.8	2
1005	Borrego	14.9	34	7.4	92	0.0	0	22.3	43
1006	Imperial Valley	0.0	0	0.1	0	0.0	0	0.1	0
2005-10 annual average region total		**50.1**	**1**	**329.7**	**53**	**0.0**	**0**	**379.7**	**9**
Imperial County		0.0	0	1.1	1	0	0	1.1	0
Riverside County		138.6	15	495.9	54	0	0	634.5	34
2005-10 annual avg. total		**138.6**	**4**	**497.0**	**49**	**0**	**0**	**635.7**	**13**

Notes:

TAF = thousand acre-feet

Percent of supply is the percent of the total water supply that is provided by groundwater.

2005-2010 precipitation equals 91 percent of the 30-year average.

Water Uses

The 1931 Seven Party Agreement established annual apportionments of Colorado River water (consumptive use volume) for California agencies. These were further quantified in the 2003 Colorado River Water Delivery Agreement: Federal Quantification Settlement Agreement. In accordance with the terms of the CRWDA Exhibit B, IID's net consumptive use of Colorado River water is to be reduced by 492.2 taf annually by 2016 and remain there through 2047. CVWD net consumptive use is to increase by 94 taf annually (Table CR-10). If the CRWDA option for termination is activated in 2017, these levels will only need to be maintained until 2037.

For the period 2006 to 2010, annual urban and agricultural water demands in the Colorado River Hydrologic Region ranged from 4,394 taf to 4,870 taf. Total demands decreased slightly in 2009 probably because increased water use efficiency program activities and the ongoing recession that started in 2008.

Figure CR-11 Colorado River Hydrologic Region Annual Groundwater Supply Trend (2002-2010)

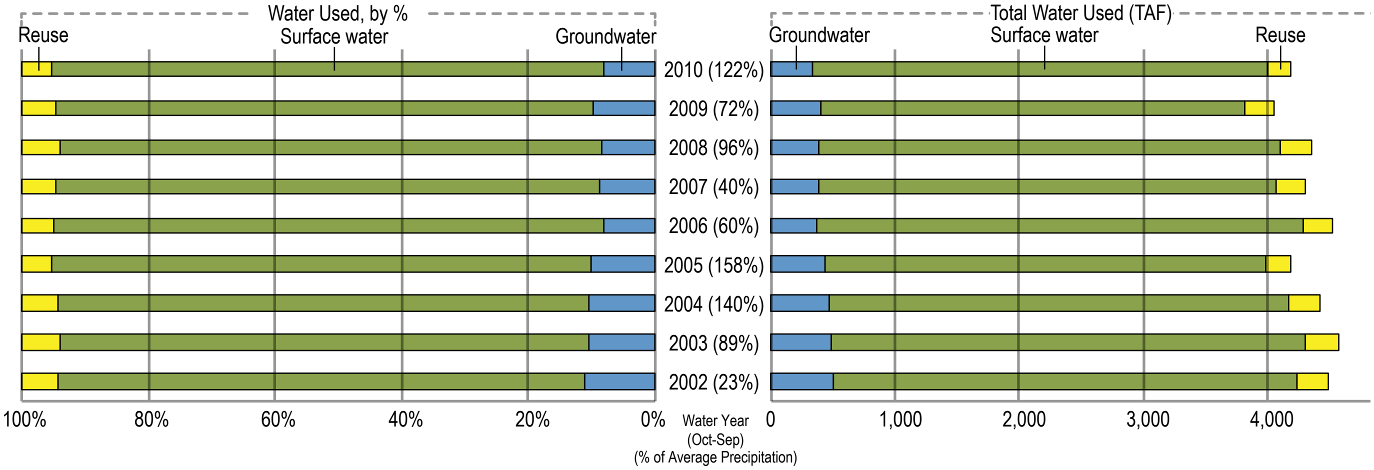
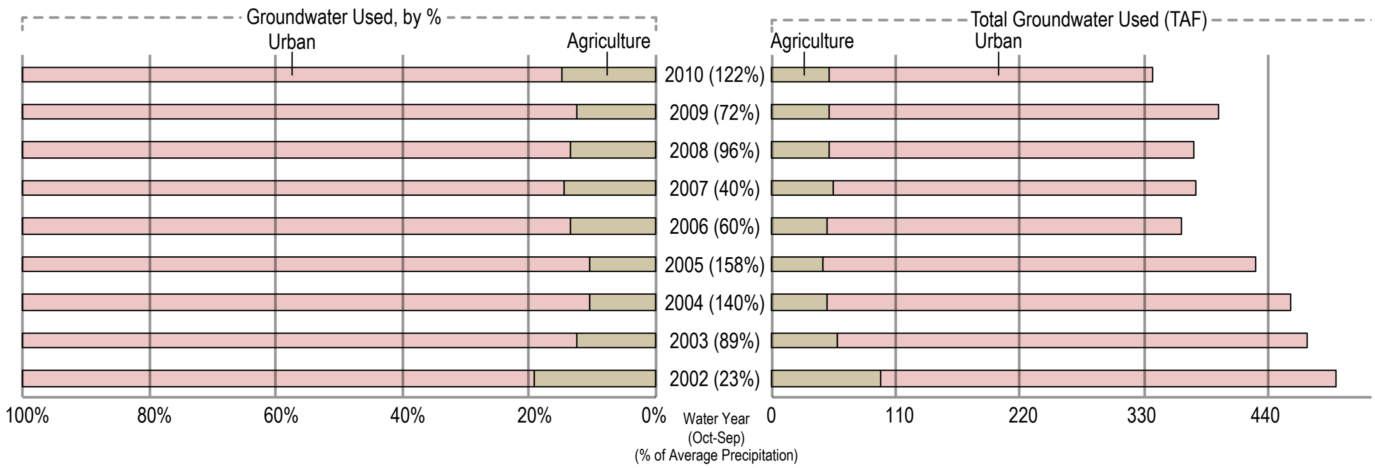


Figure CR-12 Colorado River Hydrologic Region Annual Groundwater Supply Trend by Type of Use (2002-2010)



About 75 percent of the total demands in the region came from agriculture for 2006-2010, and a majority of that was from the Imperial Valley PA. Annual total applied water demands for agriculture ranged between 4,226 taf and 3,817 taf. In the Colorado River PA, agricultural demands were lower for the period than before 2005. This is largely attributable to water transfer agreement between PVID and MWD that have resulted fallowing about 20 percent of the irrigated area in the PVID service area.

For the period between 2006 and 2010, more than half of the urban demands in the Colorado River region occurred in the Coachella Valley PA. Annual total applied water demands for urban ranged between 696 taf and 551 taf, including imported supplies used for recharge of groundwater basins. Most of the Coachella Valley, Ocotillo, and Borrego Springs urban demands were met through groundwater supplies. In the Imperial and Bard valleys and for some water users in the southern Coachella Valley PA, treated Colorado River supplies are utilized. In the

Table CR-10 Quantification and Annual Approved Net Consumptive Use of Colorado River Water by California Agricultural Agencies

	Quantified Amount	Quantified Net Consumptive Use[a], 2010	Actual Net Consumptive Use[a], 2010	Quantified Annual Net Consumptive Use[a], 2026–2047
Priority 1, 2, and 3b. Based on historical average use; deliveries above this amount in a given year will be deducted from MWDSC's diversion (order) for the next year; as agreed by MWDSC, IID, CVWD, and Secretary of the Interior (PVID and the Yuma Project are not signatories to the federal QSA.)	420 taf	420 taf	312.2 taf[d]	420 taf
Priority 3a Coachella Valley Water District	330 taf	333 taf	306.1 taf	424 taf
Priority 3a Imperial Irrigation District	3,100 taf	2733.8 taf	2545.6 taf[b]	2,607.8 taf
Total California Agricultural Use	3,850 taf	3,486.8 taf	3,163.9 taf	3,451.8 taf
IID CRWDA Exhibit C Payback		19 taf	0 taf[b]	0 taf
CVWD CRWDA Exhibit C Payback		9.2 taf	0 taf[b]	0 taf
Total Priority 1-3 Use	3,850 taf	3515 taf	3163.9 taf	3,446.3 taf
Remainder of 3.85 maf for use by MWDSC (and SDCWA and 14.5 taf Misc. PPRs) through priority rights and transfer agreements.	0 taf	335 taf[c]	686.1 taf[c]	403.7 taf[c]

Data Sources:

Colorado River Water Delivery Agreement: Federal Quantification Settlement Agreement for the purposes of Section 5(b) of Interim surplus Guidelines, Exhibits A, B and C, approved by the Secretary of the Interior on October 10 2003, http://www.usbr.gov/lc/region/g4000/QSA/crwda.pdf

Colorado River Accounting and Water User Report:: Arizona, California, and Nevada, Calendar Year 2010, US Department of the Interior, Bureau of Reclamation Lower Colorado Region, pp 37, http://www.usbr.gov/lc/region/g4000/4200Rpts/DecreeRpt/2010/2010.pdf

Notes:

CVWD = Coachella Valley Water District; IID = Imperial Irrigation District; MWDSC = Metropolitan Water District of Southern California; PVID = Palo Verde Irrigation District; QSA = Quantification Settlement Agreement; CRWDA = 2003 Colorado River Water Delivery Agreement; SDCWA = San Diego County Water Authority; taf = thousand acre-feet; maf = million acre-feet

[a] Consumptive use is defined in the federal QSA as "the diversion of water from the main stream of the Colorado River, including water drawn from the main stream by underground pumping, net of measured and unmeasured return flows."

[b] Exhibit C obligations were fully extinguished in 2009 (IID and USBR disagree on the calculation of this value; it will be finalized upon resolution of this issue)

[c] Includes miscellaneous present perfected rights, federal rights reserved, and decreed rights.

[d] Includes Palo Verde Irrigation District, Yuma Project Reservation Division, and Yuma Island Pumpers

Imperial Valley, rural residents must obtain drinking and cooking water service from a State-approved provider.

Surface irrigation and micro-irrigation systems are used to irrigate the crops in the Colorado River region. In the Palo Verde, Imperial, and Bard valleys, most of the irrigation is handled by surface irrigation systems, such as furrows and border-strip irrigation. Vegetables, melons, sugar beets, cotton, and some citrus are commonly irrigated using furrows. In the Imperial Valley, about a third of the alfalfa is grown with this system. Border-strip systems are used for the remainder of the alfalfa; grain (mainly wheat); and Sudan, Bermuda, and Klein grasses. Farmers use hand-move sprinkler systems for seed germination and during the first weeks of growth. A majority of the time, they then switch to furrow irrigation until harvest. However, some of the lettuce and spinach are now being grown on wide furrows, and irrigation water is being applied by sprinklers for the entire growing season. The use of micro-irrigation systems (sub-surface drip systems) is limited, but is becoming increasingly popular in these valleys. Plastic mulch covers the furrows for some vegetables and melons to regulate temperature and moisture content in the soils.

Irrigation operations are different in the Coachella Valley. Both surface irrigation and micro-irrigation systems are used. For truck and field crops grown from seed, hand-move sprinklers are used for germination and early stages of growth. However, farmers are increasingly using micro-irrigation or sub-surface drip irrigation systems — buried plastic drip lines — to handle the irrigation through the remainder of the growing season. Bell and other varieties of peppers are often irrigated this way. Mature date trees in the Coachella Valley are mostly irrigated using large, wide furrows, but drip systems are being used for many of the younger trees. Citrus trees and grape vineyards are irrigated exclusively with drip systems. For the vineyards, the drip lines are attached to the trellises about 2 feet above the ground. For frost protection, many of the vineyards have sprinklers installed above the plants. Center pivot systems are being used only in the Mohave Valley where only field crops are grown.

Although water supplies are reliable and relatively inexpensive, the region's water agencies and farmers, as well as urban and renewable energy water users, are fully aware of the need to manage and use those supplies efficiently. In agriculture, this involves implementing strategies to meet the requirements of the CRWDA and programs collectively known as efficiency water management practices (EWMP). The use of micro-irrigation systems is a significant step toward meeting those goals. Farmers are always seeking ways to improve the distribution uniformities of irrigation water applied by surface irrigation systems, to help with crop yields and decrease tailwater and water lost through evaporation and deep percolation. In addition to shorter irrigation runs, laser-leveling of many fields in the region (90 percent in the Imperial Valley) eliminates the surface features in the field, which impede the flow of the applied irrigation water. Farmers in the Imperial Valley operate tailwater pumpback systems to capture tailwater flows and transport them back to the head ditches for reuse.

Infrastructure and institutional changes in the water conveyance systems have also helped to achieve the water-use efficiency goals in the region. The IID-MWD transfer agreement in 1988 resulted in the concrete-lining of canals to reduce losses from seepage, automation of the conveyance systems, facilities to capture lateral spillage, and the construction of small reservoirs. Also changed were water delivery timetables, which helped farmers with their irrigation operations.

Agricultural operations throughout the region benefit from technical services on irrigation management provided by the water (IID, CVWD, and PVID) and government (National Resources Conservation Service, University of California Cooperative Extension, and USBR) agencies. To assist farmers who are scheduling irrigations to match crop evapotranspiration and other requirements, these agencies continue to work with DWR to provide adequate coverage of the region's climatology with weather stations of the CIMIS network. All of the major agricultural areas in the regions are now adequately covered by CIMIS stations. With access to new resources such as the Internet, farmers utilize real-time climate data measured by weather stations to plan their irrigation operations. IID downloads, stores, and uses the CIMIS record as part of its input for water balance calculations.

For urban water users in the region, water agencies are implementing many of the urban best management practices (BMP) programs and policies. Many of the agencies provide speakers and distribute and post water use efficiency information as part of their public and school water education programs. The CVWD and IWA provide indoor water use efficiency kits for local homeowners. The IWA has started and the MSWD will soon provide home survey services for their residential customers. The CVWD has several rebate programs, as does IID. CVWD recently began a program for homeowners for the installation of high efficiency toilets, and IID has a program for low-flow shower heads. Another CVWD program provides financial assistance to homeowners who convert their exterior landscape from a turf grass-dominant design to one emphasizing water-efficient plants and xeriscaping; the IWA has a similar program.

In compliance with Water Conservation in Landscaping Act, cities and water agencies in the Coachella Valley recently adopted a uniform landscape ordinance that provides governance for landscape designs for new developments. The goal of the ordinances is to seek significant reductions in demands for exterior landscaping in the future and provide criteria for the reduction of turf grass for golf courses. Both the CVWD and MSWD provide technical assistance to its community for the compliance with their respective ordinances. The CVWD provides technical assistance to golf courses on irrigation system issues, checks for compliance with approved plan designs, and monitors the facilities for maximum water allowance compliance.

The Borrego Water District is implementing a vigorous water conservation program with rebates and turf removal incentives. The PVID has implemented an extensive fallowing program to reduce its agricultural water use and make that water available to MWD. The IID has implemented, continues to implement, and is planning additional efficiency conservation programs to meet its CRWDA water transfer reduction obligation, which ramp up from 136,500 acre-feet (af) in 2009 to 487,500 af in 2026, in the largest agricultural to urban water transfer in California's history. For IID water conservation program activities, see section on Integrated Regional Water Management.

Drinking Water

The region has an estimated 129 community drinking water systems. The majority (some 89 percent) of these systems are considered as small, serving fewer than 3,300 people, with most small water systems serving fewer than 500 people (Table CR-11). Small and very small water systems face unique financial and operational challenges in providing safe drinking water. Given their customer base, many cannot develop or access the technical, managerial, and financial resources needed to comply with new and existing regulations. These water systems may be geographically isolated, and their staff often lacks the time or expertise to make needed infrastructure repairs, install/and or operate treatment systems; and/or develop comprehensive source water protection plans, financial plans, and/or asset management plans (U.S. Environmental Protection Agency 2012).

In contrast, medium and large water systems account for around 21 percent of region's drinking water systems; however, these systems deliver drinking water to 95 percent of the region's population (see Table CR-11). These systems generally have the financial resources to hire staff

Table CR-11 Summary of Large, Medium, Small, and Very Small Community Drinking Water Systems in the Colorado River Hydrologic Region

Water System Size by Population	Community Water Systems (CWS)		Population Served	
	SYSTEMS	PERCENT	POPULATION	PERCENT
Large >10,000	15	12	716,977	87
Medium 3,301 – 10,000	12	9	67,673	8
Small 500 – 3,300	23	18	28,719	3
Very Small <500	79	61	13,140	2
CWS that primarily provide wholesale water	0	0	---	---
Total	**129**	**---**	**826,509**	**---**

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

Note: Population estimates are as reported by each water system to CDPH and may include seasonal visitors.

who oversees daily operations and maintenance needs and who plan for future infrastructure replacement and capital improvements. This helps to ensure that existing and future drinking water standards can be met. It also provides resources needed to be competitive for State and federal grant programs; which, for small and very small agencies are often inaccessible due to their low levels of staffing and financial resources.

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

Fourteen Colorado River urban water suppliers have submitted 2010 urban water management plans to DWR. The Water Conservation Act of 2009 (SB X7-7) required urban water suppliers to calculate baseline water use and set 2015 and 2020 water use targets. Based on data reported in the 2010 urban water management plans, the Colorado River Hydrologic Region had a population-weighted baseline average water use of 380 gallons per capita per day and an average population-weighted 2020 target of 312 gallons per capita per day. The Baseline and Target Data for individual Colorado River urban water suppliers is available on the DWR Urban Water Use Efficiency Web site (http://www.water.ca.gov/wateruseefficiency/).

The Water Conservation Act of 2009 (SB X7-7) required agricultural water suppliers to prepare and adopt agricultural water management plans by December 31, 2012, and update those plans by December 31, 2015, and every 5 years thereafter. One Colorado River agricultural water supplier has submitted a 2012 agricultural water management plan to DWR.

Water Balance Summary

The water balances in the Colorado River Hydrologic Region are compiled by a detailed analysis of the six planning areas in the region. There are no instream requirements or wild and scenic rivers in this hydrologic region. Managed wetlands exist in only one area (Imperial Valley, PA 1006). Table CR-12 provides a hydrologic water balance summary for the Colorado River region.

Figure CR-13 illustrates a water balance for dedicated and developed supply by year. For more information on water balances and portfolios, go to Volume 5, *Technical Guide*.

Between 2006 and 2010, total water supplies for the Colorado River Hydrologic Region ranged from a high of 4,924 taf and 4,400 taf. About 70 percent of the water supplies needed annually were from the Colorado River and about 10 percent from local groundwater supplies. The Coachella and Twentynine Palms-Lanfair areas received some SWP supplies during the period for groundwater recharge operations.

Recycled water use of about 14,000 af occurred within three Colorado River region PAs, as determined in the 2009 Municipal Wastewater Recycling Survey completed by the SWRCB and DWR. Recycling was reported in Coachella, Calipatria, and U.S. Marine Corps Air Ground Combat Center, Twenty Nine Palms. Additional information on statewide municipal recycled water is included in the resource management strategy “Municipal Recycled Water” (Volume 3, Chapter 12). Additional information on specific recycled water uses in the Colorado River region can be found in Volume 4.

Twenty Nine Palms-Lanfair (PA 1001) lies almost exclusively in San Bernardino County and is the northwestern-most planning area in the region. The urban applied water demands ranged between 18 and 22 taf annually; agricultural demands were 10 and 12 taf. Groundwater supplies were used to meet all demands. The SWP water supplies delivered to the area were used for groundwater recharge.

The Coachella PA (PA 1002) is the most populated area in the hydrologic region. Urban demands ranged between 420 and 570 taf and were mostly met with groundwater and recycled water supplies and some Colorado River water uses in the southern end of the area. These demands continued to be significantly influenced by the high exterior water uses in the area. A large number of private and public golf courses and residential housing have been constructed over the past three decades to take advantage of the interests in outdoor recreation and retirees from outside of the area seeking to move into the area. Agricultural demands ranged between a low of 267 taf and a high of 291 taf and were met through a combination of Colorado River and groundwater supplies.

The area also received varying amounts from the SWP, from 1 to 172 taf. The low amounts reflect the statewide drought. The supplies were obtained through the exchange agreement that the CVWD and DWA have with the MWD. This water supply was used exclusively for groundwater recharge.

Urban and agricultural land uses continued to be very small in the Chuckwalla PA (PA 1003), and this is reflected in the very small annual demands during the period. Urban uses were a little more than 2 taf, and agricultural demands were closer to 3 taf. Groundwater supplies met most of these demands and an agreement with the MWD brings a small quantity of Colorado River supplies into the Chiriaco Summit, just at the east of the Coachella Valley.

The Colorado River Planning Area (PA 1004) is the easternmost planning area in the Colorado River Hydrologic Region and continues to be dominated by agricultural demands. The urban water uses were steady, averaging between 13 to 14 taf, and were met with groundwater supplies. In contrast, the annual agricultural demands ranged between 586 and 749 taf with most being

Table CR-12 Colorado River Hydrologic Region Water Balance for 2001-2010 (in taf)

Colorado River (taf)	Water Year (Percent of Normal Precipitation)									
	2001 (80%)	**2002** (23%)	**2003** (89%)	**2004** (140%)	**2005** (158%)	**2006** (60%)	**2007** (40%)	**2008** (96%)	**2009** (72%)	**2010** (122%)
WATER ENTERING THE REGION										
Precipitation	4,770	1,451	5,517	8,650	9,755	3,517	2,336	5,616	4,207	7,141
Inflow from Oregon/Mexico	155	123	111	111	128	60	47	45	42	44
Inflow from Colorado River	5,197	5,445	4,545	4,789	4,218	4,559	4,671	4,920	4,589	4,651
Imports from Other Regions	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
Total	**10,122**	**7,019**	**10,173**	**13,550**	**14,101**	**8,136**	**7,054**	**10,581**	**8,838**	**11,836**
WATER LEAVING THE REGION										
Consumptive use of applied water[a] (Ag, M&I, Wetlands)	2,937	2,905	2,992	2,951	2,716	2,962	2,844	2,914	2,702	2,674
Outflow to Oregon/Nevada/ Mexico	0	0	58	0	0	0	0	0	0	0
Exports to other regions	1,250	1,307	731	1,100	658	808	1,082	1,257	1,219	990
Statutory required outflow to salt sink	0	0	0	0	0	0	0	0	0	0
Additional outflow to salt sink	1,227	1,084	1,074	1,027	1,112	1,139	917	934	856	968
Evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, natural and incidental runoff, ag effective precipitation & other outflows	4,887	1,644	5,552	8,340	9,418	3,395	2,250	5,585	4,208	7,182
Total	**10,301**	**6,940**	**10,407**	**13,418**	**13,904**	**8,304**	**7,093**	**10,690**	**8,985**	**11,814**
CHANGE IN SUPPLY										
[+] Water added to storage [-] Water removed from storage										
Surface reservoirs	1	-3	-3	27	-35	1	21	8	-20	-4
Groundwater[b]	-180	82	-231	105	232	-169	-60	-117	-127	25
Total	**-179**	**79**	**-234**	**132**	**197**	**-168**	**-39**	**-109**	**-147**	**21**
Applied water[a] (ag, urban, wetlands) (compare with consumptive use)	4,537	4,817	4,595	4,801	4,540	4,924	4,670	4,739	4,400	4,563

Notes:

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

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

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

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

met with Colorado River water supplies. The lower demand is a reflection of the long-term land fallowing program between the PVID and MWD.

The Borrego Planning Area (PA 1005) has less urban and agricultural applied water than PA 1004. Urban applied water ranged between 7 and 9 taf for the period. Agricultural demands ranged between 43 taf and a little less than 46 taf. A significant portion of the agricultural demands occurs in that portion of the planning area that lies in the Imperial Valley. About 40 percent of the supplies come from groundwater; and 60 percent from the Colorado River.

The Imperial Valley Planning Area (PA 1006) is another area dominated by agricultural demands. It also has the greatest agricultural demands and second highest urban demands in the hydrologic region and the highest agricultural use. Urban use ranges from 85 to 88 taf, a little more than half being used for energy production (geothermal facilities). Annual agricultural applied water demands ranged between 2,400 to 2,700 taf with an additional 650 to 700 taf evaporating or seeping into the ground during conveyance. This planning area also contains the only managed wetlands in the Colorado River Hydrologic Region which consumed about 30 taf of water annually.

Most of the urban, agriculture, and environmental water demands in the Imperial Valley PA were met with Colorado River water supplies. Some of the supplies are actually return flows from the agricultural operations in Colorado River PA.

Project Operations

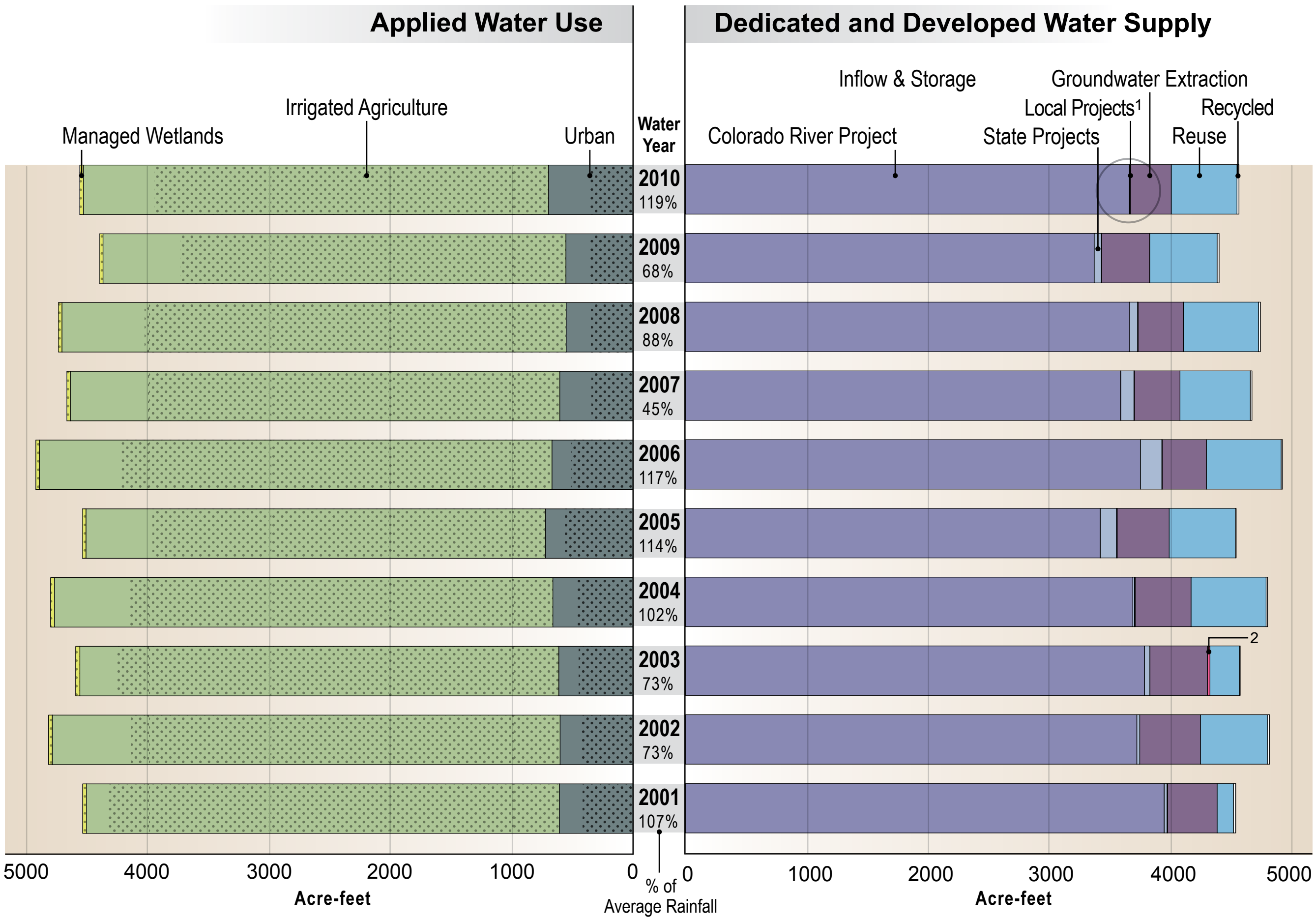
Imperial Irrigation District System Conservation Plan

As part of the CRWDA, work is under way on an ambitious project by the IID to increase the operational efficiency of its water conveyance system. The project is called the "System Conservation Plan" and will address five key system upgrades: (1) upgrades to the existing supervisory control and data acquisition system, (2) construction of mid-lateral reservoirs, (3) construction of lateral interties, (4) construction of the mid-valley collector system, and (5) installation of non-leak gates. The lateral interties would collect operational spills occurring in one lateral and transport them to other laterals or canals in the areas. The project will also improve gate measurement procedures. Seventeen separate tasks have been identified in the project. Another important program that continues to operate is main canal seepage interception program. In 2009, the IID reported that it constructed 22 seepage interception facilities to capture water supplies lost in canal and lateral seepage. These actions are in response to the IID study titled "Efficiency Conservation Definite Plan" that was released in 2007. That study identified on-farm programs, delivery system improvements, and financial incentives that would yield conserved water supplies for transfer under the CRWDA.

The IID completed the automation project of the Vail Canal of its water conveyance system in 2011. Automation of check structures and lateral headings in the canal improves the accuracy of measurement of water flows, steadiness of flows in the canal, and coordination and reliability of irrigation water deliveries service to customers. In 2010, construction of the Warren H. Brock Storage Reservoir was completed, which permits underutilized water supplies or excess surplus being delivered in the All-American Canal to be stored temporarily for later use. The facility is located about 25 miles west of Yuma, Arizona, and consists of two basins which can hold up to 8 taf each.

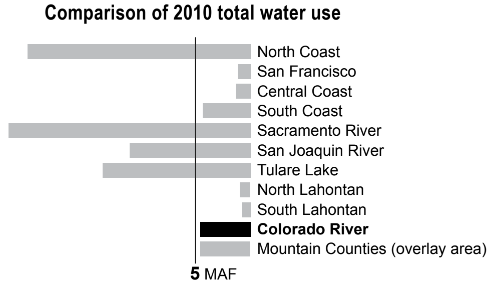
Figure CR-13 **Colorado River Hydrologic Region Water Balance Summary by Water Year, 2001-2010**

California's water resources vary significantly from year to year. Ten recent years show this variability for water use and water supply. Applied Water Use shows how water is applied to urban and agricultural sectors and dedicated to the environment and the Dedicated and Developed Water Supply shows where the water came from each year to meet those uses. Dedicated and Developed Water Supply does not include the approximately 125 million acre-feet (MAF) of statewide precipitation and inflow in an average year that either evaporates, are used by native vegetation, provides rainfall for agriculture and managed wetlands, or flow out of the state or to salt sinks like saline aquifers (see Table CR-12). Groundwater extraction includes annually about 2 MAF more groundwater used statewide than what naturally recharges – called groundwater overdraft. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years.

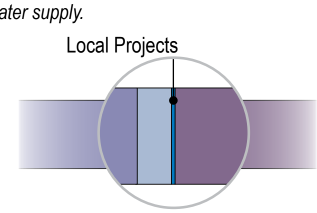


Stippling in bars indicates **depleted (irrecoverable) water use** *(water consumed through evapotranspiration, flowing to salt sinks like saline aquifers, or otherwise not available as a source of supply)*

Comparison of 2010 total water use



1 **Detail of bar graph:** *For water years 2001-2010, local projects water varied from 0 to 6.6 TAF of the water supply.*



2 *This section represents* **Inflow & Storage** *(20 TAF for 2003; 0 for water years 1998-2002 and 2004-2005.)*

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

Key Water Supply and Water Use Definitions

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

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

Instream environmental. Instream flows used only for environmental purposes.

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

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

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

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

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

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

Colorado River Water Balance by Water Year Data Table (TAF)

	2001 (80%)	**2002** (23%)	**2003** (89%)	**2004** (140%)	**2005** (158%)	**2006** (60%)	**2007** (40%)	**2008** (96%)	**2009** (72%)	**2010** (122%)
APPLIED WATER USE										
Urban	607	601	612	661	721	668	604	551	553	696
Irrigated Agriculture	3,900	4,187	3,949	4,110	3,789	4,226	4,035	4,157	3,817	3,836
Managed Wetlands	30	30	33	30	30	30	30	30	30	30
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	0	0	0	0	0	0	0	0	0	0
Wild & Scenic R.	0	0	0	0	0	0	0	0	0	0
Total Uses	**4,537**	**4,817**	**4,595**	**4,801**	**4,540**	**4,924**	**4,670**	**4,739**	**4,400**	**4,562**
DEPLETED WATER USE (STIPPLING)										
Urban	415	421	447	465	559	510	341	344	350	360
Irrigated Agriculture	3,719	3,538	3,644	3,482	3,238	3,561	3,390	3,473	3,179	3,251
Managed Wetlands	30	30	33	30	30	30	30	30	30	30
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	0	0	0	0	0	0	0	0	0	0
Wild & Scenic R.	0	0	0	0	0	0	0	0	0	0
Total Uses	**4,164**	**3,989**	**4,124**	**3,977**	**3,827**	**4,101**	**3,761**	**3,848**	**3,559**	**3,641**
DEDICATED AND DEVELOPED WATER SUPPLY										
Instream	0	0	0	0	0	0	0	0	0	0
Local Projects	4	0	0	6	6	4	4	4	1	2
Local Imported Deliveries	0	0	0	0	0	0	0	0	0	0
Colorado Project	3,947	3,722	3,785	3,689	3,420	3,751	3,589	3,663	3,370	3,661
Federal Projects	0	0	0	0	0	0	0	0	0	0
State Project	24	24	44	13	134	177	109	65	60	5
Groundwater Extraction	409	501	476	461	429	364	376	375	397	338
Inflow & Storage	0	0	20	0	0	0	0	0	0	0
Reuse & Seepage	135	552	263	619	545	616	580	619	556	542
Recycled Water	18	17	6	12	7	12	13	15	16	16
Total Supplies	**4,537**	**4,817**	**4,595**	**4,801**	**4,540**	**4,924**	**4,670**	**4,739**	**4,400**	**4,563**

Lower Colorado River Water Supply Project

Enactment of The Lower Colorado River Water Supply Act of 1986 (Public Law 99-655) by the U.S. Congress assists water users to legally obtain Colorado River water supplies to adequately meet their municipal and industrial demands. Some urban and industrial water groundwater users near the Colorado River may not have a valid right to use this water supply. All Colorado River water supplies for California have been appropriated. This includes the supplies in groundwater basins hydrologically connected to the river. The law establishes the procedures for new water users to legally secure water supplies from the river. Water supplies for the new contracts would come from the implementation of the Lower Colorado River Water Supply Project (LCRWSP), a groundwater project near the Sand Hills in Imperial County. Seepage from the All-American Canal in this area would be pumped in exchange for small quantities of water supplies being left in the Colorado River. When complete, the LCRWSP is expected to identify 10,000 af of water supply annually to help the uncontracted water users.

Water Quality

The Colorado River Hydrologic Region includes 28 major watersheds or "hydrologic units" and has water bodies of statewide, national, and international significance such as the Salton Sea and the Colorado River.

Water quality concerns exist in all of the watersheds in the Colorado River region. This section is intended to identify the highest priority water quality issues in the region. Some of the regional specific issues that have been identified, but not prioritized, are:

- Surface water quality monitoring.
- Quality of imported water.
- On-site wastewater treatment systems.
- Nitrates.
- Leaking underground storage tanks.
- Water quality impacts of animal feeding and dairy operations.

Agricultural/Irrigated Lands Regulatory Program

The Water Boards oversee the Irrigated Lands Regulatory program with the objective of preventing agricultural discharges from impairing the waters that receive these discharges. This program requires water quality monitoring of receiving waters and corrective actions when impairments occur. In the Colorado River region, the Colorado River Basin RWQCB has begun implementing this program by adopting conditional waiver of waste discharge requirements (WDR) for agricultural operations in the Palo Verde Valley, Mesa, and Bard Unit of Reservation Division. Colorado River Basin RWQCB staff are working with interested parties in the Coachella Valley and Imperial Valley to develop conditional waiver of WDRs for agricultural operations in these areas.

New River Pollution

The New River is severely polluted by waste discharges from domestic, agricultural, and industrial sources in Mexico and the Imperial Valley. New River pollution threatens public health, prevents supporting healthy ecosystems for wildlife and other biological resources in the New River, and contributes to the water quality problems of the Salton Sea. Based on the most recent available data, the following water quality problems are evident in the New River on the U.S. side of the U.S.-Mexico International Boundary:

- Pathogens.
- Low dissolved oxygen (DO).
- Toxicity.
- Trash.
- Selenium.
- Sediment/silt.
- Chlordane.
- Dichlorodiphenyltrichloroethane (DDT).
- Dieldrin.
- Toxaphene.
- Polychlorinated byphenyls (PCBs).
- Hexaclorobenzene (HCB).
- Nutrients.
- Mercury.

In the past two decades, great progress has been made on both sides of the border to improve water quality; however, the New River remains impaired under the Clean Water Act for nearly a dozen pollutants, including pathogens. In 2011, a *Strategic Plan: New River Improvement Project* was prepared in a collaborative effort to identify strategies to fully address the problems and impairments that remain in the New River. The plan is available at: http://www.calepa.ca.gov/Border/CMBRC/2011/StrategicPlan.pdf.

Drinking Water Quality

In general, drinking water systems in the region deliver water to their customers that meet federal and State drinking water standards. Recently the State Water Resources Control Board completed its report to the Legislature titled *Communities that Rely on a Contaminated Groundwater Source for Drinking Water*. This report identified 24 community drinking water systems in the region that rely on at least one contaminated groundwater well as a source of supply (see Table CR-13). The most prevalent groundwater contaminants affecting community drinking water wells in the region are gross alpha particle activity, uranium, arsenic, and fluoride (see table CR-14). The majority of the affected water systems are small water systems which often need financial assistance to construct a water treatment plant or alternate solution to meet drinking water standards. Furthermore, the systems are likely to be serving DACs.

Groundwater Quality Protection

There is an effort under way to protect groundwater supplies from contamination by on-site wastewater treatment systems or septic systems in the Colorado River Region.

Table CR-13 Percentage of Small, Medium, and Large Community Drinking Water Systems in the Colorado River Hydrologic Region that Rely on One or More Contaminated Groundwater Well(s)

Community Drinking Water Systems and Groundwater Wells Grouped by Water System Population	Number of Affected Community Drinking Water Systems	Number of Affected Community Drinking Water Wells	Total Water Systems in Region	Percentage of Affected Water Systems
Small (<3,000)	17	31	102	17
Medium (3,300 - 10,000)	2	7	12	17
Large (<10,000)	5	13	15	33
Total	24	51	129	19

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

In response to declining groundwater levels in the Warren Valley Groundwater Basin by as much as 300 feet, the Hi-Desert Water District instituted a groundwater recharge program in 1995 using imported surface water to recharge the groundwater basin. The groundwater recharge program resulted in an increase in groundwater levels by up to 250 feet near the area of the recharge ponds. However as the groundwater levels increased, some wells showed an increase in nitrate contamination. Wells that previously had a nitrate concentration of 10 mg/L now have nitrate concentrations greater than the CDPH nitrate maximum contaminant level (MCL) of 45 mg/L (as NO_3). A USGS study completed in 2003 evaluated the sources of the high-nitrate concentrations that appeared after the implementation of the groundwater recharge program and found that leachate from septic systems was the primary source of the high-nitrate concentrations measured in the basin (Nishikawa 2003). In 2011, the Colorado River Basin RWQCB adopted a resolution that prohibits the use of septic systems in the Town of Yucca Valley to protect groundwater from further nitrate contamination.

Similarly, the nearby Town of Joshua Tree utilizes groundwater for municipal supply and septic systems for wastewater disposal. To protect groundwater resources from degradation, the Joshua Tree Water District has contracted with the USGS to investigate the unsaturated zone of its subbasin. The objectives of the study are to (1) evaluate the potential for artificial recharge, (2) evaluate flow and nitrate transport in the unsaturated zone, and (3) develop a flow and transport model to investigate impacts from land use and septic load on groundwater quality. The long-term cumulative impact from wastewater discharges is an ongoing concern for the Joshua Tree Water District, and alternative wastewater treatment and disposal strategies may need to be considered to protect local groundwater supplies.

Groundwater Conditions and Issues

Groundwater Occurrence and Movement

Aquifer conditions and groundwater levels change in response to varying supply, demand, and climate conditions. During dry years or periods of increased groundwater use, seasonal groundwater levels tend to fluctuate more widely and, depending on annual recharge conditions,

Table CR-14 Summary of Contaminants Affecting Community Drinking Water Systems in the Colorado River Hydrologic Region

Principal Contaminant (PC)	Community Drinking Water Systems where PC exceeds the Primary Maximum Contaminant Level (MCL)	Community Drinking Water Wells[a,b] where PC exceeds the Primary Maximum Contaminant Level (MCL)
Gross Alpha Particle Activity	13	23
Uranium	10	17
Arsenic	9	19
Fluoride	7	13
Nitrate	1	2
Chromium, Total	1	1
Perchlorate	1	1

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

Notes:

[a] 21 wells are affected by 2 contaminants (15 of the 21 wells exceed both the uranium and gross alpha particle activity MCLs).

[b] 2 wells are affected by 3 contaminants.

may result in a long-term decline in groundwater levels, both locally and regionally. Depending on the amount, timing, and duration of groundwater level decline, nearby well owners may need to deepen wells or lower pumps to regain access to groundwater.

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

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

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

Depth to Groundwater and Groundwater Elevation Contours

The depth to groundwater has a direct bearing on the costs associated with well installation and groundwater extraction operations. Knowing the local depth to groundwater can also provide a better understanding of the interaction between the groundwater table and the surface water systems and the contribution of groundwater aquifers to the local ecosystem. Depth-to-groundwater measurements for the Borrego Valley groundwater basin are available online:

- DWR Water Data Library (http://www.water.ca.gov/waterdatalibrary/).
- DWR CASGEM system (http://www.water.ca.gov/groundwater/casgem/).
- USGS National Water Information System (http://waterdata.usgs.gov/nwis/gw).
- Coachella Valley groundwater level data are available from the following:
- Final Program EIR for the Coachella Valley Water Management Plan (2002).
- The Coachella Valley Water District Engineer’s 2010-2011 Report (http://www.cvwd.org/news/publicinfo/2010_06_22_Engineering_Report-Lower_WWR-2010-2011-w160000(FINAL052510).pdf).
- The Coachella Valley Water Management Plan 2010 Update (http://www.cvwd.org/news/publicinfo/2013_10_01_CoachellaValleyWaterManagementPlanFinalReport.pdf).

Lucerne Valley groundwater level information is included in the change in storage thesis prepared by Napoli (2004).

Several local agencies independently or cooperatively monitor the groundwater levels in the basins they operate and produce groundwater elevation contour maps. For example, groundwater elevation maps for the Borrego Valley are available from the following:

- USGS (Moyle 1982).
- DWR Southern Region Office.
- The Borrego Water District Integrated Water Resource Management Plan (2009) (http://www.borregowd.org/uploads/IWRMP_Final_3.2009.pdf.)
- The 2011 San Diego County General Plan update, Appendix A (http://www.sdcounty.ca.gov/pds/gpupdate/docs/BOS_Aug2011/EIR/Appn_D_GW_Appendices.pdf).

Groundwater elevation contours can help estimate the direction, gradient, and rate of groundwater flow.

Groundwater Level Trends

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

Figure CR-14A shows hydrograph 02S01E33J004S, which is from a well located in the San Gorgonio subbasin of the Coachella Valley Groundwater Basin. The well is constructed at the base of an alluvial fan in a sparsely developed area characterized by small residential, industrial, and commercial land use. The hydrograph shows small to large seasonal fluctuations, with a 70- to 80-foot swing in groundwater levels in response to extended periods of above and below normal precipitation. Single year rebound in groundwater levels between 30 and 40 feet are shown to follow the high precipitation years of 1978, 1993, 1998, and 2005. Although the aquifer shows large fluctuations in groundwater levels associated with periods of wet and dry conditions, the long-term aquifer response to changes in groundwater pumping appears to be relatively stable and sustainable.

Figure CR-14B shows hydrograph 07S08E34G001S, which is from an irrigated well located in the southern portion of the Indio (Whitewater) subbasin of the Coachella Valley Groundwater Basin, just northwest of the Salton Sea. The well is constructed in the alluvial portion of the aquifer. The hydrograph shows that groundwater levels steadily decreased by about 50 feet between 1926 and 1949. In 1949, the Coachella Canal began importing water from the Colorado River to help alleviate the heavy reliance on groundwater resources within the valley. The in-lieu recharge associated with conjunctive management of imported Colorado River and local groundwater resources contributed to rising groundwater levels over the next few decades. During this period, groundwater levels recovered to pre-1925 levels, with the peak at about 35 feet below ground surface during the late 1960s. Beginning in the early 1970s and continuing through the early 2000s, groundwater levels once again started a steady decline of over 75 feet due to increases in groundwater extraction to meet increases in agricultural use (Coachella Valley Water District 2010). Since 2003, groundwater levels have begun to once again somewhat recover due to increases in surface water allocations resulting from several water exchange agreements.

Figure CR-14C shows hydrograph 16S20E27B001S, which is from a well located adjacent to the All-American Canal, in the southeastern corner of the Imperial Valley Groundwater Basin. The well is constructed in alluvial deposits in an uninhabited area of the Imperial Sand Dunes. The hydrograph shows a 12-foot increase in groundwater levels between 1987 and 2000. Between 2000 and 2006, seasonal fluctuations in groundwater levels ranged from 3 to 5 feet per year, with the spring-to-spring change in groundwater levels remaining relatively steady during this time. From 2006 to the present, spring groundwater levels have steadily declined at a rate of about 5 feet per year. The steady drop of the groundwater level is likely attributed to the lining of the All-American Canal. The groundwater levels in the vicinity of this well are expected to continue to decline due to the ongoing reduction in infiltration from the lined All-American Canal. Eventually, groundwater level is expected to lower to a new equilibrium level, due to reduced infiltration. Periods of drought and high precipitation do not appear to dramatically affect groundwater levels in the well.

Change in Groundwater Storage

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

Figure CR-14 Groundwater Level Trends in Selected Wells in the Colorado River Hydrologic Region

Aquifer response to changing demand and management practices

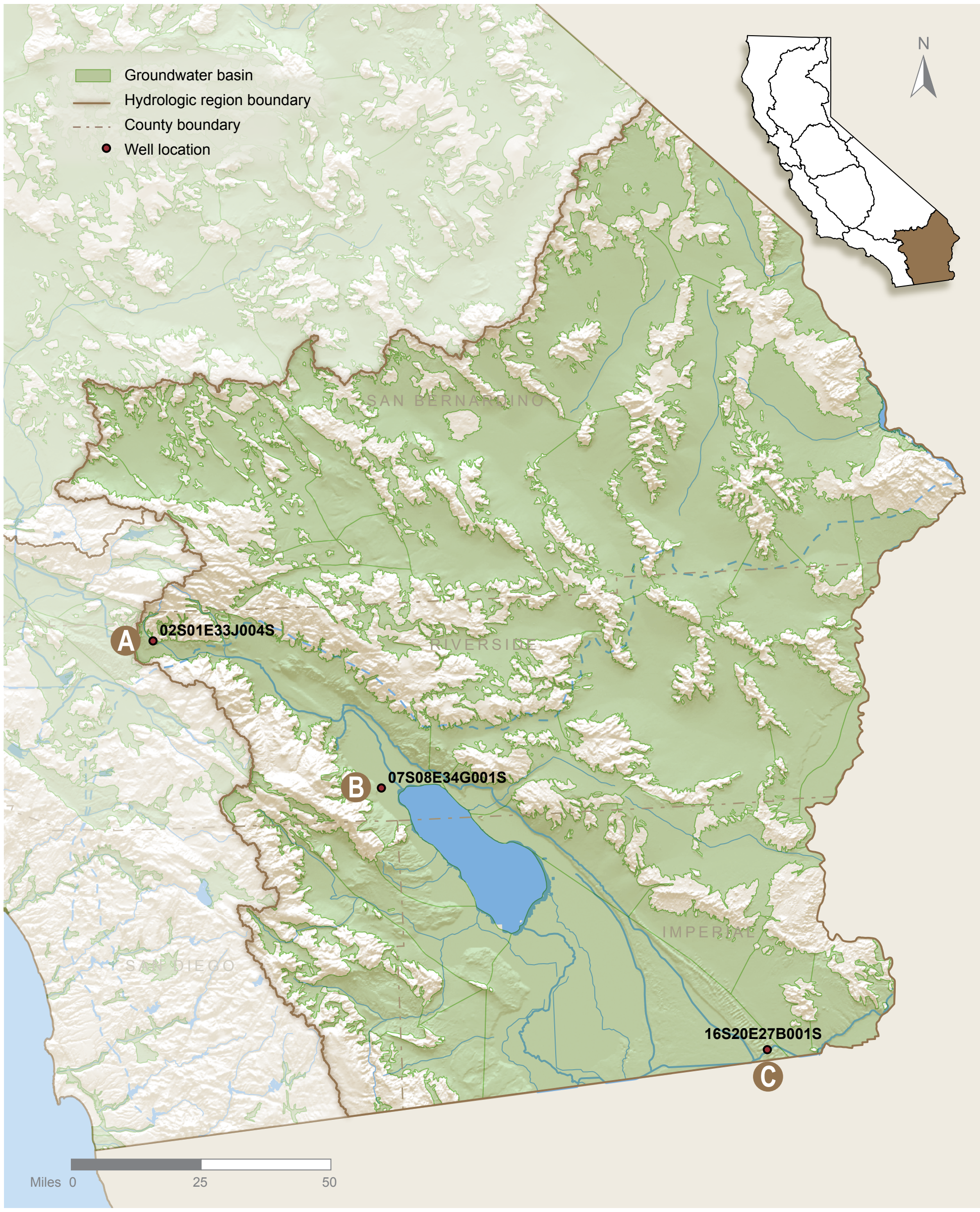
Hydrographs were selected to help tell a story of how local aquifer systems respond to changing groundwater demand and resource management practices. Additional detail is provided within the main text of the report.

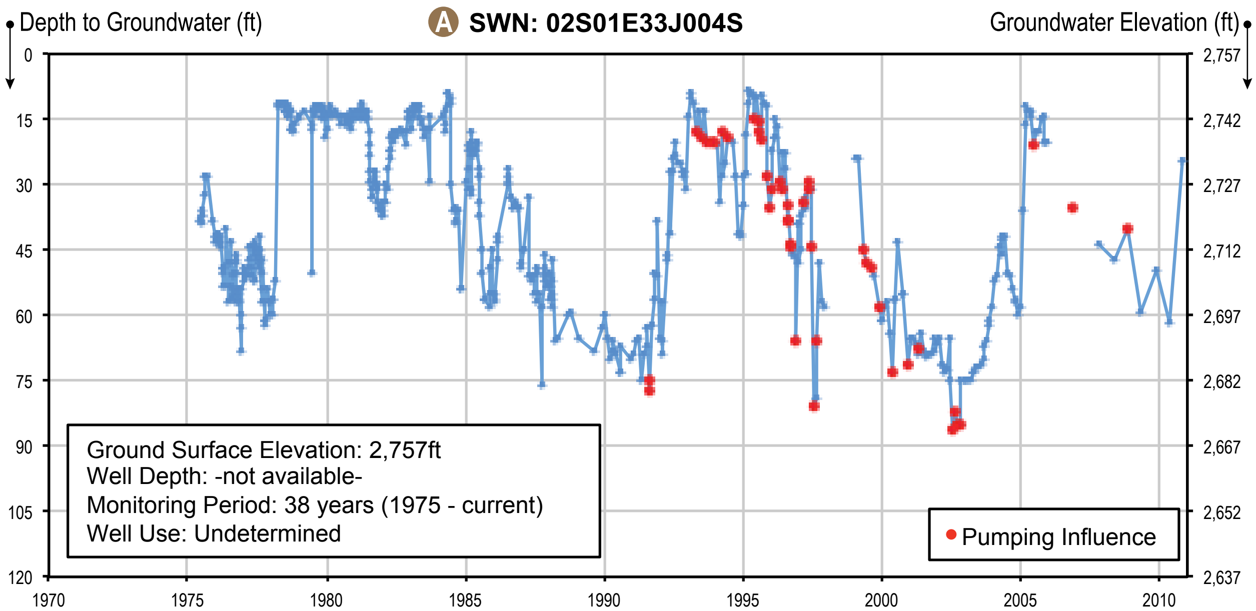
A Hydrograph 02S01E33J004S: shows the aquifer response to the long-term hydrologic cycles and season variations associated with local precipitation conditions. Despite the large fluctuations in the groundwater levels, the overall aquifer response to long-term changes in demand appears to be relatively stable.

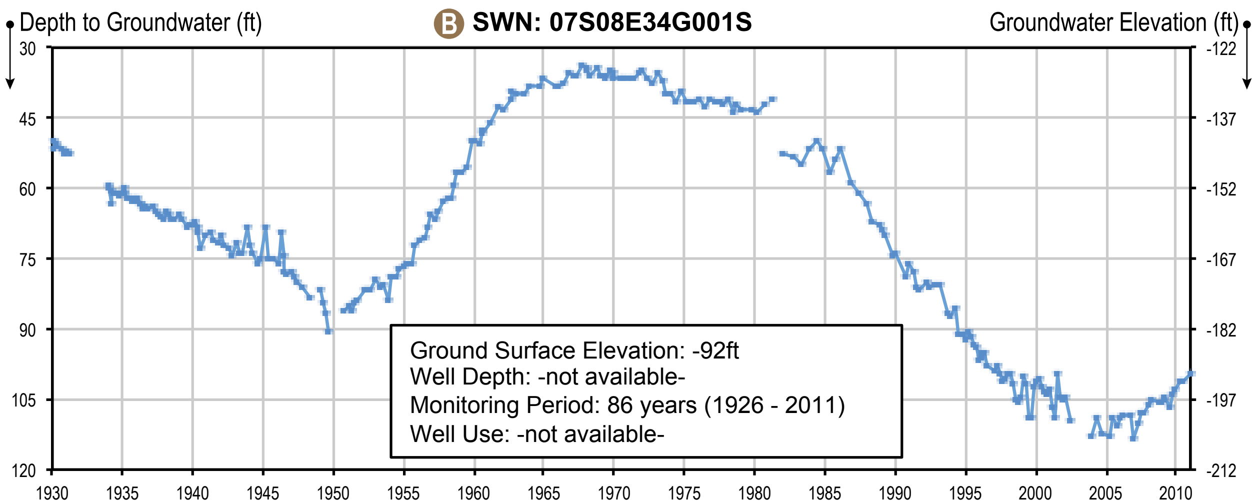
B Hydrograph 07S08E34G001S: highlights the long-term impact of unsustainable reliance on groundwater supplies. The early declining trend in groundwater levels was reversed by introducing imported surface water deliveries in 1950s. The latter declining trend was stabilized by conjunctive management of surface water and groundwater supplies beginning in 2005.

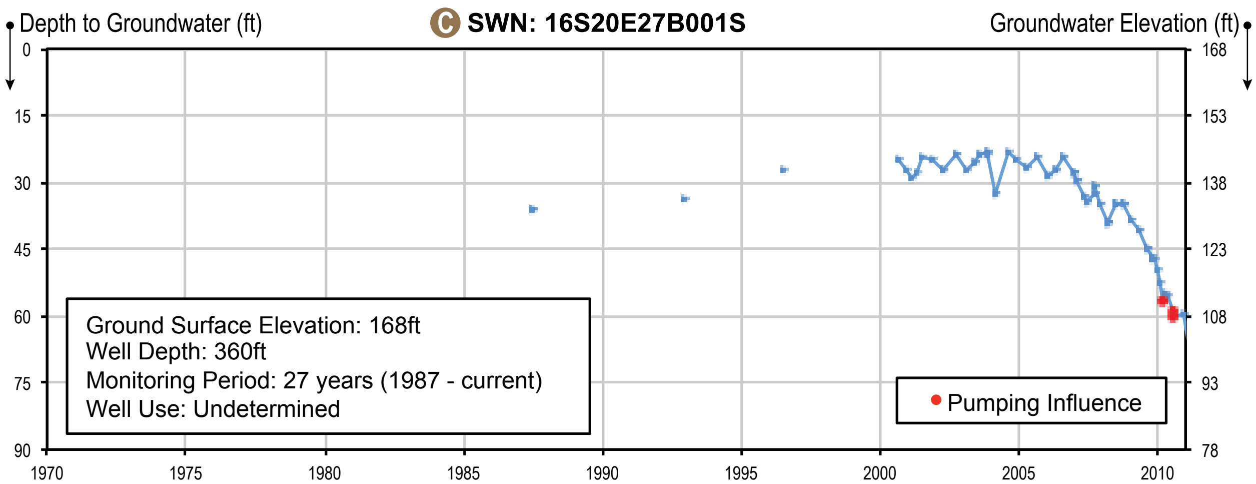
C Hydrograph 16S20E27B001S: illustrates the interplay between the groundwater aquifer and the nearby surface water conveyance. The unconfined aquifer is replenished in summer and fall when the canal runs full and vice-versa in winter and spring. Sudden drop in the seasonal variation corresponds with the lining of All American Canal in 2007.

Regional locator map




Depth to Groundwater (ft)
A SWN: 02S01E33J004S
Groundwater Elevation (ft)
0
15
30
45
60
75
90
105
120
2,757
2,742
2,727
2,712
2,697
2,682
2,667
2,652
2,637
1970
1975
1980
1985
1990
1995
2000
2005
2010
Ground Surface Elevation: 2,757ft
Well Depth: -not available-
Monitoring Period: 38 years (1975 - current)
Well Use: Undetermined
Pumping Influence


Depth to Groundwater (ft)
B SWN: 07S08E34G001S
Groundwater Elevation (ft)
30
45
60
75
90
105
120
-122
-137
-152
-167
-182
-197
-212
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Ground Surface Elevation: -92ft
Well Depth: -not available-
Monitoring Period: 86 years (1926 - 2011)
Well Use: -not available-


Depth to Groundwater (ft)
C SWN: 16S20E27B001S
Groundwater Elevation (ft)
0
15
30
45
60
75
90
168
153
138
123
108
93
78
1970
1975
1980
1985
1990
1995
2000
2005
2010
Ground Surface Elevation: 168ft
Well Depth: 360ft
Monitoring Period: 27 years (1987 - current)
Well Use: Undetermined
Pumping Influence

that the basin is being managed unsustainably or subject to conditions of overdraft. Utilization of groundwater in storage during years of diminishing surface water supply, followed by active recharge of the aquifer when surface water or other alternative supplies become available, is a recognized and acceptable approach to conjunctive water management.

Some local groundwater agencies within the region periodically develop change in groundwater storage estimates for basins within their service area. Determining the change in storage allows the local groundwater managers to evaluate trends, land use patterns, responses to climate, and water sustainability. Examples of local agencies that have determined change in storage include the Mojave Water Agency, Hi-Desert Water District, and the CVWD. Borrego Valley groundwater storage estimates have been developed as part of the San Diego County 2011 General Plan Update.

Additional information regarding the risks and benefits of conjunctive use are presented in Volume 3, Chapter 9, "Conjunctive Management and Groundwater."

Land Subsidence

In the Colorado River region, researchers have investigated the occurrence of land subsidence in Lucerne Valley and Coachella Valley. Between 1950 and 1990 (Mojave Water Agency 2004), groundwater levels in Lucerne Valley steadily declined. In 1980, DWR's *Bulletin 118* identified the Lucerne Valley Groundwater Basin as being in a state of overdraft. To prevent further overdraft Lucerne Valley was included in the 1996 groundwater rights adjudication of the Mojave Basin Area.

Based on analysis of InSAR data, Sneed et al. (2003) identified approximately two feet of subsidence at three GPS monitoring points in the Lucerne (Dry) Lake area between 1969 and 1998. In 2012, the Mojave Water Agency reported that groundwater levels in the Este subarea, which includes Lucerne Valley, have remained stable for the past several years, suggesting a relative balance between recharge and discharge.

Groundwater extractions in the Coachella Valley Groundwater Basin resulted in a water level decline as much as 50 feet during the 1920s through the 1940s. In 1949, the Coachella Branch of the All-American Canal began transporting Colorado River water into the valley. The importation of Colorado River water alleviated some of the groundwater demand, and groundwater levels recovered in some areas. However, since the late 1970s, groundwater extractions have increased because the water use could not be met by the imported water alone. By 2005, the groundwater levels in many wells had declined by 50 to 100 feet (Sneed and Brandt 2007), and the water levels have continued to decline thereafter (Coachella Valley Water District 2010). An investigation of land subsidence in Coachella Valley determined up to 0.5 feet of subsidence occurred between 1930 and 1996 (Ikehara et al. 1997). In 2007, Sneed and Brandt investigated Coachella Valley subsidence using a GPS monitoring network and InSAR data. Results from the GPS monitoring indicated as much as 1.1 feet of subsidence in the Coachella Valley between 1996 and 2005, while the InSAR data identified subsidence of between 0.36 to 1.08 feet during the same time period.

Local water management efforts are utilizing conjunctive use and water conservation measures to reduce overdraft. However, unless long-term groundwater decline can be halted, the potential for land subsidence remains.

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

Flood Management

Traditionally, the approach to flood management was to develop narrowly focused flood infrastructure projects. This infrastructure often altered or confined natural watercourses, which reduced the chance of flooding thereby minimizing damage to lives and property. This traditional approach looked at floodwaters primarily as a potential risk to be mitigated, instead of as a natural resource that could provide multiple societal benefits.

Today, water resources and flood planning involves additional demands and challenges, such as multiple regulatory processes and permits, coordination with multiple agencies and stakeholders, and increased environmental awareness. These additional complexities call for an IWM approach, that incorporates natural hydrologic, geomorphic, and ecological processes to reduce flood risk by influencing the cause of the harm, including the probability, extent, or depth of flooding (flood hazard). Some agencies are transitioning to an IWM approach. IWM changes the implementation approach based on the understanding that water resources are an integral component for sustainable ecosystems, economic growth, water supply reliability, public health and safety, and other interrelated elements. Additionally, IWM acknowledges that a broad range of stakeholders might have interests and perspectives that could positively influence planning outcomes.

An example of this is the Cushenbury Flood Detention Basin. The project is proposed to capture runoff from the San Bernardino Mountains in the Lucerne Valley Subbasin. Currently, large storm flows drain to dry lake beds in the area that have low percolation rates. Consequently, the majority of water that drains to the lake beds is lost to evaporation and never enters the basin. The project would divert storm flows to detention basins with high rates of percolation to decrease losses from evaporation. Flooding can deliver either environmental destruction or environmental benefits. Ecosystems can be devastated by extreme floods that wash away habitat, leaving deposits of debris and contaminants. Development in floodplains has reduced the beneficial connections between different types of habitat and adjacent floodway corridors; however, well-functioning floodplains deliver a variety of benefits. Floodplains provide habitat for a significant variety of plant and wildlife species. Small, frequent flooding can recharge groundwater basins and improve water quality by filtering impurities and nutrients, processing organic wastes, and controlling erosion.

Flood management challenges in the Colorado River Hydrologic Region include:

- Flood control in the desert presenting different challenges than flooding in the rest of the state.
- Outdated and undersized infrastructure.
- Lack of regional perspective, real need for regional planning efforts.

The identified issues were based upon interviews with six agencies with varying levels of flood management responsibilities in each county of the state. The agencies with flood management responsibility in the Colorado River Hydrologic Region that participated in the meeting include Imperial County Department of Planning and Development Services, IID, CVWD, and Riverside

County Flood Control and Water Conservation. The agencies were asked about the status of flood management in their respective areas of responsibility.

Flood Hazards

Of California's 10 hydrologic regions, the Colorado River Hydrologic Region has the lowest annual precipitation. Consequently, most of the natural streams are ephemeral; the exceptions are the Colorado, New, and Alamo rivers. The low annual rainfall amounts and the sparse vegetation in the region's watersheds give rise to braided streams with steep channel slopes. In these watercourses, short-duration, high-intensity rainfall from summer monsoonal thunderstorms or winter storms can result in flash floods and debris flows. Many areas in the region are still vulnerable to flood-caused damages. Flood hazards in the region include these representative situations (for specific instances, see Challenges).

- Some existing culverts and channels do not have sufficient capacity to carry flow resulting from the runoff event having a 1 percent chance of being exceeded in any year.
- Population growth and the ensuing development increase the area of impervious surface without sufficient mitigation, increasing peak runoff.
- High intensity storms combined with steep stream gradients and granular bed material to produce flash floods and debris flows.
- Alluvial fan flooding endangers some communities.

Damage Reduction Measures

Most flood events in the Colorado River region occur as a result of high-intensity summer storms and take the form of flash or alluvial fan flooding. Flood exposure identifies who and what is impacted by flooding. Two flood event levels are commonly used to characterize flooding:

- 100-Year Flood is a shorthand expression for a flood that has a 1-in-100 probability of occurring in any given year. This can also be expressed as the 1 percent annual chance of, or "1 percent annual chance flood" for short.
- 500-Year Flood has a 1-in-500 (or 0.2 percent) probability of occurring in any given year.

In the Colorado River Hydrologic Region, more than 227,000 people and over $20 billion in assets are exposed to the 500-year flood event. Figures CR-15 and CR-16 provide a snapshot of people, structures, crop value, and infrastructure, exposed to flooding in the region. Over 185 State and federal threatened, endangered, listed, or rare plant and animal species exposed to flood hazards are distributed throughout the Colorado River Hydrologic Region.

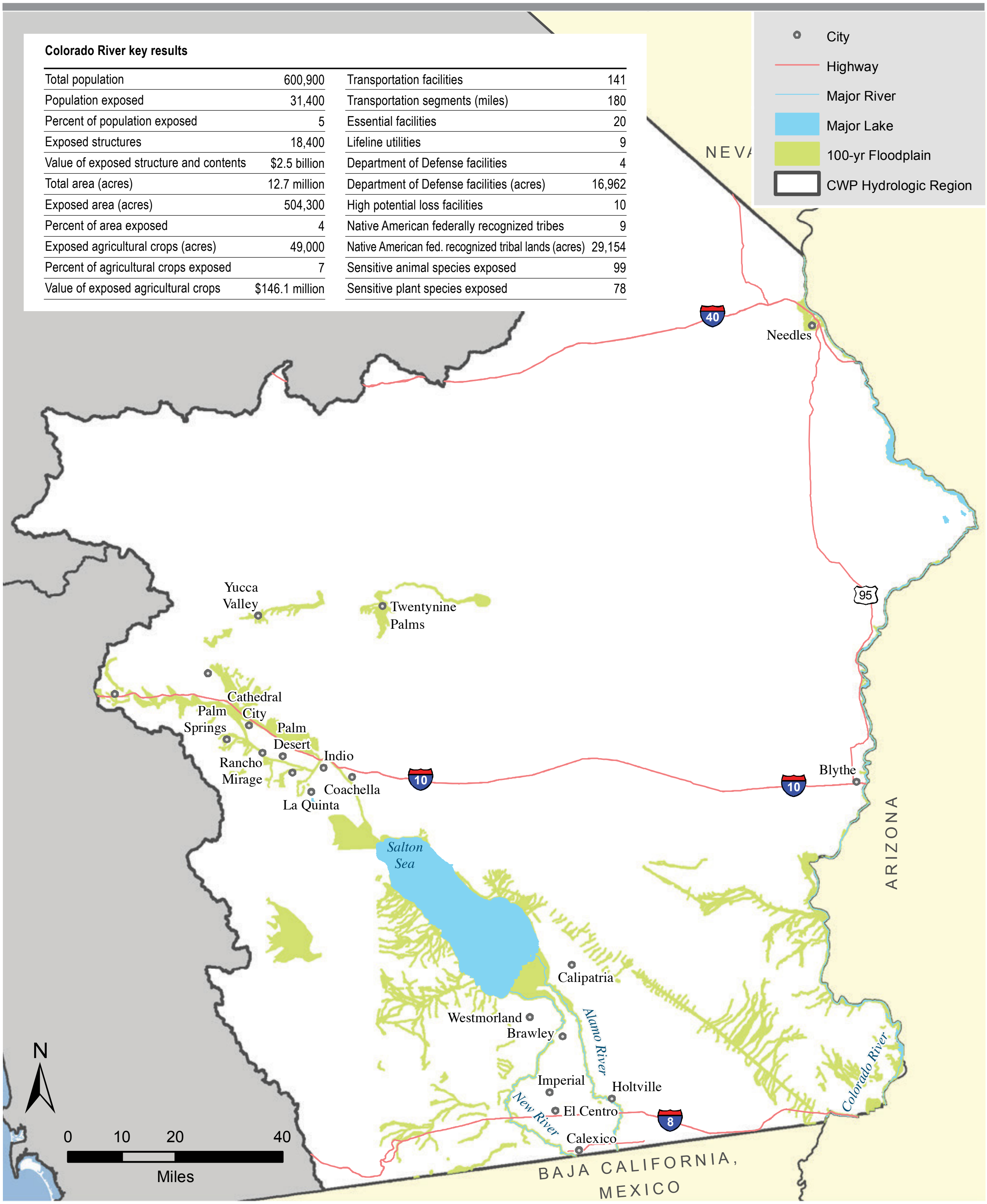
Water Governance

The Colorado River is an interstate and international river with uses apportioned among the seven Colorado River Basin states and the Republic of Mexico by a complex body of statutes, agreements, decrees, and court decisions known collectively as the "Law of the River." The 1928 Boulder Canyon Project Act (I.P. 70-642) requires that any use of mainstream Colorado River water is made pursuant to a contract between the Secretary of the Interior and individual Colorado River water users in the Lower Basin. This Section 5 water use contracting provision was affirmed by the U.S. Supreme Court in its 1963 opinion and in its consolidated decree in

Figure CR-15 **Flood Exposure to the 100-Year Floodplain, Colorado River Hydrologic Region**

Colorado River key results

Total population	600,900	Transportation facilities	141
Population exposed	31,400	Transportation segments (miles)	180
Percent of population exposed	5	Essential facilities	20
Exposed structures	18,400	Lifeline utilities	9
Value of exposed structure and contents	$2.5 billion	Department of Defense facilities	4
Total area (acres)	12.7 million	Department of Defense facilities (acres)	16,962
Exposed area (acres)	504,300	High potential loss facilities	10
Percent of area exposed	4	Native American federally recognized tribes	9
Exposed agricultural crops (acres)	49,000	Native American fed. recognized tribal lands (acres)	29,154
Percent of agricultural crops exposed	7	Sensitive animal species exposed	99
Value of exposed agricultural crops	$146.1 million	Sensitive plant species exposed	78

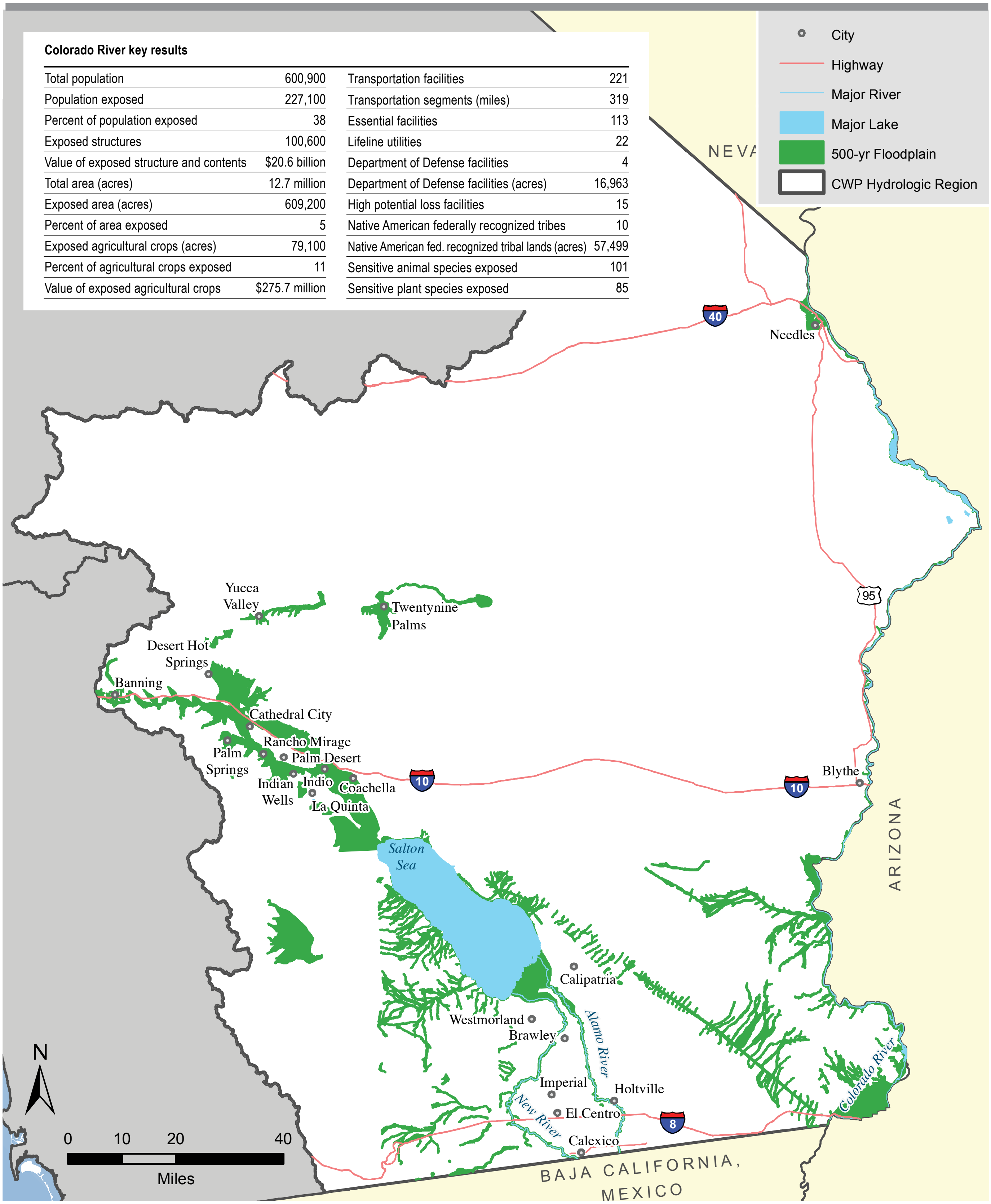


Source: California's Flood Future Report 2013

Figure CR-16 Flood Exposure to the 500-Year Floodplain, Colorado River Hydrologic Region

Colorado River key results

Total population	600,900	Transportation facilities	221
Population exposed	227,100	Transportation segments (miles)	319
Percent of population exposed	38	Essential facilities	113
Exposed structures	100,600	Lifeline utilities	22
Value of exposed structure and contents	$20.6 billion	Department of Defense facilities	4
Total area (acres)	12.7 million	Department of Defense facilities (acres)	16,963
Exposed area (acres)	609,200	High potential loss facilities	15
Percent of area exposed	5	Native American federally recognized tribes	10
Exposed agricultural crops (acres)	79,100	Native American fed. recognized tribal lands (acres)	57,499
Percent of agricultural crops exposed	11	Sensitive animal species exposed	101
Value of exposed agricultural crops	$275.7 million	Sensitive plant species exposed	85



Source: California's Flood Future Report 2013

Arizona v. California (547 U.S. 150, 2006). Tables CR-15, CR-16, and CR-17 describe the legal mandates governing the uses of Colorado River water by California.

The Colorado River Water Delivery Agreement: Federal Quantification Settlement Agreement (CRWDA) and its related agreements have been the objects of legal challenges for almost a decade. Eleven lawsuits were originally filed against the CRWDA. Five of the lawsuits were dismissed with the remaining consolidated for trial. In 2010, the trial court ruled that an important agreement in the CRWDA, the Quantification Settlement Agreement Joint Powers Agreement, was invalid because of a violation related to the appropriation clause (article XVI, section 7) of the California Constitution. This ruling also invalidated 11 other agreements in the CRWDA. However, in December 2011, the Third District Court of Appeal reversed the trial court ruling, permitted the water agencies to continue with the CRWDA implementation, and ordered some of the litigation back to the trial court for further proceedings. In early 2012, the California Supreme Court declined to hear arguments for the lawsuits. Compliance with the Brown Act and California Environmental Quality Act (CEQA) was the focus of the remaining lawsuits. In June 2013, the trail court ruled that the CRWDA was in compliance with the Brown Act and CEQA, essentially validating the historic Colorado River agreement for water transfers and exchanges for the water agencies in Southern California.

As part of its long-term planning process, the IID has developed and approved the following Interim Water Supply Policy for Non-Agricultural Projects (IWSP) and Equitable Distribution Plan (EDP). Although preliminary, the IWSP supports economic growth in Imperial Valley. It assures that all approved future non-agricultural (municipal and industrial) projects in the valley will have water supplies available to them. It also provides guidelines on whether the projects need water supply assessments /verifications (SB 610/SB 221) and identifies alternative actions that developers can take to supplement the water supplies for their project (implement urban best management practices). Fees are assessed on most projects which are then used to help fund local integrated regional water management (IRWM) efforts. The EDP provides guidelines for the agency to enforce when water supplies are exceeded by demands. The policy applies to all users of water in the IID service area, farmers, home and business owners, and industries. It was amended in 2013 to provide guidelines on how to address annual overruns in Colorado River diversions.

The Warren Valley Groundwater Basin adjudication judgment was finalized in 1977. The court appointed Hi-Desert Water District as the watermaster and ordered the agency to develop a plan to halt the overdraft of the basin. In 1991, the Warren Valley Basin Management Plan was released with recommendations that included managing extractions, importing water supplies, conserving stormwater flows, encouraging water conservation and recycling, and protecting the quality of the groundwater supplies.

The Beaumont (Groundwater) Basin adjudication judgment was finalized in 2004. The Superior Court appointed a committee to serve as the watermaster. The committee includes representatives from the cities of Banning and Beaumont, Beaumont-Cherry Valley Water District, South Mesa Mutual Water Company, and the Yucaipa Valley Water District. The judgment established the annual extraction quantities for the parties that were classified as either overlying owners or appropriators.

Table CR-15 Key Elements of the Law of the Colorado River

Document	Date	Main Purpose
Colorado River Compact	1922	The Upper and Lower Basin are each provided a basic apportionment of 7.5 maf annually of consumptive use. The Lower Basin is given the right to increase its consumptive use by an additional 1.0 maf annually.
Boulder Canyon Project Act	1928	Authorized USBR to construct Hoover Dam and the All-American Canal (including the Coachella Canal), and gave congressional consent to the Colorado River Compact. Apportioned the Lower Basin's 7.5 maf among the states of Arizona (2.8 maf), California (4.4 maf), and Nevada (0.3 maf). Provided that all users of Colorado River water stored in Lake Mead must enter into a contract with USBR for use of the water.
California Limitation Act	1929	Confirmed California's share of the 7.5 maf Lower Basin allocation to 4.4 maf annually, plus no more than half of any surplus waters.
California Seven-Party Agreement	1931	An agreement among seven California water agencies/districts to recommend to the U.S. Secretary of Interior how to divide use of California's apportionment among the California water users.
U.S.-Mexican Water Treaty	1944	Apportions Mexico a supply of 1.5 maf annually of Colorado River water, except under surplus or extraordinary drought conditions.
U.S. Supreme Court Decree in Arizona v. California, et al.	1964, supplemented 1979	Rejected California's argument that Arizona's use of water from the Gila River, a Colorado River tributary, constituted use of its Colorado River apportionment. Ruled that Lower Basin states have a right to appropriate and use tributary flows before the tributary co-mingles with the Colorado River. Mandated the preparation of annual reports documenting the uses of water in the three Lower Basin states. Quantifies tribal water rights for specified tribes, including 131,400 af/yr. for diversion in California. Quantified Colorado River mainstream present perfected rights in the Lower Basin states.
Colorado River Basin Project Act	1968	Authorized construction of the Central Arizona Project. Requires U.S. Secretary of the Interior to prepare long-range operating criteria for major Colorado River reservoirs.
Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs	1970, amended 2005	Provided for the coordinated operation of reservoirs in the Upper and Lower Basins and set conditions for water releases from Lake Powell and Lake Mead.
Colorado River Water Delivery Agreement: Federal Quantification Settlement Agreement of 2003	2003	Complex package of agreements that, in addition to many other important issues, further quantifies priorities established in the 1931 California Seven-Party Agreement and enables specified water transfers (such as the water conserved through lining of the All-American and Coachella canals to San Diego County Water Authority) in California. When Lake Mead water level is 1125 feet or less on January 1, prohibits additional overruns and requires that overruns are to be paid back in subsequent calendar year rather than in three years as allowed under normal conditions.
Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead	2007	ROD includes criteria for shortage and drought conditions. Triggered by protracted multi-year drought which began in October 1999 and ended in 2010, but resumed in 2011. It establishes Lake Powell to Lake Mead release requirements

Source: Adapted from U.S. Bureau of Reclamation Web page "The Law of the River," Updated March 2008. http://www.usbr.gov/lc/region/g1000/lawofrvr.html

Notes: af/yr. = acre-feet per year, maf = million acre-feet, ROD = Record of Decision

Table CR-16 Annual Intrastate Apportionment of Water from the Colorado River Mainstream within California under the Seven Party Agreement[a]

Priority Number[d, e]	Apportionment
Priority 1	Palo Verde Irrigation District (based on area of 104,500 acres).
Priority 2	Lands in California within USBR's Yuma Project (not to exceed 25,000 acres).
Priority 3	Imperial Irrigation District and lands served from the All American Canal in Imperial and Coachella valleys, and Palo Verde Irrigation District for use on 16,000 acres in the Lower Palo Verde Mesa.
Priority 4	MWDSC for coastal plain of Southern California - 550,000 af/yr.
Priority 5	An additional 550,000 af/yr. to MWDSC, and 112,000 af/yr for the City and County of San Diego[b, c].
Priority 6	Imperial Irrigation District and lands served from the All American Canal in Imperial and Coachella Valleys, and Palo Verde Irrigation District for use on 16,000 acres in the Lower Palo Verde Mesa, for a total not to exceed 300 taf/yr.
Priority 7	All remaining water available for use in California, for agricultural use in California's Colorado River Basin.

Notes: (amounts represent consumptive use)

af = acre-feet; taf = thousand acre-feet; maf = million acre-feet; af/yr. = acre-feet per year

USBR = U.S. Bureau of Reclamation; MWDSC = Metropolitan Water District of Southern California; SDCWA = San Diego County Water Authority

[a] Indian tribes and miscellaneous present perfected right holders that are not encompassed in California's Seven Party Agreement have the right to divert up to approximately 90 taf /yr. (equating to about 50 taf/yr. of consumptive use) within California's 4.4 maf basic apportionment. Present consumptive use under these miscellaneous and tribal present perfected rights is approximately 15 taf/yr.

[b] Subsequent to execution of the Seven Party Agreement, MWDSC, SDCWA, and the City of San Diego executed a separate agreement transferring its apportionment to MWDSC.

[c] Under the Colorado River Water Delivery Agreement: Federal Quantification Settlement Agreement of 2003, MWDSC (and SDCWA) gained access to water that may be available under Priority 6 and 7.

[d] Priorities 1 through 3 collectively are not to exceed 3.85 maf/yr. The Seven Party Agreement did not quantify the division of this volume among the three parties. Priorities 1-3 were further defined in the 2003 Quantification Settlement Agreement.

[e] Total of Priorities 1 through 6 is 5.362 maf/yr.

State Water Project Water Deliveries

The Colorado River Hydrologic Region receives approximately 66,967 af of water supplies from the SWP through contracts with the Coachella Valley Water District, Desert Water Agency, and the San Gorgonio Pass Water Agency. These supplies are used to recharge local groundwater basins. See Table CR-18 for a breakdown of the contract amounts. (Although the Mojave Water Agency services the South Lahontan Hydrologic Region, it also plans to use SWP water in the Morongo Subarea of the Colorado River Hydrologic Region in the future).

Table CR-17 Annual Apportionment of Use of Colorado River Water Interstate/International

Description	Amount
Upper Basin. Required to deliver 75 maf over a 10-year period measured at Lee Ferry. (small portion of Arizona, Colorado, New Mexico, Utah, and Wyoming)	7.5 maf
Lower Basin. (portions of Arizona, Nevada, California, and Utah draining below Lee Ferry)	7.5 maf plus 1 maf
Republic of Mexico[a]	1.5 maf
Total	17.5 maf[b]

Notes:

Amounts represent consumptive use; maf = million acre-feet, taf = thousand acre-feet

[a] Plus 200 taf of surplus water, when available as determined by the United States. Water delivered to Mexico must meet specified salinity requirements. During an extraordinary drought or other cause resulting in reduced uses in the United States, deliveries to Mexico would be reduced proportionally with uses in the United States.

[b] The total volume of 17.5 maf/yr refers to all waters of the Colorado River System, which is defined as that portion of the Colorado River and its tributaries in the United States.

Flood Governance

Agencies with Flood Responsibilities

California's water resource development has resulted in a complex, fragmented, and intertwined physical and governmental infrastructure. Although primary responsibility might be assigned to a specific local entity, aggregate responsibilities are spread among more than 65 agencies in the Colorado River Hydrologic Region with many different governance structures. A list of agencies can be found in *California's Flood Future Report* Technical Attachment E: Information Gathering (California Department of Water Resources and U.S. Army Corps of Engineers 2013b). Agency roles and responsibilities can be limited by how the agency was formed, which might include enabling legislation, a charter, an MOU with other agencies, or facility ownership.

The Colorado River Hydrologic Region contains floodwater storage facilities and channel improvements funded and/or built by State and federal agencies. Flood management agencies are responsible for operating and maintaining approximately 1,800 miles of levees, 17 dams and reservoirs, and 10 debris basins within the Colorado River Hydrologic Region. For a list of major infrastructure, refer to *California's Flood Future Report* Technical Attachment E: Information Gathering Findings (California Department of Water Resources and U.S. Army Corps of Engineers 2013b).

Flood Management Governance and Laws

CWC Division 5, Sections 8,000-9,651 has special significance to flood management activities and is summarized in *California's Flood Future Report* Technical Attachment E: Information Gathering Findings (California Department of Water Resources and U.S. Army Corps of Engineers 2013b).

Table CR-18 State Water Project Water Deliveries to the Colorado River Hydrologic Region

Agency	Amount (acre-feet)
Coachella Valley Water District	23,100
Desert Water Agency	38,100
San Gorgonio Pass Water Agency	5,767

A number of laws regarding flood risk and land use planning were enacted in 2007. These laws establish a comprehensive approach to improving flood management by addressing system deficiencies, improving flood risk information, and encouraging links between land use planning and flood management. Two of the Assembly bills that the California Legislature passed are summarized below.

- AB 70 (2007) Flood Liability — provides that a city or county might be responsible for its reasonable share of property damage caused by a flood, if the State liability for property damage has increased due to approval of new development after January 1, 2008.
- AB 162 (2007) General Plans — requires annual review of the land use element of general plans for areas subject to flooding, as identified by the Federal Emergency Management Agency (FEMA) or DWR floodplain mapping. The bill also requires that the safety element of general plans provide information on flood hazards. Additionally, AB 162 requires the conservation element of general plans to identify rivers, creeks, streams, flood corridors, riparian habitat, and land that might accommodate floodwater for purposes of groundwater recharge and stormwater management.

State Funding Received

State funding awarded for planning and implementation of water-related infrastructure in the region through spring 2013 has been a total of $12 million. IID received a planning grant for $1 million. The CVWD received a planning grant for $1 million. Following that, CVWD received an implementation grant for $4 million. Mojave Water Agency received an implementation grant for $6 million.

Groundwater Governance

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

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

Groundwater Management Assessment

Table CR-19 lists some of the GWMPs in the region, while Figure CR-17 shows the location and distribution of the GWMPs. GWMPs prepared in accordance with the 1992 AB 3030 legislation, as well as those prepared with the additional required components listed in the 2002 SB 1938 legislation are shown.

The GWMP inventory shows four GWMPs in the Colorado River Hydrologic Region, Three of which are fully contained within the region. The other plan includes portions of the adjacent South Lahontan Hydrologic Region. One of the plans is a water management plan that meets the requirements of a GWMP, but that also includes surface water management. All four GWMPs were developed or updated to include the SB 1938 requirements and are considered active for the purposes of the GWMP assessment. All six basins identified as high or medium priority under the CASGEM Basin Prioritization are covered by these four active GWMPs.

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

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

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

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

A summary of the GWMP assessment is provided in Table CR-20.

Factors Contributing to Success and Impediment to Groundwater Management

The survey participants were also asked to identify key factors that promoted or impeded successful groundwater management. All three responding agencies identified broad stakeholder participation, collection and sharing of data, developing an understanding of common interest, adequate funding, outreach and education, and adequate time as key factors for a successful

GWMP implementation. Having adequate surface water supplies, surface water storage and conveyance, and developing and using a water budget were also identified as important factors.

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

Two respondents felt long-term sustainability of their groundwater supply was possible while the other respondent contended that long-term sustainability was not possible.

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

Groundwater Ordinances

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

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

Special Act Districts

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

There are many Special Act Districts established by the California State Legislature consisting of different authorities that may or may not have groundwater management authority. It is not part of the scope for the California Water Plan Update 2013 to identify Special Act Districts in the region or the established agencies. This report includes the GWMPs that were prepared by some of these agencies, as discussed in the preceding section. However, one special act district readily identified in the Colorado River region — the Desert Water Agency — imports water to its service area, replenishes local groundwater supplies, and collects fees necessary to support a groundwater replenishment program.

Table CR-19 Groundwater Management Plans in the Colorado River Hydrologic Region

Map[a] Label	Agency Name	GWMP Title	Date	County	Basin Number	Basin Name
CR-1	Borrego Water District	Borrego Water District GWMP	2006	Imperial	7-24	Borrego Valley
	No signatories on file					
CR-2	Twentynine Palms Water District	GWMP Update Final Report	2008	San Bernardino	7-9	Dale Valley
	No signatories on file				7-10	Twentynine Palms Valley
					7-62	Joshua Tree
CR-3	Coachella Valley Water District	Coachella Valley Water District Water Management Plan (Draft)	2010	Riverside, Imperial, San Diego	7-21.01	Indio
	No signatories on file				7-21.02	Mission Creek Subbasin
					7-21.03	Desert Hot Springs Subbasin
					7-22	West Salton Sea
					7-31	Orocopia Valley
					7-32	Chocolate Valley
					7-33	East Salton Sea
SL-4 (CR-4)	Mojave Water District	2004 Regional Water Management Plan	2004	San Bernardino, Kern, Los Angeles	6-35	Cronise Valley
	No signatories on file				6-38	Caves Canyon Valley
					6-40	Lower Mojave River Valley
					6-41	Middle Mojave River Valley
					6-42	Upper Mojave River Valley
					6-44	Antelope Valley

Map[a] Label	Agency Name	GWMP Title	Date	County	Basin Number	Basin Name
					6-46	Fremont Valley
					6-48	Goldstone Valley
					6-49	Superior Valley
					6-50	Cuddeback Valley
					6-51	Pilot Knob Valley
					6-52	Searles Valley
					6-53	Salt Wells Valley
					6-54	Indian Wells Valley
					6-77	Grass Valley
					6-89	Kane Wash Area
					7-11	Copper Mountain Valley
					7-12	Warren Valley
					7-13.01	Deadman Lake Subbasin
					7-13.02	Surprise Spring Subbasin
					7-15	Bessemer Valley
					7-16	Ames Valley
					7-18.01	Soggy Lake Subbasin
					7-18.02	Upper Johnson Valley Subbasin
					7-19	Lucerne Valley
					7-20	Morongo Valley

Map[a] Label	Agency Name	GWMP Title	Date	County	Basin Number	Basin Name
					7-50	Iron Ridge Area
					7-51	Lost Horse Valley
					7-62	Joshua Tree

Notes:

GWMP = groundwater management plan

Table represents information as of August, 2012.

[a] See Figure CR-17 - Location of Groundwater Management Plans in the Colorado River Hydrologic Region

Court Adjudication of Groundwater Rights

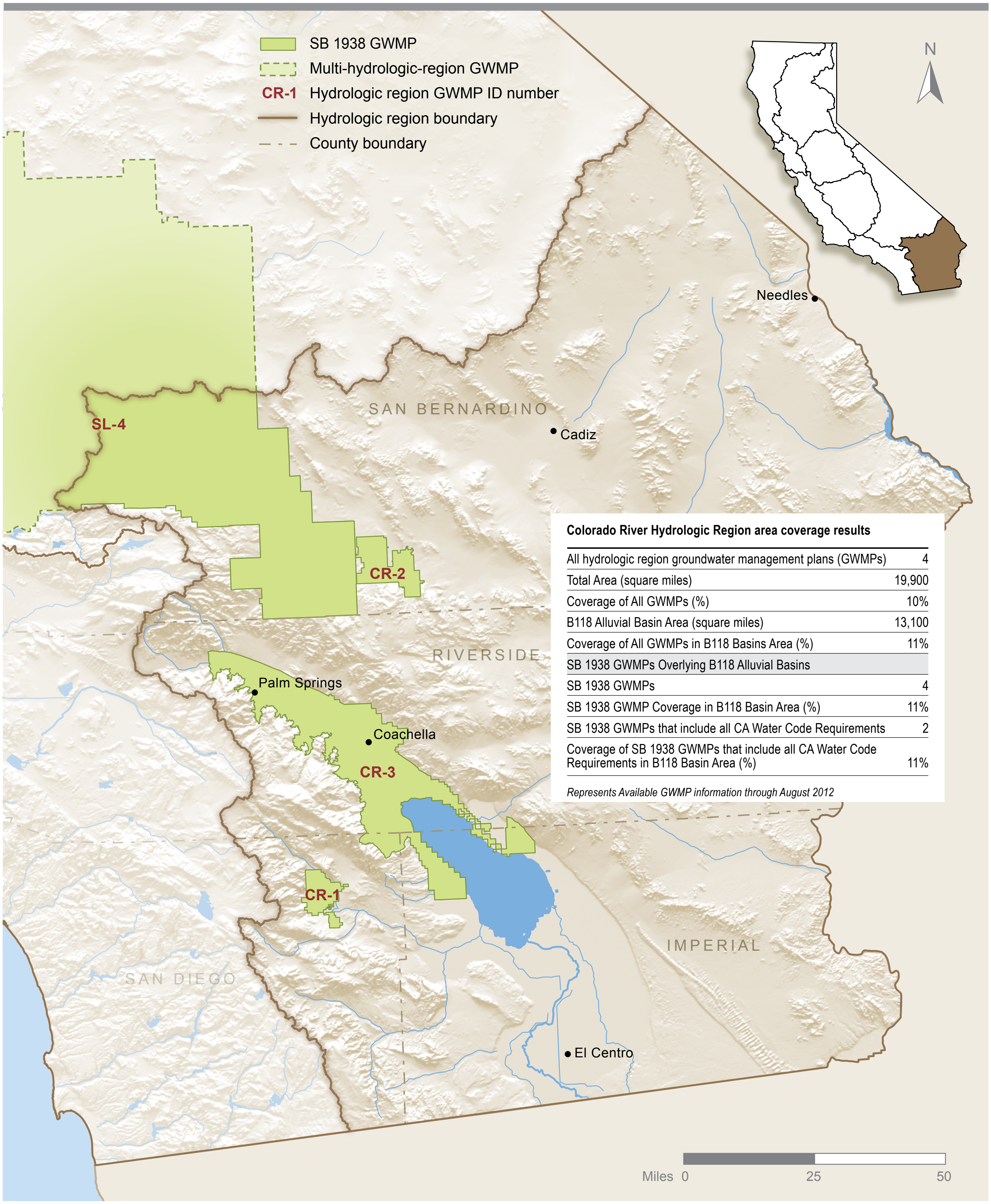
Another form of groundwater management in California is through the courts. The court typically appoints a watermaster to administer the judgment to ensure that annual groundwater extractions follow the terms of the adjudication and to periodically report to the court. There are currently 24 groundwater adjudications in California. As shown in Table CR-21 the Colorado River Hydrologic Region contains three of those adjudications.

Due to heavy groundwater use and declining groundwater levels, water rights were adjudicated in Warren Valley Basin, with the adjudication judgment finalized in 1977. The court appointed Hi-Desert Water District as the watermaster and ordered the district to develop a plan to halt the overdraft of the basin. In 1991, the Warren Valley Basin Management Plan was prepared with recommendations to manage extractions, import water supplies, conserve water flows, encourage water conservation and recycling, and protect the quality of the groundwater supplies.

The Mojave Basin Area adjudication judgment was finalized in 1996. The Superior Court appointed the Mojave Water Agency to serve as the watermaster to ensure that the conditions set forth in the adjudication are followed. The judgment established Free Production Allowance (FPA) for the water producers, which is the amount of water that a producer can pump for free during a year without having to pay for replacement water. A producer who needs more FPA than its assigned value must pay for the excess water used either by arranging to transfer the desired amount from another producer or by buying the amount required from the watermaster. The Lucerne Valley Basin is included in this adjudication, see Table CR-21.

The San Gorgonio Pass subbasin of the Coachella Valley Groundwater Basin is included in the Beaumont Basin adjudication judgment that was finalized in 2004 (Table CR-21). The Court appointed a committee including representatives from the cities of Banning and Beaumont, Beaumont-Cherry Valley Water District, South Mesa Mutual Water Company, and the Yucaipa Valley Water District to serve as the water master. The judgment established the annual extraction quantities for the parties that were classified as either overlying owners or appropriators.

Figure CR-17 Location of Groundwater Management Plans in the Colorado River Hydrologic Region



Colorado River Hydrologic Region area coverage results

All hydrologic region groundwater management plans (GWMPs)	4
Total Area (square miles)	19,900
Coverage of All GWMPs (%)	10%
B118 Alluvial Basin Area (square miles)	13,100
Coverage of All GWMPs in B118 Basins Area (%)	11%
SB 1938 GWMPs Overlying B118 Alluvial Basins	
SB 1938 GWMPs	4
SB 1938 GWMP Coverage in B118 Basin Area (%)	11%
SB 1938 GWMPs that include all CA Water Code Requirements	2
Coverage of SB 1938 GWMPs that include all CA Water Code Requirements in B118 Basin Area (%)	11%

Represents Available GWMP information through August 2012

Table CR-20 Assessment of Groundwater Management Plan Components

SB 1938 Groundwater Management Plan (GWMP) Required Components	Percent of Plans that Meet Requirements
Basin Management Objectives	75
BMO: Monitoring/Management Groundwater Levels	100
BMO: Monitoring Groundwater Quality	100
BMO: Inelastic Subsidence	75
BMO: SW/GW Interaction & Affects to Groundwater Levels & Quality	75
Agency Cooperation	100
Map	100
Map: Groundwater basin area	100
Map: Area of local agency	100
Map: Boundaries of other local agencies	100
Recharge Areas (1/1/2013)	Not assessed
Monitoring Protocols	75
MP: Changes in groundwater levels	100
MP: Changes in groundwater quality	100
MP: Subsidence	75
MP: Surface water/ groundwater Interaction & Affects to Groundwater Levels & Quality	75
SB 1938 Voluntary Components	**Percent of Plans that Include Components**
Saline Intrusion	50
Wellhead Protection & Recharge	75
Groundwater Contamination	75
Well Abandonment & Destruction	75
Overdraft	100
Groundwater Extraction & Replenishment	100
Monitoring Groundwater Levels and Storage	100
Conjunctive Use Operations	100
Well Construction Policies	100
Construction and Operation	50
Regulatory Agencies	100
Land Use	100

Bulletin 118-03 Recommended Components	Percent of Plans that Include Components
GWMP Guidance	75
Management Area	100
Basin Management Objectives - Goals & Actions	100
Monitoring Plan Description	25
Integrated Regional Water Management Planning	75
GWMP Implementation	100
GWMP Evaluation	100

Notes:

BMO = basin management objective, IRWM = integrated regional water management, GWMP = groundwater management plan, MP = monitoring rotocols, SW/GW = surface water/groundwater

Other Groundwater Management Planning Efforts

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

Current Relationships with Other Regions and States

International cooperation continues to be critical for successful management of the Colorado River. The United States and Mexico have collaborated in the past on Colorado River issues. In late 2012, the countries did so again with the development of Minute 319 to the United States-Mexico Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande: "Interim International Cooperative Measures in the Colorado River Basin Through 2017 and Extension of Minute 318 Cooperative Measures to Address the Continued Effects of the April 2010 Earthquake in the Mexicali Valley, Baja California." Minute 319 calls for the implementation of certain actions and policies that include (1) a continuation of agreement identified in Minute 318 related to the repair and upgrade of infrastructure in Mexico impacted by the 2010 earthquake in the Mexicali Valley, (2) establishment of water supply delivery procedures for the U. S. and Mexico during wet and dry hydrologic conditions, (3) establishment of a program (the Intentionally Created Mexican Allocation) that permits Mexico to store water in the United States for delivery at a later time, and (4) implementation of a pilot study focused on the re-establishment of waterflows to the Colorado River delta in Mexico.

The land fallowing and water supply transfer program between the PVID and MWD is being implemented smoothly. The 35-year program began in 2005 and fallows between 7 and 28 percent of irrigated lands in the Palo Verde Valley each year. Between 29.5 taf and 118.05 taf of water is available annually for MWD. The payment received for the fallowing of land helps stabilize the local economy in the valley and provide financial assistance for specific local community improvement programs. In 2009, about 129 taf of water supplies were transferred. For the following year, 2010, it was a little more than 116 taf.

Table CR-21 Groundwater Adjudications in the Colorado River Hydrologic Region

Court Judgment	Colorado River HR Basin/Subbasin	Basin Number	County	Judgment Date
Warren Valley Basin	Warren Valley Basin	7-12	San Bernardino	1977
Mojave Basin Area	Lucerne Valley Basin	7-19	San Bernardino	1996
Beaumont Basin	San Gorgonio Pass Subbasin of Coachella Valley Basin	7-21.04	Riverside	2004

Note: Table represents information as of April 2013.

During the Colorado River Upper Basin drought years of 2009 and 2010, PVID and MWD worked together to move additional Colorado River water supplies to MWD's service area. In calendar year 2010, MWD received a little more than 32 taf of water supplies from PVID to help mitigate the impacts of the drought.

The projects completed for the 1988 Water Conservation Agreement between the IID and MWD permits the transfer of conserved water supplies to MWD's service area. In 2010, approximately 97 taf of water supply was transferred to the MWD; in 2011, it was almost 100 taf.

CVWD and the DWA continue to reach out to water agencies outside of the region to acquire new SWP water supplies to help with the management of the local groundwater basins. Long-term water transfer agreements were reached with the Berenda Mesa Water District and Tulare Lake Water Basin Storage District. Short-term agreements were also reached with the Rosedale-Rio Bravo Water Storage District and DMB Pacific, Inc. Additional exchange agreements between CVWD, DWA, and MWD were also reached that would allow import of SWP supplies purchased during DWR's Dry Year program.

Other important water transfer agreements continue to be implemented in accordance with the CRWDA. The transfers include agencies within and outside of the region. These are the SDCWA-IID and the CVWD and IID water transfer agreements. The quantities of water supplies to be transferred will originate from the implementation of on-farm and water conveyance water use efficiency programs. For the SDCWA-IID agreement, the annual maximum amount of water to be transferred from the IID to SDCWA will be 200 taf. Water supplies are now being transferred, from a combination of savings and land fallowing; and full delivery is projected for 2021. The maximum amount of water supplies to be transferred in the CVWD-IID agreement will be 103 taf. This is expected to be achieved by 2026.

Regional Water Planning and Management

The Colorado River Hydrologic Region's two main outside water resources, Northern California and the Colorado River, are of concern. The Coachella Valley's share of SWP water from Northern California is being temporarily reduced by up to one-third after federal Judge Wanger Decision in 2008 found harm to fish from SWP operations. Simultaneously, the worst drought in

Box CR-1 Other Groundwater Management Planning Efforts in the Colorado River Hydrologic Region

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

Integrated Regional Water Management Plans

There are four integrated regional water management (IRWM) regions covering a portion of the Colorado River Hydrologic Region. Three regions have adopted IRWM plans, and one region is currently developing an IRWM plan. The Mojave Water Agency Regional Water Management Plan intends to use a combination of surface water, groundwater, and conservation to prevent long-term declines in groundwater storage, prevent land subsidence, and provide a sustainable water supply to meet current and future water demands.

The Coachella IRWM plan goals include specific objectives including managing groundwater levels, importing water, improving surface water quality, optimizing conjunctive use opportunities, addressing the water-related needs of local Native American culture, maximizing local water supply through water conservation, recycling, and capturing infiltration and runoff, and maintaining the affordability of water to users in the region.

The Imperial IRWM plan goals include diversifying the regional water supply sources, protecting or improving water quality, protecting and enhancing wildlife habitat, providing flood protection and stormwater management, and developing regional policies for groundwater management.

Urban Water Management Plans

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

Agricultural Water Management Plans

Agricultural water management plans are developed by water and irrigation districts to advance the efficiency of farm water management while benefitting the environment. New and updated agricultural water management plans addressing several new requirements were submitted to DWR by December 31, 2012, for review and approval. These new or updated plans provide another avenue for local groundwater management; but because of the timeline, the plans could not be reviewed for assessment for *California Water Plan Update 2013*.

500 years has reduced flows on the Colorado River to about half of normal, and storage in Lake Mead and Lake Powell are also at about 50 percent.

Years after desert farmers reduced their water use, CVWD is building the $70 million Mid-Valley Pipeline. The pipeline will provide about 50 of the valley's 124 golf courses with Colorado River water for irrigation, leaving higher-quality aquifer water for drinking use. Another $40 million project to build a new groundwater recharge facility south of La Quinta will use Colorado River water to replenish the east valley portion of the underground aquifer.

Flood management in the future will require unprecedented integration among traditionally varying agencies that have overlapping and sometimes conflicting goals and objectives. More reliable funding and improved agency alignment are required at all levels. Updated technical and risk management approaches will be needed to protect the public from flooding by assessing risk, as well as by improving flood readiness, making prudent land use decisions, and promoting flood awareness. Project implementation methods could benefit from IWM-based approaches to leverage the limited funding and other flood management resources. In short, future solutions should be aligned with broader watershed-wide goals and objectives and must be crafted in the context of IWM.

Integrated Regional Water Management Coordination and Planning

Integrated regional water management promotes the coordinated development and management of water, land, and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. Flood management is a key component of an IWM strategy.

Four IRWM regions have been formed for the Colorado River Hydrologic Region. They are identified as the Anza-Borrego Desert, Coachella Valley, Imperial, and the southern portion of Mojave Desert. Presently, the members of each group are either in the process of developing a suitable IRWM plan for their area or updating an existing plan to meet current standards. IRWM members and stakeholders have reached out to a wide range of interest groups for assistance with the development of strategies to resolve present-day and future water management challenges in the region. The Colorado River region has several disadvantaged communities, and the IRWM groups are involving them in the planning process. Interest has grown for the IRWM activities as local agencies have come to recognize that regional integration can enhance their collective power and ability to manage the region’s water resources in a sustainable way.

As a result of IRWM planning efforts, local agencies and stakeholders in the region have developed an array of projects and programs to meet their water management objectives. The array includes projects that will sustain existing and future surface water and groundwater supplies and protects the environment. The region is now poised to begin implementation of projects that have been developed through the planning process including recycled water expansion, desalters, pipeline interconnection, habitat restoration and invasive species control, stormwater capture and reuse, and water use efficiency programs. Important projects include City of Imperial’s Keystone Water Reclamation Facility; the IWA Recycled Water Program, which promotes groundwater recharge (replenishment) and increased reliability; the Smart Water Conservation Programs (a project that utilizes a variety of education and outreach methods to increase water conservation throughout the Coachella Valley); East Brawley Groundwater Desalination Project; and the East Wide Channel, Long Canyon and Tributaries Master Plan project (improve current detention dams, levees and reservoirs near the mouths of Long Canyon and West Wide Canyon to make stormwater collection/capture more efficient and floodwaters more manageable in Coachella Valley).

Other examples of IRWM planning and implementation activities include the Mojave IRWM group facilitating water conservation programs and, with the funding aid, complete a recharge project in the Joshua Basin. The Coachella Valley Regional Water Management Group (RWMG) is including integrated flood management and a groundwater monitoring strategy into its IRWM plan update and has received implementation funds to treat arsenic in the water supply of DACs.

Priorities for the Imperial Valley RWMG include protecting its sole-source aquifer in the Ocotillo area and managing groundwater to include desalination and storage.

Implementation Activities (2009-2013)

Drought Contingency Plans

In their preparations of urban water management plans, most water agencies in the Colorado River region also updated existing water supply shortage contingency plans. These documents describe the different actions that will be undertaken to mitigate the impacts caused by either natural or human-made water supply shortages. Actions include the stages of supply shortages, actions to be taken at each stage, programs and policies that will be implemented to decrease demands (including restrictions on certain kinds of water uses), procedures to monitor uses, and penalties for those who do not comply with specific orders. The plans also outline short-term and long-term strategies to supplement existing water supplies to lessen the impacts of shortages during real emergencies.

For over two decades, the CVWD and DWA have taken the necessary steps to replenish and store water supplies in the Whitewater Groundwater Basin in the Coachella Valley. As reported in the Water Supply section, CVWD and DWA have entered into agreements with various agencies, including MWD, Berenda Mesa Water District and Tulare Lake Water Basin Storage District to bring additional SWP water supplies into the region for the purpose of groundwater recharge. These additional supplies would then be available to them in the event of possible future shortfalls from the SWP and Colorado River.

Accomplishments

Ecosystem Restoration

Environmental Mitigation Projects

Although the All-American and Coachella Canal lining projects were completed several years ago, environmental mitigation projects associated with both are currently being implemented. Several important mitigation projects were identified for the Coachella Canal project including the Dos Palmas Water Supply System (DPWSS) and Created Marsh and maintenance and rehabilitation of the Dos Palmas Conservation Area on the northeast shore of the Salton Sea. For the DPWSS, water supplies from the Coachella Canal are conveyed to specific locations in this system for groundwater recharge and irrigation of the marsh and aquatic vegetation in the Dos Palmas Conservation Area. For the Dos Palmas Conservation Area, maintenance is being provided to the Core Marsh and aquatic habitat and birds are being monitored, including the Yuma clapper rail. Restoration activities are also under way in the conservation area. Salt cedar plants have been cleared; and desert riparian plant species are being planted, including wolf berry, honey mesquite, ironwood, and palo verde.

Environmental mitigation requirements for the All-American Canal Lining Project (AACLP) include the Chanan Remington Memorial Wetland Enhancement Area. This restored freshwater marsh is providing habitat for a diversity of species, including mesquite and cottonwood trees.

All non-native weed populations have been controlled, and the freshwater marsh habitat has expanded to the original size of the wetland. Both the California black rail and the Yuma clapper rail surveys are performed annually. Groundwater elevations were monitored to generate baseline conditions for the Chanan Remington Memorial Wetland Enhancement area prior to the lining of the All-American Canal. Results have shown that there are no significant changes to groundwater levels between pre and post canal-lining; monitoring will continue through 2014. Other environmental mitigation requirements of the AACLP include dune restoration. The area is monitored for sand accumulation and botanical species; results show that the site has been colonized by both native and non-native species with a low vegetative cover overall. Silt fencing to encourage sand accumulation will be installed as part of the active restoration phase. Native seed has also been collected and stored for a more active approach to restoration activities, if needed. The monitoring of sand accumulation and botanical species growth continued through 2013. This plan differed from the original monitoring plan by reducing aerial surveys. Annual deer surveys show that deer continue to use the rip-rap under the I-8 Bridge for access to the canal water and are also utilizing the wildlife water guzzlers constructed as mitigation for the AACLP.

An MOU was recently finalized to provide an endowment for DFW to purchase canal water for a fishing pond in the Imperial Valley as mitigation for the project-related loss of canal fishery habitat.

Lower Colorado River Multi-Species Conservation Program

Progress is being made to implement the $626 million Lower Colorado River Multi-Species Conservation Program (LCRMSCP). The program activities are separated into different categories, which include habitat restoration, fish augmentation, species research, and system monitoring. Work has been initiated on a number of programs including those involving system monitoring and conservation area development and management. Additional information can be found at the program's Web site at: http://www.lcrmscp.gov/general_program.html.

Since 2005, over 2,400 acres of new habitat have been established adjacent to the Colorado River with nearly 1,000 of the acres created within the Colorado River area. One of the more prominent activities of the restoration work is the planting of trees and shrubs, cottonwood trees, several varieties of willow trees, and mesquite. Future activities will include the establishment of ponds off the main channel of the Colorado River that would provide aquatic habitat for razorback sucker, bonytail, and flannel mouth sucker fish species. Effectiveness monitoring surveys are continuing to determine the number of birds and land animals that live in the newly restored habitat preserves. The LCRMSCP Steering Committee annual work and accomplishments may be found online at http://www.lcrmscp.gov/general_program.html.

Habitat Mitigation Programs

Several environmental mitigation projects are under way in the region for compliance with requirements of the CRWDA including the Managed Marsh project, Air Quality Mitigation Program, and Burrowing Owl Burrow Avoidance Program. These projects are managed and funded by the Joint Powers Authority, which consists of members from IID, SDCWA, CVWD, and DFW. The Managed Marsh Project is the phased planning and construction of a managed wetland (marsh) for small animals and birds. Phase I established 365 acres of new wetlands and was completed in 2009. Phase II will add 330 acres to this habitat and is currently in the design stage. The final phase will be completed by 2019 and will increase the size of the wetland to approximately 959 acres. The Air Quality Mitigation Program installed six air quality monitoring stations around the Salton Sea to gather baseline data on dust emissions. The Burrowing Owl Avoidance Program is being implemented; it (1) provides on-site monitoring during operation and maintenance tasks to help maintenance crews identify and avoid sensitive burrowing habitats, (2) provides semi-annual training to IID staff on the owl habitat, and (3) modifies existing and develops new strategies to mitigate the impacts of these maintenance activities.

Salton Sea Species Conservation Habitat Project

Habitat values at the Salton Sea continue to decline as salinity increases and as water levels recede. To address near-term loss and degradation of habitat during the period prior to implementation of a larger restoration plan, the California Legislature appropriated funds for the purpose of implementing conservation measures necessary to protect the fish and wildlife species dependent on the Salton Sea. DFW was given authority, under Fish and Wildlife Code 2932, to pursue this objective. The 2009 Species Conservation Habitat (SCH) Project set forth a plan to create approximately 2,400 acres of shallow pond habitat at the sea to support fish populations which in turn would support bird populations. In August 2011 the Salton Sea SCH Project Draft EIS/EIR was issued. As of March 2013, no habitat had been constructed under the Salton Sea SCH Shallow Habitat Project.

The Legislature appropriated $5.4 million in Proposition 84 funds for the SCH Project. An additional $20 million in Proposition 84 funds will need to be appropriated and placed in the Salton Sea Restoration Fund for completion of the project (Chapter 5). The Salton Sea Mitigation Fund (up to $30 million) would be used for operations and maintenance of the project. Through the Salton Sea Financial Assistance Program (FAP) stakeholders can participate in the restoration process of the Salton Sea using funds provided by Proposition 84. The FAP will provide grant monies to eligible applicants (local agencies, nonprofit organizations, tribes, universities, and State and federal agencies) for projects that conserve fish and wildlife within the Salton Sea ecosystem. DFW and DWR released the final documents for the Salton Sea Financial Assistance Program in July 2012, with proposals due September 10, 2012. On April 8, 2013, $3 million were awarded to projects for this program.

Along the Colorado River, several national wildlife areas have been established. Managed by the USFWS, these include the Havasu National Wildlife Refuge, Imperial National Wildlife Refuge, Bill Williams River national Wildlife Refuge, and Cibola National Wildlife Refuge. The facilities occupy land in California as well as in Arizona. Lush riparian habitats have been established in both refuges, creating important habitat for both permanent and migratory birds and other wildlife.

A number of federally designated wilderness areas have been established in the Colorado River Hydrologic Region. These areas are managed by one of the following federal agencies: U.S. Bureau of Land Management, USFWS, or the U.S. Forest Service. Some of the larger designated areas are in the southern portion of the Mojave Desert Preserve. These include the Turtle Mountain Wilderness Area (177,000 acres) and the Palen-McCoy Wilderness Area (259,000 acres). The latter is known for its desert ironwood trees. Other wilderness areas that exist along the Colorado River include the Chemehuevi Mountains and Big Maria Mountains wilderness areas.

Coachella Valley Multiple Species Habitat Conservation Plan

In 2008, USFWS and DFW both issued permits for the Coachella Valley Multiple Species Habitat Conservation Plan (HCP). The Coachella Valley Conservation Commission, which is composed of representatives from State, county, and city agencies and other important organizations, was formed to implement the action items in the plan. Work is under way to develop and approve management plans and monitor activities for six environmental areas identified in the plan. Management activities would include the acquisition of land, strategies for the protection of endangered species and their habitats, and strategies to mitigate impacts from regional climate change. Activities and programs that have been taken can be found in the 2011 Annual Report.

Environmental and Habitat Protection and Improvement

Elements of the biological mitigation measures from the IID's 2002 Draft HCP are being used as the agency implements its Water Conservation and Transfer Project in compliance with provisions of the CRWDA. The measures are required under the existing incidental take authorizations pursuant to the ESA and California Endangered Species Act (CESA). The IID is preparing the HCP and natural communities conservation plan (NCCP) that will contain modified or new mitigation and conservation measures not included in the 2002 Draft HCP and not evaluated in the Transfer Project Final EIR/EIS.

In 2012, IID and USFWS announced plans for the joint preparation of the Subsequent EIR/Supplement EIS to the Final EIR/EIS for the IID Water Conservation and Transfer Project. The document evaluates modifications to the Transfer Project and mitigation requirements in the Transfer Project, draft 2002 HCP and draft NCCP proposed in the IID-SDCWA Joint Petition.

Although most of its study area is located in the South Coast Hydrologic Region, the City of Banning is a cooperative participant in the Western Riverside County Multi-Species HCP. It is a comprehensive plan for the preservation of open space and important native habitat for local mammals and birds for the western sections of Riverside County. In 2004, DFW issued a NCCP permit for the plan.

Colorado River Basin Salinity Control Program

Salinity concentrations in the Colorado River have been an issue since the early 1970s. Not only to the water users in California but with quality of water being delivered to Mexico pursuant to the treaty between the countries. These concerns, coupled with the passage of the Clean Water Act amendments in 1972 and concerns over EPA mandating water quality standards, led the seven Colorado River Basin states to work with U. S. Department of Interior agencies, the State Department, and Congress in passage of the Colorado River Basin Salinity Control Act in 1974. Now, nearly four decades later, this partnership of federal and state agencies continues to work cooperatively with hundreds of local agencies and thousands of individual water users to control the salinity levels of the Colorado River while allowing development and usage of its waters pursuant to the Colorado River Compact apportionments. The salt load of the Colorado River has now been reduced by about 1.2 million tons annually, but continuance of the program is required to offset what otherwise would be increases in salinity levels.

Water Self Sufficiency

USBR Colorado River Study

The sustainability of the Colorado River water supplies was examined in a new study released by the USBR in 2012. The study is titled "Colorado River Basin Water Supply and Demand Study." With contributions from the Basin states and stakeholders throughout the Colorado River watershed, the study attempts to define the water supply and use imbalances which may occur 50 years into the future and demonstrate the effectiveness of possible strategies or portfolios (actions and programs) that might be used to mitigate the imbalances. The hydrology of the watershed is examined under historical conditions and with emphasis on any conditions that may be impacted by global climate change. Water demands in the watershed were made under different economic scenarios. Regardless of the conditions, municipal and industrial uses are expected to increase in response to population growth. The Colorado River supplies will be stressed if no actions are taken. The study concludes that the implementation of strategic plans or portfolios (resource management strategies) can limit the impacts of the problems. Programs and actions in the plans include urban and agricultural water use efficiency programs, utilization of recycled water and other alternative sources of potable water supplies, and water supply transfer and exchange agreements.

Imperial Irrigation District — Land Fallowing Program

In compliance with the CRWDA, the IID continues to implement its voluntary land-fallowing to generate conserved water supplies to meet its obligations for the mitigation of Salton Sea impacts related to water supplies transfers out of Imperial Valley. These supplies are also used in the IID/SDCWA water supply transfer agreement and Colorado River overrun payback obligations. Fallowing activities commenced in fiscal year 2003-2004 with 5,764 acres and water supply savings of 38.6 taf. In fiscal year 2012-2013, the total land fallowed in the program was 31,860 acres with a savings of 185.6 taf; and in 2013-2014, the totals are 34,433 acres and 185.6 taf (provisional) of conserved supply. The program ends in 2017.

Water Quality and Supplies

Water Quality of Drain Water

Additional programs are under way in the Imperial Valley to manage the water conveyance system, tailwater drain vegetation and soil erosion. In 2010, the IID approved and began implementation of its Vegetation Management Plan. Important goals of the plan included:

1. The control and management of undesirable plants in its water conveyance canals and tailwater drains.
2. Control soil erosion and remove suspended sediments in tailwater flows in the drains.
3. Maintain the slopes of the drains.
4. Promote the growth of desirable plants.

Implementation activities include the training of water agency personnel in the identification of beneficial and non-beneficial plants, utilization of excavator-mounted laser GPS-controlled cleaning equipment to eliminate the undesirable vegetation and maintain the slopes of the unlined drains, and repairing infrastructure.

With Proposition 50 and 84 funding, the IID is also commenced with actions to meet total maximum daily load (TMDL) goals established in its Drain Water Quality Improvement Plan. The GPS-controlled equipment mentioned previously was acquired through this program. Other activities include the training of operators of this equipment, enforcement of tailwater box compliance, implementing action to address high silt levels in some drains in the valley, conducting a study to determine the feasibility of using vegetation for drain slope stability, and monitor the quality of flows in the drains. These activities will assist the IID in meeting its TMDL goal of a 50 percent decrease in silt in drain water flows.

Groundwater Storage

Greater cooperation is occurring between water agencies within and outside of the Coachella Valley to address the overdraft of the local groundwater basin. Programs described in California Water Plan Update 2009 are continuing to be implemented. They include the advanced storage agreement between CVWD, DWA, and MWD regarding Colorado River supplies and the 75-year project between CVWD and IID that would permit the latter agency to store a portion of its Colorado River supplies in the Whitewater Groundwater Basin. This is in addition to long- and short-term transfers of SWP water supplies between CVWD and DWA and water agencies in the San Joaquin Valley.

For the upper or northern portion of the Whitewater Groundwater Basin, the SWP supplies received through the exchange program are released into the Whitewater River channel which eventually percolates and recharges the basin. In the lower or southern portion of the basin, CVWD operates the Thomas E. Levy Groundwater Replenishment Facility, which is located near Lake Cahuilla, and recently activated the Martinez Canyon Pilot Recharge Facility in the same part of the Coachella Valley. Colorado River water supplies are used for the recharge operations at these facilities. About 32,250 af was recharged at the Thomas E. Levy facility.

Urban Water Conservation

CVWD has updated and approved a revised landscape ordinance for customers within its service area. With this update, the CVWD hopes to decrease overall water use, eliminate the runoff of irrigation water into the streets, and limit turf grass allowance for golf courses.

The Twentynine Palms Water District has been implementing very aggressive water audit, leak detection, and water main replacement programs for the past decade. The agency conducts a very efficient preventive maintenance program and detects and repairs leaks in its distribution system quickly. Annual unaccounted water losses have been reduced by over 90 percent.

Water and Wastewater Treatment

For several years, the City of Blythe has been able to treat and deliver potable water supplies to its residential and commercial customers with its new water treatment facility. Completed in 2007, the facility has two 1,500 gpm wells, new filtration equipment, and reservoir storage.

The new wells have allowed the city to terminate other wells in its service area that have had bacteriological and chemical contamination problems.

Design activities are nearing completion for the City of Imperial's Keystone Regional Water Reclamation Facility. The facility will provide wastewater treatment for urban residents and businesses in an area that includes the City of Imperial, southern portion of the City of Brawley, and the Imperial Community College. It will be able treat wastewater flows up to 5 million gallons a day and produce recycled water supplies. Potential users of the recycled water have been identified.

New River

In addition to the establishment of the three wetland sites, discussions are moving ahead for the development and finalization of a strategic plan for the New River that would identify specific actions to address public health concerns and help meet environmental and water quality benchmarks for the Salton Sea. The plan is a part of the New River Improvement Project and is being developed under the guidance of the City of Calexico and the California-Mexico Border Relations Council under the authority granted by AB 1079 (Perez 2009). Cal EPA is also technical support. A framework for a plan was released in July 2012. Possible actions that could be taken include the installation of screens to collect the large items and trash floating in the river and the construction of a treatment plant for the removal of contaminants and raw sewage in the water. The actions in this proposed strategic plan would be performed in conjunction with activities currently under way. This would include the partial treatment of the water in the New River in Mexico before it flows into the United States, the voluntary TMDL compliance program being implemented by the farmers in the Imperial Valley, and the Drain Water Improvement Program by the Imperial Irrigation District.

This is not the sole activity concentrating on the New River. The EPA will also examine the problems of the New River as part of its Border 2020 Plan.

Other Accomplishments

Solar Power Plants

Due to its favorable climate, planning and installation activities continue for new solar power plants in the Colorado River region. The expansion is in response to State energy policies that require electric utilities to use power from renewable resources for 33 percent of its power by 2020. Both the U.S. Bureau of Land Management and California Energy Commission are playing important roles in the planning and construction process. These facilities will use groundwater supplies and annual water demands are expected to be small. However, some of the groundwater supplies may have hydrologic connections to the Colorado River, which creates problems with the appropriations of the Colorado River supplies for California (see further discussion in "Challenges" section). Construction is under way for some of the facilities. These include the Desert Sunlight Solar Farm and Genesis Solar Project, both of which are near the City of Blythe. In the National Environmental Policy Act (NEPA)/CEQA process are the McCoy Solar Energy Project (near the City of Blythe), Desert Harvest Solar Project (near the community of Desert Center, Riverside County), Ocotillo Sol Project (Imperial Valley), and the Chevron Lucerne Valley Solar Project (Lucerne Valley, San Bernardino County).

Challenges

Threatened or endangered fish species on the main stem of the Colorado River include the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub. Efforts to protect these fish may impact reservoir operations and streamflow in the main stem and tributaries, which are critically important to California's ability to store and divert Colorado River water supplies. Other species of concern in the basin include the bald eagle, Yuma clapper rail, black rail, southwestern willow flycatcher, yellow warbler, vermilion flycatcher, yellow-billed cuckoo, and Kanab ambersnail.

The region faces challenges in intra-regional planning and management including how to better integrate land use and water plans and resolve conflicts within the region related to new water demands and future land use changes. The major source of water to the region, the Colorado River, is vulnerable because of the prolonged Colorado River Basin drought. In addition, the region is characterized by cities and unincorporated communities that are spread over large areas resulting in high cost of projects and making outreach to remote and isolated communities difficult. However, the projects that have been developed through the planning efforts are expected to produce regional benefits that include water quality improvement, enhancement of water supply reliability, ecosystem improvement, flood control enhancement, enhanced partnerships and public participation, understanding of water-related issues, and improved water management.

Vulnerabilities to the SWP water supplies also exist. The MWD, CVWD and DWA are subjected to reductions in annual allocations because of federal court rulings on Delta diversions and poor hydrologic conditions.

The IRWM process has provided a rare opportunity for increased water management coordination and collaboration among agencies in the region, even as the region is faced with significant water resources challenges. Increasing use of recycled water is helping to offset the use of groundwater for non-potable uses, resulting in energy savings and reduced costs of pumping from deep wells. Recycled water distribution systems are being expanded to maximize the use of recycled water in the region. Interagency partnerships on regional projects would help alleviate challenges associated with bringing recycled water supply to customers and upgrading of existing treatment facilities to provide tertiary treatment and improved opportunities to reuse the water.

The freshwater marshes and wetlands of Salton Sea face rising salinity through evaporation and declining water elevations. At the same time, prolonged Colorado River Basin drought and climate change scenarios point to decreased runoff to the Colorado River. Preservation and restoration of these water sources and the quality of their water is critical to the survival and propagation of numerous wildlife species.

Excessive pumping has put many of the region's groundwater basins in a state of overdraft causing groundwater levels to decrease considerably in many areas and raising significant concern about water quality degradation and land subsidence. There is a need to diversify water portfolio components to reduce pressure on the use of groundwater in addition to promoting water use efficiency and conservation.

Elevated levels of arsenic in the groundwater, degradation from salts in using Colorado River water for recharge and irrigation, and saline intrusion from Salton Sea have all led to water quality issues. Similarly, failing septic systems and a high density of septic tanks and leach fields in some areas have the potential to contaminate the local groundwater basins. Reducing groundwater overdraft and developing and implementing a Salts and Nutrients Management Plan and conversion of septic tanks to sewer system will help alleviate these problems.

Some of the groundwater supplies utilized during the construction and maintenance of the newly built solar plants in the region may have hydrologic connections with the Colorado River and would be new uses. However, Colorado River water supplies are fully apportioned in California; and no additional supplies are available for any new users except through an agreement with an existing 1928 Boulder Canyon Project Act Section 5 contract holder, subject to agreement by the U.S. Bureau of Reclamation.

As mentioned earlier, the region has many DACs scattered over a large area with many falling into the category of SDACs. Tribal lands have their own unique challenges. Lack of adequate water and wastewater infrastructure is prevalent in these communities. Many of them have expressed concerns that their needs are being neglected in favor of the urban areas. Engaging DACs and sustaining their involvement is a necessary first step in providing access and affordability to safe drinking water and wastewater systems for these communities.

Flood Challenges

Although characterized by very low annual precipitation, the region is subject to local thunderstorms that cover smaller areas and result in high-intensity, short duration precipitation. In the late 1970s, severe flood damage occurred to homes and businesses in many cities in the Coachella Valley region and, as a result, flood control infrastructure was constructed in the early 1980s with the help of the U.S. Army Corps of Engineers and local funding. However, many areas still lack flood control facilities and are vulnerable to devastating alluvial fan flash riverine flooding (more discussion of alluvial fan flooding can be found in the Alluvial Fan Task Force report (http://aftf.csusb.edu/). In some areas, the lack of a regional agency with jurisdiction over multiple service areas and a stable funding mechanism has been identified as the largest constraint to solving stormwater and flood problems. The lack of adequate stormwater management and conveyance infrastructure is, however, pervasive throughout the hydrologic region and remains the biggest constraint to economic development of planned urban areas.

Flood management in the Colorado River Hydrologic Region has a unique set of challenges that were identified during meetings with local agencies. These challenges include:

- Flood control in the desert having different challenges than flooding in the rest of the state.
- Inadequate agency alignment.
- Right-of-way restrictions that impact projects and future management options.
- Outdated and undersized infrastructure.
- Inconsistent and unreliable funding.
- Lack of regional perspective, real need for regional planning efforts.
- More clearly designed and articulated roles and responsibilities for agencies.
- Inadequate public and policy maker awareness and education.
- Overly complex permitting that involves too many agencies, takes too long, and is costly.
- Land use conflicts.

Looking to the Future

Future Conditions

Future Scenarios

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

Water Conservation

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

Colorado River Growth Scenarios

Future water demand in the Colorado River Hydrologic Region is affected by a number of growth and land use factors such as population growth, planting decisions by farmers, and size and type of urban landscapes. See Table CR-22 for a conceptual description of the growth scenarios used in the California Water Plan. The Water Plan quantifies several factors that provide a description of future growth and how growth could affect water demand for the urban and agricultural sectors in the Colorado River Hydrologic Region. Growth factors are varied between the scenarios to describe some of the uncertainty faced by water managers. For example, it is impossible to predict future population growth accurately, so the Water Plan uses three different but plausible population growth estimates when determining future urban water demands. In addition, the Water Plan considers up to three alternative views of future development density. Population growth and development density will reflect how large the urban landscape will become in 2050 and are used by the Water Plan to quantify encroachment into agricultural lands by 2050 in the Colorado River Hydrologic Region.

Table CR-22 Conceptual Growth Scenarios

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

For Update 2013, DWR worked with researchers at the University of California, Davis, to quantify how much growth might occur in Colorado River Hydrologic Region through 2050. The UPlan model was used to estimate a year 2050 urban footprint under the scenarios of alternative population growth and development density (see http://ice.ucdavis.edu/project/uplan for information on the UPlan model). UPlan is a simple rule-based urban growth model intended for regional or county-level modeling. The needed space for each land use type is calculated from simple demographics and is assigned based on the net attractiveness of locations to that land use (based on user input), locations unsuitable for any development, and a general plan that determines where specific types of development are permitted. Table CR-23 describes the amount of land devoted to urban use for 2006 and 2050, and the change in the urban footprint under each scenario. As shown in the table, the urban footprint grew by about 80 thousand acres under low-population growth scenario (LOP) by 2050 relative to 2006 base-year footprint of about 310 thousand acres. Urban footprint under high population scenario (HIP), however, grew by about 200 thousand acres. The effect of varying housing density on the urban footprint is also shown.

Table CR-24 describes how future urban growth could affect the land devoted to agriculture in 2050. Irrigated land area is the total agricultural footprint. Irrigated crop area is the cumulative area of agriculture, including multicrop area, where more than one crop is planted and harvested each year. Each of the growth scenarios shows a decline in irrigated acreage over existing conditions, but to varying degrees. As shown in the table, irrigated crop acreage declines by about 10,000 acres by year 2050 as a result of low population growth and urbanization in Colorado River region, while the decline under high population growth was higher by about 35,000 acres.

Colorado River 2050 Water Demands

This section provides a description for how future water demands might change under scenarios organized around themes of growth and climate change described earlier in this chapter. The change in water demand from 2006 to 2050 is estimated for the Colorado River Hydrologic Region for the agriculture and urban sectors under nine growth scenarios and 13 scenarios of future climate change. The climate change scenarios include the 12 Climate Action Team

Table CR-23 Growth Scenarios (Urban) — Colorado River Hydrologic Region

Scenario[a]	2050 Population (thousand)	Population Change (thousand) 2006[b] to 2050	Development Density	2050 Urban Footprint (thousand acres)	Urban Footprint Increase (thousand acres) 2006[c] to 2050
LOP-HID	1,470.8[d]	760.1	High	378.9	72.5
LOP-CTD	1,470.8	760.1	Current Trends	389.8	83.4
LOP-LOD	1,470.8	760.1	Low	402.2	95.8
CTP-HID	1,749.2[e]	1,038.5	High	423.6	117.2
CTP-CTD	1,749.2	1,038.5	Current Trends	441.2	134.8
CTP-LOD	1,749.2	1,038.5	Low	460.9	154.5
HIP-HID	2,246.9[f]	1,536.2	High	480.3	173.9
HIP-CTD	2,246.9	1,536.2	Current Trends	507.1	200.7
HIP-LOD	2,246.9	1,536.2	Low	541.9	235.5

Notes:

[a] See Table CR-22 - Conceptual Growth Scenarios,for scenario definitions.

[b] 2006 population was 710.7 thousand.

[c] 2006 urban footprint was 306.4 thousand acres.

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

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

[f] Values modified by DWR from the Public Policy Institute of California.

scenarios described in Chapter 5, Volume 1 and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a “without climate change” condition.

Figure CR-18 shows the change in water demands for the urban and agricultural sectors under nine growth scenarios, with variation shown across 13 climate scenarios. The nine growth scenarios include three alternative population growth projections and three alternative urban land development densities, as shown in Table CR-22. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050. Urban demand is the sum of indoor and outdoor water demand where indoor demand is assumed not to be affected by climate. Outdoor demand, however, depends on such climate factors as the amount of precipitation falling and the average air temperature.

Urban demand increased under all nine growth scenarios tracking with population growth. On average, it increased by about 35 taf under the three low population scenarios, 175 taf under the three current trend population scenarios and about 320 taf under the three high population scenarios when compared to historical average of about 490 taf. The results show change in future urban water demands are less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

Table CR-24 Growth Scenarios (Agriculture) Colorado River Hydrologic Region

Scenario[a]	2050 Irrigated Land Area[b] (thousand acres)	2050 Irrigated Crop Area[c] (thousand acres)	2050 Multiple Crop Area[d] (thousand acres)	Change in Irrigated Crop Area (thousand acres) 2006 to 2050
LOP-HID	567.9	660.4	92.5	-8.0
LOP-CTD	566.6	658.9	92.3	-9.5
LOP-LOD	565.1	657.2	92.1	-11.1
CTP-HID	558.6	649.5	91.0	-18.8
CTP-CTD	556.4	647.0	90.6	-21.3
CTP-LOD	554.2	644.5	90.3	-23.8
HIP-HID	547.1	636.2	89.1	-32.1
HIP-CTD	543.3	631.8	88.5	-36.5
HIP-LOD	538.8	626.6	87.8	-41.7

Notes:

[a] See Table CR-22 - Conceptual Growth Scenarios, for scenario definitions

[b] 2006 irrigated land area was estimated by the California Department of Water Resources (DWR) to be 589.3 thousand acres.

[c] 2006 Irrigated crop area was estimated by DWR to be 668.3 thousand acres.

[d] 2006 multiple crop area was estimated by DWR to be 79.0 thousand acres.

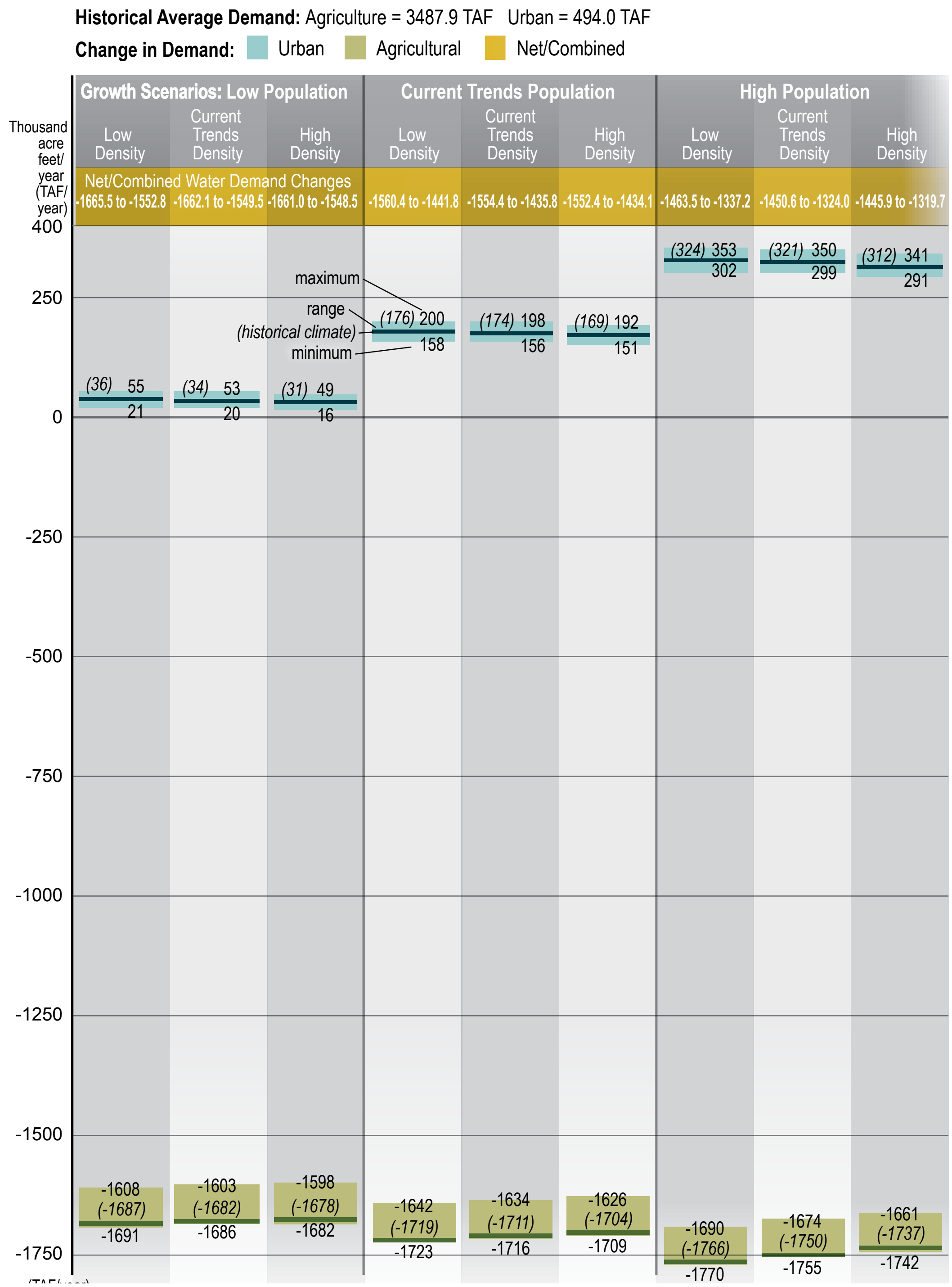
Agricultural water demand decreases under all future scenarios due to reduction in irrigated lands as a result of urbanization and background water conservation when compared with historical average water demand of about 3,490 taf. Under the three low population scenarios, the average reduction in water demand is about 1,650 taf while it is about 1,720 taf for the three high population scenarios. For the three current trend population scenarios, this change was about 1,680 taf. The results show that low density housing would result in more reduction in agricultural demand since more lands are lost under low-density housing than high density housing.

Integrated Regional Water Management Plan Summaries

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

All IRWM plans are different in how they are organized. Therefore, finding and summarizing the content in a consistent way proved difficult. It became clear through these efforts that a process

Figure CR-18 Change in Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050



is needed to allow those with the most knowledge of the IRWM plans, those that were involved in the preparation, to have input on the summary. It is the intention that this process be initiated following release of Update 2013 and will continue to be part of the process of the update process for Update 2018. This process will also allow for continuous updating of the content of the "atlas" (explained below) as new IRWM plans are released or existing IRWM plans are updated.

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

As can be seen in Figure CR-19, there are four regional water management planning groups in the Colorado River Hydrologic Region. A large portion of the Mojave area lies within the South Lahontan Hydrologic Region and is also reported in that regional report.

Region Description

As of late 2013, the RWMGs in the Colorado River Hydrologic Region have received a total of about $93.5 million in funding from both State and non-State sources: $44,254,480 from the State and $49,239,178 from non-state sources. Table CR-25 provides a funding source breakdown for the region. No information was available for Anza Borrego Desert IRWM plan for Update 2013.

The following are short descriptions of the IRWM areas and plans in the Colorado River Hydrologic Region.

Imperial

The Imperial region is located in the southeast corner of Imperial County and falls entirely within SWRCB Region 7. It is generally bounded by the U.S./Mexico border to the south, the crest of the Chocolate Mountains to the east, San Diego County to the west, and Riverside County, the Salton Sea, and the Coachella Valley IRWM plan boundary to the north. Much of the land within the Imperial region is under federal control, which is managed under existing plans prepared pursuant to federal laws.

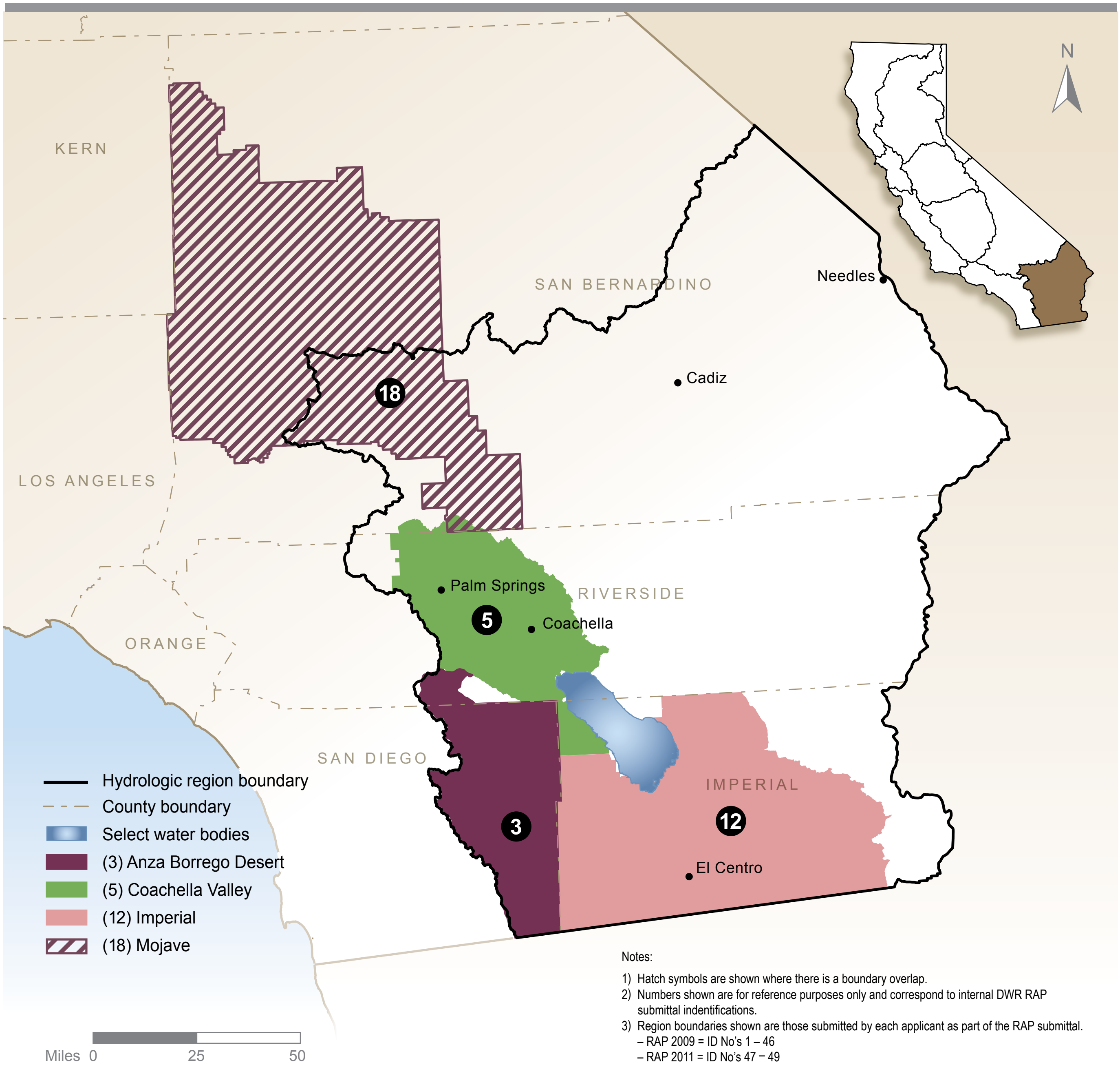
Coachella Valley

Located in central Riverside County, the boundary of the Coachella Valley IRWM region largely follows the Whitewater River watershed. The region is bounded on the north by the Mojave Desert, San Bernardino Mountains, Little San Bernardino Mountains, and Mecca Hills; on the west by the DWA and MSWD jurisdictional boundary; on the east by Mortmar, the Salton Sea, and Travertine Rock; and on the south by the CVWD jurisdictional boundary.

Mojave

The Mojave region lies in the California High Desert, located on the northeastern flanks of the San Bernardino and San Gabriel mountains in Southern California. The Mojave River is the main surface water drainage feature within the region and is fed by rainfall and snowpack from the

Figure CR-19 Regional Water Management Groups in the Colorado Hydrologic Region



San Bernardino Mountains. In addition to the Mojave River, the region also has a number of terminal dry lakes, which are lakebeds that collect water only during periods when there is sufficient runoff, have no outlet, and lose all their water to evaporation. The region is made up of relatively small urban centers with low population densities, including Barstow, Victorville, and Yucca Valley.

Table CR-25 Colorado River Hydrologic Region IRWM Plan Funding

IRWM Region	Prop. 50 Planning Grant	Prop. 50 Implementation Grant	Prop. 84 Planning Grant	Prop. 84 Implementation Grant[a]	Prop. 1E Stormwater Grant	Regional Totals
Imperial			**$1,000,000** $512,500			$1,512,500
Coachella Valley			**$1,000,000** $386,380	**$4,000,000** $2,992,375		$8,378,755
Mojave		**$25,000,000** $23,594,500		**$8,000,000** $16,498,944	**$5,254,480** $5,254,479	$83,602,403
Total		**$25,000,000** $23,594,500	**$2,000,000** $898,880	**$12,000,000** $19,491,319	**$5,254,480** $5,254,479	
Grand Total $93,493,658						

Notes:

This table is up-to-date as of late 2013. Information on the Anza Borrego Desert IRWM plan was not available for Update 2013.

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

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

Key Challenges and Goals

Imperial

The Imperial region faces the following challenges:

- Water supply.
- Water quality.
- Flood protection and stormwater management.
- Environmental protection and enhancement.

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

- **Water supply.** Diversify the regional water supply portfolio to ensure a long-term, verifiable, reliable, and sustainable supply to meet current and future agricultural, municipal, commercial, industrial, and environmental demands.
- **Water quality.** Protect water quality for beneficial uses consistent with regional community interests and the Colorado River RWQCB Basin Plan through cooperation with stakeholders and local and State agencies.
- **Environmental protection and enhancement.** Protect and enhance aquatic ecosystems and wildlife habitat consistent with municipal, commercial, industrial, and agricultural land uses.

- **Flood protection and stormwater management.** Protect life and property from flooding and develop regional and local flood protection and stormwater management strategies.
- **Develop regional policies.** Develop regional policies, in accordance with and respecting the individual agencies' jurisdiction and authorities, by engaging the water and land use agencies and other interested parties in a cooperative, regional approach.

Coachella Valley

Coachella Valley region faces the following challenges:

- Water supply reliability.
- Groundwater levels.
- Imported water supply.
- Local water supply opportunities.
- Groundwater and surface water quality.

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

- Optimize water supply reliability.
- Protect and improve water quality.
- Provide stewardship of our water-related natural resources.
- Coordinate and integrate water resource management.
- Ensure cultural, social, and economic sustainability of water in the valley.

Mojave

Mojave faces the following challenges:

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

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

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

Water Supply and Demand

Imperial

Colorado River supplies the majority of the region's water, with groundwater being too poor to use except for industrial use. The Colorado River entitlement is held by IID; and as a senior water right, is highly reliable and relatively stable compared to more junior water right holders, even during dry or multiple dry years. IID's water rights entitle it to 3.1 maf of Colorado River water per year. Ninety-five percent of the supply goes to agricultural users with the remaining 5 percent distributed to the region's water purveyors. In 2009, municipal water demands were 37,325 af/yr., which the region estimates will increase as population grows in the future.

Coachella Valley

The region's water supply consists of groundwater, imported water from the Colorado River, and surface water from mountain streams, with groundwater being the largest source. The region projects that supply will increase from 670,000 af/yr. in 2010 to 878,620 af/yr. in 2030. Water demand for the region is projected to increase 44 percent from 533,250 af/yr. in 2005 to 816,938 af/yr. in 2030. Over half of demand is attributed to non-potable uses, including agriculture and landscape irrigation. Urban demands are expected to increase at a faster rate than agricultural demands due to projected population growth in the region.

Mojave

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

Water Quality

Imperial

Surface supplies from the Colorado River are generally of good quality, with occasional high salinity and total dissolved solids (TDS) levels. Elevated levels of selenium are found in drain water and are thought to be an imported contaminant from the Colorado River supply. Groundwater within the region is poor, with high concentrations of TDS, sulfates, nitrate, and fluoride. One of the management objectives within the IRWM plan is to improve water quality through salt and nutrient management, urban runoff management, and pollution prevention.

Coachella Valley

Groundwater supply is generally of high quality but is still a concern in isolated areas of the region. In the East Valley, high-TDS water migrates into the Upper aquifer, which then, due to decreasing water levels in the Lower aquifer, migrates into the Lower aquifer. This migration results in a decline in the water quality of the Lower aquifer in the East Valley. Additionally, various naturally occurring contaminants including arsenic, uranium, and fluoride have been found in groundwater. Quality issues with imported supply include TDS, hardness, minerals, the potential presence of Quagga mussels, and salinity of Colorado River water. Local surface water is of good quality, with TDS and nitrate concentrations below MCLs.

Mojave

Surface water quality within the region suffers from a number of constituents including TDS, fluoride, sulfates, and nitrate. Impaired surface water bodies within the region include Crab

Creek, Sheep Creek, and portions of the Mojave River. Surface water, while not used as potable water, is used to recharge groundwater which is then used for drinking water. Groundwater within the region suffers from arsenic, nitrates, iron, and hexavalent chromium. Some of these are naturally occurring, like arsenic; but others, like hexavalent chromium, are associated with human activities.

Flood Management

Imperial

The region recognizes the importance of flood management and has actively been involved in flood management strategies. Imperial County's 2007 Flood Management Plan documents flood history, identifies known flood problem areas, establishes goals, objectives, policies, and implementation programs to reduce flooding and flood-related hazards, and ensures that natural functions of the floodplains are protected. The IRWM plan expands on current flood management within the region through its goal to improve flood management and by promoting projects such as the Holtville Stormwater Master Plan Project, the Holtville Stormwater Conveyance System and Detention Basin Project, and a number of drainage upgrade projects throughout the region.

Coachella Valley

The Coachella Valley region averages around 3 inches of rain a year and is subject to flash flooding. The Riverside County Flood Control and Water Conservation District and the CVWD are the two flood control districts within the region and are responsible for operating and maintaining a series of regional flood control facilities. While there has been a number of flood control projects within the region, there are plans to develop an integrated flood management plan as one of the region's future planning efforts. This plan will integrate flood management planning, promote development of integrated flood management solutions, and present near-term integrated flood management solutions.

Mojave

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

Groundwater Management

Imperial

The region overlies portions of eight groundwater basins including the Imperial Valley Basin and the East and West Salton Sea basins, with a combined groundwater storage estimated at 14 maf. There has been very limited development of groundwater within the region due to low natural recharge, limited yields, and poor water quality found in many places. The IRWM plan states that groundwater storage and banking is a priority for the region. The plan proposes the development of a GWMP for the region. This plan would support groundwater storage and banking projects and help meet State funding requirements.

Coachella Valley

The Coachella Valley Groundwater Basin underlies the region and is its largest source of water supply, with an estimated storage capacity of 39 maf. Groundwater overdraft has caused groundwater levels to decrease more than 60 feet in portions of the East Valley and has raised significant concerns about water quality degradation and land subsidence in this area. Because of these concerns, a number of recharge projects have been implemented, including spreading areas and recharge facilities. Groundwater supply is generally of high quality, but some localized areas have seen elevated nitrate levels.

Mojave

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

Environmental Stewardship

Imperial

The region has a number of existing plans which address the local environment including the Imperial Irrigation District HCP/NCCP Draft and the Temporary Land Conservation Fallowing Program. Within the IRWM plan, the Imperial region has made environmental protection and enhancement a goal, with objectives to identify opportunities for open space, investigate and develop environmental mitigation projects, and mitigate impacts that could result from the reduced flows.

Coachella Valley

Environmental stewardship is promoted in the Coachella Valley IRWM region directly through the goals to provide stewardship of water-related natural resources and to coordinate and integrate water resources management. The region also has a Multiple Species HCP, which aims to protect 240,000 acres of open space and 27 species, ensuring the survival of endangered species and enhancing regional infrastructure without causing environmental conflicts.

Mojave

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

Climate Change

Climate change is already affecting these IRWM regions and will have significant impacts on water and other resources in the future. Changes in timing, amount, and type of precipitation and surface runoff affect the availability of local and imported water supplies. Sensitive habitats, such as the Salton Sea, are already competing for water used by urban populations elsewhere.

Imperial

With declining snowpacks and increasing temperatures, precipitation extremes, and wildfire risks, the Imperial IRWM region is taking action to mitigate and adapt to a changing climate. The USBR has conducted a basin study to define current and future imbalances in water supply and demand from the Colorado River. In addition, priorities for the Imperial Valley IRWM region have been identified and include protecting its sole-source aquifer in the Ocotillo area and managing groundwater through desalination and storage, all of which assist in adapting to climate change.

Coachella Valley

The Coachella Valley IRWM region is susceptible to severe flooding from the Whitewater River. With declining snowpacks and increasing temperatures, precipitation extremes, flooding, and wildfire risks, the region is taking action to mitigate and adapt to a changing climate. The USBR has conducted a basin study to define current and future imbalances in water supply and demand from the Colorado River. In ensuring sufficient and safe water supplies, the Coachella Valley IRWM region is treating arsenic in the water supply of DACs. Furthermore, the region is including integrated flood management and a ground water monitoring strategy in its IRWM plan update, while also convening a climate change workgroup to facilitate a vulnerabilities analysis for addressing additional climate change concerns.

Mojave

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

Tribal Communities

Imperial

No tribes are identified within the region, and no further tribal information is available in the region's IRWM plan.

Coachella Valley

The region includes five Native American reservations (Torres-Martinez Desert Cahuilla, Cabazon Band of Mission, Augustine Band of Cahuilla, Agua Caliente Band of Cahuilla, and Twenty-Nine Palms Band of Mission), and two tribal lands (Santa Rosa and Morongo). The region created an Issue Group focused on Native American tribes' special needs including cultural water uses. Tribal leaders and the U.S. Bureau of Indian Affairs staff attended several meetings throughout the IRWM plan process.

Mojave

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

Disadvantaged Communities

Imperial

Currently 18 out of the 19 county subdivisions in the region contain DACs, 10 of which are classified as severely disadvantaged (less than 60 percent of the statewide median household income). A DACs needs analysis was conducted early in the IRWM planning process to identify DACs for inclusion. The region compiled a DAC Needs Analysis Report based on interviews with DACs. The report describes the current state of each of the systems (stormwater, wastewater, and potable water systems), system notes, system issues/concerns, and list of priority projects that have a specific focus on DACs.

Coachella Valley

Using the 2006-2008 American Community Survey data, six cities in Coachella Valley qualify as DACs: Cathedral City, Coachella, Desert Hot Springs, Indio, Palm Desert, and Palm Springs. An additional eight unincorporated communities were identified as DACs using data from the 2010 Nielsen Update Demographics: Desert Edge, North Shore, Mecca, Sky Valley, Thermal, Thousand Palms, and Vista Santa Rosa. As part of the IRWM planning process, the region included representatives from two different Issues Groups to consider and scope the final issues, goals, and objectives of the IRWM plan. One of the Issues Groups was identified as DACs.

Mojave

The inclusion and participation of DACs is considered essential to the Mojave IRWM plan process, as more than half of the region qualifies as disadvantaged. The DACs identified in the region include Adelanto; Barstow; Daggett; El Mirage; Hinkley; Johnson Valley; Joshua Tree;

Kramer Junction; Landers; Lenwood; Lucerne Valley; Newberry Springs; Oro Grande; Pinon Hills; Pioneertown; Yermo; Yucca Valley; and portions of Apple Valley, Hesperia, Phelan, and Victorville. Numerous efforts have been conducted to identify needs of, seek input from, and communicate with DACs in the region. The region held three DAC-specific public meetings in different locations as part of the IRWM plan update process. The region also outreached to DACs through informational invitations mailed and e-mailed to individuals and water agencies servicing known DACs.

Governance

Imperial

There are three groups which comprise the RWMG for the Imperial region: Imperial Irrigation District, Imperial County, and Imperial-region Cities. Cities included are Brawley, El Centro, Imperial, Westmorland, Calipatria, Niland, Seeley, Heber, Calexico, NAF El Centro, and Holtville. Through a charter, the RWMG is responsible for overseeing the development and implementation of the IRWM plan. Several groups such as the Water Forum, Project Work Groups, Demand Management Work Group, and other ad hoc work groups were formed to assist the RWMG during the process.

Coachella Valley

The Coachella Valley IRWM program is led by the Coachella Valley RWMG, which is composed of five Coachella Valley water purveyors: Coachella Valley Authority, Coachella Valley Water District, Desert Water Agency, Indio Water Authority (IWA), and MSWD. The group was formed in September 2008 through the adoption of an MOU signed by all five water purveyors that established procedures for collaboration and development of an IRWM plan.

Mojave

The Mojave RWMG was formed through an MOU between the Mojave Water Agency, the Victor Valley Wastewater Reclamation Authority, the Mojave Water Agency Technical Advisory Committee, the Mojave Desert Resource Conservation District, and the Morongo Basin Pipeline Commission. The RWMG is responsible for the development of the region’s IRWM plan. The coordinating committee, consisting of one staff member and an alternate from each of the RWMG agencies, is tasked with overseeing the plan through its adoption, including reviewing drafts of the plan.

Resource Management Strategies

Volume 3, *Resource Management Strategies*, contains detailed information on the various resource management strategies that can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in the available IRWM plans for the Colorado River Hydrologic Region is summarized in Table CR-26.

Conjunctive Management and Groundwater Storage

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

A DWR/ACWA survey was undertaken in 2011 and 2012 to inventory and assess conjunctive management projects in California. Box CR-2 is a summary of the inventory effort.

Of the 89 agencies or programs identified as operating a conjunctive management or groundwater recharge program in California, two programs are located in the Colorado River Hydrologic Region. The management agencies identified reported some of the details of their conjunctive management programs, as furnished below.

The first program consists of a direct groundwater percolation program started in 1991 with Mojave Water Agency identified as the lead agency and the administrator/operator of the project. The goal of the program is to address the groundwater overdraft problem in the Warren Valley Groundwater Basin. Annual recharge and extraction amounts vary from year to year. Current recharge and extraction capacity is estimated at 50,000 af/yr., while the cumulative recharge volume is estimated at 390,000 af. Efforts are under way to increase program capacity. The SWP was identified as the source of surface water for the program. Current operating cost for the program is estimated at $900,000 per year. Project cost was identified as the most significant constraint for the program. Limited aquifer storage was determined to be a moderate constraint, while other constraints include political, legal, institutional, and water quality issues.

The second program also consists of a direct groundwater percolation program started in 1973 with the Coachella Valley Water District as the lead agency and the administrator/operator of the project. The project location is in the Indo subbasin of the Coachella Valley Groundwater Basin. Current recharge capacity is up to 300,000 af/yr., while the cumulative recharge volume is estimated at 2.4 maf at the end of 2010. Colorado River and the SWP were identified as the sources of recharge water for the program. Operating cost was identified as the most significant constraint for the program, as the annual operating cost of the program was reported to be $9 million per year. Limited aquifer storage was reported to be a moderate constraint, while other constraints include political, legal, institutional, and water quality issues.

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

Climate Change

For over two decades, the State and federal governments have been preparing for climate change effects on natural and built systems with a strong emphasis on water supply. Climate change is already affecting many resource sectors in California, including public health, water, agriculture, biodiversity, and transportation and energy infrastructure (U.S. Global Change Research

Table CR-26 Resource Management Strategies Addressed in IRWM Plans in the Colorado River Hydrologic Region

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

Note: Information from the Anza Borrego Desert IRWM plan was not available for Update 2013.

Box CR-2 Statewide Conjunctive Management Inventory Effort in California

The effort to inventory and assess conjunctive management projects in California was conducted through literature research, personal communication, and documented summary of the conjunctive management projects. The information obtained was validated through a joint California Department of Water Resources/Association of California Water Agencies (DWR/ACWA) survey undertaken in 2011-2012. The survey requested the following conjunctive use program information:

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

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

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

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

Program 2009; California Natural Resources Agency 2009). Climate model simulations, based on the Intergovernmental Panel on Climate Change's 21st century scenarios, project increasing temperatures in California, with greater increases in the summer (Intergovernmental Panel on Climate Change 2013). Projected changes in annual precipitation patterns in California will result in changes to surface runoff timing, volume, and type (Cayan et al. 2008). Recently developed computer downscaling techniques (model simulations that refine computer projections to a scale smaller than global models) indicate that California flood risks from warm-wet, atmospheric river-type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011).

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

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

Observations

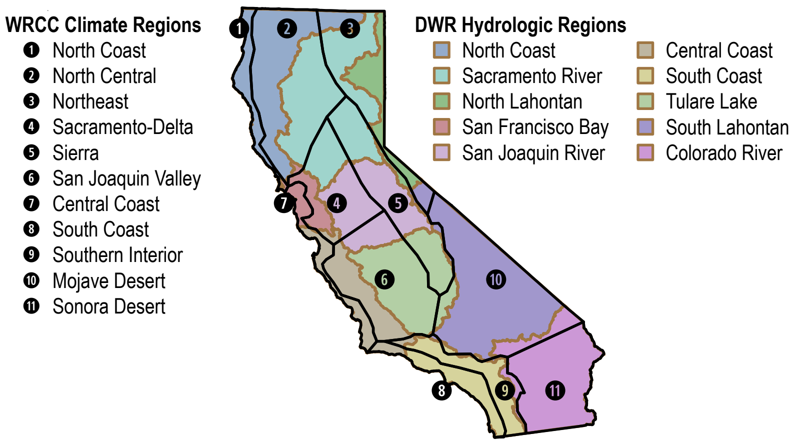
The region's observed temperature and precipitation vary greatly owing to complex topography, geography, and relation to the Pacific Ocean. Regionally specific air temperature trends for the past century are available from the Western Regional Climate Center (Western Regional Climate Change 2013). The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

Statewide, California's temperature already has risen by 1 °F (0.6 °C), mostly at night and during the winter, with higher elevations experiencing the highest increase (California Department of Water Resources 2008). Locally in the Colorado River Hydrologic Region within the WRCC Sonoran Desert climate region, mean temperatures have increased by about 1.0 to 2.1 °F (0.5 to 1.1 °C) in the past century, with minimum and maximum temperatures increasing by about 1.7 to 2.7 °F (0.9 to 1.5 °C) and by 0.2 to 1.5 °F (0.1 to 0.8 °C), respectively (Western Regional Climate Center 2013). Within the WRCC Mojave Desert climate region, mean temperatures have increased by about 1.3 to 2.5 °F (0.7 to 1.4 °C) in the past century, with minimum and maximum temperatures increasing by about 1.6 to 2.7 °F (0.9 to 1.5 °C) and by 1.0 to 2.4 °F (0.6 to 1.3 °C), respectively (Western Regional Climate Center 2013).

The Colorado River region also is experiencing impacts from climate change through changes in precipitation patterns, surface runoff volumes and timing, and streamflow timing, which in turn affect availability of local and imported water supplies. During the last century, the average early snowpack in the Sierra Nevada, which is an important source of water for parts of the Colorado River region through the SWP, decreased by about 10 percent, which equates to a loss of 1.5 maf of snowpack storage (California Department of Water Resources 2008).

Water supplies coming from the Colorado River Basin outside California are also decreasing (California Natural Resources Agency 2009). Similar climate effects, although much more variable, are occurring in the Rocky Mountains snowpack that supplies the Colorado River, another important source of water for the Colorado River region (Christensen et al. 2004; Mote et al. 2005; Williamson et al. 2008; Guido 2008). Even though variability exists in the snowpack levels of the Rocky Mountains and spatial patterns of trends are not consistent, streamflows in the Colorado River appear to be peaking earlier in the year (Stewart et al. 2005; Garfin 2005); and the average water yield of the Colorado River could be reduced by 10 to 20 percent as a result of climate change (U.S. Bureau of Reclamation 2011).

Figure CR-20 DWR Hydrologic and Western Region Climate Center Climate Regions



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

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

Projections and Impacts

While historical data are directly observed indicators of how the climate is changing, they cannot by themselves project what future conditions may be like under different GHG emissions scenarios. Current climate science uses computer modeling to simulate and develop future climate projections. A recent study by the Scripps Institution of Oceanography uses the most sophisticated methodology to date and indicates that between 2060 and 2069, temperatures are projected to be 3.4 to 4.9 °F (1.9 to 2.7 °C) higher across the state than they were between 1985 and 1994 (Pierce et al. 2012). Between 2060 and 2069, annual mean temperature would increase by 4.7 °F (2.6 °C) for the WRCC Sonoran Desert climate region, with increases of 3.6 °F (2.0 °C) during the winter months and 5.4 °F (3.0 °C) during summer. The WRCC Mojave Desert climate region has similar projections with annual mean temperatures increasing by 4.9 °F (2.7 °C), winter temperatures increasing by 3.6 °F (2.0 °C), and summer temperatures increasing by 5.9 °F (3.3 °C). Climate projections from Cal-Adapt indicate that the mean temperatures between 1990 and 2100 are projected to increase about 5 to 8 °F (2.8 to 4.4 °C) during winter and up to 6 to 9 °F (3.3 to 5.0 °C) during summer (California Emergency Management Agency and California Natural Resources Agency 2012b).

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

Although annual precipitation will vary by area, reduced snow and precipitation in the Sierra Nevada range and the Colorado River basin would affect the imported water supply for the Colorado River region and could cause potential overdrafting of the region's groundwater basins. Of California's 10 hydrologic regions, the Colorado River region has the lowest annual precipitation (California Department of Water Resources 2009). Projections for the Colorado River region indicate that the annual rainfall would decrease in the more urbanized areas, with the southern Imperial County getting about 0.5 inch (1.3 cm) of less rain and the more eastern desert areas seeing little change (California Emergency Management Agency and California Natural Resources Agency 2012b).

On the other hand, extremes in California's precipitation are projected to increase with climate change. Recent computer downscaling techniques (model simulations that refine computer projections to a scale smaller than global models) indicate that California flood risks from warm-wet, atmospheric river-type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011). Increased winter runoff could result in increased flood hazards. Higher flow volumes could scour stream and flood control channels, degrading habitats already affected by shifts in climate and placing additional stress on special-status species. The lower deserts of the Colorado River region are susceptible to flooding, which is a concern in the Borrego and Coachella valleys. The Whitewater River has caused severe flooding back in 1965, 1969, and 1976 (California Department of Water Resources 2009). The occasional summer monsoonal thunderstorms that the lower deserts experience could increase in frequency and intensity and result in flash floods and debris flows, especially in areas with alluvial fans.

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

Water supplies within California are already stressed because of current demand and expected population growth. Even though the Colorado River region represents about 2 percent of the state's population, it grew by 18 percent between 2000 and 2005 (California Department of Water Resources 2009). The uncertainty regarding the extent of these environmental changes may reduce the ability of local agencies to meet the water demand for the Colorado River region, if these agencies are not adequately prepared.

Changes in climate and runoff patterns may create competition among sectors that utilize water. The agricultural water demand and demand for landscape irrigation within the region could increase as a result of higher evapotranspiration rates caused by increased temperatures and potentially longer growing seasons. Prolonged drought and decreased water quality could further diminish the viability of intermittent streams characteristic of this region and the Salton Sea, the state's largest lake. The Salton Sea is a critical stop for migratory birds on the Pacific and Central flyways. As the lake's level declines and sediments currently underwater get exposed, birds and fish would be impacted, and increased amounts of windborne dust could affect human health in the Coachella and Imperial valleys, as well as in Mexico (U.S. Geological Survey 2007; Pitzer 2013).

Environmental water supplies would need to be retained for managing flows in habitats for aquatic and migratory species throughout the dry season not only for the Salton Sea, but also for the region's imported water. Currently, Delta pumping restrictions are in place to protect endangered aquatic species. Climate change is likely to further constrain the management of these endangered species and the state's ability to provide water for other uses. Although the Colorado River region imports a relatively small amount of water from the SWP, climate change impacts that affect the Delta could further reduce supplies available for import through the SWP during the non-winter months. SWP operators already must balance between preventing winter floods with maintaining water storage for summer dry periods, a balance that could be disrupted by earlier runoff (Cayan et al. 2008; Hayhoe et al. 2004). The USBR Lower Colorado Region, which serves as the watermaster for the lower Colorado River, must also balance water supply with demand, including water-dependent ecological systems and habitats, hydroelectric generation, water quality, and recreation (U.S. Bureau of Reclamation 2011). USBR's Colorado River Basin Study confirms a range of potential future imbalances between water supply and water demand, as well as a need for an approach that applies a multitude of options at all levels to address such imbalances (U.S. Bureau of Reclamation 2012).

Besides earlier runoff, reservoir managers and operators of SWP and Colorado River Aqueduct (CRA) also are challenges by other factors. With increasing temperatures, net evaporation from reservoirs is projected to increase by 15 to 37 percent (Medellin-Azuara et al. 2009; California Natural Resources Agency 2009). In addition, prolonged drought events are likely to continue and further affect the availability of local and imported surface water and contribute to the depletion of groundwater supplies. The Colorado River Basin is a critical source of water for the Colorado River region. Although the existing storage capacity for the Colorado River has provided the ability to meet water demands during sustained droughts, droughts of greater severity have occurred and will likely occur again in the future (U.S. Bureau of Reclamation 2011). According to the USBR, droughts lasting 5 or more years are projected to occur 50 percent of the time over the next 50 years (U.S. Bureau of Reclamation 2012).

Higher temperatures and decreased moisture during the summer and fall seasons, particularly in the mountain reaches of the lowland desert area, would increase vulnerability to wildfire hazards in the Colorado River region and affect local watersheds, though the extent to which climate change will alter existing risk to wildfires is variable (Westerling and Bryant 2006). Little change is projected for most of the region, except for the Mecca San Gorgonio and San Jacinto Mountains, which would likely have one and half to two times more wildfires (California Emergency Management Agency and California Natural Resources Agency 2012b). However, early snowmelt and drier conditions have been correlated with an increase in the size and intensity of these fires (Westerling 2012).

Furthermore, wildfires can contribute to debris flow flooding in vulnerable communities in the foothills of the Colorado River region. Past events have shown flooding to be a real concern after fires occur. The community of Borrego Springs was flooded in 2003 by stormwater runoff flowing from the Ranchita area that had earlier been scorched by fire (California Department of Water Resources 2009). The highly unpredictable nature of alluvial fans within a region can create flooding situations dependent on rain, vegetation, and wildfires (Stuart 2012).

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

Even though this study focused on the western side of Sierra Nevada, these scenarios could potentially be indicative of other regional settings already experiencing flooding risks. Therefore, it is essential for local agencies to take action and be ready to adapt to climate change to protect the well-being of local communities.

Adaptation

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

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

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

Adaptation strategies to consider for managing water in a changing climate include developing coordinated plans for mitigating future flood, landslide, and related impacts, implementing activities to minimize and avoid development in flood hazard areas, restoring existing flood control and riparian and stream corridors, implementing tiered pricing to reduce water consumption and demand, increasing regional natural water storage systems, and encouraging low-impact development to reduce stormwater flows, and promoting economic diversity and supporting alternative irrigation techniques within the agriculture industry. To further safeguard water supplies, other promising strategies include adopting more water-efficient cropping systems, investing in water saving technologies, and developing conjunctive use strategies. In addition, tracking forest health in the mountain areas and reducing accumulated fuel load would provide a more resilient watershed ecosystem that can mitigate for floods and droughts (California Department of Water Resources 2008; Hanak and Lund 2011; California Emergency Management Agency and California Natural Resources Agency 2012c; Jackson et al. 2012.).

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

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

Already, RWMGs in the Colorado River region are taking action. The Mojave RWMG is implementing projects that assist in adapting to climate change such as water conservation and groundwater recharge in the Joshua Basin. The Coachella Valley RWMG is integrating flood management and including a groundwater monitoring strategy into its IRWM plan update and has received funds to treat arsenic in the water supply of DACs. Priorities for the Imperial Valley RWMG include protecting its sole-source aquifer in the Ocotillo area and managing groundwater to include desalination and storage.

Additional work is under way to better understand impacts of climate change and other stressors on water supply and demand for the Colorado River region. USBR has completed a basin study to define current and future imbalances in water supply and demand in the Colorado River Basin and the adjacent areas of the Basin States, including California, that receive Colorado River water (U.S. Bureau of Reclamation 2011, 2012). Through this study, USBR developed and analyzed adaptation and mitigation strategies to resolve those imbalances. Future actions must occur to implement these solutions; therefore, USBR is coordinating with the Basin States, tribes, conservation organizations, and other stakeholders (U.S. Bureau of Reclamation 2012).

DWR is assisting the Anza-Borrego RWMG by documenting the past, present, and range of foreseeable future conditions within the local groundwater basins of the Borrego Valley and summarizing the information in an Anza-Borrego Desert Region Summary report. In 2012, USBR completed its study of the Colorado region to access the effects of prolonged drought, population growth, and climate change; and develop adaptation strategies for the region to handle future water supply and water quality demands. The USBR collaborated with the Borrego Water District and other local agencies on the study.

The Salton Sea Species Conservation Habitat Project completed a draft EIS/EIR that discussed climate change impacts and provided an analysis of GHG emissions (U.S. Army Corps of Engineers and California Natural Resources Agency 2011), and the cities of Palm Desert and Palm Springs have conducted GHG emissions inventories and adopted GHG targets (DeShazo and Matute 2012). According to the Luskin Center for Innovation report, roughly one-third of Southern California cities have taken steps toward reducing GHG emissions (DeShazo and Matute 2012), but more work needs to be done, not only in mitigating for but also in adapting to climate change.

The Imperial Valley RWMG recognizes the disconnect between land use planning and water supply within its area and has brought land use representatives from Imperial County, local cities, and unincorporated towns into its IRWM membership in updating its IRWM plan and prioritizing its projects. A mitigation policy for cumulative impact of development within the region is one of the priorities for the Imperial Valley RWMG. Another example of integrating across sectors is a tool developed by the California State University at San Bernardino – Water Resources Institute in partnership with DWR. This tool is a Web-based portal for land use planning in alluvial fans and uses an integrated approach in assessing hazards and resources (California State University, San Bernardino 2012; Lien-Longville 2012).

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

- *Safeguarding California: Reducing Climate Risk* (http://resources.ca.gov/climate_adaptation/docs/Safeguarding_California_Public_Draft_Dec-10.pdf), which identifies a variety of strategies across multiple sectors (other resources can be found at http://www.climatechange.ca.gov/adaptation/strategy/index.html).
- *California Adaptation Planning Guide* (http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html) developed into four complementary documents by the California Emergency Management Agency and the California Natural Resources Agency to assist local agencies in climate change adaptation planning.

- Cal-Adapt (http://cal-adapt.org/), an online tool designed to provide access to data and information produced by California's scientific and research community.
- Urban Forest Management Plan Toolkit (http://www.ufmptoolkit.com/), sponsored by the California Department of Forestry and Fire Management to help local communities manage urban forests to deliver multiple benefits, such as cleaner water, energy conservation, and reduced heat-island effects.
- California Climate Change Portal (http://www.climatechange.ca.gov/).
- DWR Climate Change Web site (http://www.water.ca.gov/climatechange/resources.cfm).
- The Governor's Office of Planning and Research Web site (http://www.opr.ca.gov/m_climatechange.php).

There are several resource management strategies found in Volume 3 of Update 2013 that not only assist in meeting water management objectives but also provide benefits for adapting to climate change, including the following:

- Chapter 2, "Agricultural Water Use Efficiency."
- Chapter 3, "Urban Water Use Efficiency."
- Chapter 4, "Flood Management."
- Chapter 8, "Water Transfers."
- Chapter 9, "Conjunctive Management and Groundwater."
- Chapter 10, Desalination — Brackish and Sea Water."
- Chapter 12, "Recycled Municipal Water."
- Chapter 14, "Surface Storage — Regional/Local."
- Chapter 15, "Drinking Water Treatment and Distribution."
- Chapter 16, "Groundwater/Aquifer Remediation."
- Chapter 18, "Pollution Prevention."
- Chapter 19, "Salt and Salinity Management."
- Chapter 21, "Agricultural Land Stewardship."
- Chapter 22, "Ecosystem Restoration."
- Chapter 23, "Forest Management."
- Chapter 24, "Land Use Planning and Management."
- Chapter 25, "Recharge Area Protection."
- Chapter 27, "Watershed Management."
- Chapter 28, "Economic Incentives — Loans, Grants, and Water Pricing."

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

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

Type of Water	Energy Intensity (= 1-250 kWh/AF = 251-500 kWh/AF)	Percent of Regional Water Supply*
Colorado (Project)	<250 kWh/AF	79%
Federal (Project)	*This type of water not available*	0%
State (Project)		1%
Local (Project)	<250 kWh/AF	<1%
Local Imports	*This type of water not available*	0%
Groundwater		9%

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

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

Water managers and others will need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystem services important for human society, such as flood management, carbon sequestration, pollution remediation, and recreation. Land use decisions are central components in preparing for and minimizing the impacts from climate change (California Natural Resources Agency 2009). Increased cross-sector collaboration among water managers, land use planners and ecosystem managers provides opportunities for identifying common goals and actions needed to achieve resilience to climate change and other stressors.

Mitigation

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

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

Box CR-3 Energy Intensity

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

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

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

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

Accounting for Hydroelectric Energy

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

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

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

This methodology does not account for several unique benefits that hydroelectric generating facilities at reservoirs provide, including grid stabilization, back up for intermittent renewable energy sources, and large amounts of GHG free energy.

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

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

References

References Cited

Abatzoglou JT, Redmond KT, Edwards LM. 2009. "Classification of Regional Climate Variability in the State of California." Journal of Applied Meteorology and Climatology, 48, 1527-1541.

Alluvial Fan Task Force. 2010. *Findings and Recommendations Report*. Sacramento (CA): Alluvial Fan Task Force. In partnership between: California Department of Water Resources and Water Resources Institute. 84 pp. Viewed online at: http://aftf.csusb.edu/documents/FINDINGS_Final_Oct2010_10-29-10_web.pdf

California Air Resources Board. 2008. *AB32 Climate Change Scoping Plan*. Sacramento (CA): California Air Resources Board. California Environmental Protection Agency. 152 pp. Viewed online at: http://www.arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm.

———. 2013. *Climate Change Scoping Plan: First Update (Public Draft)*. Sacramento (CA): Air Resources Board. 123 pp. Viewed online at: http://www.arb.ca.gov/cc/scopingplan/2013_update/discussion_draft.pdf.

California Department of Water Resources. 1980. *Ground Water Basins in California: Bulletin 118-80.* Sacramento (CA): California Department of Water Resources. California Natural Resources Agency. 85 pp. Viewed online at: http://www.water.ca.gov/pubs/groundwater/bulletin_118/ground_water_basins_in_california__bulletin_118-80_/b118_80_ground_water_ocr.pdf.

———. 2003. *California's Groundwater - Bulletin 118, Update 2003*. Sacramento (CA): California Department of Water Resources. California Natural Resources Agency. 265 pp. Viewed online at: http://www.water.ca.gov/groundwater/bulletin118/bulletin118update2003.cfm.

———. 2008. *Managing an Uncertain Future*. Sacramento (CA): California Department of Water Resources. California Natural Resources Agency. 34 pp. Viewed online at: http://www.water.ca.gov/climatechange/docs/ClimateChangeWhitePaper.pdf.

———. 2009. *California Water Plan Update 2009: Colorado River Regional Report.* Sacramento (CA): California Department of Water Resources. California Natural Resources Agency. 58 pp. Viewed online at: http://www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v3_coloradoriver_cwp2009.pdf.

———. 2010. *Proposition 84 & Proposition 1E Integrated Regional Water Management Guidelines.* Sacramento (CA): California Department of Water Recourses. Viewed online at: http://www.water.ca.gov/irwm/grants/guidelines.cfm.

———. 2012. *Proposition 84 & Proposition 1E Integrated Regional Water Management Guidelines.* Sacramento (CA): California Department of Water Resources. California Natural Resources Agency. 88 pp. Viewed online at: http://www.water.ca.gov/irwm/grants/docs/Guidelines/GL_2012_FINAL.pdf.

———. 2013. "Municipal Wastewater Recycling Survey: Results." [Web site]. Sacramento (CA): California Department of Water Resources. California Natural Resources Agency. Viewed online at: http://www.waterboards.ca.gov/water_issues/programs/grants_loans/water_recycling/munirec.shtml.

California Department of Water Resources and the U.S. Army Corps of Engineers. 2013a. *California's Flood Future: Recommendations for Managing the State's Flood Risk*. Final. Attachment C: History of Flood Management in California. Sacramento (CA): California Department of Water Resources and the U.S. Army Corps of Engineers. Viewed online at: http://www.water.ca.gov/sfmp/flood-future-report.cfm.

———. 2013b. *California's Flood Future: Recommendations for Managing the State's Flood Risk.* Final. Attachment E: Existing Conditions of Flood Management (Information in Gathering Findings). Sacramento (CA): California Department of Water Resources and the U.S. Army Corps of Engineers. Viewed online at: http://www.water.ca.gov/sfmp/flood-future-report.cfm.

———. 2013c. *California's Flood Future: Recommendations for Managing the State's Flood Risk.* Final. Nov 2013. Technical Attachment G: Risk Information Inventory. Sacramento (CA): California Department of Water Resources and the U.S. Army Corps of Engineers. Viewed online at: http://www.water.ca.gov/sfmp/resources.cfm#floodreport.

California Emergency Management Agency and California Natural Resources Agency. 2012a. *Adaptation Planning Guide for Local Governments. Sacramento (CA): California Emergency Management Agency/California Natural Resources Agency. 60 pp. Vi*ewed online at: http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html.

———. 2012b. *California Adaptation Planning Guide: Understanding Regional Characteristics*. Sacramento (CA): California Emergency Management Agency and California Natural Resources Agency. 114 pp. Viewed online at: http://resources.ca.gov/climate_adaptation/docs/APG_Understanding_Regional_Characteristics.pdf.

———. 2012c. *California Adaptation Planning Guide: Identifying Adaptation Strategies*. Sacramento (CA): California Emergency Management Agency and California Natural Resources Agency. 68 pp. Viewed online at: http://resources.ca.gov/climate_adaptation/docs/APG_Identifying_Adaptation_Strategies.pdf.

California Energy Commission. 2005. *Integrated Energy Policy Report*. Sacramento (CA): California Energy Commission. 208 pp. Viewed online at: http://www.energy.ca.gov/2005publications/CEC-100-2005-007/CEC-100-2005-007-CMF.PDF.

———. 2013. *Integrated Energy Policy Report.* Sacramento (CA): California Energy Commission. 322 pp. Viewed online at: http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-LCF.pdf.

California-Mexico Border Relations Council. 2011. *Strategic Plan: New River Improvement Project.* Sacramento (CA): California-Mexico Border Relations Council. Prepared by: New River Improvement Project Technical Advisory Committee. 98 pp. Viewed online at: http://www.calepa.ca.gov/Border/CMBRC/2011/StrategicPlan.pdf.

California Natural Resources Agency. 2009. *California Climate Adaptation Strategy*. Sacramento (CA): California Natural Resources Agency. 200 pp. Viewed online at: http://resources.ca.gov/climate_adaptation/docs/Statewide_Adaptation_Strategy.pdf.

California Public Utilities Commission. 2010. *Embedded Energy in Water Studies, Studies 1, 2, and 3*. Sacramento (CA): California Public Utilities Commission. Prepared by GEI Consultants and Navigant Consulting, Inc. Viewed online at: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/Embedded+Energy+in+Water+Studies1_and_2.htm.

California State University, San Bernardino. 2012. "Water Resources Institute." [Web site]. San Bernardino (CA): California State University, San Bernardino. Viewed online at: http://wri.csusb.edu/wriProjects/.

California Urban Water Conservation Council. 2011. *Memorandum of Understanding Regarding Urban Water Conservation in California.* Sacramento (CA): California Urban Water Conversation Council. 83 pp. Viewed online at: http://www.cuwcc.org/WorkArea/showcontent.aspx?id=18274.

Cayan DR, Maurer EP, Dettinger MD, Tyree M, and Hayhoe K. 2008. "Climate Change Scenarios for the California Region." Climatic Change. 87: 21-42 pp. [Journal.] Viewed online at: http://tenaya.ucsd.edu/~dettinge/cccc08_scenarios.pdf.

Christensen NS, Wood AW, Voisin N, Letternmaier DP, and Palmer RN. 2004. "The Effects of Climate Change on the Hydrology and Water Resources of the Colorado River Basin." Climatic Change, Volume 62: 337 – 363 pp.

Coachella Valley Water District. 2010. *Coachella Valley Water Management Plan 2010, Update*. Coachella (CA): Coachella Valley Water District. Prepared by MWH. 286 pp. Viewed online at: http://www.cvwd.org/news/publicinfo/2013_10_01_CoachellaValleyWaterManagementPlanFinalReport.pdf.

Das T, Dettinger MD, Cayan DR, and Hidalgo HG. 2011. "Potential Increase in Floods in California's Sierra Nevada Under Future Climate Projections." California Energy Commission. 51 pp. Viewed online at: http://tenaya.ucsd.edu/~tdas/data/publications/submitted/das_et_al_2010/floods_California_Tapash_Das_etal_2010_merged.pdf.

DeShazo JR and Matute J. 2012. Progress Report: Climate Action Planning in Southern California. Los Angeles (CA): Luskin Center for Innovation, Luskin School of Public Affairs, University of California – Los Angeles. 12 pp. Viewed online at: http://innovation.luskin.ucla.edu/content/climate-action-planning-progress-report-southern-california.

Dettinger M. 2011. "Climate Change, Atmospheric Rivers, and Floods in California - A Multimodal Analysis of Storm Frequency and Magnitude Changes." Journal of the American Water Resources Association. 47: 514-523 pp. [Journal.] Viewed online at: http://tenaya.ucsd.edu/~dettinge/md_jawra2011.pdf.

eGrid. 2012. *Version 1.0 Year 2009 GHG Annual Output Emission Rates*. Washington (DC): United States Environmental Protection Agency. 1 pp. Viewed online at: http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2012V1_0_year09_GHGOutputrates.pdf.

Garfin G. 2005. "Climate Change in the Colorado River Basin." In: *Colorado River Basin Climate: Paleo, Present, Future*. Special Publication for Association of California Water Agencies and Colorado River Water Users Association Conferences. 36-44 pp. Viewed online at: http://www.climas.arizona.edu/files/climas/pubs/colorado-river-basin-climate-2005.pdf.

Grafin G, Jardine A, Merideth R, Black M, LeRoy S. 2013. *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment.* Washington (DC): Island Press. 531 pp. Viewed online at: http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf.

Guido Z. 2008. "Mountain Snowpack in the West and Southwest." [Web site]. Southwest Climate Change Network. Phoenix (AZ): The University of Arizona. Viewed online at: http://www.southwestclimatechange.org/impacts/water/snowpack.

Hanak E, Lund, JR. 2011. "Adapting California's Water Management to Climate Change." Climatic Change Vol. 111(1): 17-44 pp. Viewed online at: http://www.waterlawsymposium.com/sites/default/files/Hanak&Lund_climatic_change.pdf.

Hayhoe K, Cayan D, Field CB, Frumhoff PC, Maurer EP, et al. 2004. "Emissions Pathways, Climate Change, and Impacts on California." Proceedings of the National Academy of Science Vol. 101(34): 12422-12427. Viewed online at: http://www.pnas.org/content/101/34/12422.abstract.

Ikehara ME, Predmore SK, and Swope DJ. 1997. *Geodetic Network to Evaluate Historical Elevation Changes and to Monitor Land Subsidence in Lower Coachella Valley, California, 1996.* Denver (CO): U.S. Geological Survey. Viewed online at: http://pubs.er.usgs.gov/publication/wri974237.

Imperial Irrigation District. 2007. *Efficiency Conservation Definitive Plan*. Imperial (CA): Imperial Irrigation District. 53 pp. Viewed online at: http://www.iid.com/Modules/ShowDocument.aspx?documentid=805.

Intergovernmental Panel on Climate Change. 2013. *Climate Change 2013: The Physical Science Basis.* Geneva (SW): 2216 pp. Viewed online at: http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_All.pdf.

Jackson L, Haden VR, Wheeler SM, Hollander AD, Perman J, O'Green T, Mehta VK, Clark V, Williams J, and Trupp A. 2012. Vulnerability and Adaptation to Climate Change in California Agriculture. Sacramento (CA): California Energy Commission. 113 pp. Viewed online at: http://www.energy.ca.gov/2012publications/CEC-500-2012-031/CEC-500-2012-031.pdf.

Lien Longville S. 2012. "Reducing Impacts of Climate Change, Extreme Weather, and Southern California Floods: Case Study in Implementation of the Integrated Approach for Sustainable Development on Alluvial Fans." [Presentation]. Los Angeles County (CA).

Medellin-Azuara J, Connell CR, Madani K, Lund JR, Howitt RE. 2009. *Water Management Adaptation with Climate Change*. Sacramento (CA): California Energy Commission. California Climate Change Center. 34 pp. Viewed online at: http://www.energy.ca.gov/2009publications/CEC-500-2009-049/CEC-500-2009-049-F.PDF.

Milly PCD, Betancourt J, Falkenmark M, Hirish RM, Kundzewicz ZW, Letternmainer DP, and Stouffer RJ. 2008. "Stationarity is Dead: Whither Water Management?" Science. 319: 573-574 pp. [Journal.] Viewed online at: http://wwwpaztcn.wr.usgs.gov/julio_pdf/milly_et_al.pdf.

Mojave Water Agency. 2004. *2004 Regional Water Management Plan*. Apple Valley (CA): Mojave Water Agency. 252 pp. Viewed online at: http://www.mojavewater.org/files/mwa_2004_rwmp.pdf.

Mote PW, Hamlet AF, Clark M, Lettenmaier DP. 2005. "Declining Mountain Snowpack in Western North America." American Meteorological Society Vol. 86(1): 39-49 pp. Viewed online at: http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-86-1-39.

Moyle WR. 1982. *Water Resources of Borrego Valley and Vicinity, California; Phase 1, Definition of Geologic and Hydrologic Characteristics of the Basin*. San Diego (CA): U.S. Geological Survey. 43 pp. Viewed online at: http://pubs.usgs.gov/of/1982/0855/report.pdf.

Napoli NR. 2004. Change in Groundwater Storage in the Lucerne Valley Groundwater Sub-basin — 1954 to 2002, Lucerne Valley, California. [Thesis]. Fullerton (CA): California State University Fullerton. Viewed online at: http://groundwater.fullerton.edu/groundwater/Old/Past_and_Present_Student_Projects_Thesis_files/Thesis%20napoli.pdf.

Nishikawa T, Densmore JN, Martin P, and Matti J. 2003. *Evaluation of the Source and Transport of High Nitrate Concentrations in Ground Water, Warren Subbasin, California*. Sacramento (CA): U.S. Geological Survey. 146 pp. Viewed online at: http://www.waterboards.ca.gov/coloradoriver/water_issues/programs/basin_planning/docs/yuccavalley/appnd_a.pdf.

Pierce DW, and Cayan DR. 2013. "The Uneven Response of Different Snow Measures to Human-Induced Climate Warming." Journal of Climate, Vol. 26: 4148-41-67 pp. Viewed online at: http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00534.1?journalCode=clim.

Pierce DW, Das T, Cayan DR, Maurer EP, Miller NL, Bao Y, Kanamitsu M, Yoshimura K, Snyder MA, Sloan LC, Franco G, and Tyree M. 2012. "Probabilistic Emissions of Future Changes in California Temperature and Precipitation Using Statistical and Dynamical Downscaling." Climate Dynamics Vol. 40(3-4): 839-856 pp. Viewed online at: http://meteora.ucsd.edu/cap/pdffiles/Pierce_etal_2012_CD.pdf.

Pitzer, Gary. 2013. Finding a Solution for the Salton Sea. Sacramento (CA): Colorado River Project, River Report. Water Education Foundation. 11 pp. Viewed online at: http://content.yudu.com/A2ap3u/RRsummer13/resources/index.htm?referrerUrl=http%3A%2F%2Fwww.watereducation.org%2Fdoc.asp%3Fid%3D876.

Qian Y, Ghan SJ, Leung LR. 2010. "Downscaling Hydroclimatic Changes Over the Western US Based on CAM Subgrid Scheme and WRF Regional Climate Simulations." International Journal of Climatology Vol. 30(5): 675-693 pp. Viewed online at: http://onlinelibrary.wiley.com/doi/10.1002/joc.1928/abstract.

Sneed M, and Brandt JT. 2007. *Detection and Measurement of Land Subsidence Using Global Positioning System Surveying and Interferometric Synthetic Aperture Radar, Coachella Valley California, 1996-2005*. Coachella Valley (CA): U.S. Geological Survey. Coachella Valley Water District. 40 pp. Viewed online at: http://pubs.usgs.gov/sir/2007/5251/pdf/sir_2007-5251.pdf.

Sneed M, Ikehara ME, Stork SV, Amelung F, and Galloway DL. 2003. *Detection and Measurement of Land Subsidence Using Interferometric Synthetic Aperture Radar and Global Positioning System, San Bernardino County, Mojave Desert, California.* Sacramento (CA): U.S. Geological Survey. Mojave Water Agency. 69 pp. Viewed online at: http://pubs.usgs.gov/wri/wri034015/wrir034015.book.pdf.

State Water Resources Control Board. 2013. *Report to the Legislature: Communities that Rely on a Contaminated Groundwater Source for Drinking Water.* Sacramento (CA): State Water Resources Control Board. California Environmental Protection Agency. 121 pp. Viewed online at: http://www.swrcb.ca.gov/water_issues/programs/gama/ab2222/index.shtml.

Stewart IT, Cayan DR, Dettinger MD. 2005. "Changes toward Earlier Streamflow Timing across Western North America." Journal of Climate Vol. 18: 1136–1155 pp. Viewed online at: http://journals.ametsoc.org/doi/pdf/10.1175/JCLI3321.1.

Stuart, M. 2012. “Alluvial Fan Task Force: Mission, History, and Outcomes.” [Presentation]. Los Angeles County Department of Public Works Headquarters. Viewed online at: http://www.water.ca.gov/climatechange/docs/Mark%20Stuart_AFTF2012Jan31_ClimateChangeExtremeWeatherSoCalFlooding%20Final-MarkStuart131.pdf.

The World Bank. 2012. “Climate Change: Adaptation Guidance Notes - Key Words and Definitions.” [Web site]. Washington D.C.: The World Bank. Viewed online at: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTTOOLKIT3/0,,contentMDK:22284629~pagePK:64168445~piPK:64168309~theSitePK:3646251,00.html.

U.S. Army Corps of Engineers and California Natural Resources Agency. 2011. *Salton Sea Species Conservation Habitat Project: Draft Environmental Impact Statement/Environmental Impact Report.* Sacramento (CA): U.S. Army Corps of Engineers. California Natural Resources Agency. 590 pp. Viewed online at: http://www.water.ca.gov/saltonsea/docs/eir2011/Part%20I_Draft%20EIS-EIR.pdf.

U.S. Bureau of Reclamation. 2010. *Southeast California Regional Basin Study Fact Sheet*. U.S. Bureau of Reclamation. 1 pp. Viewed online at: http://www.usbr.gov/WaterSMART/bsp/docs/fy2010/SE_CA_Regional_Factsheet_Final.pdf.

———. 2011. *Colorado River Basin Water Supply and Demand Study: Basin Study Program Fact Sheet.* U.S. Bureau of Reclamation. 1 pp. Viewed online at: http://www.usbr.gov/lc/region/programs/crbstudy/FactSheet_May2011.pdf.

———. 2012. *Colorado River Basin Water Supply and Demand Study: Executive Summary*. U.S. Bureau of Reclamation. 26 pp. Viewed online at: http://www.usbr.gov/lc/region/programs/crbstudy/finalreport/Executive%20Summary/Executive_Summary_FINAL_Dec2012.pdf.

U.S. Environmental Protection Agency. 2012. “Water: Small Systems and Capacity Development, Basic Information.” [Web site]. Washington D.C.: U.S. Environmental Protection Agency. Viewed online at: http://water.epa.gov/type/drink/pws/smallsystems/basicinformation.cfm.

U.S. Environmental Protection Agency and California Department of Water Resources. 2011. *Climate Change Handbook for Regional Water Planning.* Sacramento (CA): U.S. Environmental Protection Agency and California Department of Water Resources. 246 pp. Viewed online at: http://www.water.ca.gov/climatechange/CCHandbook.cfm.

U.S. Geological Survey. 1999. *Land Subsidence in the United States.* Denver (CO): U.S. Geological Survey. Viewed online at: http://pubs.usgs.gov/circ/circ1182/#pdf.

———. 2007. “The USGS Salton Sea Science Office Fact Sheet.” [Web site]. U.S. Geological Survey. Viewed online at: http://pubs.usgs.gov/fs/2007/3097/.

U.S. Global Change Research Program. 2009. *Global Climate Change Impacts in the United States*. Cambridge (NY): U.S. Global Change Research Program. National Oceanic and Atmospheric Administration. 196 pp. Viewed online at: http://nca2009.globalchange.gov/.

Westerling A. 2012. “DWR Workshop: Climate Change, Extreme Weather, and Southern California Floods.” [Presentation]. Alhambra (CA): California Department of Water Resources. Viewed online at: http://www.water.ca.gov/climatechange/docs/DWR_extremes-Tony%20Westerlling131.pdf.

Westerling A and Bryant B. 2006. *Climate Change and Wildfire in and around California: Fire Modeling and Loss Modeling*. Sacramento (CA): California Climate Change Center. 33 pp. Viewed online at: http://ulmo.ucmerced.edu/pdffiles/06CEC_WesterlingBryant.pdf.

Western Region Climate Center. 2013. “Climate Variability in the State of California.” Journal of Applied Meteorology and Climatology Vol. 48: 1527-1541 pp. Viewed online at: http://www.wrcc.dri.edu/.

Wilkinson RC. 2000. *Methodology for Analysis of the Energy Intensity of California’s Water Systems and an Assessment of Multiple Potential Benefits through Integrated Water-Energy Efficiency Measures*. Sacramento (CA): California Institute for Energy Efficiency. 89 pp. Viewed online at: http://large.stanford.edu/courses/2012/ph240/spearrin1/docs/wilkinson.pdf.

Williamson S, Ruth M, Ross K, Irani D. 2008. *Economic Impacts of Climate Change on Colorado: A Review and Assessment Conducted by the Center for Integrative Environmental Research.* College Park (MD): University of Maryland. 18 pp. Viewed online at: http://www.cier.umd.edu/climateadaptation/Colorado%20Economic%20Impacts%20of%20Climate%20Change.pdf.

Personal Communications

Bandt J, Senior environmental Scientist, California Department of Fish and Wildlife, Ontario (CA). February 12, 2013, letter to Moeller L. California Department of Water Resources, Sacramento (CA).

Devine AJ, Senior Planner, Imperial Irrigation District, Imperial (CA). Numerous e-mail and telephone conversations with Knoop V. California Department of Water Resources, Glendale (CA).

Gobler TE, Water Resources Planning Analyst, Mojave Water Agency, Apple Valley (CA). March 29, 2012, letter and email correspondence with Knoop V, California Department of Water Resources, Glendale (CA).

Harris CS, Deputy Director, Colorado River Board of California, Glendale (CA). Personal consultation and e-mail correspondence with Knoop V, California Department of Water Resources, Glendale (CA).

Trujillo TM, Executive Director, Colorado River Board of California, Glendale (CA). Personal consultation and e-mail correspondence with Knoop V, California Department of Water Resources, Glendale (CA).

Additional References

Alvarez C. 2012. “The Building of Future Wetlands Depends on Funding.” [Web site]. Imperial Valley Press. Imperial Valley (CA): Imperial Valley Press. Viewed online at: http://articles.ivpressonline.com/2012-08-12/wetlands_33171254.

Brownstein, Hyatt, Farber, and Schreck. 2011. “Court of Appeal Reinstates Historic Quantification Settlement Agreements.” [Web site]. Viewed online at: http://www.bhfs.com/portalresource/lookup/wosid/contentpilot-core-2301-33102/pdfCopy.name=/Court%20of%20Appeal%20Reinstates%20Historic%20Quantification%20Settlement%20Agreements.Client%20Alert.pdf.

Center for Integrated Environmental Research. 2008. *Economic Impacts of Climate Change on Colorado.* Center for Integrated Environmental Research. Viewed online at: http://www.cier.umd.edu/climateadaptation/Colorado%20Economic%20Impacts%20of%20Climate%20Change.pdf.

Cushman, MR, and Quellette M. 2013. “Court Upholds California’s Landmark Quantification Settlement Agreement.” [Web site]. Viewed online at: http://www.martindale.com/litigation-law/article__1838364.htm.

California Climate Action Team. 2010. *State of California Sea-Level Rise Interim Guidance Document, Appendix A*. Sacramento (CA): California Climate Action Team. 13 pp. Viewed online at: http://www.opc.ca.gov/webmaster/ftp/pdf/docs/2013_SLR_Guidance_Update_FINAL1.pdf.

———. 2013. *State of California Sea-Level Rise Guidance Document: March 2013 Update.* Sacramento (CA): California Action Team. 13 pp. Viewed online at: http://scc.ca.gov/files/2013/04/2013_SLR_Guidance_Update_FINAL.pdf.

California Department of Water Resources. 2006. *Progress on Incorporating Climate Change into Management of California’s Water Resources*. Sacramento (CA): California Department of Water Resources. California Natural Resources Agency. 339 pp. Viewed online at: http://baydeltaoffice.water.ca.gov/climatechange/DWRClimateChangeJuly06.pdf.

California Energy Commission. 2006. *Refining Estimates of Water-Related Energy Use in California.* Sacramento (CA): California Energy Commission. 95 pp. Viewed online at: http://www.energy.ca.gov/2006publications/CEC-500-2006-118/CEC-500-2006-118.PDF.

———. 2013. “Cal-Adapt.” [Web site]. Sacramento (CA): California Energy Commission. Viewed online at: http://cal-adapt.org/.

———. 2013. “Hydroelectric Power in California.” [Web site]. Sacramento (CA): California Energy Commission. Viewed online at: http://www.energy.ca.gov/hydroelectric/.

California Natural Resources Agency. 2013. *Safeguarding California: Reducing Climate Risk. An Update to the 2009 California Climate Adaptation Strategy (Public Draft).* Sacramento (CA): California Natural Resources Agency. 289 pp. Viewed online at: http://resources.ca.gov/climate_adaptation/docs/Safeguarding_California_Public_Draft_Dec-10.pdf.

California Urban Forests Council and the Inland Urban Forest Council. 2013. "Urban Forest Management Plan Toolkit." [Web site]. Viewed online at: http://www.ufmptoolkit.com/.

California Environmental Protection Agency. 2013. "California Climate Change Portal." [Web site]. Viewed online at: http://www.climatechange.ca.gov/.

California Department of Water Resources. 2013. "DWR Climate Change." [Web site]. Viewed online at: http://www.water.ca.gov/climatechange/.

Geoscience Inc. 2011. *City of Banning 2010 Urban Water Management Plan.* Claremont (CA): Geoscience. City of Banning. 663 pp. Viewed online at: http://banning.ca.us/archives/53/110722%20Banning%202010%20UWMP%20Final_6-12-2.pdf.

Goldrath DA, Wright, MT, Belitz, K. 2009. *Ground-Water Quality Data in the Coachella Valley Study Unit, 2007: Results from the California GAMA Program.* Sacramento (CA): U.S. Geological Survey. State Water Resources Control Board. 70 pp. Viewed online at: http://pubs.usgs.gov/ds/373/.

———. 2010. *Groundwater-Quality Data in the Colorado River Study Unit, 2007: Results from the California GAMA Program*. Sacramento (CA): U.S. Geological Survey. State Water Resources Control Board. 66 pp. Viewed online at: http://pubs.usgs.gov/ds/474/.

Governor's Office of Planning and Research, The. 2013. "Climate Change." [Web site]. Viewed online at: http://www.opr.ca.gov/m_climatechange.php.

Imperial Irrigation District. 2009. *2009 Annual Water Report*. Imperial (CA): Imperial Irrigation District. 36 pp. Viewed online at: http://www.iid.com/Modules/ShowDocument.aspx?documentid=4214.

———. 2009. *IID Interim Water Supply Policy for Non-Agricultural Projects.* Imperial (CA): Imperial Irrigation District. 7 pp. Viewed online at: http://www.iid.com/Modules/ShowDocument.aspx?documentid=5395.

———. 2010. *2010 Annual Water Report*. Imperial (CA): Imperial Irrigation District. 36 pp. Viewed online at: http://www.iid.com/Modules/ShowDocument.aspx?documentid=5057.

———. 2013. *Resolution No. 13-2013. Exhibits 1 and 2*. Imperial (CA): Imperial Irrigation District. 14 pp. Viewed online at: http://www.iid.com/Modules/ShowDocument.aspx?documentid=8319.

Intergovernmental Panel on Climate Change. 2007. *Climate Change 2007 - Synthesis Report*. Geneva (Switzerland). 104 pp. Viewed online at: http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html.

Janetos A, Hansen L, Inouye D, Kelly BP, Meyerson L, Peterson B, and Shaw R. 2008. *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States: Biodiversity.* Washington D.C.: U.S. Climate Change Science Program. 252 pp. Viewed online at: http://www.usda.gov/oce/climate_change/SAP4_3/CCSPFinalReport.pdf.

Knowles N, Dettinger M, Cayan D. 2007. *Trends in Snowfall versus Rainfall for the Western United States, 1949-2001.* Sacramento (CA): California Energy Commission, Public Interest Energy Research Program. 39 pp. Viewed online at: http://water.usgs.gov/nrp/proj.bib/Publications/2007/knowles_dettinger_etal_2007.pdf.

Lee M. 2012. "New Plan Could Revive Filthy New River." [Web site]. San Diego Union-Tribune. Viewed online at: http://www.utsandiego.com/news/2012/jul/15/new-plan-could-revive-filthy-new-river/.

Lenihan JM, Bachelet D, Drapek R, Neilson RP. 2006. *The Response of Vegetation Distribution, Ecosystem Productivity, and Fire in California to Future Climate Scenarios Simulated by the MC1 Dynamic Vegetation Model.* Sacramento (CA): California Climate Change Center, California Energy Commission. 25 pp. Viewed online at: http://www.energy.ca.gov/2005publications/CEC-500-2005-191/CEC-500-2005-191-SF.PDF.

Moser S, Franco G, Pittiglio S, Chou W, and Cayan D. 2008. *The Future is Now: An Update on Climate Change Science Impacts and Response Options for California*. Sacramento (CA): California Energy Commission 114 pp. Viewed online at: http://www.energy.ca.gov/2008publications/CEC-500-2008-071/CEC-500-2008-071.PDF.

National Research Council. 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Washington D.C.: National Research Council. 201 pp. Viewed online at: http://www.nap.edu/catalog.php?record_id=13389.

Perry T, and Marosi R. 2012. "U. S., Mexico Reach Pact on Water." [Web site]. Los Angeles Times. San Diego (CA). Viewed online at: http://articles.latimes.com/2012/nov/20/local/la-me-water-deal-20121120.

San Gorgonio Pass Water Agency. 2012. *Report on Water Conditions: Reporting Period 2011.* Beaumont (CA): San Gorgonio Pass Water Agency. 45 pp. Viewed online at: http://www.sgpwa.com/pdfs/2011RepOnWaterConditions.pdf.

van Vuuren DP, Edmonds J, Kainuma M, Riahi K, Thomson A, Hibbard K, et al. 2011. "The Representative Concentration Pathways: An Overview." Climatic Change Vol. 109(1-2): 5-31 pp. Viewed online at: http://link.springer.com/article/10.1007%2Fs10584-011-0148-z#.

Varin E. 2012. "QSA will not be heard at Supreme Court." [Web site]. The Courant. Viewed online at: http://www.courant.com/topic/ivp-california-supreme-court-not-to-hear-qsa-case-20120315,0,346992.story.

Westerling AL, Bryant BP, Preisler HK, Hidalgo HG, Das T, and Shrestha SR. 2009. *Climate Change, Growth, and California Wildfire*. Sacramento (CA): California Climate Change Center. 43 pp. Viewed online at: http://www.energy.ca.gov/2009publications/CEC-500-2009-046/CEC-500-2009-046-D.PDF.

Young B. 2011. "Californians Push for New River Cleanup in Health Plan." [Web site]. California Watch. Viewed online at: http://californiawatch.org/dailyreport/californians-push-new-river-cleanup-health-plan-12915.

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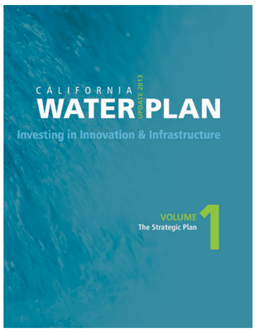

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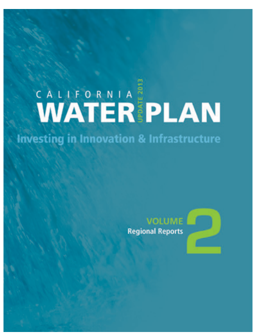

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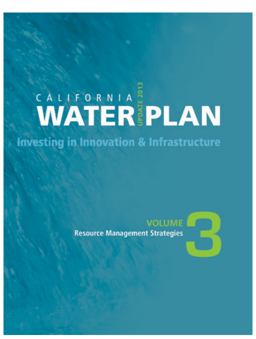

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