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Acronyms and Abbreviations Used in This Report

AB	Assembly Bill
ACWA	Association of California Water Agencies
af	acre-feet
af/yr.	acre-feet per year
BMO	basin management objective
BMP	best management practices
DFW	California Department of Fish and Wildlife
DWR	California Department of Water Resources
cfs	cubic feet per second
CAL FIRE	California Department of Forestry and Fire Protection
CASGEM	California Statewide Groundwater Elevation Monitoring
CTC	California Tahoe Conservancy
CWC	California Water Code
DAC	disadvantaged community
EI	energy intensity
EIS	environmental impact statement
GAMA	Groundwater Ambient Monitoring and Assessment
GHG	greenhouse gas
GIS	geographic information system
gpm	gallons per minute
GWMP	groundwater management plan
HIP	high-population growth scenario
HLWA	Honey Lake Wildlife Area
IRWM	integrated regional water management
kWh	kilowatt hours
kWh/af	kilowatt hours per acre-foot
LOP	low-population growth scenario

LRWQCB	Lahontan Regional Water Quality Control Board
M&I	municipal and industrial
maf	million acre-feet
MHI	median household income
MOU	memorandum of understanding
MTBE	methyl-tertiary butyl ether
MWh	megawatt-hour
PA	planning area
RWMG	regional water management group
SB	Senate Bill
SB X7-7	The Water Conservation Law of 2009
SCADA	supervisory control and data acquisition
SNMP	salt and nutrient management plan
STPUD	South Tahoe Public Utilities District
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TCID	Truckee-Carson Irrigation District
TMDL	total daily maximum load
TMWA	Truckee Meadows Water Authority
TRA	Truckee River Agreement
TRCD	Tahoe Resource Conservation District
TROA	Truckee River Operating Agreement
TRPA	Tahoe Regional Planning Agency
TTSA	Tahoe Truckee Sanitation Dsitrict
Update 2013	California Water Plan Update 2013
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
WRCC	Western Regional Climate Center

Between Tahoe City and Truckee, CA. After originating from Lake Tahoe, the Truckee River flows up to 120 miles to its terminus in Pyramid Lake. Similar to other streams in the North Lahontan Hydrologic Region, the snowmelt-fed Truckee River supports a multitude of instream, recreational, agricultural, and municipal benefits along its path.

North Lahontan Hydrologic Region

North Lahontan Hydrologic Region Summary

The North Lahontan Hydrologic Region (North Lahontan region) includes part of the western edge of the Great Basin, a large landlocked area that covers most of Nevada and northern Utah. The eastern drainages of the Cascade Range and the eastern Sierra Nevada, north of the Mono Lake drainage, make up the region. All surface water drains eastward toward Nevada. This hydrologic region extends about 270 miles from the Oregon border to the southern boundary of the Walker River drainage in Mono County (Figure NL-1). The region covers 6,122 square miles, about 4 percent of California's total area, but is inhabited by only about 0.3 percent of the state's population. The region includes portions of Modoc, Lassen, Sierra, Nevada, Placer, El Dorado, Alpine, and Mono counties.

The region abounds with large, natural landscapes. The northern part is primarily arid high desert with relatively flat valleys at elevations of 4,000 to 5,000 feet. The eastern slopes of the Sierra Nevada comprise the central and southern portions of this region, which includes the California portion of the Lake Tahoe Basin and the western Great Basin. The major rivers of the region — Truckee, Carson, and Walker — carry the mountain snowmelt through California into Nevada. Mountain peaks up to 12,279 feet from the western boundary of the region.

Current State of the Region

Setting

Watersheds

The North Lahontan region contains all of the Susan River; the upper parts of the Truckee, Carson, and Walker River basins; and the Surprise Valley watersheds (see Figure NL-1). These streams have no outlets to the sea and terminate in lakes or playas. Most rivers have elevated baseflows due to snowmelt from the Sierra Nevada and Cascade mountains, and from reservoir releases that maintain instream flows.

In the north, the Susan River flows southeasterly and empties into Honey Lake. Other minor streams in the north begin in the Warner Mountains and drain into Lower, Middle, or Upper Alkali lakes in Surprise Valley. The major portion of the Truckee River system originates in California and flows into Lake Tahoe and out toward Reno, Nevada, and then into Pyramid Lake. Trout Creek and the Upper Truckee River flow from the western slopes of the Carson Range and the eastern slopes of the Sierra into Lake Tahoe at the city of South Lake Tahoe. The Little Truckee River conflates with the Truckee River near the head of Truckee Canyon just west of the river's exit into Nevada. The east and west forks of the Carson River are separate in California. These watersheds drain Alpine County and flow into Nevada. The two forks of the Carson River meet near Minden, Nevada, and terminate near Fallon, Nevada, in either Carson Lake and Pasture or the Carson Sink. The East and West Walker rivers, entirely separate in California, originate in Mono County, flow into Nevada, join near Yerington, and then flow to Walker Lake.

Figure NL-1 Map of the North Lahontan Hydrologic Region

The North Lahontan region watersheds are listed in Table NL-1 and can be seen in Figure NL-2.

Groundwater Aquifers and Wells

Groundwater resources in the North Lahontan 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, or 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. Groundwater extracted by wells located outside of the alluvial basins is supplied largely from fractured-rock aquifers. In some cases, groundwater stored within a thin overlying layer of alluvial deposits or a thick soil horizon may also contribute to the well's groundwater supply. A brief description of the aquifers for the region is provided below.

Alluvial Aquifers

The North Lahontan region contains 27 alluvial groundwater basins and subbasins recognized under *Bulletin 118-2003* (California Department Water Resources 2003). They underlie approximately 1,600 square miles, or about 26 percent of the 6,100 square mile hydrologic region. Figure NL-3 shows the location of the alluvial groundwater basins and subbasins. Table NL-2 lists the associated names and numbers. The most heavily used groundwater basins in the region are Honey Lake Valley and Surprise Valley Groundwater basins. Well yields in Honey Lake Valley Groundwater Basin range from 20 to 2,500 gallons per minute (gpm), with an average yield of 780 gpm while well yields in Surprise Valley Groundwater Basin range from 350 to 2,500 gpm, with an average yield of 1,400 gpm. The two basins account for more than 70 percent of the average 166 thousand acre-feet (taf) of groundwater pumped annually during the 2005-2010 period. Two other basins are also considered important for the region — Martis Valley and Madeline Plains Groundwater basins. Well yields in Martis Valley Groundwater Basin can be up to 1,500 gpm, with an average yield of 150 gpm; well yields in Madeline Plains Groundwater Basin are generally limited to domestic or stock wells.

Fractured Rock Aquifers

Fractured rock aquifers are generally found in the mountainous areas of a region, extending from the edges of the alluvial groundwater basins and foothill areas, up into the surrounding mountains. Due to the highly variable nature of the void spaces within fractured-rock aquifers, wells drawing from fractured-rock aquifers tend to have less capacity and less reliability than wells drawing from alluvial aquifers. On average, wells drawing from fractured-rock aquifers yield 10 gpm or less. Although fractured-rock aquifers are less productive compared to alluvial aquifers, they tend to be a critically important water supply source for many individual domestic wells and small public water systems in the region.

A significant fractured-rock groundwater-bearing geologic formation in the Honey Lake Valley Groundwater Basin is the late Pliocene and early Pleistocene volcanic rocks. These rocks can be highly permeable where fractured or jointed and act as a recharge conduit and can yield significant amounts of groundwater.

Table NL-1 North Lahontan Hydrologic Region Watersheds Proceeding from North to South

Watershed	Area (square miles)	Location	Planning Activity	Comments
Cow Head	No data	Modoc County mostly in OR, NV		
Surprise Valley	756	Modoc County partly in NV		
Madeline Plains	793	Lassen & Modoc counties mostly in CA		Receives water from Sacramento Hydrologic Region, Pit River
Smoke Creek Desert	No data	Lassen County almost entirely in NV		
Honey-Eagle Lakes	1,939	Lassen & Sierra counties partly in NV	Subject to Lassen County Groundwater Ordinance	Groundwater extracted for wetlands and, in NV, from Fish Springs Ranch
Truckee River	932	Sierra, Nevada, & Placer counties	TROA, Tahoe-Sierra IRWM	Subject to numerous court orders & decrees, subject of major planning efforts
Lake Tahoe	506	Placer & El Dorado counties, partly in NV	TROA, Tahoe-Sierra IRWM, Tahoe Reg. Planning Agency	Subject to numerous court orders & decrees, subject of major planning efforts
Upper Carson	341	El Dorado, Alpine, & Mono counties in CA	TROA, Carson Water Subconservancy District, Alpine Watershed Group	Subject to the Alpine decree within TROA
West Walker	250	Alpine & Mono counties		Currently in litigation
East Walker	380	Mono County		Currently in litigation, Virginia Creek diversion in Walker Basin to Mono Lake Basin, which lies in South Lahontan Hydrologic Region

Notes: TROA = Truckee River Operating Agreement, IRWM = integrated regional water management

Another significant source of groundwater in the Madeline Plains Groundwater Basin is the Pliocene-Pleistocene and Pleistocene basalt that comprises approximately 80 percent of the land surface of the surrounding basin. The basalt is highly permeable and exists extensively in both the surface and subsurface of the area, and it acts as the primary aquifer and primary recharge conduit for the basin. The groundwater yields are generally less than 500 gpm, but can be as high as 3,000 gpm or more.

Figure NL-2 North Lahontan Region Watersheds

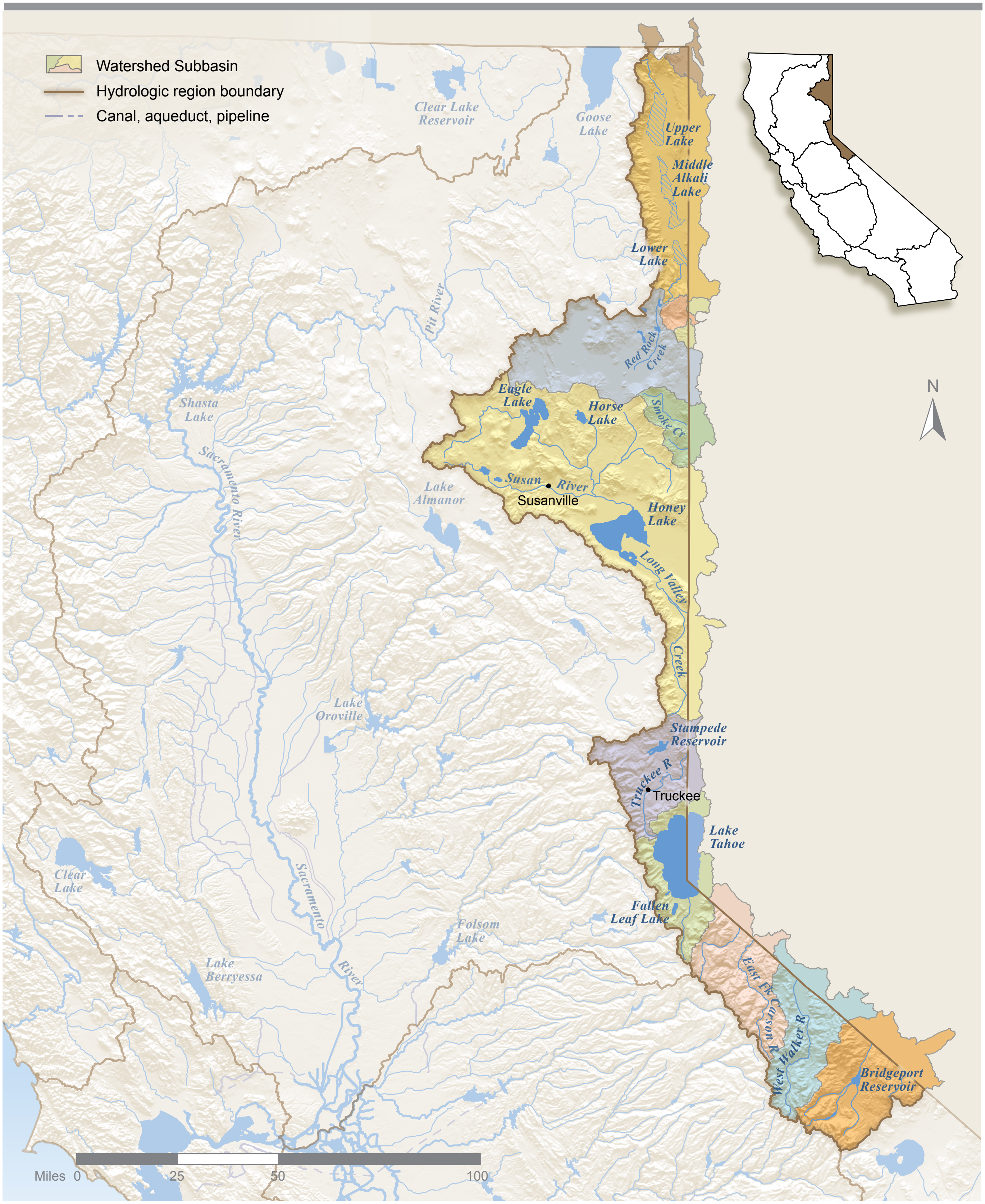


Figure NL-3 Alluvial Groundwater Basins and Subbasins within the North Lahontan Hydrologic Region

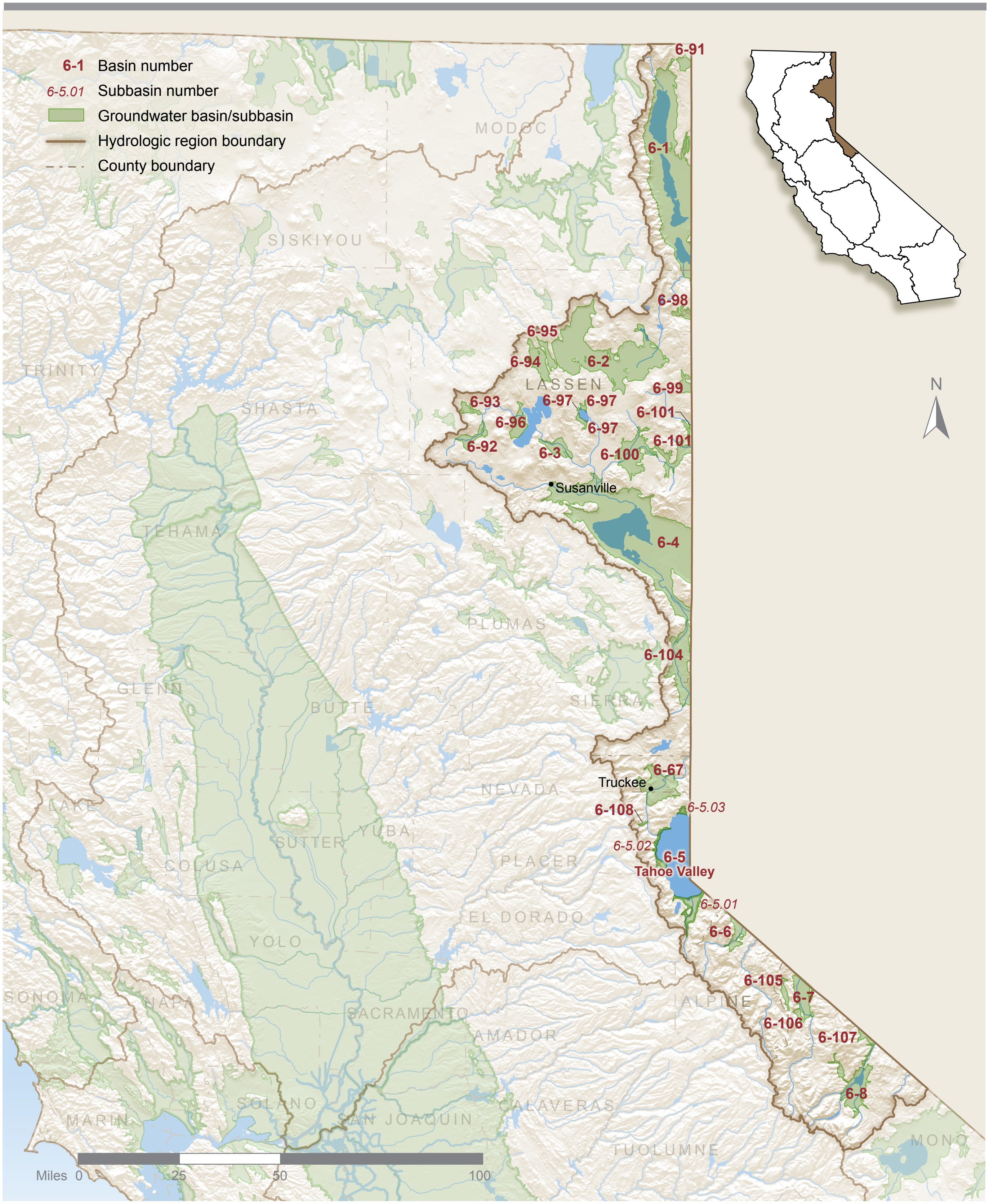


Table NL-2 Alluvial Groundwater Basins and Subbasins within the North Lahontan Hydrologic Region

Basin/Subbasin		Basin Name	Basin/Subbasin	Basin Name
6-1		Surprise Valley	6-93	Harvey Valley
6-2		Madeline Plains	6-94	Grasshopper Valley
6-3		Willow Creek Valley	6-95	Dry Valley
6-4		Honey Lake Valley	6-96	Eagle Lake Area
6-5		Tahoe Valley	6-97	Horse Lake Valley
	6-5.01	Tahoe Valley South	6-98	Tuledad Canyon Valley
	6-5.02	Tahoe Valley West	6-99	Painters Flat
	6-5.03	Tahoe Valley North	6-100	Secret Valley
6-6		Carson Valley	6-101	Bull Flat
6-7		Antelope Valley	6-104	Long Valley
6-8		Bridgeport Valley	6-105	Slinkard Valley
6-67		Martis (Truckee) Valley	6-106	Little Antelope Valley
6-91		Cow Head Lake Valley	6-107	Sweetwater Flat
6-92		Pine Creek Valley	6-108	Olympic Valley

More detailed information regarding the aquifers in the North Lahontan Hydrologic Region is available online from *California Water Plan Update 2013* (Update 2013), Volume 4 *Reference Guide* article, "California's Groundwater Update 2013," and in *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 North Lahontan region. Many wells could have been drilled prior to 1977 or without submitting well logs to DWR. As a result, the total number of wells in the region is probably higher than what is here. DWR does not have well logs for all the wells drilled in the region; and for some well logs, information regarding well location or use is inaccurate, incomplete, ambiguous, or missing. Hence, some well logs could not be used in the current assessment. However, for a regional scale evaluation of well installation and distribution, the quality of the data is considered adequate and informative. The number and distribution of wells in the region are grouped according to their location by county and according to six most common well-use types: domestic, irrigation, public supply, industrial, monitoring, and other. Public supply wells include all wells identified in the well completion report as municipal or public. Wells identified as "other" include a combination of the less common well types, such as stock wells, test wells, or unidentified wells (no information listed on the well log).

The well log information is reported for Lassen and Alpine counties. The well log information listed in Table NL-3 and illustrated in Figure NL-4 shows 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 4,100, of which about 3,900 are in Lassen County and a little over 200 in Alpine County. Domestic wells make up the majority of well logs in both counties (about 2,900 in Lassen County and 130 in Alpine County), while monitoring wells account for the second highest number of well logs (about 300 in Lassen County and 50 in Alpine County). Communities with a high percentage of monitoring wells compared to other well types may indicate monitoring of groundwater quality to help characterize groundwater quality issues.

Figure NL-5 shows that domestic wells make up the majority (75 percent) of well logs in the region while irrigations wells account for only about 8 percent of well logs. Monitoring wells make up 9 percent of the wells.

Figure NL-6 shows a cyclic pattern of well installation for the region, with new well construction ranging from about 50 to 200 wells per year. The average number of new wells constructed is about 125 wells per year. Multiple factors are known to affect the annual number and type of wells drilled. Some of these factors include the annual variations in climate, economy, agricultural cropping trends, or alternative water supply availability.

The increase in the number of domestic wells drilled from 2001 to 2005 is likely due to growth in housing construction. Similarly, the decrease in the number of domestic wells drilled from 2006 to 2010 is likely due to declining economic conditions and the related drop in housing construction. A portion of the lower number of well logs recorded for 2009 and 2010 could also be due to delays in receiving and processing of well completion reports.

Irrigation well installation is more closely related to hydrologic conditions, cropping trends and surface water availability. Installation of irrigation wells increase in dry water year conditions, for example, during the 1976-77 and 1991-1996 droughts.

The onset of monitoring well installation in the mid- to late-1980s is likely associated with federal underground storage tank programs signed into law in the mid-1980s. The installation of monitoring wells in the region peaked in 1990 at about 50 wells, with an average of about 15 to 20 monitoring wells installed per year from 1988 through 2007. Since 2007, monitoring well installation in the region has dropped to an average of approximately five wells per year.

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

Table NL-3 Number of Well Logs by County and Use for the North Lahontan Hydrologic Region (1977-2010)

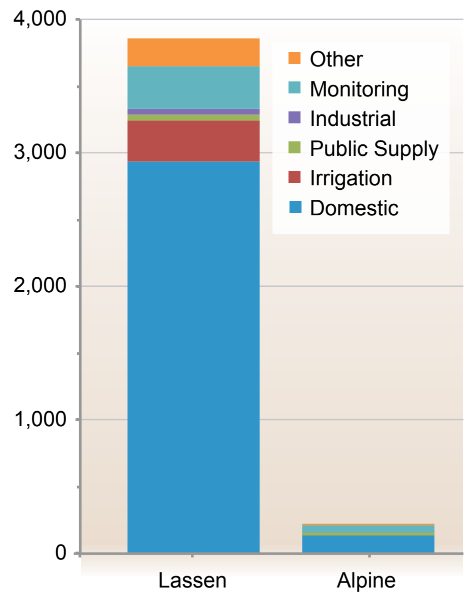
	Total Number of Well Logs by Well Use						
County	Domestic	Irrigation	Public Supply	Industrial	Monitoring	Other	Total Well Records
Lassen	2,932	315	43	38	319	211	3,858
Alpine	132	4	25	2	47	1	211
Total well records	3,064	319	68	40	366	212	4,069

North Lahontan Hydrologic Region Groundwater Monitoring

Groundwater monitoring and evaluation is a key aspect to understanding groundwater conditions, identifying effective resource management strategies, and implementing sustainable resource management practices. California Water Code (CWC) Section 10753.7 requires local agencies seeking State funds administered by DWR to prepare and implement groundwater management plans that include monitoring groundwater levels, groundwater quality, inelastic land subsidence, and changes in surface water flow and quality that directly affect groundwater levels or quality. This section summarizes some of the groundwater level and groundwater quality monitoring efforts within the North Lahontan 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* article "California's Groundwater Update 2013."

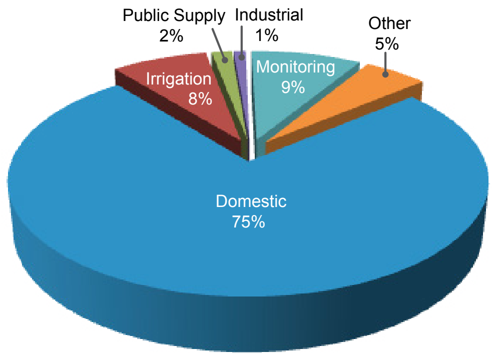
Figure NL-4 Number of Well Logs by County and Use for the North Lahontan Hydrologic Region (1977-2010)



Groundwater Level Monitoring

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

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



information on the program is available online at http://www.water.ca.gov/groundwater/casgem/.

The locations of monitoring wells by monitoring entity and monitoring well type for the region are shown in Figure NL-7. Irrigation wells, other wells, observations wells, and domestic wells account for 34, 28, 22, and 16 percent of the monitoring wells in the region, respectively.

A list of the number of monitoring wells in the region is provided in Table NL-4. Groundwater levels have been actively monitored in 221 wells since 2010. DWR monitors 138 wells in 12 basins, the USGS monitors 24 wells in three basins, and four cooperators monitor the remaining 59 wells. At present, there are no CASGEM wells being monitored as no monitoring entities have been designated by DWR.

CASGEM Basin Prioritization

Figure NL-8 shows the groundwater basin prioritization for the region. Of the 27 basins within the region, 2 basins were identified as medium priority, 2 basins as low priority, and the remaining 23 basins as very low priority. Table NL-5 lists the medium and low CASGEM priority groundwater basins for the region. The two basins designated as medium priority include about 55 percent of the population and account for 9 percent of groundwater supply in the region. Basin prioritization could be a valuable tool to help evaluate, focus, and align limited resources for effective groundwater management, and reliable and sustainable groundwater resources.

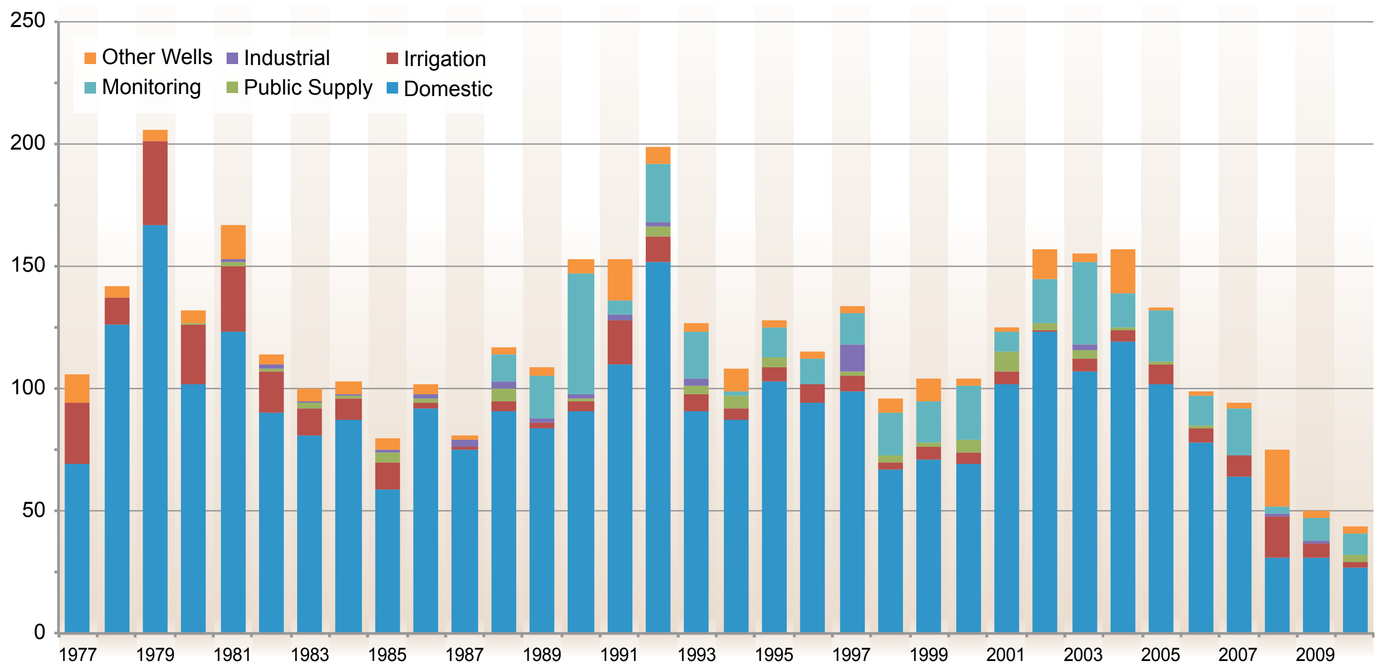
More detailed information on groundwater basin prioritization is available online from Update 2013, Volume 4, *Reference Guide* article "California's Groundwater Update 2013."

Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect to effective groundwater basin management and is one of the components 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 California State Water Resources Control Board (SWRCB) Groundwater Ambient Monitoring and Assessment 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,

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



California Department of Public Health, Department of Pesticide Regulation, 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 NL-6 provides agency-specific groundwater quality information.

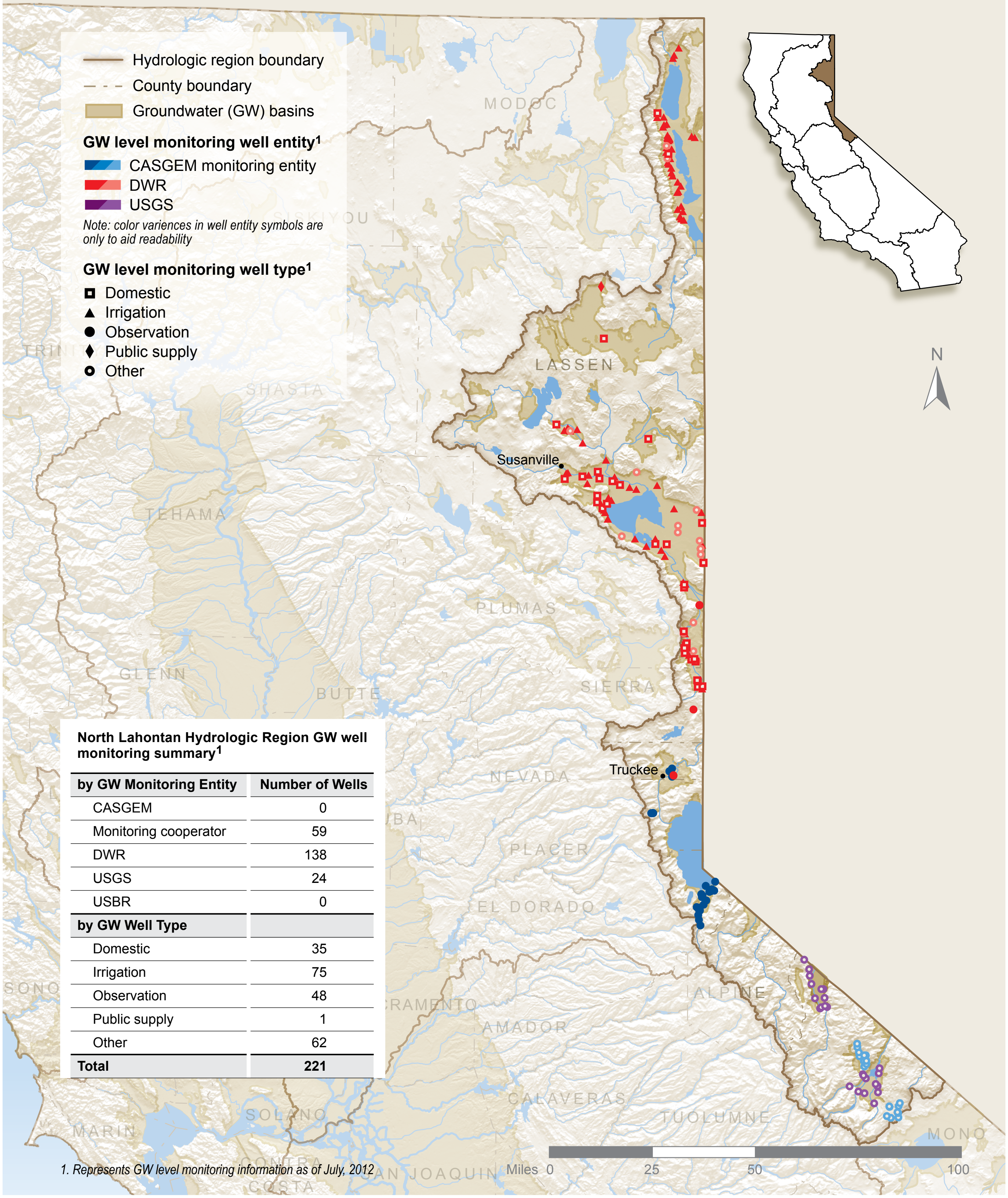
Groundwater Protection

In the North Lahontan region, a number of efforts are under way to protect groundwater quality. The Lahontan Regional Water Quality Control Board (LRWQCB) is taking different regulatory approaches addressing specific groundwater impacts and is working with local stakeholders to develop comprehensive salt and nitrate management plans. Collaborative basin planning efforts are addressing problems with salinity and nitrate in groundwater in these management plans.

Groundwater Quality Protection Regulatory Approaches. The LRWQCB is taking the following regulatory approaches to address groundwater quality impacts in the North Lahontan region:

- Issuance of individual and general waste discharge requirement orders requiring specific actions for dischargers to protect and monitor groundwater quality such as:
    - Impose federal Subtitle D standards for landfills, including final covers at closed landfills and liners at expanded landfills.
    - Impose State title 27 standards for waste management units, including double lined surface impoundments.

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



North Lahontan Hydrologic Region GW well monitoring summary[1]

by GW Monitoring Entity	Number of Wells
CASGEM	0
Monitoring cooperator	59
DWR	138
USGS	24
USBR	0
by GW Well Type	
Domestic	35
Irrigation	75
Observation	48
Public supply	1
Other	62
Total	**221**

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

Table NL-4 Groundwater Level Monitoring Wells by Monitoring Entity in the North Lahontan Hydrologic Region

State and Federal Agencies	Number of Wells
Department of Water Resources	138
U.S. Geological Survey	24
Total State and federal wells:	**162**
Monitoring Cooperators	**Number of Wells**
Mono County	19
Placer County Water Agency	3
South Tahoe Public Utility District	30
Squaw Valley Public Service District	7
Total cooperator wells:	**59**
CASGEM Monitoring Entities	**Number of Wells**
None designated	0
Total CASGEM Monitoring Wells:	**0**
Grand total	**221**

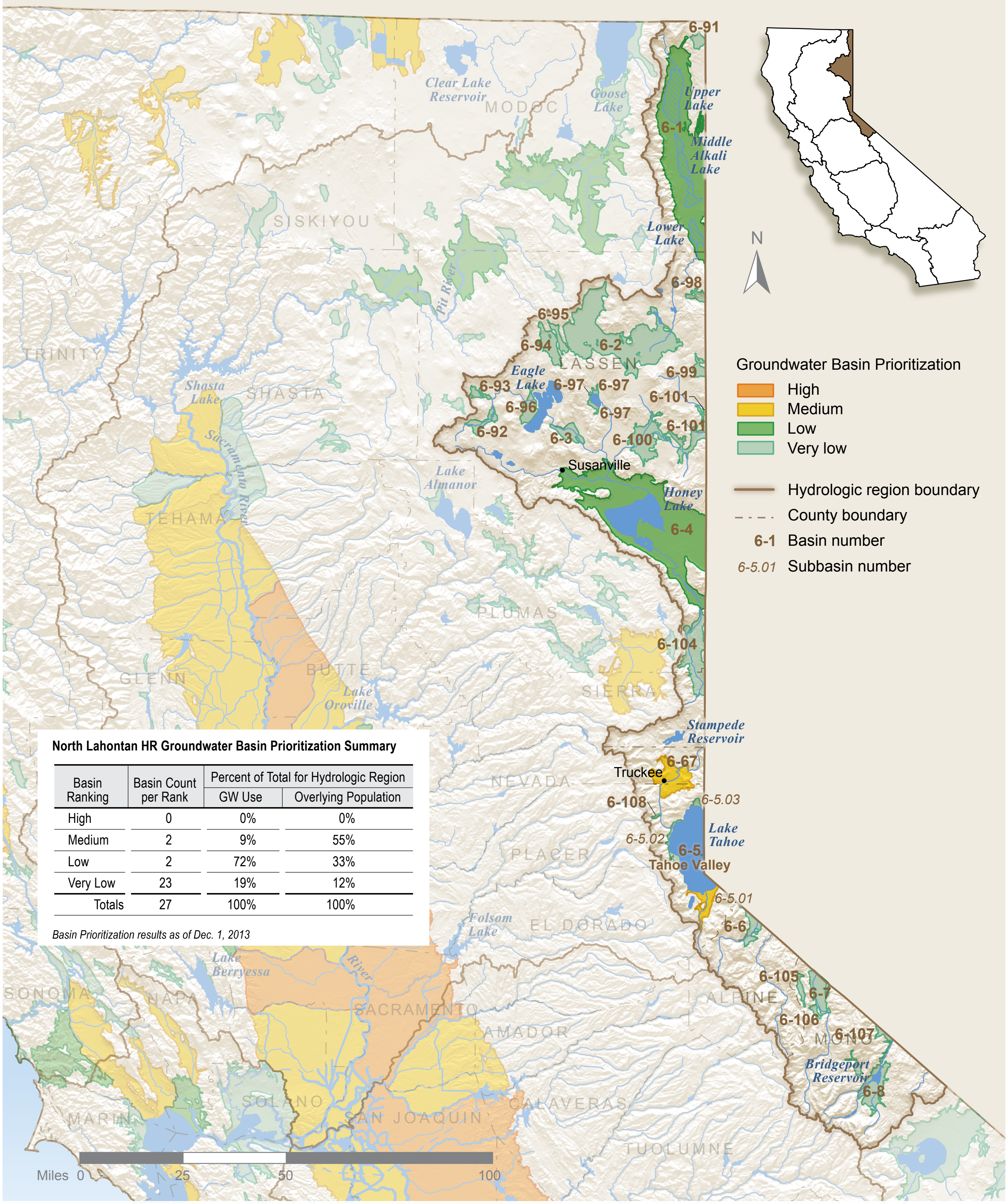
Notes:

CASGEM = California Statewide Groundwater Elevation Monitoring

Table represents monitoring information as of July 2012.

    - Impose time schedules to line certain waste treatment or discharge units at wastewater treatment plants and reduce effluent nitrogen levels along with groundwater monitoring where wastes are directly discharged to groundwater.
- Require responsible parties to clean up polluted groundwater at sites such as:
    - Department of Defense installations that have large chlorinated solvent and petroleum hydrocarbon releases.
    - Leaking underground petroleum storage tanks, especially in areas not served by public water supplies.
    - Wastewater plants that contributed to groundwater nitrate pollution.
    - Mines where historical releases caused groundwater pollution.
    - Industrial site such as rail facilities with chlorinated solvent pollution and bulk oil distribution facilities with petroleum hydrocarbon pollution.
    - Commercial sites such as former dry cleaner operations with chlorinated solvent pollution.
- Collaboration with local agencies and other stakeholders in areas such as:
    - Local agencies regarding alternative on-site septic treatment systems.
    - Local agencies to develop Local Agency Management Plans for SWRCB’s Onsite Wastewater Treatment System policy.

Figure NL-8 CASGEM Groundwater Basin Prioritization for the North Lahontan Hydrologic Region



North Lahontan HR Groundwater Basin Prioritization Summary

Basin Ranking	Basin Count per Rank	Percent of Total for Hydrologic Region	
		GW Use	Overlying Population
High	0	0%	0%
Medium	2	9%	55%
Low	2	72%	33%
Very Low	23	19%	12%
Totals	27	100%	100%

Basin Prioritization results as of Dec. 1, 2013

Table NL-5 CASGEM Groundwater Basin Prioritization for the North Lahontan Hydrologic Region

Basin Prioritization	Count	Basin/Subbasin Number	Basin Name	Subbasin Name	2010 Census Population
Medium	1	6-5.01	Tahoe Valley	Tahoe South	25,967
Medium	2	6-67	Martis Valley		14,743
Low	1	6-4	Honey Lake Valley		23,566
Low	2	6-1	Surprise Valley		1,127
Very Low	23	See *California Water Plan Update 2013*, Volume 4, *Reference Guide* article, "California's Groundwater Update 2013."			
Totals	**27**	**Population of groundwater basin area**			**74,609**[a]

Notes:

Senate Bill 7x 6 (SB 7x 6; Part 2.11 to Division 6 of the California Water Code Sections 10920 et seq.) requires DWR, as part of the CASGEM program, 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 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.

[a] Total includes population from Very Low Basin Prioritization. See *California Water Plan Update 2013* Volume 4, *Reference Guide* article, "California's Groundwater Update 2013" for more information.

- ○ Evaluation of and input to separate federal, state, regional, and county public agency plans with groundwater protection elements.
- ○ Stakeholders developing comprehensive Salt and Nutrient Management Plans, further discussed below.

- Evaluate required groundwater quality monitoring program data.
- Broaden public participation in all programs.
- Coordinate with local agencies to implement Well Design and Destruction Programs.
- Reduce site cleanup backlog.

Salt and Nutrient Management Plans. The SWRCB's *Recycled Water Policy* was adopted in 2009 (Resolution No. 2009-0011) with a goal of managing salt and nutrients from all sources in a basin-wide or watershed-wide basis. This policy requires the development of regional or sub-regional salt and nutrient management plans (SNMPs) for every groundwater basin/sub-basin in California; and each plan must include monitoring, source identification, and implementation measures.

Throughout the Lahontan region, participating in the development of the SNMP is of paramount importance to improve water quality in the region and provide for a sustainable economic and environmental future. The LRWQCB is working with partners/stakeholders to develop SNMPs for 12 priority groundwater basins, with 5 located in the northern part of the region and 7 in the

Table NL-6 Sources of Groundwater Quality Information for the North Lahontan Hydrologic Region

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

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
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)

south. The LRWQCB will be collaborating with integrated regional water management groups and affected stakeholders to develop SNMPs for Antelope, Mojave (three groundwater basins), Owens/Indian Wells, Honey Lake, Fremont Valley (and Tehachapi), and Tahoe Sierra (three groundwater basins).

Ecosystems

Table NL-7 lists threatened, endangered, and species of special concern found in the counties of the North Lahontan Hydrologic Region.

The ecosystems in the North Lahontan region are diverse and vary from alpine to semi-arid desert. The ecosystems by county in the North Lahontan region are described below.

Modoc County is a sagebrush steppe into which western and Utah juniper are expanding. Within that county, Surprise Valley is a high altitude (4,000 feet) desert valley with forested mountains on the west and a series of alkaline lakes in the valley. Surprise Valley is considered part of the Great Basin because water drains to these lakes and evaporates. Western and Utah juniper are native to the region, but have been found to be expanding beyond their historical distribution from anthropogenic changes such as cattle grazing and fire suppression. The U.S. Forest Service and Bureau of Land Management have contributed funding to the Sierra Nevada Conservancy for juniper removal projects

Lassen County contains a sagebrush ecosystem, portions of which are being preserved in the Buffalo-Skedaddle Population Management Unit northeast of Susanville. It also has Eagle and

Table NL-7 Threatened, Endangered and Special Concern Species of the North Lahontan Hydrologic Region

Common Name	Scientific Name	Federal Status	California Status	CA Dept. Fish and Wildlife Status	CA Native Plant Society List
American badger	*Taxidea taxus*	None	None	SSC	
American marten	*Martes Americana*	Candidate			
bald eagle	*Haliaeetus leucocephalus*	Delisted	Endangered		
bank swallow	*Riparia riparia*	None	Threatened		
Boggs lake hedge-hyssop	*Gratiola heterosepala*	None	Endangered		1B.2
black swift	*Cypseloides niger*	None	None	SSC	
burrowing owl	*Athene cunicularia*	None	None	SSC	
California spotted owl	*Strix occidentalis occidentalis*	None	None	SSC	
Carson wandering skipper	*Pseudocopaeodes eunus obscurus*	Endangered	None		
California wolverine	*Gulo gulo*	Candidate	Endangered		
gray wolf	*Canis lupus*	Endangered	None		
great gray owl	*Strix nebulosa*	None	Endangered		
greater sage-grouse	*Centrocercus urophasianus*	Candidate	None	SSC	USF&WS to determine status by 2015
greater sandhill crane	*Grus canadennsis*	None	Threatened		
High Rock Spring tui chub	*Siphateles bicolor ssp. 2*	None	None	SSC	
Lahontan Cutthroat Trout	*Oncorhynchus clarki henshawi*	Threatened	None		
long eared owl	*Asio otus*	None	None	SSC	
Modoc sucker	*Catostomus microps*	Endangered	Endangered		
mountain sucker	*Catostomus platyrhynchus*	None	None	SSC	
northern goshawk	*Accipiter gentilis*	None	None	SSC	
northern leopard frog	*Lithobates pipiens*	None	None	SSC	

Common Name	Scientific Name	Federal Statue	California Status	CA Dept. Fish and Wildlife Status	CA Native Plant Society List
Oregon spotted frog	*Rana pretiosa*	Candidate	None	SSC	
Pacific fisher	*Martes pennant pacifica*	Candidate	Candidate	SSC	
pallid bat	*Antrozous pallidus*	None	None	SSC	
Sierra Nevada big horn sheep	*Ovis Canadensis sierrae*	Endangered	Endangered		
Sierra Nevada mountain beaver	*Aplodontia rufa californica*	None	None	SSC	
Sierra Nevada red fox	*Vulpes vulpes necator*	None	Threatened		
Sierra Nevada snowshoe hare	*Lepus Americanus tahoensis*	None	None	SSC	
Sierra Nevada yellow-legged frog	*Rana sierrae*	Candidate	Candidate Threatened	SSC	
slender Orcutt grass	*Orcutia tenuis Hitchc.*	Threatened	Endangered		
Swainson's hawk	*Buteo swainsoni*	None	Threatened		
Tahoe yellow cress	*Rorippa subumbellata*	Candidate	Endangered		1B.1
tricolored blackbird	*Agelaius tricolor*	None	None	SSC	
western snowy plover	*Charadrius alexsandrinus nivosus*	Threatened	None	SSC	
Webber Ivesia	*Ivesia webberi*	Candidate			
western white tailed jackrabbit	*Lepus townsendii townsendii*	None	None	SSC	
Willow Flycatcher	*Empidonax traillii exitimus*	None	Endangered		
Yellow headed blackbird	*Xanthocephalus xanthocephalus*	None	None	SSC	
Yellow warbler	*Dendroica petechia brewsteri*	None	None	SSC	

Source: California Natural Diversity Database (CNDDB) Quick Viewer

Notes:

SSC = Species of Special Concern, USF&WS = U.S. Fish and Wildlife Service

Honey lakes in its low-lying portion. The Honey Lake and Willow Creek Wildlife Areas preserve existing wetlands in the area. Approximately 50,000 cattle graze in Lassen County on the grasses in the sagebrush areas and on irrigated pasture. The establishment of exotic species of grasses such as cheatgrass, an annual that lacks deeper root systems, has changed the ecosystem to one that is more erosive and fire prone than that which existed when native grasses predominated. This condition can lead to higher sediment loads in runoff and less infiltration in case of fire.

In Mono County the ecosystem reverts to the sagebrush desert of the northern portions, irrigated pasture and alfalfa fields with some produce in the eastern valleys, and forested mountains bordering on the west. Notably, the West Walker River that meanders through this section of the region has been designated a California Wild and Scenic River and therefore is protected from further human-made modifications.

In the more alpine counties — Sierra, El Dorado, Nevada, Placer, Mono, and Alpine — exist riparian and lacustrine (natural lakes, ponds and human-made reservoirs) ecosystems. The riparian ecosystems are labeled according to their inhabitants, thus area streams are referred to by conifer forest snowmelt streams, trout headwater streams, trout/sculpin streams, sucker/dace/redside streams, and whitefish cutthroat/sucker streams. In the last group, the Lahontan cutthroat trout riverine variant (the other variant being lacustrine) persists currently in only 8.8 miles (2.4 percent) of the historical 360 miles of stream habitat. The goal of current watershed management initiatives is to increase that percentage. The small lakes (less than one-tenth acre in size) in this region are in glaciated, mountainous areas and were formed either as glacially scoured basins or deposited ridges of glacial debris that dammed streams. Snowmelt pools are clear, low in basic nutrients for plants (oligotrophic), and may contain only seasonal organisms. Farther downslope, smaller natural lakes have been augmented by the placement of low, human-made dams to provide water for agriculture or (originally) hydropower and now increasingly urban uses.

The most notable feature of the North Lahontan region is Lake Tahoe, one of the low dammed, oligotrophic lakes. Now low in basic nutrients for plants, the lake's state could change if current efforts to keep it pristine are not effective. Concerns arise from the presence of invasive flora, Eurasian milfoil (*Myriophyllum spicatum*) and curly pond weed (*Potamogeton crispus*), and fauna such as the Asian clam (*Corbicula fluminea*). The clam was first observed in 2002, but now is abundant along the lake's southeast shore at depths of 3 to 30 feet. This is particularly unfortunate because it may indicate that Tahoe's waters contain enough calcium to support zebra and quagga mussels (if introduced) and because their very presence presents a substrate for such an invasion. Worse still is the perceived association of filamentous algae blooms that are thought to spring from the nitrogen laden excretions of the Asian clam.

Various species have invaded the area including the Asian clam and the white top plant (*Lepidium draba*, and *Lepidium latifolium*). In the case of the Asian clam, this can cause filamentous algal blooms; and in the case of whitetop, it excludes more desirable, native plant species. The assemblage of fish present in the waters of the area contains numerous introduced species that exclude desirable native species such as the Lahontan cutthroat trout.

The whitetop plant (*Lepidium draba* and *Lepidium laitfolium*) is very aggressive and eliminates desirable vegetation. The plant tends to grow in floodplains and near water courses over the entire region and can be spread over longer distances by water conveyance of seeds or root fragments. Unfortunately, although the plant's root system is extensive, it does not hold soil during flood events resulting in bank caving along water courses as is shown in the photograph below. Most of the water courses in the region have a whitetop infestation that may extend up to tens of thousands of acres, presenting a major problem. Control methods include mechanical removal, grazing by sheep and goats during the pre-flowering phase, and multiple applications of herbicides, which is the proposed method at this time.

In the lower elevations of the region, human-made, multipurpose reservoirs were constructed originally for agriculture, flood control, and urban and recreational uses. But increasingly, often through legal intervention and water rights purchases, they have been turned to environmental restoration and urban uses. The ecosystems of human-made reservoirs differ from those of natural lakes in that the reservoir levels rise and fall. They are generally steeper sided, and thus vegetative littoral (shore side) zones are not established. Generally, habitat structural diversity is reduced, altering fish populations.

Lastly, an update to the spotting of a lone wolverine that entered the region in 2009: As of February 2012, the same specimen still resided in the Tahoe National Forest. Early in 2012, a gray wolf tagged with a radio collar in Idaho and called OR-7 visited the region. This male wolf was near Litchfield in Lassen County not far from Susanville, but has since left the state and the region.

Flood

Approximately 4,000 people are exposed to the 500-year flood event in the North Lahontan region, as well as approximately $823 million in the value of structures and $10 million in the value of crops. Flooding primarily occurs in the Truckee River region, including Lake Tahoe, Honey Lake, Walker River Basin, and Susan River. Martis Creek Reservoir is identified as being at high risk for catastrophic failure, which could result in severe flooding downstream; therefore, the reservoir only operates as a check and is not filled. Floods in the hydrologic region originate principally from the melting of the Sierra snowpack and from rainfall in December and January.

Major floods occur less regularly in the North Lahontan region compared with most of the state. Major historic floods in the hydrologic region include floods in February 1968, February 1986, and January 1997. In February 1968, continuous rain for nearly a week caused extensive flooding in the Honey Lake watershed. The Susan River and storm drains overflowed, inundating roads and stranding travelers in Susanville. Flooding in Honey Lake Valley isolated many ranchers from emergency services. In January 1997, an intense rainstorm falling on a large snowpack caused catastrophic flooding throughout the hydrologic region. The West Fork Walker River damaged approximately 6 miles of Highway 395 and 100 homes in Walker and Antelope Valley. The swollen Truckee River destroyed sewer and power lines leading to ski resorts, inundated residences and stores in Truckee, and damaged 20 bridges and several stream gauges and destroyed a power plant diversion. In Alpine County, floodwaters washed out road shoulders, destroyed bridges, and damaged Highways 4, 88, and 89; damages for the county were estimated at $8.4 million. The flood control of the region, other than in the Lake Tahoe region, is not well developed; and therefore, some agricultural and urban areas are subject to flooding by flood events of one percent probability or less. In addition in the Tahoe region, the U.S. Army Corps of Engineers (USACE) Martis Creek Dam is subject to seepage and potential collapse if the pool is raised. Therefore, it is operated with spillways open at all times until the problem is addressed. Other dams in the Tahoe area have been proposed to being raised slightly to allow them to contain a recently revised maximum credible flood event.

Whitetop (perennial pepperweed) roots do not form interlocking mesh that holds soil.

Climate

Dry summers with occasional scattered thundershowers characterize the region's climate. Most precipitation falls in late fall and winter. Precipitation is less than 5 inches in the valleys of eastern Modoc and Lassen counties. Precipitation is about 30 inches in the Walker Mountains and more than 60 inches in the Sierra Nevada in the upper reaches of the Truckee, Carson, and Walker River basins. Most of the winter precipitation is snow, which generally accumulates in mountain areas above 5,000 feet. In the valleys, winter precipitation is a mixture of rain and some snow, which usually melts between storms. Snowpack from the eastern slopes of the Sierra Nevada melts in the late spring and summer to become the primary source of surface water supplies for northern Nevada and for much of California in the region east of the Sierra.

Demographics

Population

The North Lahontan region has the smallest population of the state's 10 hydrologic regions. As of 2010, about 111,762 people live in this region (approximately 0.3 percent of the state's total population). Incorporated cities account for 56 percent of the region's population. Between 2000 and 2010, the region shrank by 2,125 people, a decline of 2.15 percent over the 10-year period. For areas not near the population center in and around Lake Tahoe, the trend is for slow growth and maintenance of an agriculture and recreation-based lifestyle with some increase in timbering for the sole purpose of reducing the severity of wildfire.

In the Tahoe-Truckee region, the populace of the Truckee region grew by 14 percent while that in the Lake Tahoe basin within California declined by 9 percent. Overall the population of the two areas combined, declined 3.5 percent because the majority of the population was in the Tahoe Basin. The increase in water use in Truckee is related to recreation and part-time vacation home visits, and the services that relate thereto. There is also a trend toward developments that may increase the amount of recreational usage, but at the same time reduce the environmental impacts by replacing facilities that were not as environmentally friendly.

Tribal Communities

Tribes in the North Lahontan region are given in Table NL-8. Each tribal community that is listed as having land also has water rights for that land. In addition to land holdings within the North Lahontan region, there are 14 allotments within the region that tribal communities have the right to use, including the collection of vegetation.

Currently, tribal landholdings located in this region include Antelope Valley (Coleville), Bridgeport, Cedarville, Fort Bidwell, Meeks Bay, Susanville (Susanville, Honey Lake, Maidu Nation, and Wadatkuta), and Woodfords reservations, rancherias, and communities. The Pyramid Lake and Walker River Paiute tribes have their land bases in Nevada. Approximately 14 individual allotments are also located within this region.

Table NL-8 California Native American Tribes in the North Lahontan Hydrologic Region

California Native American Tribe	Cultural Affiliation
Andrew Jackson, Susanville, CA	Aporiage (Pit River Tribe) and Maidu
Antelope Valley Paiute Tribe, Coleville, CA	Maidu
Honey Lake Maidu	Maidu

Source: California Native American Heritage Commission

Tribal Collaborative Efforts

The Walker River Tribe actively participates in the Walker River Recovery Implementation Team and the Management Oversight Group, as well as monitoring water conditions on the Walker River.

The Washoe Tribe has a series of memorandums of understanding (MOUs) with the U.S. Forest Service for land use management in the Lake Tahoe Basin. In 2008, a pilot program was initiated to use traditional stewardship practices to regenerate meadow vegetation.

The Pyramid Lake Tribe is working with the U.S. Fish and Wildlife Service on Lahontan cutthroat trout restoration and recovery; the tribe is part of the management oversight team.

Concerns and priorities:

- Protection of surface waters from contamination.
- Maintaining sufficient flow to sustain a healthy environment.
- Dam removal performed in a manner that avoids or mitigates negative environmental effects.
- Water rights.
- Water quality: Water may be accessible, but quality is not acceptable for use.
- Watershed restoration using natural, indigenous plants.

Challenges tribes are facing regarding water or water-related conditions:

- Pressure from urban, agriculture, and industrial interests to divert increasing quantities of water from instream flows.
- Falling water tables that dry up historical springs.
- Local agencies lacking cultural sensitivity needed to work with tribes.
- Lack of long-term water quality monitoring data and need to establish same.

Disadvantaged Communities

Disadvantaged community status is determined based on the DAC definition provided in DWR's Proposition 84 and 1E Integrated Regional Water Management (IRWM) Guidelines. The State defines a DAC as a community with an annual median household income of less than 80 percent of the statewide MHI. There are a total of 17 DACs as identified by DWR's DAC mapping tool.

Six DACs are located in the Lahontan Basins' IRWM region, five in the Tahoe-Sierra IRWM region, two in the Inyo-Mono IRWM region; and four DACs are in an area without an IRWM group, established in the Surprise Valley area of Modoc County.

Land Use Patterns

The North Lahontan region consists mainly of national forests, lands under the jurisdiction of the U.S. Bureau of Land Management, and ski and vacation resorts. Cattle ranching is the principal agricultural activity, and pasture and alfalfa are the dominant irrigated crops. Commercial crop production is limited because of the short growing season, although garlic has been grown in Antelope Valley near Coleville on the West Walker River in the region's southern portion and also in Surprise Valley in eastern Modoc County.

The majority of the counties in the North Lahontan region are wild lands or open space owned by the government. Some of the counties, notably those at the extreme north and south ends of the region have significant numbers of acres dedicated to agriculture. The portions of Nevada, Placer, and El Dorado counties within the North Lahontan region have zero acres of active agriculture. The Modoc and Lassen counties have 45,751 and 79,134 acres of active agriculture, respectively.

In the Truckee-Tahoe area and surrounding mountains, tourism and recreation are the principal economic activities. The lower meandering streams of the Walker, Carson, and Truckee rivers are famous for trout fly-fishing and also offer water sports, hiking, and camping with the eastern Sierra as a backdrop. On a typical summer day in the high country, visitors in the Tahoe basin will outnumber full-time residents. During the winter, the population swells again as ski resorts attract visitors from all over the world as well as California's urban areas due to the region's number of world-class resorts. Due to the beauty and recreational opportunities in these areas, a rapid increase in the number of new vacation homes in the 1990s and the early 21st century brought about controls on their effects to environmental issues such as stormwater and total daily maximum loads (TMDLs) along with the ascendancy of watershed protection groups. Urban growth in the Lake Tahoe Basin is controlled by the Tahoe Regional Planning Agency (TRPA), which is responsible for protecting the basin's sensitive environment and water quality.

State wildlife areas around Honey Lake divert water to provide important habitat for waterfowl and several threatened or endangered species, including the bald eagle, sandhill crane, bank swallow, and peregrine falcon.

Regional Resource Management Conditions

Water in the Environment

The North Lahontan region's rivers, in decreasing order of flow magnitude, are the Truckee, Walker, Carson, and Susan. An ongoing concern is the clarity of Lake Tahoe, which has been the subject of a $1.2 billion program and MOU between the United States and the states of California and Nevada. The east and west forks of the Carson River and Leavitt Creek, a tributary to the West Carson, are wild and scenic rivers. The east fork of the Carson River, Heenan Lake on Heenan Creek, a tributary to the east fork, the East Walker River, the Little Truckee River, and Martis Creek Lake are trophy trout waters. Lahontan cutthroat trout, Paiute cutthroat trout found in Silver King Creek, and Eagle Lake Rainbow trout are heritage trout, or trout that existed in California before the intervention of European societies.

Another initiative in the region in the area of water governance is Truckee River Operating Agreement (TROA) (http://www.usbr.gov/mp/troa/final_oa/index.html). If implemented, it would resolve basin-wide issues for a number of water rights decrees, court orders, and purchased water rights that affect the Truckee and Carson rivers. TROA contains operating procedures designed to make more efficient use of existing Truckee River reservoirs and to provide multiple benefits, such as enhanced conditions for endangered cui-ui (pronounced *kwee-wee*) and threatened Lahontan cutthroat trout; reduced streamflow variability; improved streamflows and water quality in all seasons; and maintenance of reservoir storage to better serve recreational uses.

The principal environmental uses of water in the North Lahontan region are those of State wildlife areas around Honey Lake. The Honey Lake Wildlife Area (HLWA) in southern Lassen County consists of the 4,271-acre Dakin Unit and the 3,569-acre Fleming Unit. The two units provide important habitat for several threatened or endangered species, including the bald eagle, sandhill crane, and bank swallow. This wildlife area has winter-storage rights from the Susan River from November 1 until the last day of February. The HLWA also operates eight wells, each producing between 1,260 and 2,100 gpm. In an average year, the HLWA floods 3,000 acres by March 1 for waterfowl brood habitat.

In 1989, the California Department of Fish and Wildlife (DFW) purchased the 2,714-acre Willow Creek Wildlife Area in Lassen County to preserve existing wetlands and to increase the potential for waterfowl production and migration habitat. About 2,000 acres are wetlands and riparian habitats. The endangered bald eagle and sandhill crane also inhabit this area. The DFW operates the Doyle Wildlife Area, also in the Honey Lake Basin. This wildlife area is protected as dry land winter range for deer and requires less water than the Honey Lake or Willow Creek areas.

In the southern portion of the region, the DFW has established the Slinkard/Little Antelope Valley Wildlife Area. This area of previously established agricultural land to the west of Topaz and Walker, California, uses water from legacy irrigation works to create deer and wildlife habitat. Farther south, the West Walker River Wildlife Area uses water from streams, rivers, and springs for the same purpose.

Medical Marijuana Cultivation and Watershed Impacts

Some of the unanticipated consequences resulting from the passage of Proposition 215 in 1996 and Senate Bill 420 in 2003 (allowing for medical use of marijuana and its sale of through collectives) are the rise in ecological damages that are occurring in California's watersheds. The impacts of growing medical marijuana vary depending on whether it is produced in national forest, private land, or by hydroponic operations. Some of the impacts include (California Department of Fish and Game 2012):

- Unauthorized diversions from rivers, creeks, and streams.
- Lack of best management practices for roads, stream crossings, ponds, and cleared areas.
- Pollution from petroleum products, fertilizers, soils amendments, killing agents, sediment, thermal pollution, trash, and human waste.

Bridgeport, CA. Juvenile Lahontan Cutthroat Trout from By Day Creek Ecological Reserve.

- Deforestation, conversion, and fragmentation of natural areas and wildlife habitat.
- Impacts to sensitive species and habitats.

This is both an urban and rural problem. Regulatory and planning approaches to reduce the environmental impacts have had its impediments. One issue concerns the federal government. The federal government has threatened to prosecute local officials if actions prohibited under U.S. law (such as growing medical marijuana) are somehow sanctioned through permitting or zoning. Requiring permits or providing zoning ordinances to help address the environmental impacts of growing marijuana can be considered to be sanctions of a federally prohibited activity (Zuckerman 2013). This viewpoint is changing with recent federal guidance provided by the U.S. Department of Justice. The guidance identifies federal enforcement priorities focusing on criminal enterprises, interstate trafficking, firearms, preventing the growing or possession of marijuana on public lands, and preventing State-authorized activity from being used as a cover or pretext for trafficking of other illegal drugs or other illegal activity (U.S. Department of Justice 2013).

Permits that can be enforced deal with site development on private lands consistent with State and federal law. These permits and associated requirements apply to any site preparation work, regardless of crop. Cultivation of medical marijuana may ultimately fall under the Agricultural Lands Discharge Program. Discharges of waste from site development and growing activities on U.S. Forest Service land are not authorized and are subject to immediate enforcement actions under the CWC (State Water Resources Control Board 2013).

Efforts to reduce the environmental damage are a focus of the 2014-15 State budget. Funding is proposed for several positions to address illegal diversions and impacts to water quality and sensitive habitats. Excerpts from the budget are provided below.

- Enforcement of Marijuana Cultivation Laws — $1.8 million Waste Discharge Permit Fund and 11 positions (for the SWRCB) to improve the prevention of illegal stream diversions, discharges of pollutants into waterways, and other water quality impacts associated with marijuana production. This proposal will be a coordinated effort with the DFW.
- Marijuana Related Enforcement — $1.5 million from various special funds and seven positions (for DFW) to investigate and enforce violations of illegal streambed alterations and the Endangered Species Act associated with marijuana production. This proposal will be a coordinated effort with the State Water Resources Control Board.

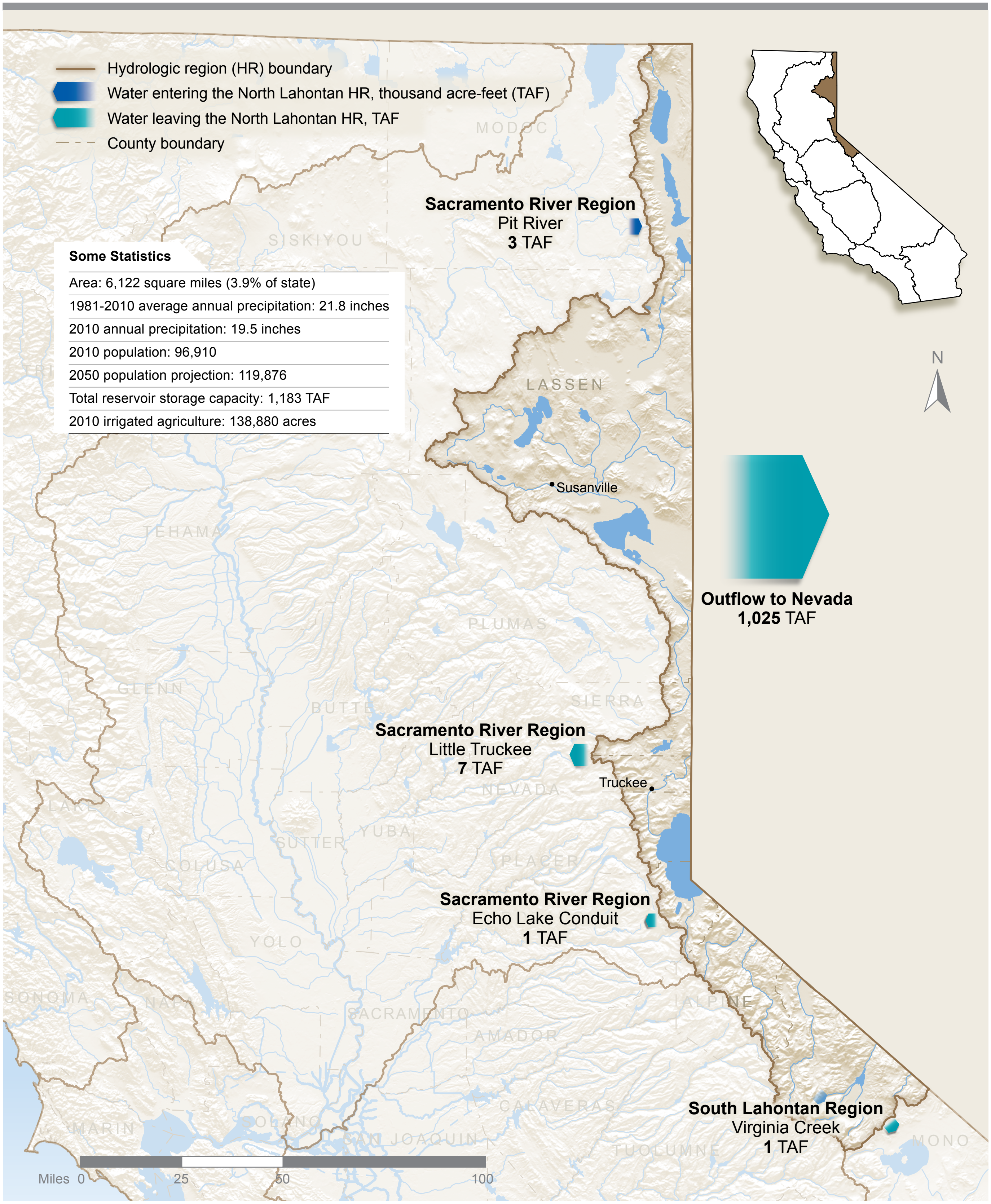
Water Supplies

For an overview of the region’s water inflows and outflows, see Figure NL-9.

Surface Water

Unimpaired runoff of the streams and rivers of the North Lahontan region averages 1.5 million acre-feet (maf) per year, of which only about one-fifth occurs in the drier, northern portion. The largest rivers in the region and their average regulated runoff at the Nevada state line are the Truckee River with 540,000 acre-feet (af); the Carson River, 469,000 acre feet; and the Walker River, 428,000 af. The Susan River is the only major river in the northern half of the region. The average annual discharge from the Susan River at Susanville is about 60,000 af.

Figure NL-9 **North Lahontan Regional Inflows and Outflows in 2010**



Runoff in Modoc County flows into terminus lakes, specifically the upper, middle and lower lakes in Surprise Valley. A smaller portion of the runoff from the north and east portions of the region flow into basins that feed groundwater in Oregon and Nevada. The Susan River flows in a southerly direction into Honey Lake in Lassen County, and Long Valley Creek flows in a northerly direction to the same lake. There is an interbasin transfer into the North Lahontan region from the South Pit River system, which is in the Sacramento River Hydrologic Region from Moon Lake (formerly Tule Lake Reservoir) and to the Madeline Plain basin.

Most of the runoff in the Truckee River Basin originates in the Sierra Nevada in California. A portion of that runoff is stored in federal reservoirs — Lake Tahoe in California and Nevada and Prosser Creek, Stampede, Boca, and Martis Creek reservoirs — and non-federal reservoirs — Donner and Independence lakes in California. Operation of these reservoirs regulates much of the flow in the Truckee River Basin in most years. Together these reservoirs can store about a maf of water. A number of court decrees, agreements, and regulations govern day-to-day operations, administered by the Federal Water Master for the Orr Ditch court. The reservoirs are operated to capture runoff as available when flow in the river is greater than that needed to serve downstream water rights in Nevada and to maintain prescribed streamflows in the Truckee River. The prescribed streamflows are known as Floriston rates and are measured at the Farad gage near the California-Nevada state line. Floriston rates provide water for hydropower, urban use in Truckee Meadows, instream flow, and agricultural water rights. In general, each reservoir has authorization to serve specific uses. Releases are made from the reservoirs as necessary to meet dam safety or flood control requirements and to serve water rights when unregulated flow cannot be diverted to serve those rights. Minimum reservoir release rates are maintained as specified in applicable agreements and the reservoir licenses.

Water is exported from this region through an interbasin diversion (6,000 to 10,000 acre-feet per year[af/yr.]) from the Little Truckee River in the vicinity of Henness Pass to Sierra Valley in the Sacramento River Hydrologic Region for agricultural use. This diversion began in the late 19th century. Of similar vintage is a diversion of a lesser amount, approximately 1,000 af/yr., from Echo Lake south of Lake Tahoe into the Sacramento River Hydrologic Region for hydroelectric power generation.

In the southern half of the region, the east fork of the Carson River originates south of Ebbetts Pass in the Carlson-Iceberg wilderness at an elevation of 11,460 feet. The west fork of the Carson River originates near Lost Lakes at an elevation of 9,000 feet. The two forks cross the California-Nevada border and rejoin a mile southeast of Genoa, Nevada, to form the main stem. The only regulation on the Carson River in California are the relatively small (3,100 af) Heenan Lake Dam and Indian Creek Reservoir (3,100 af) on tributaries to the east fork of the Carson River.

Farther south on the Walker River, both Bridgeport Reservoir and Topaz Lake are large reservoirs operated by the Walker River Irrigation District to capture the spring snowmelt from the Sierra Nevada and provide summer irrigation water to Nevada farmers in that watershed. Because of the continuing lowering of the level of Walker Lake (the terminus lake for the Walker River) and resultant increase in total dissolved solids, water rights on the Walker River are currently being litigated.

Table NL-9 lists the major lakes and reservoirs in the North Lahontan region other than the USACE Martis Creek Lake, which is used only to impound water if inflows exceed what the dam structure can release; it is not used for storage.

Groundwater

Groundwater supply estimates are based on water supply and balance information derived from DWR land use surveys and from groundwater supply information that water purveyors or other State agencies voluntarily provide to DWR. Groundwater supply is reported by water year (October 1 through September 30) and is categorized according to agriculture, urban, and managed wetland uses. The groundwater information is presented by planning area, county, and type of use.

Figure NL-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 513 taf, of which 166 taf is from groundwater supply (32 percent). (Reference to total water supply represents the sum of surface water and groundwater supplies in the region, local reuse.) The figure also shows that the Lassen Planning Area is the larger user of groundwater in the region, being supplied with an annual average of 148 taf (89 percent of the total groundwater supply in the region).

Table NL-10 provides the 2005-2010 average annual groundwater supply by planning area and type of use. Groundwater supplies meet 27 percent (118 taf) of the overall agricultural water use, 84 percent (37 taf) of the overall urban water use, and 48 percent (11 taf) of managed wetland uses in the region. Although the Alpine Planning Area relies on groundwater supplies for only 11 percent of its overall water use, 82 percent of the urban water use in the Alpine Planning Area is met by groundwater. The Lassen Planning Area provides an average annual groundwater supply of 148 taf (43 percent of the overall water supply), which meets 39 percent of the agricultural water use, 85 percent of the urban water use, and 48 percent of the managed wetlands use in the planning area.

Although groundwater extraction in the region accounts for only about one percent of California's 2005-2010 average annual groundwater supply, it accounts for nearly 100 percent of the supply for some local communities in the region.

Regional totals for groundwater based on county area will vary from the planning area estimates shown in Table NL-10 because county boundaries do not necessarily align with planning area or hydrologic region boundaries.

For the North Lahontan region, county groundwater supply is reported for Lassen and Alpine counties. Table NL-11 shows that the total groundwater supply in the two counties is about 129 taf, with all of that pumping occurring in Lassen County. Groundwater contributes 36 percent of the total water supply in Lassen County and meets 33 percent of the agricultural water use, 80 percent of the urban water use, and 42 percent of the managed wetlands use.

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

The right side of Figure NL-11 illustrates the annual amount of groundwater versus other water supply, while the left side identifies the percent of the overall water supply provided by groundwater relative to total water supply. The center column in the figure identifies the water year along with the corresponding amount of precipitation, as a percentage of the 30-year running

Table NL-9 Major Lakes and Reservoirs in the North Lahontan Hydrologic Region

	Active Storage (af)	Date	Description	Major Tributary
NORTHERN				
Eagle Lake	550,000[a]	Geologic	Terminal lake	Pine Creek
Honey Lake	Variable	Geologic	Terminal lake	Susan River
MIDDLE				
Boca Reservoir	41,100	1937	U.S. Bureau of Reclamation	Little Truckee River
Donner Lake	9,500	1930s	Truckee Meadows Water Authority, Truckee-Carson ID	Snowmelt
Independence Lake	17,500	1939	Truckee Meadows Water Authority	Snowmelt
Lake Tahoe	744,600[b]	1913	U.S. Bureau of Reclamation	Upper Truckee River
Prosser Creek Reservoir	29,800	1962	U.S. Bureau of Reclamation	Prosser Creek
Stampede Reservoir	226,500	1970	U.S. Bureau of Reclamation	Little Truckee River
SOUTHERN				
Bridgeport Lake	44,000	1924	Walker River Irrigation District	E. Walker River
Heenan Lake	3,100	1923	DFW fish rearing lake	E. Heenan Lake Creek
Topaz Lake	65,000	1937	Walker River Irrigation District	W. Walker River

Notes:

af = acre-feet, DFW = California Department of Fish and Wildlife

[a] No controlled outflow

[b] This represents the acre-feet that is in top 6.1 feet above the rim and therefore controllable.

average for the region. The figure shows that the annual water supply in the region has fluctuated between 440 taf in 2005 and 550 taf in 2007. The annual groundwater supply has fluctuated between 140 taf in 2005 and 180 taf in 2007, providing between 32 and 34 percent of the total water supply.

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

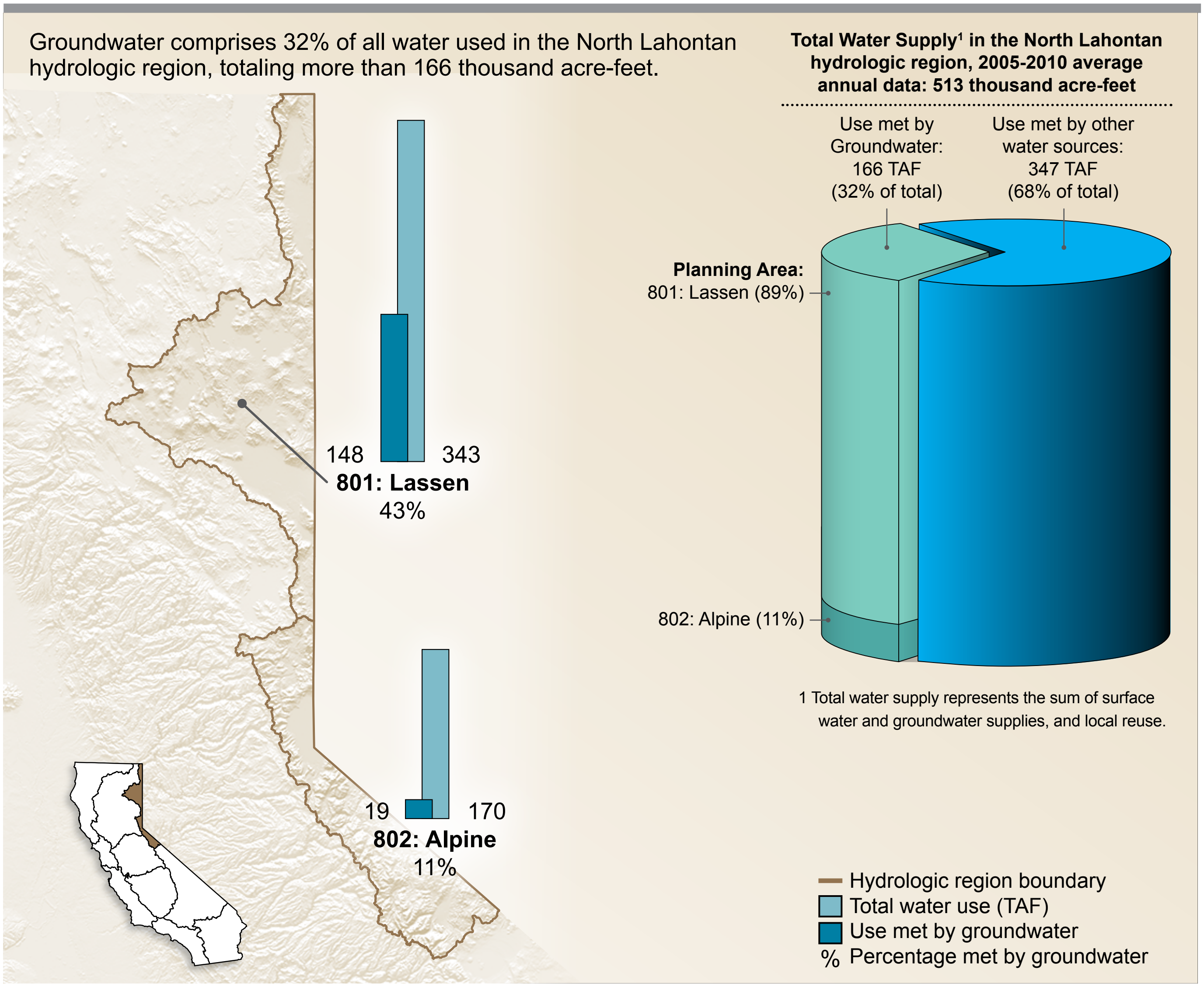


Figure NL-12 shows the annual amount and percentage of groundwater supply trends for meeting urban, agricultural, and managed wetland uses. The figure indicates that 70 to 75 percent of the annual groundwater supply met agricultural use and 20 to 25 percent of the annual groundwater supply met urban water use, while the remaining groundwater supply met managed wetlands use.

Geothermal

The City of Susanville pumps geothermally heated groundwater and uses it for heating its central district. In addition, in Cedarville the Surprise Valley High School, elementary school, and the medical clinic are heated by 130 °F water from geothermal wells 1,860- and 1,135-feet deep. The system discharges these waters at a rate of approximately 50 af/yr. to an irrigation ditch and an old mill pond. Also at the upper end of Surprise Valley as was noted in Update 2009, the Fort Bidwell Indian Reservation had drilled several geothermal wells that had been used for heating

Table NL-10 North Lahontan Hydrologic Region Average Annual Groundwater Supply by Planning Area (PA) and by Type of Use (2005-2010)

North Lahontan Hydrologic Region		Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
PA NUMBER	PA NAME	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT
801	Lassen	117.8	39	18.9	85	10.7	48	147.5	43
802	Alpine	0.6	0	18.2	82	0.0	0	18.8	11
2005-2010 annual average region total		**118.4**	**27**	**37.1**	**84**	**10.7**	**48**	**166.3**	**32**

Notes:

TAF = thousand acre-feet

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

2005-2010 precipitation equals 94 percent of the 30-year average for the North Lahontan Region.

Table NL-11 North Lahontan Hydrologic Region Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

North Lahontan Hydrologic Region	Agriculture Use Met by Groundwater		Urban Use Met wby Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
COUNTY	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT
Lassen	99.2	33	18.7	80	10.7	42	128.6	36
Alpine	0.0	0	0.0	0	0.0	0	0.0	0
2005-2010 annual average total	**99.2**	**31**	**18.7**	**79**	**10.7**	**4**	**128.6**	**35**

Notes:

TAF = thousand acre-feet

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

2005-2010 precipitation equals 94 percent of the 30-year average for the North Lahontan Hydrologic Region.

and an experimental aquaculture operation. In October 2007, another geothermal exploratory well was drilled at Fort Bidwell; however, lack of funding caused the well to be left untested. In 2012, the Geothermal Resources Development Account funded researchers to complete the planned assessment of the geothermal resource, but the well had an obstruction that precluded carrying out the planned measurements and assessment. The Assessment of Fort Bidwell Geothermal Well FB-4, written by the Fort Bidwell Indian Community Council, recommended returning to the well with a drilling rig to clean out the obstruction and rig test the well. It is estimated that the minimum reservoir temperature will be about 289 °F (Fort Bidwell Indian Community Council 2012).

Figure NL-11 North Lahontan Hydrologic Region Annual Groundwater Water Supply Trend (2002-2010)

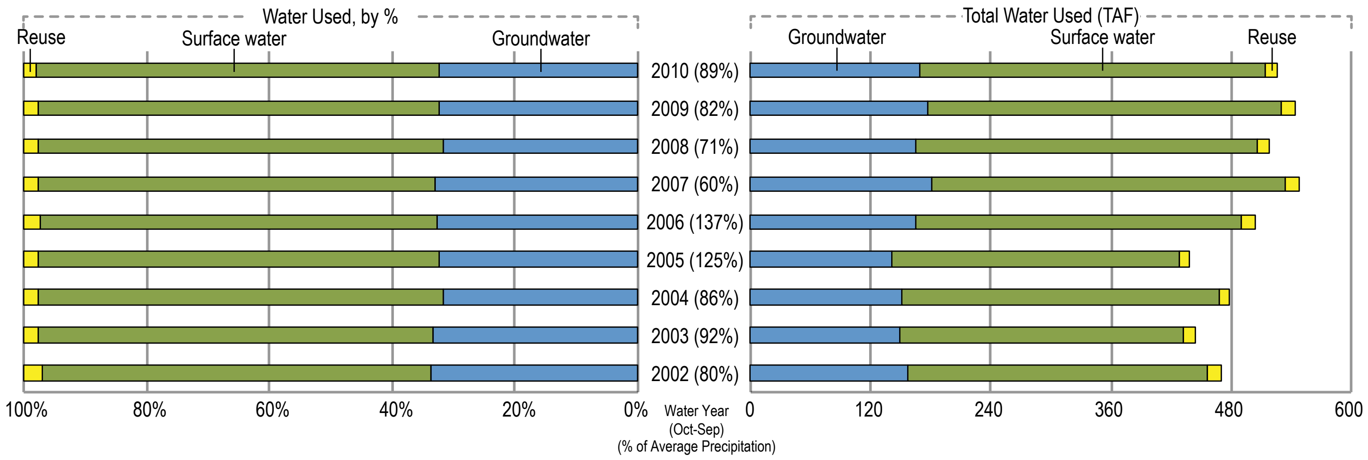
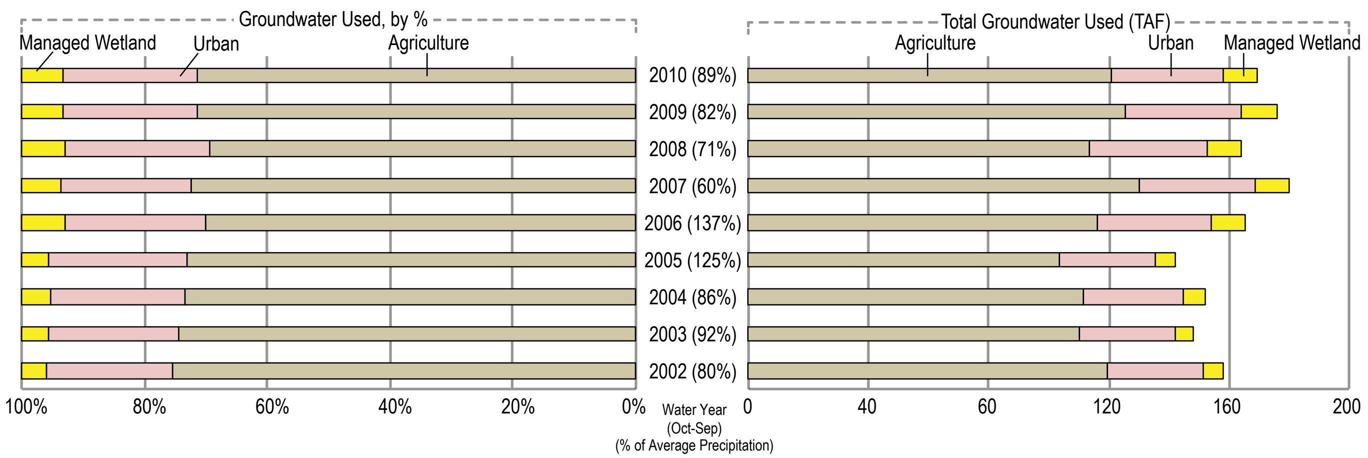


Figure NL-12 North Lahontan Hydrologic Region Annual Groundwater Supply Trend by Type of Use (2002-2010)



Recycled Water

Approximately 5,000 af of reclaimed municipal wastewater is exported annually out of the Lake Tahoe Basin (to Alpine County) by the South Tahoe Public Utility District for agricultural irrigation in the Carson River watershed. A slightly smaller amount of sewage effluent, in aggregate, is also exported from the basin by two sanitary districts on the Nevada side of Lake Tahoe. The only other documented recycling occurring in the North Lahontan region is at the Susanville Department of Corrections facilities — approximately 130 af of recycled water was used for agricultural irrigation in 2009.

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

Water Uses

The major agricultural use of water in the North Lahontan region is irrigated pasture or alfalfa, although garlic had been grown near Coleville in the south. Pasture and alfalfa can require three to four af of water each growing season. Grain crops require less, only needing to be irrigated early in the season with one to one and one-half af of water. Typically, surface water is used during the spring runoff from snowmelt-fed streams, and then groundwater is used to supplement that flow through the end of the irrigation season at the end of August. Urban water use is less than that for agriculture, but is of growing importance. The major increases in population are in the region's neighboring state, Nevada. Most California urban uses are supplied by groundwater; urban use is growing in the population centers of Truckee, the Lake Tahoe area, and the city of Susanville. A major portion of the water resources in the Truckee River Basin are used for environmental enhancement, mostly in Nevada, except that instream flows in California are additionally met as the water flows from California to Nevada.

Drinking Water

The region has approximately 56 community drinking water systems. The majority (more than 85 percent) of these community drinking water systems are considered small (serving fewer than 3,300 people) with most small water systems serving fewer than 500 people (Table NL-12). Small water systems face unique financial and operational challenges in providing safe drinking water. Given their small customer base, many small water systems cannot develop or access the technical, managerial, and financial resources needed to comply with new and existing regulations. These water systems may be geographically isolated, and their staff often lacks the time or expertise to make needed infrastructure repairs; install or operate treatment; or develop comprehensive source water protection plans, financial plans, or asset management plans (U.S. Environmental Protection Agency 2012).

In contrast, medium and large water systems account for less than 15 percent of region's drinking water systems; however, these systems deliver drinking water to more than 70 percent of the region's population. These water systems generally have financial resources to hire staff to oversee daily operations and maintenance needs and to plan for future infrastructure replacement and capital improvements. This helps to ensure that existing and future drinking water standards can be met.

Snowmaking

One use of water unique to the Lake Tahoe and Truckee basins is water used for snow-making at ski areas. TROA contains special provisions for snow-making water. Snow-making water is mostly recovered through springtime melting; therefore, a major fraction of snow-making water under TROA would not be counted in calculating the allocation of water between California and Nevada. California is allowed 825 af/yr., and Nevada is allowed 350 af/yr. These must be reported, but they are not counted against either's allocation under TROA because snow-making is not a consumptive use. After the water freezes it melts and returns to the system, with an insignificant amount evaporating.

Table NL-12 Summary of Large, Medium, Small, and Very Small Community Drinking Water Systems in the North Lahontan Hydrologic Region

Water System Size by Population	Community Water Systems (CWS)		Population Served	
	SYSTEMS	PERCENT	POPULATION	PERCENT
Large >10,000	3	5	56,730	57
Medium 3,301 – 10,000	3	5	18,134	18
Small 500 – 3,300	18	32	19,087	19
Very Small <500	32	57	5,224	5
CWS that primarily provide wholesale water	0	0	---	---
Total:	**56**	**---**	**99,175**	**---**

Source: California Departrment of Public Health (CDPH) Permits, Inspection, Compliance, Monitoring, and Enforcement Database, June 2012.

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

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

Four North Lahontan urban water suppliers have submitted 2010 urban water management plans to DWR. The Water Conservation Law of 2009 (SB X7-7) required urban water suppliers to calculate baseline water use and set 2015 and 2020 water use targets. The urban water management plans indicate the North Lahontan region had a population-weighted baseline average water use of 265 gallons per capita per day with an average population-weighted 2020 target of 213 gallons per capita per day. The baseline and target data for the North Lahontan urban water suppliers is available on the DWR Urban Water Use Efficiency Web site http://www.water.ca.gov/wateruseefficiency/.

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. No plans were submitted from the North Lahontan region. The region has no agricultural suppliers over the 25,000 irrigated-acres threshold.

Water Balance Summary

Figure NL-13 summarizes the total developed water supplies and distribution of the dedicated water uses within this hydrologic region for the 10 years from 2001 through 2010. As indicated by the variation in the horizontal bars for wet (1998) and dry (2001) years, the distribution of the dedicated supply to various uses can change significantly based on the wetness or dryness of the water year. The more detailed numerical information about the developed water supplies and uses is presented in Update 2013, Volume 5, *Technical Guide*, which provides a breakdown of the components of developed supplies used for agricultural, urban, and environmental purposes and water portfolio data.

In the North Lahontan region, agricultural water use is the largest component of developed water supply, and water for instream flows is the largest use of environmental water. Urban water uses in this region are a much smaller portion of the total. The water supply portion of Figure NL-13 also indicates that the largest supply source is from surface water flows followed by groundwater use and water reuse from agricultural runoff.

Presented in Table NL-13 is the total water supply available to this region for the 10 years from 2001 through 2010, and the estimated distribution of these water supplies to all uses. The annual change in the region's surface water and groundwater storage is also estimated as part of the balance between supplies and uses. In wetter water years, water will usually be added to storage; but during drier water years, storage volumes may be reduced. Of the total water supply to the region, more than half is either used by native vegetation; evaporates to the atmosphere; provides some of the water for agricultural crops and managed wetlands (effective precipitation); or flows to Nevada and terminus lakes. The remaining portion, identified as consumptive use of applied water, is distributed among urban and agricultural uses and for diversions to managed wetlands. For some of the data values presented in Table NL-13, the numerical values were developed by estimation techniques because actual measured data are not available for all categories of water supply and use.

Project Operations

Truckee River Reservoir Operations

System operations are governed primarily by the managing entities of seven lakes and reservoirs: Lake Tahoe, Donner Lake, Prosser Creek Reservoir, Martis Creek Reservoir, Independence Lake, Stampede Reservoir, and Boca Reservoir. A total of 1.09 maf of usable storage is available for managing water supplies. Of this total usable storage, a maximum of 65,000 af of joint-use space is used for flood control on a seasonal basis. As much as possible, the flood-control operations of Martis and Prosser creeks and Stampede and Boca reservoirs are coordinated to limit Truckee River flows at Reno to 6,000 cubic feet per second (cfs). The usable storage in these reservoirs is the key element to operations within the basin.

Estimates of the downstream demands, water content of the snowpack, and capacity of these facilities to store and control releases downstream govern operations in any particular year. The operations of these facilities are described below.

Central to the current operations of the Truckee River are the Floriston flow rates; these rates account for the flow of water that passes the gage at Farad, California, which is near the California-Nevada border. These flow rates are a legacy of a paper mill at Floriston that no longer exists and run-of-the-river hydroelectric plants, some of which still exist and are fed by flumes that are routed along the sides of Truckee Canyon on the river's path toward Reno. The Truckee River is currently operated in accordance with a number of agreements, the most recent being the Truckee River Agreement (TRA) signed in 1935. In part, the agreement confirmed the Floriston rates. The parties agreed to operate Lake Tahoe and Boca Reservoir to meet Floriston rates, which were modified to supply water for irrigation, municipal purposes, and hydroelectric generation. Floriston rates currently vary between 300 and 500 cfs depending on Lake Tahoe water surface elevation and season as shown in Table NL-14.

Table NL-13 North Lahontan Hydrologic Region Water Balance for 2001-2010 (in taf)

North Lahontan (taf)	Water Year (Percent of Normal Precipitation)									
	2001 (49%)	2002 (80%)	2003 (92%)	2004 (86%)	2005 (125%)	2006 (137%)	2007 (60%)	2008 (71%)	2009 (82%)	2010 (89%)
WATER ENTERING THE REGION										
Precipitation	3,756	5,752	6,560	6,132	8,992	9,714	4,244	5,042	5,851	6,347
Inflow from Oregon/Mexico	0	0	0	0	0	0	0	0	0	0
Inflow from Colorado River	0	0	0	0	0	0	0	0	0	0
Imports from Other Regions	3	3	3	3	3	3	3	4	3	3
Total	**3,759**	**5,755**	**6,563**	**6,135**	**8,995**	**9,717**	**4,247**	**5,046**	**5,854**	**6,350**
WATER LEAVING THE REGION										
Consumptive use of applied water[a] (Ag, M&I, Wetlands)	321	366	342	369	336	383	421	396	416	401
Outflow to Oregon/Nevada/ Mexico	389	730	921	738	1350	2001	742	772	911	1025
Exports to other regions	10	10	8	11	7	8	11	9	1	9
Statutory required outflow to salt sink	0	0	0	0	0	0	0	0	0	0
Additional outflow to salt sink	92	7	7	10	8	10	9	9	9	10
Evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, natural and incidental runoff, ag effective precipitation & other outflows	3,484	4,885	5,311	5,258	7,066	6,977	3,511	4,207	4,688	4,697
Total	**4,296**	**5,998**	**6,589**	**6,386**	**8,767**	**9,379**	**4,694**	**5,393**	**6,025**	**6,142**
CHANGE IN SUPPLY										
[+] Water added to storage [-] Water removed from storage										
Surface reservoirs	-430	-151	59	-170	307	434	-342	-254	-70	305
Groundwater[b]	-107	-92	-85	-81	-79	-96	-105	-93	-101	-97
Total	**-537**	**-243**	**-26**	**-251**	**228**	**338**	**-447**	**-347**	**-171**	**208**
Applied water[a] (ag, urban, wetlands) (compare with consumptive use)	496	538	506	546	499	573	625	591	619	599

Notes:

taf = thousand acre-feet

M&I = municipal and industrial

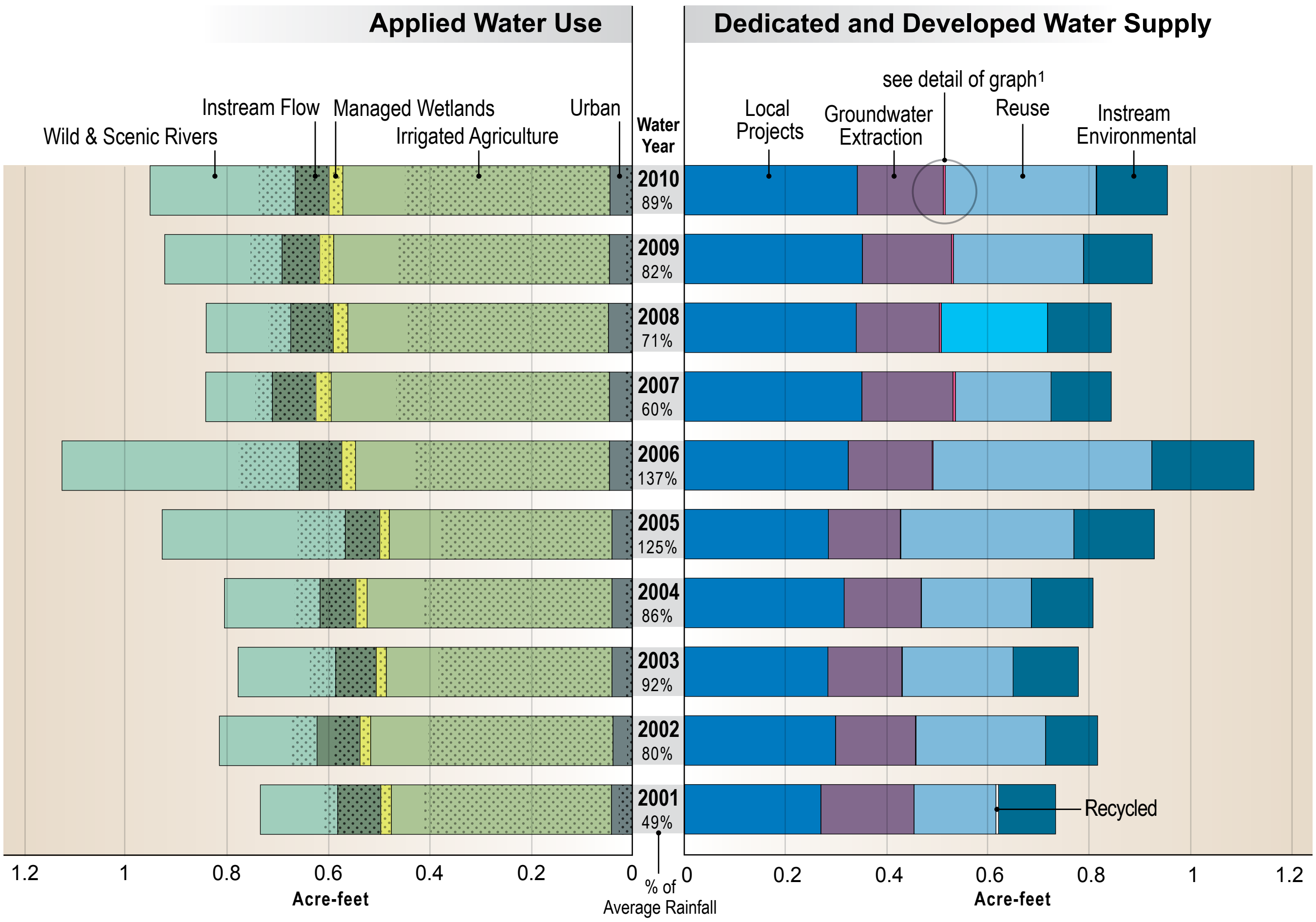
[a] Definition: Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

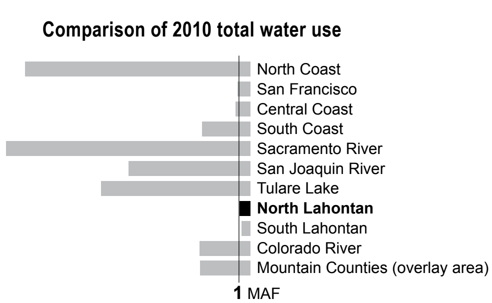
[b] Definition: Change in Supply: Groundwater – The difference between water extracted from and water recharged into groundwater basins in a region. All regions and years were calculated using the following equation: change in supply: groundwater = intentional recharge + deep percolation of applied water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

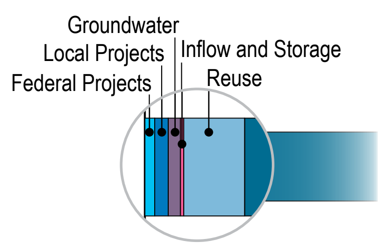
Figure NL-13 North Lahontan Hydrologic Region Water Balance by Water Year, 2001-2010

California's water resources vary significantly from year to year. Ten recent years show this variability for water use and water supply. Applied Water Use shows how water is applied to urban and agricultural sectors and dedicated to the environment and the Dedicated and Developed Water Supply shows where the water came from each year to meet those uses. Dedicated and Developed Water Supply does not include the approximately 125 million acre-feet (MAF) of statewide precipitation and inflow in an average year that either evaporates, are used by native vegetation, provides rainfall for agriculture and managed wetlands, or flow out of the state or to salt sinks like saline aquifers (see Table NL-13). 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.





[1] **Detail of bar graph:** *For water years 2001-2010, inflow & storage water varied from 0 to 5 TAF of the water supply.*



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.

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

	2001 (49%)	2002 (80%)	2003 (92%)	2004 (86%)	2005 (125%)	2006 (137%)	2007 (60%)	2008 (71%)	2009 (82%)	2010 (89%)
APPLIED WATER USE										
Urban	41	38	40	40	40	45	46	47	45	44
Irrigated Agriculture	435	479	446	484	440	502	550	515	545	528
Managed Wetlands	21	21	20	22	19	27	30	29	28	27
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	85	85	80	71	68	84	86	84	74	67
Wild & Scenic R.	153	193	193	189	362	469	132	167	232	287
Total Uses	**733**	**816**	**778**	**806**	**929**	**1,125**	**843**	**842**	**924**	**953**
DEPLETED WATER USE (STIPPLING)										
Urban	26	10	12	14	14	13	14	16	13	12
Irrigated Agriculture	369	365	342	369	337	384	421	394	418	405
Managed Wetlands	17	18	16	17	15	21	22	22	22	21
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	85	53	80	71	68	84	86	84	74	67
Wild & Scenic R.	29	50	50	50	92	119	33	42	62	72
Total Uses	**526**	**496**	**499**	**522**	**525**	**620**	**576**	**558**	**589**	**578**
DEDICATED AND DEVELOPED WATER SUPPLY										
Instream	113	103	129	122	159	202	119	126	136	140
Local Projects	269	298	283	315	284	323	351	339	352	341
Local Imported Deliveries	0	0	0	0	0	0	0	0	0	0
Colorado Project	0	0	0	0	0	0	0	0	0	0
Federal Projects	0	0	0	0	0	0	0	0	0	0
State Project	0	0	0	0	0	0	0	0	0	0
Groundwater Extraction	184	158	146	152	142	166	180	164	176	170
Inflow & Storage	0	1	1	1	1	2	5	4	4	4
Reuse & Seepage	162	256	219	217	342	432	188	210	256	298
Recycled Water	5	0	0	0	0	0	1	0	0	1
Total Supplies	**733**	**816**	**778**	**806**	**929**	**1,125**	**843**	**842**	**924**	**953**

Table NL-14 Basic Floriston Rates, Truckee River Flow at Farad

March – September	October – February
500 cubic feet per second	400 cubic feet per second

Floriston rates require that there be a mean flow of water in the Truckee River near Floriston of 500 cfs during the period from March 1 to September 30, and 400 cfs between October 1 and the last day of February. The TRA required that if there was insufficient flow from the remaining portion of the Truckee River system to meet the Floriston rates, water would be released, if possible, from Lake Tahoe to maintain those specific rates of flow. These basic Floriston rates were modified by the TRA in the event of insufficient flows even as augmented by Lake Tahoe. These modified flows are referred to as reduced Floriston rates. The reduced Floriston rates are dependent upon the level of Lake Tahoe and are as indicated in Table NL-15.

If the Floriston rate flows set forth in the TRA are not being met by natural flow, water must be released from Lake Tahoe and/or Boca Reservoir to maintain the required rate of flow.

Lake Tahoe

When water from Lake Tahoe is available, it is released to maintain Floriston rates as follows:

- Release from Lake Tahoe if Lake Tahoe water surface elevation is more than 6,225.5 feet above mean sea level mean sea level.
- Release from Boca Reservoir if Lake Tahoe water surface elevation is less than or equal to 6,225.5 feet above mean sea level.

When the Floriston rate is met without Lake Tahoe releases, sufficient water is released to maintain but not exceed minimum flows of 50 cfs from October 1 to March 31, and 70 cfs from April 1 to September 30 below Lake Tahoe Dam.

Donner Lake

Donner Lake has a capacity of 9,500 af. The dam at Donner Lake is operated to prevent the water surface elevation from exceeding 5,935.8 feet above mean sea level. If the lake elevation is less than 5,932.0 feet, no water can be released during June, July, and August. The elevation of Donner Lake must be lowered to 5,926.9 feet by November 15 to meet dam safety requirements. During normal operations, all inflow is released between November 15 and April 15. Donner Lake stores privately owned water, so releases are not used to meet Floriston rates.

Martis Creek Reservoir

Currently Martis Creek reservoir is operated in a spillway gates open mode only until seepage issues with the dam can be addressed. As such, Martis Creek Reservoir is operated only as a flow through reservoir unless its inflow rate exceeds the capacity of the spillway gates. At that point it would simply retard flow by storing it until reservoir levels lower until the reservoir again returns to the flow through condition.

Table NL-15 Reduced Floriston Rates, Truckee River Flow at Farad (cubic feet per second)

Lake Tahoe Elevation	October	November 1 – February 28-9	March	April – September
Under 6225.25 ft.	400	300	300	500
6225.25-6226 ft.	400	350	350	500
Above 6226 ft.	400	400	500	500

Prosser Creek Reservoir

Prosser Creek Reservoir has a storage capacity of 29,800 af. It has to be drawn down to provide 20,000 af of storage space for flood control by November 1 of each year. Other than the flood control space requirement, up to 30,000 af of water can be stored in Prosser Reservoir from April 10 to August 10 if the Floriston rate and Truckee Canal demands are met and if Boca, Independence, and Stampede reservoirs are full or at their flood control limits.

Independence Lake

The usable storage capacity of Independence Lake is 17,500 af. Truckee Meadows Water Authority (TMWA) has a pre-1914 right to store the first 3,000 af of water before the Floriston rate requirements are implemented. TMWA can store more water in Independence Lake only if Boca Reservoir is full and the Floriston rate is met. TMWA does not release water stored in Independence to meet Floriston Rates.

Stampede Reservoir

Stampede Reservoir has a storage capacity of 226,500 af. For flood control, Stampede Reservoir must be drawn down to have 22,000 af of storage space by November 1 of each year. A credit storage system has been established to use water supplies more efficiently to meet municipal and industrial demands as well as enhance the instream fishery; this system is currently in use and would likely be modified should TROA go into effect. Under this system, water stored can be credited for various purposes if all other water right demands are met. The credit-storage operation cannot adversely affect other water rights. Other than the flood control space requirement, water can be stored in Stampede Reservoir if Boca Reservoir and Independence Lake are filled and if the Floriston rates are met. Because it has junior water rights and because it does not have a water right permit for the full capacity of the reservoir, Stampede Reservoir seldom fills.

Boca Reservoir

Boca reservoir has a storage capacity of 41,100 af. For flood control, Boca Reservoir must have 8,000 af of storage space by November 1 of each year. If the Floriston rates are met, the reservoir can store up to 25,000 af before meeting Truckee-Carson Irrigation District (TCID) demand downstream. Boca Reservoir can store up to 40,000 af if the Floriston rates and Washoe County Conservation District demands are met. Releases are made from the reservoir or Lake Tahoe to maintain the Floriston rates.

Heenan Lake Reservoir

The only significant reservoir in the Carson River watershed in California is Heenan Lake Reservoir on Heenan Creek, with a capacity of 3,100 af. It is owned by the DFW and is used for the purpose of rearing trout. Its operations scheme is not known, but it is likely used just to provide pondage for the trout rather than actively for other purposes such as irrigation and certainly not for flood operations.

Bridgeport Reservoir

The second largest reservoir on the Walker River system is Bridgeport Reservoir located on the East Walker River. Completed in 1924, it is a 63-foot high dam that impounds approximately 44,000 af of water. Bridgeport Reservoir, along with Topaz Reservoir, constitutes Walker River Irrigation District's main facilities for water storage for agriculture in Nevada.

Topaz Reservoir

The largest reservoir on the Walker River system is the Topaz Reservoir located on the West Walker River. Completed in 1937, the reservoir has a capacity of 60,000 af and diverts water from the West Walker River via a 1,200-foot tunnel on the California side of the Topaz Lake to supply it. There is a canal on the Nevada side to return water back to the river.

Presented in Table NL-16 are most of the other reservoirs in the region except some that are so small that they are not within the jurisdiction of DWR's Division of Safety of Dams.

Water Quality

The region's surface water and groundwater is generally of high quality given its alpine origins, but water quality can be affected by human activities. In some areas, groundwater is affected by nitrate or methyl-tertiary butyl ether (MTBE) contamination. In Lake Tahoe fine sediment from urban stormwater runoff restricts the clarity of the lake. Some rivers and streams within the region are impaired by various other pollutants from metals in mining districts to pathogens in areas where grazing takes place. In addition to contamination from human activities, some groundwater is contaminated by chemical constituents that occur naturally in the environment, such as arsenic and uranium.

Surface Water Quality

Priority Subregional Water Quality Issues/Status

Truckee River. Stressors within the Truckee River watershed are primarily related to non-point-sources including the legacy effects from grazing, railroad construction, channel crossing and straightening, gravel mining, and an extensive road network. In 2012, the Truckee River Watershed Council began restoration of the lower alluvial fan of Cold Creek channel to create 0.8 acres of floodplain; remove 4,995 tons of fine sediment from eroding streambanks; re-grade stream banks to sustainable slopes along 1,035 feet of stream channel; increase existing riparian habitat by 0.8 acres; and improve hydrologic function to restore natural process and reduce risk of future downstream erosion (Truckee River Watershed Council 2013).

The Middle Truckee River Watershed TMDL was approved by the LRWQCB in May 2008 and by the U.S. Environmental Protection Agency in September 2009, as a plan to attain sediment-related water quality objectives to protect instream aquatic life beneficial uses (State Water Resources Control Board 2009). Flow events from thunderstorms, snowmelt, and dam releases were producing turbidity spikes that exceeded the water quality objective, and a TMDL for sediment was necessary. Population growth and urbanization within the surrounding region have also impacted the instream aquatic beneficial uses. The TMDL target is to reach the annual 90th percentile value of less than or equal to 25 milligrams per liter suspended sediment as measured at the Farad monitoring station (State Water Resources Control Board 2011). Additional information is available at: http://www.waterboards.ca.gov/lahontan/water_issues/programs/tmdl/index.shtml.

Lake Tahoe. The clarity and water quality in Lake Tahoe is of high importance and concern. The LRWQCB and the Nevada Division of Environmental Protection developed the Lake Tahoe TMDL to address the loss of deep water transparency and reduce the pollutants impacting the near shore environment. A comprehensive pollutant source analysis found that more than 70 percent of the fine sediment particles causing Lake Tahoe's deep water transparency loss originate in urban stormwater runoff. Roadways are a particularly high source of fine sediment particles. Other sources include runoff from undeveloped lands, streambank and bed erosion, and atmospheric deposition. The Lake Tahoe TMDL implementation plan emphasizes the reduction in fine sediment particles from urban stormwater runoff and the restoration of natural environments to reduce pollutant loading and enhance native habitat. Actions taken to reduce fine sediment particle loading are also expected to reduce the amount of nitrogen and phosphorus reaching Lake Tahoe, consequently reducing the amount of attached and floating algae near the lake's shore.

A regional plan adopted by the TRPA seeks to reduce loads of sediment and algal nutrients to Lake Tahoe to assist in implementing the Lake Tahoe TMDL and achieve other environmental standards, including water quality standards related to deepwater and nearshore conditions in Lake Tahoe. Strategies to achieve these water quality standards include implementing a multi-agency environmental improvement program to restore degraded watersheds and manage stormwater; promoting a land use and transportation pattern that reduces development in environmentally sensitive areas and minimizes vehicle trips; and regulating land uses and projects that could result in fine sediment, nutrient, or other pollutant loading into Lake Tahoe.

Carson, Susan, and Walker Rivers. Activities such as livestock grazing, camping, fishing, and mining, and the occurrence of droughts, floods, and wastewater effluent disposal have affected the water quality within the Carson and Walker river watersheds. The LRWQCB has set sodium standards for the Carson and Walker river watersheds in Resolution R6T-2006-0047, amending the Basin Plan (Lahontan Regional Water Quality Control Board 2006).

The Susan River Watershed currently has three impaired segments at the Honey Lake Wildfowl Management Ponds and the Susan River. The Honey Lake Wildfowl Management Ponds contain approximately 665 acres that are impaired with metals, salinity, total dissolved solids, and chlorides from agriculture and geothermal development activities, and the Susan River contains approximately 58 miles that are impaired with mercury from an unknown source. The proposed TMDL completion date is 2019 (U.S. Department of Agriculture 2011).

Table NL-16 Operations of Other Reservoirs in North Lahontan Region by County from North to South

County/ Reservoir	Owner	Latitude Longitude	Source	Storage (af)	Operations
MODOC					
Lake Annie	Schandler Ranch, Inc	41.9082/ -120.109	Eight Mile Creek	200	Early season release assumed
Fee Reservoir	Fee Ranch, Inc. & P.H. Peterson	41.8187/ -120.03	Rock Creek	7,120	Early season release assumed
LASSEN					
Antelope (Ducasse) Reservoir	Robert Harvey	40.8356/ -120.48	Madeline Plains	1,500	Early season release assumed
Buckhorn Reservoir	Edgar S. Roberts	40.852/ -120.09	Buckhorn Creek	2,000	Early season release assumed
Branham Flat Reservoir	Mapes Ranch, Inc.	40.7289 -120.51	Branham Creek	1,200	Early season release assumed
Dodge Reservoir	Edgar S. Roberts	40.9678 -120.14	Red Rock Creek	10,000	Early season release assumed
Eagle Lake	Not a reservoir	40.6027 -120.7012	Pine Creek is major tributary	500,000	Not actually operated; water leaks through Bly Tunnel into Willow Creek
Hog Flat Reservoir	Lassen Irrigation Company	40.4363 -120.91	Tributary to Susan River	8,000	Spring release ending no later than July 1
Horse Lake Reservoir	Snow Storm Ranch	40.6806 -120.39	Snowstorm Creek	75	Early season release assumed
Leavitt Lake	Lassen Irrigation Company	40.3756 -120.50	Tributary to Susan River	7,482	Early season release assumed
McCoy Flat Reservoir	Lassen Irrigation Company	40.4537 -120.94	Susan River	17,290	Spring release ending no later than July 1
Pete's Valley Reservoir	Pete's Valley Partners	40.5441 -120.45	Pete's Creek	240	Early season release assumed
Round Corral Reservoir	BLM	40.9 -120.017	Buckhorn Canyon	720	Seasonal watering

County/ Reservoir	Owner	Latitude Longitude	Source	Storage (af)	Operations
Round Valley	Jack and Thomas Swickard	40.5154 -120.66	Round Valley Creek	5,500	Seasonal watering
Smoke Creek Reservoir	Jackrabbit Properties, LLC	40.6281 -120.00	Smoke Creek	960	Seasonal watering
Snowstorm Reservoir	BLM	40.66 -120.45	Snowstorm Creek	160	Seasonal watering
Spaulding Lake	R.C. Roberts Ranches, Licensee	40.9243 -120.28	Tributary to Madeline Plains	147	Seasonal watering
Sworinger Reservoir	John & Lani Estill	401.1798 -120.1	Tributary to Silver Creek	4,050	Early season release assumed
Upper/ Lower Biscar Reservoirs	BLM	40.545 -120.31	Snowstorm Creek	174	Operated for aquatic habitat
SIERRA					
	See major reservoirs above				
NEVADA	**SEE MAJOR RESERVOIR ABOVE**				
Placer					
Fallen Leaf Lake	USFS	38.922 -120.06	Taylor Creek	6,800	Operated to maintain instream flows
Lake Tahoe	USBR	39.167 -120.15	Upper Truckee River	732,000	See operations discussion above
Quail Lake	USFS	39.0710 -120.16	Tributary to Lake Tahoe	70	Operated to maintain instream flows
EL DORADO					
Upper & Lower Echo Lakes	El Dorado Irrigation District	38.8350 -120.04	Tributary to Upper Truckee River	1,900	Inter-basin transfer to American River averaging 703 af mostly after Labor Day. Level maintained July-Labor Day for navigation between upper & lower lakes

County/ Reservoir	Owner	Latitude Longitude	Source	Storage (af)	Operations
Fallen Leaf Lake	USFS	38.5513 -120.0620	Tributary to Lake Tahoe	NA	NA
Lake Tahoe	USBR	39.167 -120.15	Upper Truckee River	732,000	See operations discussion above
ALPINE					
Harvey Place Reservoir	South Lake Tahoe Public Utility District	38.7647 -119.78	Treated effluent from South Lake Tahoe wastewater plant	3,700	Releases of 4,000 + af of treated effluent during growing season, but expansion of land applied to is under way
Indian Creek Reservoir	South Lake Tahoe Public Utility District	38.7518 -19.78	Indian Creek	3,160	Level maintained for recreational purposes
Kinney Reservoir	Alpine Land & Reservoir Company	38.5572 -119.81	Tributary to Silver Creek	900	Early season release assumed
Upper & Lower Kinney Lakes	Alpine Land & Reservoir Company	38.5583 -119.83	Tributary to Silver Creek	1,248	Early season release assumed
East & West Lost Lakes	Carson Water Subconservancy Dist.	38.6461 -119.95	Lost Creek	340	Operated to maintain instream flows
Upper & Lower Sunset Lakes	Alpine Land & Reservoir Company	38.6136 -119.88	Pleasant Valley Creek	860	Early season release assumed
Red Lake Reservoir	California Department of Fish & Wildlife	38.6987 -119.97	Red Lake Creek	1,410	Operated to maintain instream flows
Tamarac Lake	Alpine Land & Reservoir Company	38.6082 -119.90	Tributary to Pleasant Valley Creek	400	Early season release assumed
Wet Meadows Lake	Alpine Land & Reservoir Company	38.6079 -119.87	Tributary to Pleasant Valley Creek	450	Early season release assumed
MONO					
Black/Junction Reservoir	Bently Family LP	38.3374 -119.48	Black Creek	185	Early season release assumed

County/ Reservoir	Owner	Latitude Longitude	Source	Storage (af)	Operations
Bridgeport Reservoir	Walker River Irrigation District	38.3226 -119.21	East Walker River	44,100	Captures snowmelt for later release
Lobdell Lake	Unknown	38.441 -119.365	Deep Creek	Unknown	Apparently not jurisdictional lake
Poore Lake Reservoir	Park Livestock Co.	38.3159 -119.52	Poore Creek	1,200	Early season release assumed
Topaz Lake	Walker River Irrigation District	38.6499 -119.50	West Walker River	15,000	Captures snowmelt for later release
Upper/Lower Twin Lakes	Centennial Livestock	38.1679 -119.33	Robinson Creek	6,081	Early season release assumed

Notes:

af = acre-feet, BLM = Bureau of Land Management, USBR = U.S. Bureau of Reclamation, USFS = U.S. Department of Agriculture Forest Service

Numeric water quality objectives for the Susan River Watershed are defined in the basin plan for total dissolved solids, chloride, sulfate, boron, nitrogen, and phosphorus. Historical toxicity and pesticide detections in Susan River water samples violated the narrative water quality objectives for toxicity and pesticides contained in the Lahontan Basin Plan. Since the magnitude of toxicity in Susan River was found to be in the low to moderate level range and the source of toxicity was unknown a TMDL was not recommended (Lahontan Regional Water Quality Control Board 2005).

Groundwater Quality

As part of California's GAMA program, the USGS in conjunction with the SWRCB, is conducting a statewide assessment of groundwater quality. In the North Lahontan region the USGS has completed data summary reports for the following study units that partially or entirely reside within the region.

- Cascade Range and Modoc Plateau.
- Tahoe-Martis.
- Sierra Nevada.

These data summary reports along with additional groundwater quality information are available at: http://ca.water.usgs.gov/gama/.

In addition, the SWRCB recently completed a statewide assessment of community water systems that rely on contaminated groundwater as a source of drinking water. Contamination of local groundwater resources results in higher costs for ratepayers and consumers due to the need for additional water treatment. This report identified 10 community drinking water systems in the region that rely on at least one contaminated groundwater well as a source of supply (Table NL-17). A total of 25 community drinking water wells are affected by groundwater contamination. The most prevalent contaminants are arsenic and gross alpha particle activity, which are naturally occurring and reflect their presence in geological formations throughout the region (Table NL-18). The majority of the affected systems are small water systems which often need financial assistance to construct a water treatment plant or to obtain an alternate solution to meet drinking water standards.

Groundwater Conditions and Issues

Groundwater Occurrence and Movement

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

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

During years of 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. Rock and soil with low permeability can restrict groundwater flow through a basin.

Depth to Groundwater and Groundwater Elevation Contours

Groundwater monitoring makes data available to prepare the depth to groundwater and groundwater elevation contours. Depth to groundwater has 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 to the local ecosystem.

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

Table NL-17 Summary of Small, Medium, and Large Community Drinking Water Systems in the North Lahontan Hydrologic Region that Rely on One or More Contaminated Groundwater Well(s)

Water System Size by Population	Number of affected community drinking water systems	Number of affected community drinking water wells
Small Systems ≤ 3,300	7	12
Medium Systems 3,301 – 10,000	0	
Large systems > 10,000	3	13
Total	**10**	**25**

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

Table NL-18 Summary of Contaminants Affecting Community Drinking Water Systems in the North Lahontan Hydrologic Region

Principal Contaminant (PC)	Community Drinking Water Systems Where PC Exceeds the Primary Maximum Contaminant Level (MCL)	Community Drinking Water Wells Where PC Exceeds the Primary Maximum Contaminant Level (MCL)
Arsenic	8	19
Gross alpha particle activity	3	7

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

Note: MCL = maximum contaminant level

Groundwater Level Trends

Groundwater levels within groundwater basins in the North Lahontan region can be highly variable because of the physical variability of aquifer systems, the variability of surrounding land use practices, and the variability of annual 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 NL-14A to NL-14C help explain how local aquifer systems respond to changing groundwater pumping quantities and to resources management practices. The hydrograph name refers to the well location (township, range, section, and tract).

Figure NL-14A shows hydrograph 41N16E35D003M, which is from an irrigation well in the Surprise Valley Groundwater Basin, with an unknown depth. The hydrograph shows a decline and recovery from the early 1970s through the 1990s and then a gradual recovery from the early 2000s to 2010. The hydrograph shows an overall decline in groundwater levels since the early 1970s and also an increase in seasonal groundwater level fluctuations since the middle 1990s,

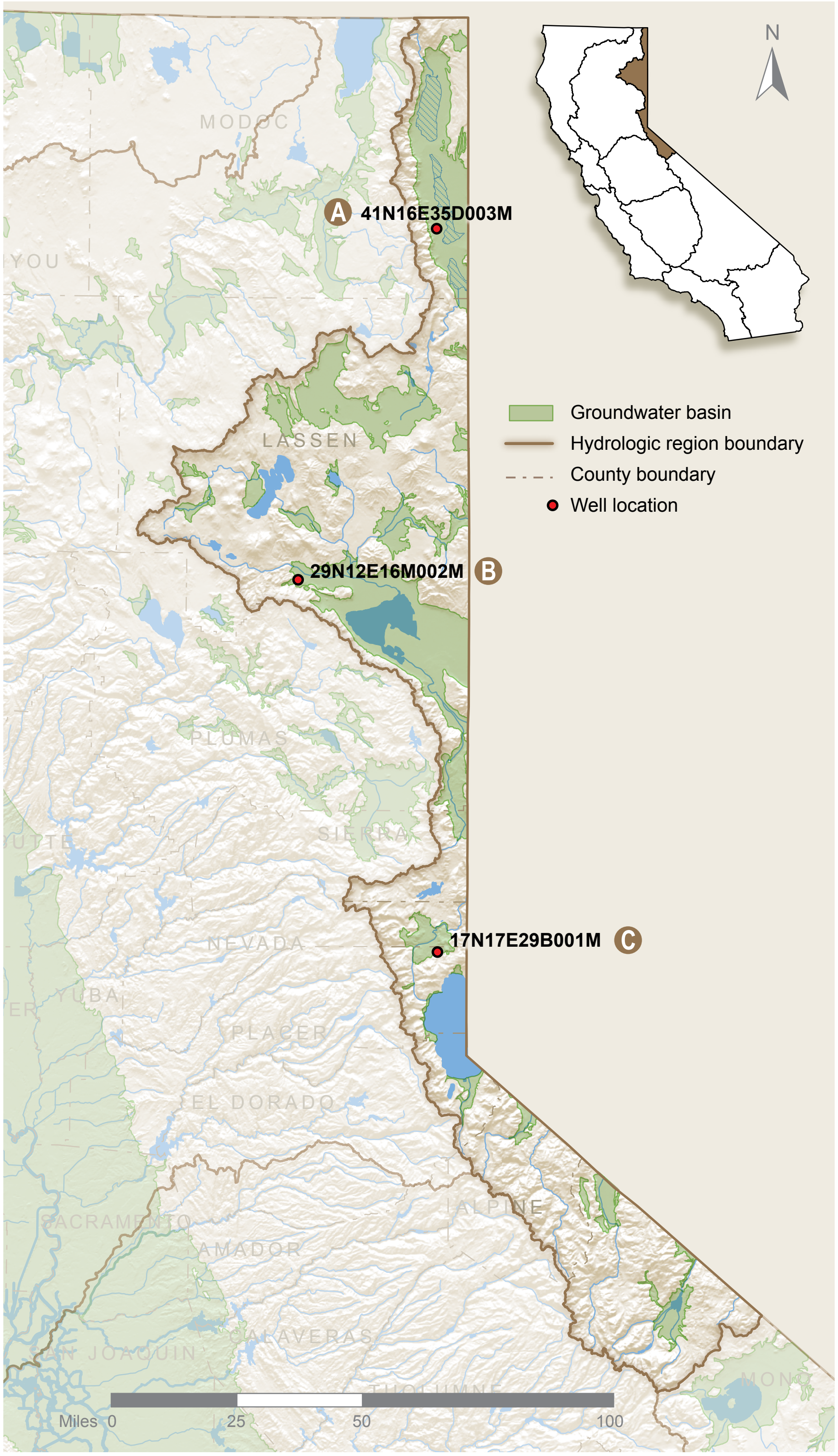
Figure NL-14 Groundwater Level Trends in Selected Wells in the North Lahontan Hydrologic Region

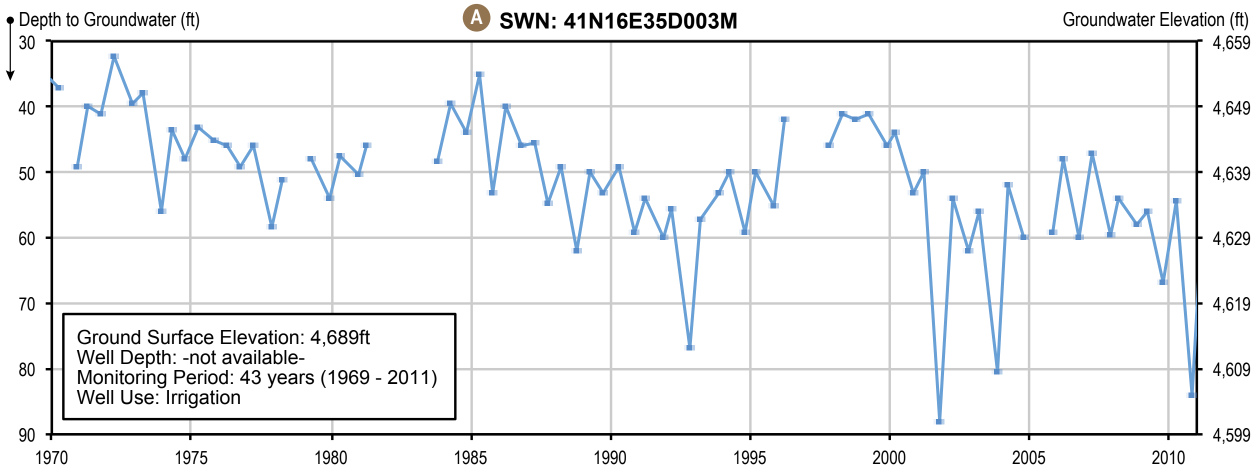
Aquifer response to changing demand and management practices

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.

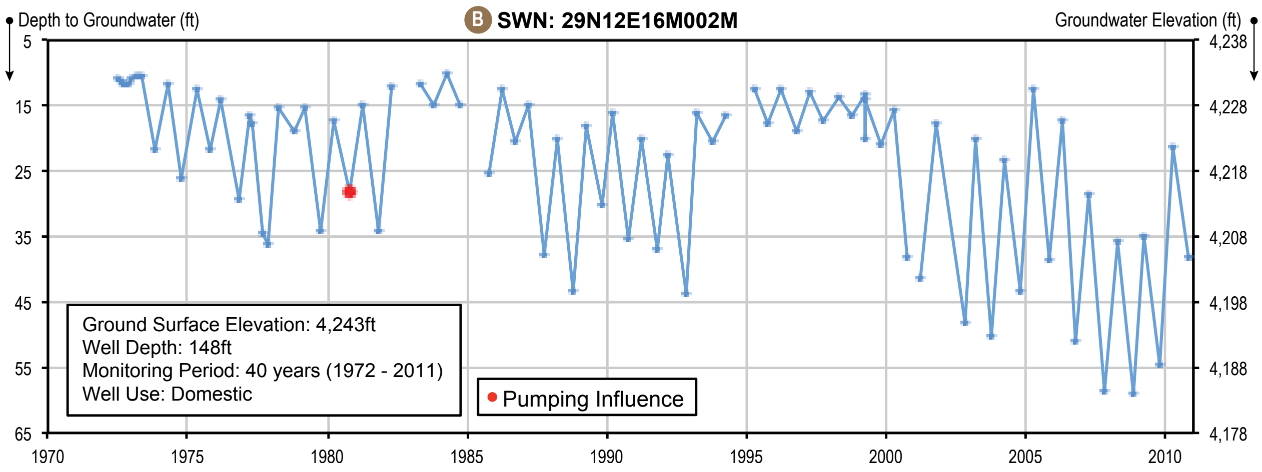
Hydrographs (A) 41N16E35D003M, (B) 29N12E16M002M and (C) 17N17E29B001M: shows the aquifer response to the long-term hydrologic cycles and season variations associated with local precipitation conditions. The large seasonal fluctuations in the recent years indicate intensification of pumping activity.

Regional locator map

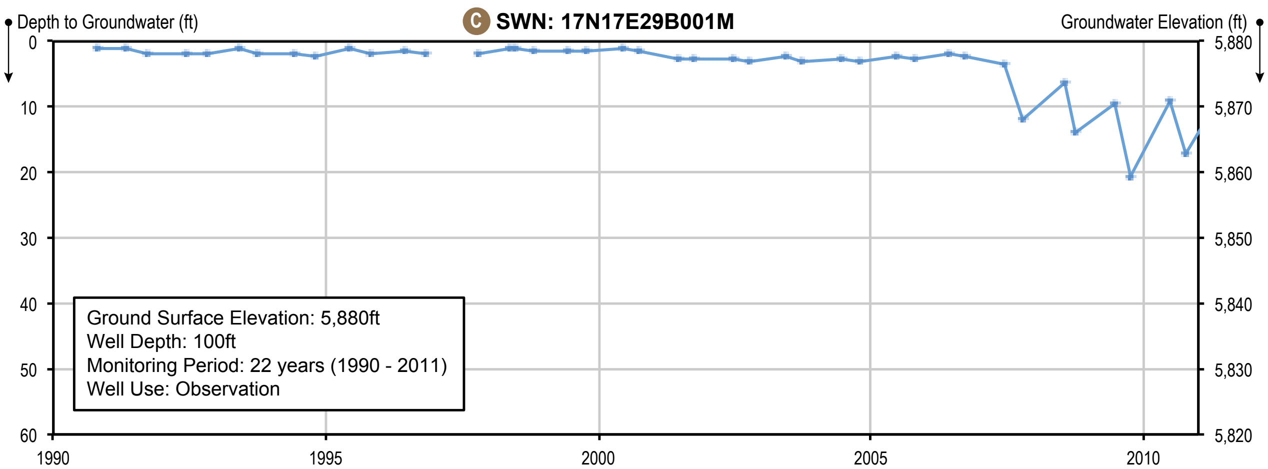




A SWN: 41N16E35D003M
Depth to Groundwater (ft)
Groundwater Elevation (ft)
30 40 50 60 70 80 90
4,659 4,649 4,639 4,629 4,619 4,609 4,599
1970 1975 1980 1985 1990 1995 2000 2005 2010
Ground Surface Elevation: 4,689ft
Well Depth: -not available-
Monitoring Period: 43 years (1969 - 2011)
Well Use: Irrigation



B SWN: 29N12E16M002M
Depth to Groundwater (ft)
Groundwater Elevation (ft)
5 15 25 35 45 55 65
4,238 4,228 4,218 4,208 4,198 4,188 4,178
1970 1975 1980 1985 1990 1995 2000 2005 2010
Ground Surface Elevation: 4,243ft
Well Depth: 148ft
Monitoring Period: 40 years (1972 - 2011)
Well Use: Domestic
Pumping Influence



C SWN: 17N17E29B001M
Depth to Groundwater (ft)
Groundwater Elevation (ft)
0 10 20 30 40 50 60
5,880 5,870 5,860 5,850 5,840 5,830 5,820
1990 1995 2000 2005 2010
Ground Surface Elevation: 5,880ft
Well Depth: 100ft
Monitoring Period: 22 years (1990 - 2011)
Well Use: Observation

with greater fluctuations during drought years due to increased groundwater pumping (1976-77, 1988-1991, 2001-2002, and 2007-2009).

Figure NL-14B shows hydrograph 29N12E16M002M, which is from a domestic well located in the Honey Lake Valley Groundwater Basin. The well is in the semi-confined portion of the upper aquifer system. The hydrograph shows a gradual decline and recovery of groundwater levels associated with the 1976-1977 and the 1988-1994 drought periods. Aquifer response to the recent 2008-2009 drought resulted in all-time lows for groundwater levels in the region, with levels about 25 feet below the 1976-1977 drought and 15 feet below the 1988-1994 drought levels. Recovery from the 2007-2010 drought period has just begun with an above average water year in 2011. There is an increasing trend in groundwater level fluctuations since the middle 1970s, with greater fluctuations during drought years due to increased groundwater pumping.

Figure NL-14C shows hydrograph 17N17E29B001M, which is from an active observation well located southeast of the town of Truckee in the Martis Valley Groundwater Basin. The well is 100 feet below the groundwater surface and reflects water table fluctuations in the alluvial aquifer that overlies a fractured bedrock system in the Sierra Nevada. The hydrograph shows hardly any groundwater level fluctuations between 1990 and 2007. After 2007, groundwater levels dropped by about 8 feet and subsequently fluctuated an additional 10 feet between spring and fall. The lowering of groundwater level in the area since 2007 can be attributed to the adjacent residential and recreational land development.

Change in Groundwater Storage

Change in groundwater storage is the difference in stored groundwater volume between two time periods. Examining the annual change in groundwater storage over a series of years helps identify the aquifer response to changes in climate, land use, or groundwater management over time. If the change in storage is negligible over a period represented by average hydrologic and land use conditions, the basin is considered to be in equilibrium under the existing water use scenario and current management practices. However, declining storage over a relatively short period characterized by average hydrologic and land use conditions does not necessarily mean that the basin is being managed unsustainably or subject to conditions of overdraft. Utilization of groundwater in storage during years of diminishing surface water supply, followed by active recharge of the aquifer when surface water or other alternative supplies become available, is a recognized and acceptable approach to conjunctive water management.

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

Because of resource and time constraints, changes in groundwater storage estimates for basins within the region were not developed as part of the groundwater content enhancement for Update 2013.

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. For example, in Alpine County, the Markleeville Creek Floodplain Restoration Project is designed to re-establish the natural form and function of Markleeville Creek as it flows through the former site of a U.S. Forest Service guard station. In Nevada County, the Trout Creek Restoration Project would require infrastructure improvements to create the ideal stream restoration alignment. Infrastructure improvements include adjusting the Glenshire Drive alignment and constructing two new bridges across Trout Creek to support the relocated balloon track.

Flood management challenges in the North Lahontan region include:

- Inadequate flood information, including maps and data.
- Inconsistent control of upstream water sources.
- Aging and undersized flood infrastructure.
- Inadequate flood risk awareness.

The identified issues were based upon interviews with 10 agencies with varying levels of flood management responsibilities in each county of the hydrologic region. For a list of agencies with flood management responsibility in the North Lahontan region that participated in these meetings, refer to *California's Flood Future Report,* Attachment E (California Department of Water Resources and U.S. Army Corps of Engineers 2013).

Damage Reduction Measures

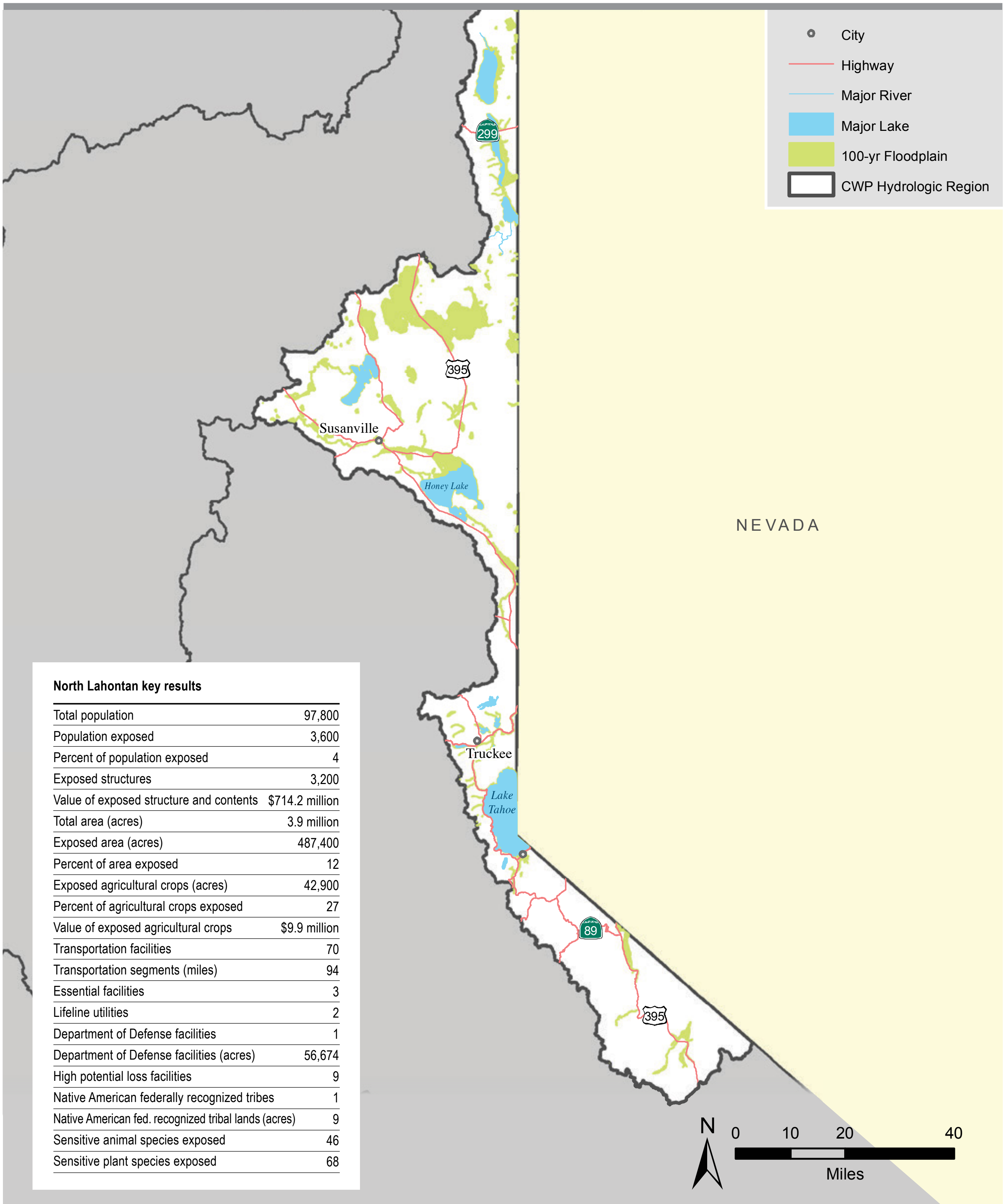
Flood exposure in the North Lahontan region occurs along the Walker River Basin in Mono County; Trout Creek in El Dorado County; Truckee, Carson, Walker, and Susan rivers in Placer County; Truckee River and Martis Creek in Nevada County; and Susan River in Lassen County. Floods within the region originate principally from melting of the Sierra snowpack and from rainfall. Most flood events occur in December and January as a result of multiple storms and saturated soil conditions, but floods can occur in October and November or during the late winter or early spring months.

In the North Lahontan region, more than 4,000 people and more than $823 million in assets are exposed to the 500-year flood event. Figures NL-15 and NL-16 provide a snapshot of people, structures, crop value, and infrastructure, exposed to flooding in the region for the 100-year and 500-year floodplain. More than 110 State and federal threatened, endangered, listed, or rare plant and animal species exposed to flood hazards are distributed throughout the North Lahontan region.

Levee Performance and Risk Studies

Flood hazard mitigation planning is an important part of emergency management planning for floods and other disasters. Hazard mitigation is defined as any sustained action taken to reduce or eliminate long-term risk to human life and property from hazards.

Figure NL-15 Flood Hazard Exposure to the 100-Year Floodplain in the North Lahontan Region

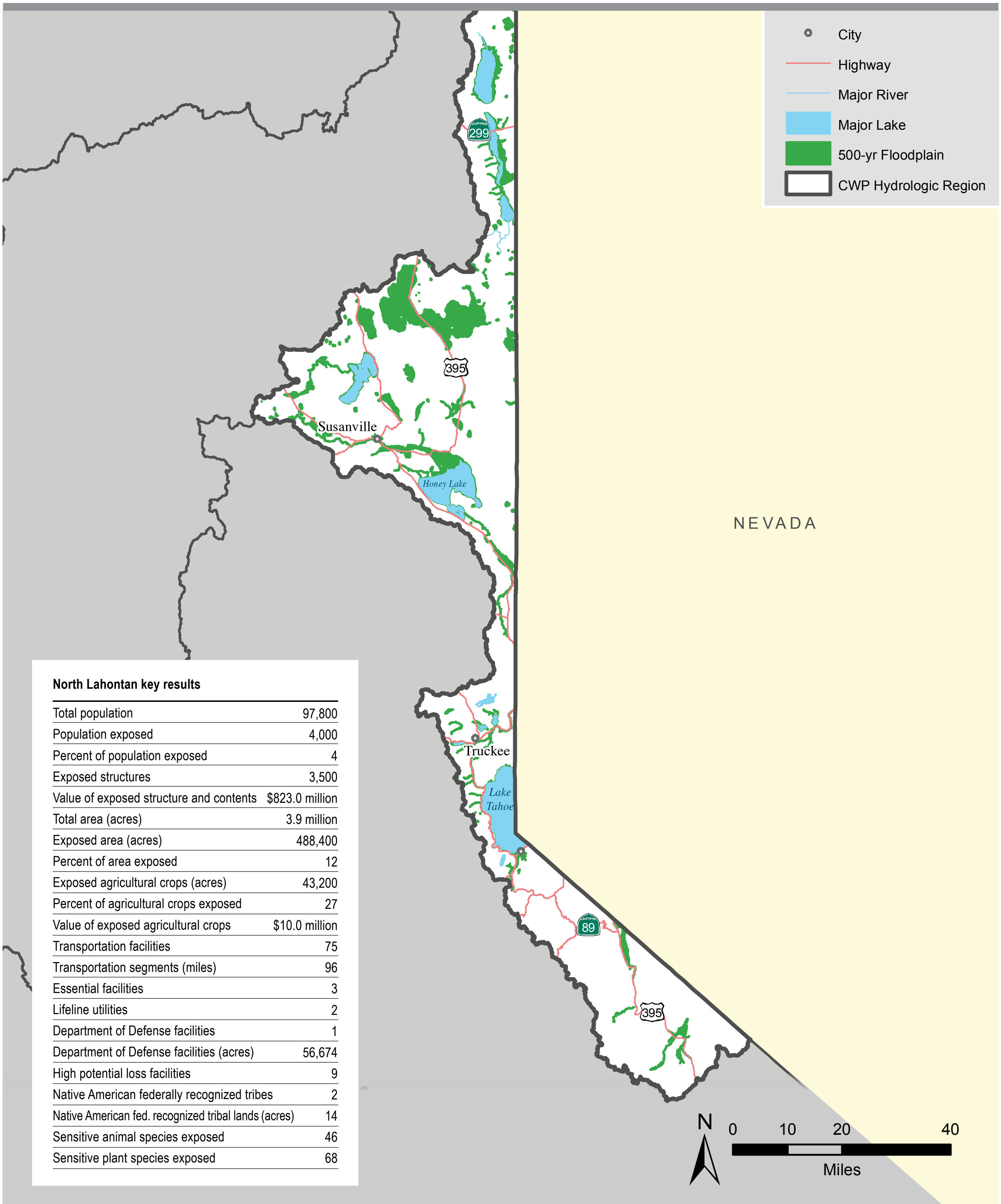


North Lahontan key results

Total population	97,800
Population exposed	3,600
Percent of population exposed	4
Exposed structures	3,200
Value of exposed structure and contents	$714.2 million
Total area (acres)	3.9 million
Exposed area (acres)	487,400
Percent of area exposed	12
Exposed agricultural crops (acres)	42,900
Percent of agricultural crops exposed	27
Value of exposed agricultural crops	$9.9 million
Transportation facilities	70
Transportation segments (miles)	94
Essential facilities	3
Lifeline utilities	2
Department of Defense facilities	1
Department of Defense facilities (acres)	56,674
High potential loss facilities	9
Native American federally recognized tribes	1
Native American fed. recognized tribal lands (acres)	9
Sensitive animal species exposed	46
Sensitive plant species exposed	68

Source: California's Flood Future Report 2013

Figure NL-16 Flood Hazard Exposure to the 500-Year Floodplain in the North Lahontan Region



North Lahontan key results

Total population	97,800
Population exposed	4,000
Percent of population exposed	4
Exposed structures	3,500
Value of exposed structure and contents	$823.0 million
Total area (acres)	3.9 million
Exposed area (acres)	488,400
Percent of area exposed	12
Exposed agricultural crops (acres)	43,200
Percent of agricultural crops exposed	27
Value of exposed agricultural crops	$10.0 million
Transportation facilities	75
Transportation segments (miles)	96
Essential facilities	3
Lifeline utilities	2
Department of Defense facilities	1
Department of Defense facilities (acres)	56,674
High potential loss facilities	9
Native American federally recognized tribes	2
Native American fed. recognized tribal lands (acres)	14
Sensitive animal species exposed	46
Sensitive plant species exposed	68

Source: California's Flood Future Report 2013

In the North Lahontan region, 14 local flood management projects or planned improvements were identified. Four of these projects have identified costs totaling approximately $17 million while the remaining projects do not have costs associated with them at this time. Five local planned projects use an integrated water management approach to flood management, including the Markleeville Creek Restoration Project and the Susan River Parkway Project. These identified projects and improvements are summarized in the *California's Flood Future Report Attachment E* (California Department of Water Resources and U.S. Army Corps of Engineers 2013).

Fire Management

A predominant factor in the shaping of the landscapes and habitat in the North Lahontan region are forest fires. Forest fires, particularly those that result from a century of fire suppression, can increase flooding, surface erosion, mass wasting (landslides), and consequent degradation of water clarity through increased sediment loads. Forest fire effects that worsen runoff are the reduced surface vegetation and the "cooking" out of soil organics, which can result in a nearly impervious (hydrophobic) layer of tars below the soil surface. As a result of the June 2007 Angora fire, 15 percent of highly erosive area tributary to the Upper Truckee River developed a high degree of hydrophobicity. Fortunately, this degree of hydrophobicity and precipitation conditions did not result in mass erosion. In the aftermath of the fire, rebuilding of the area commenced. After cleanup, 63 percent of homeowners had filed building plans by June 2008, and as of June 2012, 84 of 499 affected parcels have changed ownership, displaying the resiliency of the residents in the region (Lake Tahoe News 2012).

In response to the Angora fire, California Governor Arnold Schwarzenegger and Nevada Governor Jim Gibbons signed an MOU establishing the California-Nevada Tahoe Basin Fire Commission. The commission performed a comprehensive review of the laws, policies, and practices that affect the vulnerability of the Tahoe Basin to wildfires. Its findings and recommendations were made public May 27, 2008. One recommendation was to reduce forest floor fuel; a $200 million (plus) joint effort was established over the next 10 years. Fuel reduction treatment is expected to proceed at approximately 5,000 acres per year.

The cooperating agencies in the 10 year Lake Tahoe Basin Multi-Jurisdictional Fuel Reduction Plan are as follows:

- CAL FIRE — California Tahoe Conservancy.
- California State Parks.
- Fallen Leaf Fire Department.
- Lake Tahoe Basin Management Unit.
- Lake Valley Fire Protection District.
- Meeks Bay Fire Protection District.
- Nevada Division of Forestry.
- Nevada Division of State Lands.
- Nevada Fire Safe Council.
- Nevada Tahoe Resource Team.
- North Tahoe Fire Protection District.
- South Lake Tahoe Fire Department.

- Tahoe Regional Planning Agency.
- Tahoe-Douglas Fire Protection District.

Starting in 2007, under the 10-year plan approximately 68,000 acres of fuel reduction is targeted for fuel reduction treatments, which has progressed at a rate of 5,000 to 7,000 acres per year (U.S. Forest Service 2007). As of September 2013, approximately 54,000 acres have been treated for fuel reduction since 2007. The plan target will be accomplished through the efforts of the cooperating agencies. While the fuel reduction effort will help reduce the amount and voracity of wildfires in the area, there are some concerns of the reduction leading to increased runoff and water quality issues.

For example, the LRWQCB considered water quality issues resulting from a 10,000 acre, decade-long fuel reduction project called the South Shore Fuel Reduction and Healthy Forest Restoration Project. In the environmental impact statement (EIS) submitted by the Lake Tahoe Basin Management Unit of the U.S. Forest Service, erosion control protocols that apply to forest operations were instituted until vegetative cover became established. The conclusion of the study was that erosion potential of some areas, mainly the skid trails and landings used in conjunction with whole tree removal, would temporarily increase. However, the implementation of best management practices (BMPs) would reduce or eliminate these impacts; in the event they did not, the methods could be adaptively managed to cause no impacts. As to the majority of the vegetation removal, there would be no negative effect on erosion characteristics because increased sunlight exposure would promote the growth of ground cover. Furthermore, the removal of trees would tend to raise the water table leading to longer contributions from ephemeral or perennial springs and seeps.

Some of the concerns about the project were based on habitat values, which were also dealt with in the EIS. First, the EIS stated that the majority of destruction of habitat would be in the so-called wildlife-urban interface; which would be close to urbanized areas either not used extensively by wildlife or not of high habitat potential as a result of urbanization. Further, the report concluded that thinning would lead to increased growth of remaining vegetation; increased stand resistance to drought, insects and disease; and decreased fire risk. Reduction of fire risk was generally concluded to outweigh any reduction in habitat so that the project as a whole was rated as having a low risk for creating a significant negative effect.

Water Governance

Agencies with Responsibilities

Of the 140 separate entities that manage water in this hydrologic region, a few are listed in Table NL-19; it includes those Nevada interests that control most of the water in the region.

Flood Governance

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 for flood management are spread among more than 26 agencies in the North Lahontan region with many different governance structures.

Table NL-19 Water Management Entities

Water Management Entity	Sector
Agate Bay Water Company	water
Alpine Peaks System	water
Alpine Springs Water District	water
American Legion Tract	water
Bridgeport Public Utility District	water/wastewater
Carson Water Sub-conservancy District	bi-state watershed organization
Cascade Mutual Water Company	water
Cathedral Peaks Mutual Water Company	water
City of Susanville	water
Fallen Leaf Lake Associates	water
Fallen Leaf Mutual Water Company	water
Fulton Water Company	water
Glenridge Water Company	water
Lake Forest Water Company	water
Lakeside Mutual Water	water
Lakeside Park Association	water
Leavitt Lake Community Service District	water/wastewater
Lukins Bros. Water Company	water
Madden Creek Water Company	water
McKinney Estates Water Company	water
McKinney/Quail System	water
North Tahoe Public Utility District	water
Northstar Community Services District	water
Placer County Water Agency	water
Pyramid Lake Paiute Tribe	water for endangered species
Rainbow Tract Water Association	water
Rubicon System	water
Skyland/Nielsen Water Company	water
South Tahoe Public Utility District	water/wastewater
Spring Creek Associates	water
Squaw Valley Public Service District	water
Squaw Valley Water District	water

Water Management Entity	Sector
Susanville Park River Water Company	water
Tahoe Cedars Water Company	water/wastewater
Tahoe City System	water
Tahoe City System Truckee	water
Tahoe Keys Water	water
Tahoe Park Water Company	water
Tahoe Pines/Tahoe Swiss Village Water Company	water
Tahoe Timber Trails Water System	water
Tahoe Truckee Forest Tract System	water
Tahoe-Truckee Sanitation Agency (TTSA)	wastewater
Tahoma Meadows Mutual Water Company	water
Tahoma Meadows Water Company	water
Talmont Resort Improvement District	water
Timberland Water Company	water
Truckee Carson Irrigation District	agricultural water
Truckee Donner Public Utility District	water
Truckee Meadows Water Authority	urban water for Reno/Sparks
Twin Lakes Enterprises	water
Walker River Irrigation District	agricultural water
Ward Well Water Company	Water
Washoe County Water Conservation District	agricultural water
Washoe Paiute Tribe	water

The North Lahontan region contains four small floodwater storage facilities and channel improvements that have been built by USACE or USBR. For a list of major infrastructure, refer *California's Flood Future Report Attachment E* (California Department of Water Resources and U.S. Army Corps of Engineers 2013). The North Lahontan region contains floodwater storage facilities and channel improvements funded and/or built by the State and federal agencies. Flood management agencies are responsible for operating and maintaining approximately 25 miles of levees, more than 60 dams and reservoirs, and other facilities within the North Lahontan region. Reservoirs with flood control capability have been built by USACE, USBR, and DWR on Prosser Creek, the Little Truckee River, and Martis Creek.

Truckee River Operating Agreement

As of September 2013, TROA is yet to be implemented and may not be implemented for years. While TROA is pending, a number of decrees and agreements govern the operation of the Truckee River system and take into consideration the urban uses, agricultural uses, and environmental needs including the level of Pyramid Lake and the well-being of its cui-ui population. The primary agreements and decrees are General Electric Decree (1913, U.S. District Court, Eastern District of California); Truckee River Agreement (1935); Decree C-125 (1940, U.S. District Court, Reno, Nevada) pertaining to the Walker River; Orr Ditch Decree (1944, U.S. District Court, Reno, Nevada); and the Alpine Decree (1980, U.S. District Court, Reno, Nevada), which apportions the waters of the Carson River. Other decrees, agreements, and administrative regulations also affect the operation of the Truckee River. The California-Nevada Interstate Compact (1971) was ratified by both states, but not by Congress, which must ratify all such compacts before they take effect. However, California and Nevada both have policies to abide by the compact, and its terms informed the provisions of TROA. The above pre-TROA documents impose an operating regime on the Truckee River system that is inflexible in terms of storage and water releases but that TROA would improve upon. Public Law 101-618 (1990), the Truckee-Carson-Pyramid Lake Water Rights Settlement Act, will go into effect once TROA is implemented. The act will settle numerous lawsuits over Truckee River water rights, formally allocate the waters between the states of California and Nevada, adopt the Alpine Decree, and usher in river operations pursuant to the more flexible terms of TROA.

The TROA identifies instream flow requirements for the Truckee River system at various points (Table NL-20). TROA establishes “bypass flows” or flows that are not to be diverted into hydropower stations on the Truckee Canyon reach of the main stem of the Truckee River. Instream flows have not been established for the Carson River in California because there are no regulation facilities on that river except Heenan Reservoir. As a result of drought effects on fish, SWRCB issued a decision that a minimum instream flow of 20 cfs should be maintained below Bridgeport Dam on the East Walker River.

Groundwater Governance

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

A summary assessment of some of the GWMPs in the region is provided below, while a detailed assessment is available online in Update 2013, Volume 4, *Reference Guide* 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 NL-21 lists the GWMPs in the region, and Figure NL-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.

Table NL-20 Flow Requirements for the Truckee River System

Location	Existing Minimum instream flow (cfs)	Enhanced Minimum TROA flow (cfs)
Below Lake Tahoe Dam	50-70	75
Below Donner Lake	2-3	5-8
Below Prosser Creek Dam	0-5	12-25
Below Independence Lake	2	2-8
Below Stampede Res.	22.5	45
Bypass flows, Truckee River	0-50	50-150

Notes:

cfs = cubic feet per second, TROA = Truckee River Operating Agreement

The GWMP inventory indicates that four groundwater management plans exist within the region although none of the four GWMPs are fully contained within the region. Three of the four GWMPs have been developed or updated to include the SB 1938 requirements and are considered active for the purposes of the GWMP assessment. One of the two the basins identified as medium priority under the CASGEM Basin Prioritization is covered by a pre-SB 1938 GWMP, while the other medium priority basin is not covered by any GWMP.

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 was not 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 GWMP. *Bulletin 118-2003, Appendix C* (California Department of Water Resources 2003) provides a list of seven recommended components related to management development, implementation, and evaluation of a GWMP, that 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 twelve 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 *Bulletin 118-2003* (2003)?

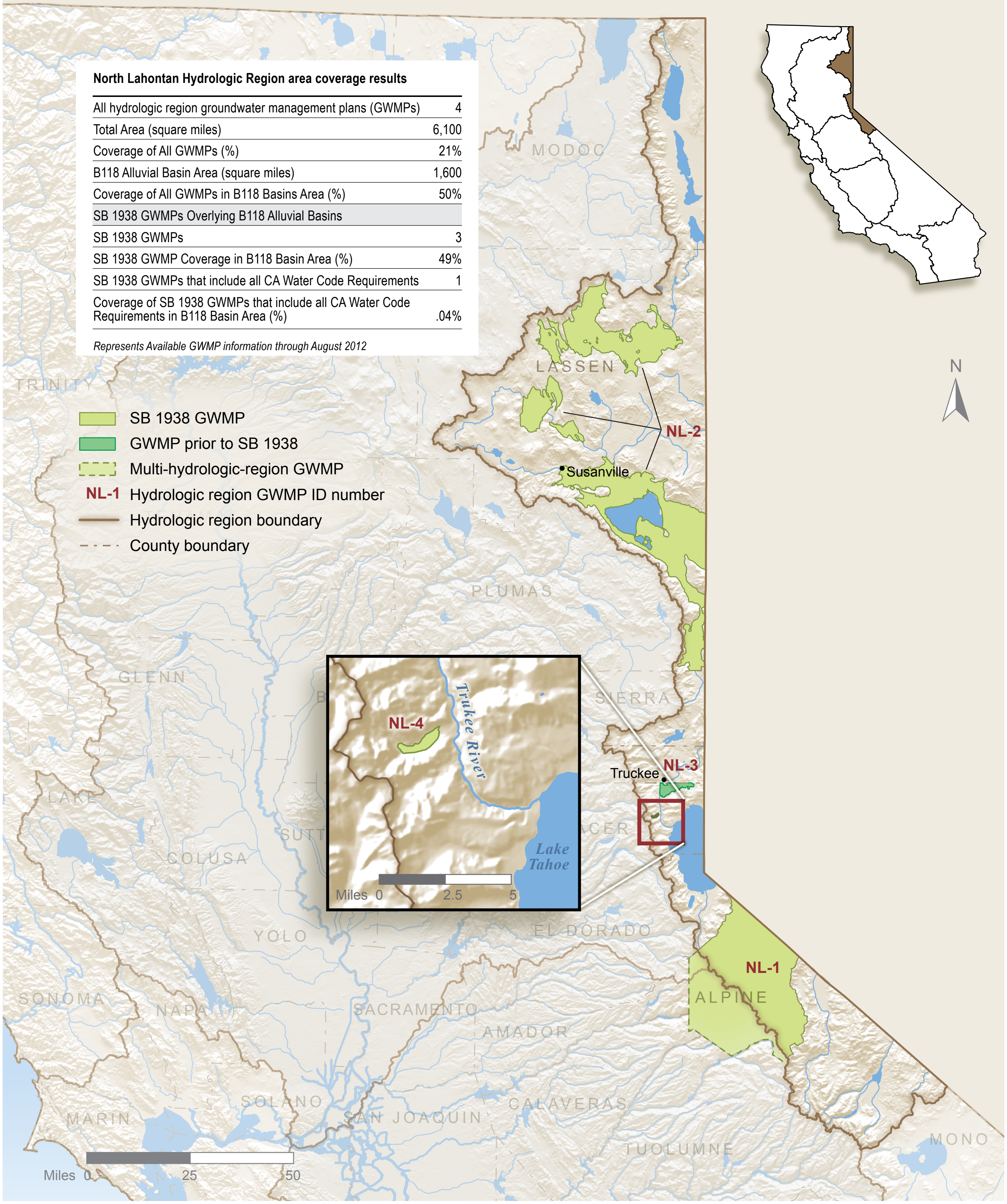
A summary of the GWMP assessment is provided in Table NL-22.

Table NL-21 Groundwater Management Plans in the North Lahontan Hydrologic Region

Map Label	Agency Name	Date	County	Basin Number	Basin Name
	Alpine County	2007	Alpine	6-6	Carson Valley Basin
	No signatories on file				Non-B118 Basin
NL-2	Lassen County	2007	Lassen	6-104	Long Valley Basin
	No signatories on file			6-2	Madeline Plains Basin
				6-3	Willow Creek Valley Basin
				6-4	Honey Lake Valley Basin
				6-94	Grasshopper Valley Basin
				6-95	Dry Valley Basin
				6-96	Eagle Lake Area Basin
				5-4	Big Valley Basin
NL-3	Placer County Water Agency	1998	Placer	6-67	Martis (Truckee) Valley Basin
	No signatories on file				Non-B118 Basin
NL-4	Squaw Valley Public Service District	2007	Placer		Non-B118 Basin
	No signatories on file				

Note: Table represents information as of August 2012, Bulletin 118 (California Department of Water Resources 2003).

Figure NL-17 Location of Groundwater Management Plans in the North Lahontan Hydrologic Region



North Lahontan Hydrologic Region area coverage results

All hydrologic region groundwater management plans (GWMPs)	4
Total Area (square miles)	6,100
Coverage of All GWMPs (%)	21%
B118 Alluvial Basin Area (square miles)	1,600
Coverage of All GWMPs in B118 Basins Area (%)	50%
SB 1938 GWMPs Overlying B118 Alluvial Basins	
SB 1938 GWMPs	3
SB 1938 GWMP Coverage in B118 Basin Area (%)	49%
SB 1938 GWMPs that include all CA Water Code Requirements	1
Coverage of SB 1938 GWMPs that include all CA Water Code Requirements in B118 Basin Area (%)	.04%

Represents Available GWMP information through August 2012

Table NL-22 Assessment for SB 1938 GWMP Required Components, SB 1938 GWMP Voluntary Components, and Bulletin 118-03 Recommended Components

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

Bulletin 118-03 Recommended Components	Percent of Plans that Include Component
GWMP Guidance	67
Management Area	100
BMOs, Goals, & Actions	67
Monitoring Plan Description	100
IRWM Planning	100
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

Factors Contributing to Success and Impediment to Groundwater Management

Participants of the DWR/ACWA survey were also asked to identify key factors that promoted or impeded successful groundwater management.

Only one responding agency in the region identified sharing of data and ideas, broad stakeholder participation, adequate surface water supplies and surface storage and conveyance systems, and adequate funding as key factors to successful GWMP implementation.

Two survey respondents pointed to limited participation and data collection and sharing of information as impediments to GWMP implementation. Funding, unregulated pumping, access to planning tools, and outreach and education were also identified as factors that impeded successful implementation of GWMPs. Funding is a challenging factor for many agencies because the implementation and the operation of groundwater management projects are generally expensive and because the sources of funding for projects typically are limited to either locally raised monies or to grants from State and federal agencies.

The two survey respondents felt long-term sustainability of their groundwater supply was possible.

More detailed information on the DWR/ACWA 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. Five of the counties in the region have groundwater ordinances that require a permit for transferring groundwater out of the basin. Only a few of the ordinances stipulate establishing basin management objectives and guidance committees. None of the ordinances address groundwater recharge.

Special Act Districts

Special acts of the Legislature have granted greater authority to manage groundwater to a few local agencies or districts. These agencies generally have the authority to:

- Limit groundwater export and extraction (upon evidence of overdraft or threat of overdraft) or
- Require reporting of groundwater extraction and to levy replenishment fees.

No special act districts appear to exist in the North Lahontan region.

Court Adjudication of Groundwater Rights

Another form of groundwater management in California is through the courts. There are currently 24 groundwater adjudications in California. The North Lahontan region contains none of those adjudications.

Other Groundwater Management Planning Efforts

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

Current Relationships with Other Regions and States

Because the river channels of the Truckee, Carson, and Walker rivers naturally flow into Nevada, a large amount of the surface water from these watersheds has historically been reserved for use by Nevada interests under various interstate water rights settlements and agreements.

There are three small historical exports of surface water out of the North Lahontan region. At Echo Lakes in the upper Lake Tahoe Basin, an average of about 703 af/yr. is exported through the Echo Lake Conduit into the south fork of the American River in the Sacramento River region in conjunction with a hydroelectric power development (Project 184) that began in 1876. Another water export of 6,000 to 10,000 af/yr. is taken from the upper reaches of the Little Truckee River for irrigation use in Sierra Valley (a part of the Feather River Basin within the Sacramento River Hydrologic Region). At the southern end of the North Lahontan region, a third small water diversion from Virginia Creek provides approximately 1,000 af/yr. of surface water to the Mono Lake Basin in the South Lahontan Hydrologic Region for summer irrigation purposes.

Box NL-1 Other Groundwater Management Planning Efforts in the North Lahontan Hydrologic Region

The Integrated Regional Water Management plans, Urban Water Management plans, and Agriculture Water Management plans in the North Lahontan Hydrologic Region that also include components related to groundwater management are briefly discussed below.

Integrated Regional Water Management Plans

There are three IRWM plans covering the majority of the North Lahontan Hydrologic Region. Two IRWM plans are currently being implemented, and one IRWM plan is being developed. One of the adopted IRWM regions resides completely within the North Lahontan Hydrologic Region, and the other adopted IRWM region extends from the southern part of the North Lahontan Hydrologic Region into the Mono County of the South Lahontan Hydrologic Region.

One of the adopted IRWM plans relies on local groundwater management plans for managing groundwater resources. This plan states that conflicts over groundwater supply have occurred when pumping has exceeded natural recharge, as well as due to large seasonal fluctuations in population. In order to address future groundwater supply conflicts, the IRWM plan relies on the development and adoption of local groundwater management plans which contain conflict resolution procedures. Other groundwater management objectives for this IRWM region include creating a reliable groundwater supply, protecting groundwater quality, and managing groundwater for multiple uses.

The other adopted IRWM plan relies on counties within the region that do not have adopted groundwater management plans but have groundwater ordinances in place which utilize land-use planning and police powers of locally elected county boards to manage groundwater resources. The ordinances establish policies to manage the transport, transfer, acquisition, and sale of surface water and groundwater to protect the overall economy and environment of the counties. The ordinances also include policies regarding transfers or transport of groundwater to areas outside the county and the watershed.

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 DWR staff into a database. Online methods for urban water managers to directly enter their water use along with their plan updates is currently under evaluation and review by DWR. Because of the time-line, the plans could not be reviewed for assessment for 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 time-line, the plans could not be reviewed for assessment for Water Plan Update 2013.

The only water import into the North Lahontan region occurs in northern Lassen County, where an average of about 3,000 af is imported from Moon Lake in the South Fork of the Pit River (Sacramento River Hydrologic Region) for irrigation in the Madeline Plains area.

The rivers of the region all flow eastward from mountain valleys, which provide sites for dams. Therefore, all the flood control on the Truckee River system is exercised in California at the aforementioned Boca, Prosser and Stampede dams whose flood functions are controlled by USACE, notwithstanding the fact that the dams are owned by the USBR. This flood control may have some effect in California, but basically are in place to keep the Truckee River flows in Reno, Nevada, below 6,000 cfs. These dams are currently being raised by small increments to be able to contain newly imposed maximum credible events. In addition, the Reno area is working to put into place greater capacity channels because the current channels were overwhelmed by the 1997 flood.

On the Carson River there is no real means of regulating flow and floods such as those that flooded populated areas of the Carson Valley in 1997. Likewise there is effectively no regulation on either of the Walker rivers in California, notwithstanding the existence of Bridgeport and Topaz lakes that simply pass flood flows. But downstream areas are not as populated as the neighboring state areas in the Carson River Valley so much of the damage from the 1997 flood occurred to California infrastructure.

The inter-regional water operations affect recreation in Nevada in the terms of the level of Pyramid Lake, which in prior days was the home to very large Lahontan cutthroat trout. After water began to be diverted away from flow into Pyramid Lake, recreational values in terms of the size and numbers of fish declined because of disrupted migratory pathways to spawning beds. TROA has, as one of its objectives, the restoration of Lahontan cutthroat trout populations through more flexible control of flows which would have a beneficial effect on recreation within Nevada. On a smaller scale, The TROA contains provisions concerning the amount of water that may cross the border in the form of artificially made snow. In water year 2011, rafting in the Truckee Canyon in Nevada was initiated because of the ample flows provided by that wet year. This is not the ordinary case, however, as much of the rafting industry activity is located in the Truckee River in a short reach just below Tahoe Dam. Regulation of flows under the existing agreement that regulates the interstate flow of water in the Truckee River has had the effect of delaying the date on which California rafting can begin. Water-skiing in California lakes can be limited by lake levels. Therefore, lakes drawn down, perhaps, by fish procreation needs in Nevada during the water-skiing season constitute another inter-regional recreational effect of water operations.

Interregional and Interstate Planning Activities

The TROA process has extended over two decades in an attempt to coordinate the releases from the storage in the Sierra and has accomplished a degree of interstate planning in as much as the TROA EIS looks out into the future to 2030 in its impact analyses.

Under the SECURE Water Act, the USBR established WaterSMART (Sustain and Manage America's Resources for Tomorrow), in February 2010. Under WaterSMART, USBR is conducting a Truckee Basin study for the purpose of projecting water supplies for the next 50 years, including the effects of climate change. The USBR also conducted an updated flood analysis which resulted in a more extreme maximum credible (flood) event which caused them to raise the height of local flood control dams by a few feet. The USACE study of what to do about the collapse hazard at Martis Dam might also be considered an interstate planning activity because Martis Dam's purpose is to protect the Truckee Meadows area, including Reno, from floods.

Practicing Resource Stewardship

The level of stewardship in the immediate vicinity of Lake Tahoe is high in that it is classified as an outstanding national water resource that has received top tier recognition both nationally and internationally through such organizations as the Tahoe-Baikal Institute. In addition, there are numerous governmental and non-governmental organizations concerned with environmental stewardship such as California Trout, Trout Unlimited, the Truckee River Watershed Council, the California Tahoe Conservancy, the League to Save Lake Tahoe, the Sierra Club, the Sierra Nevada Conservancy, numerous resource conservation districts, and many more organizations that are constantly proposing improvements in environmental stewardship. Outside the shadow of notoriety cast by Lake Tahoe and its environs there are trail councils, river councils and numerous other organizations intent on improving the relationship of society with the environment.
The Sierra Nevada Alliance, for example works Sierra-wide to protect and restore the natural environment, including restoring and protecting Sierra watersheds, for future generations while ensuring healthy and sustainable communities. The Sierra Nevada Conservancy is a state agency working Sierra-wide, with the exception of the Lake Tahoe Basin; and the Sierra Business Council focuses on Sierra Nevada-wide sustainability solutions.

Regional Water Planning and Management

IRWM regions have been formed in the Truckee and Carson River basins (Tahoe-Sierra IRWM region), the East and West Walker River basin (Inyo-Mono IRWM region) and the Madeline Plains, Honey-Eagle Lake, and Smoke Creek basins region (Lahontan Basins IRWM region). The Tahoe-Sierra IRWM is currently in the process of updating their IRWM plan, which is tentatively scheduled to be completed by June 2015. The Inyo-Mono IRWM adopted an updated IRWM plan in November 2012, which is intended to serve as a primary reference for water resources management in the Inyo-Mono region. The Lahontan Basins IRWM region was approved by DWR in the region acceptance process in September 2011; it is at a more formative stage in the planning process, compared to Tahoe-Sierra and Inyo-Mono.

Between 2000 and 2010, the population of both the Lahontan Basins and Inyo-Mono IRWM regions did not change drastically; while the population of the Truckee area in the Tahoe-Sierra IRWM region increased 14 percent. The Tahoe portion of that region decreased nine percent.

Since the Tahoe-Sierra region encompasses the Truckee and Carson rivers, the region is subject to decrees and agreements of many decades duration and could at least prospectively be covered by the more encompassing Truckee River Operating Agreement if it should go into effect after the resolution of pending litigation. The Walker rivers, subject to the C-125 decree, are also in litigation and in the process of being re-operated in a way to provide more water to continuingly declining and more saline Walker Lake.

The Lake Tahoe Basin, part of the Tahoe-Sierra IRWM, is within the area covered by the California Tahoe Conservancy (CTC), a State agency within the California Natural Resources

Agency. The CTC is the owner of more than 4,800 parcels of undeveloped land, including urban lots in the basin totaling more than 6,000 acres acquired for the protection of natural resources and open space. The CTC has undertaken many projects that have preserved the environment and enhanced recreational opportunities.

The Sierra Nevada Conservancy region boundary surrounds the CTC and includes the Truckee River Basin along with the counties of Modoc, Lassen, Alpine, and the northern portion of Mono. The Sierra Nevada Conservancy is a State agency created in 2004 that supports working forests, watershed health, and recreational projects in its area. The Sierra Nevada Conservancy has acquired land or conservation easements on land and has supported projects in the hydrologic region at Independence Lake, Lacey Meadows, and Webber Lake on the Little Truckee River, and in Cold Stream Canyon feeding Donner Creek.

Integrated Regional Water Management (IRWM) Planning and Projects

IRWM 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 integrated water management strategy. In the future, IRWM planning efforts will need to be coordinated with flood management planning efforts. Historically, this has been a challenging task because the agencies involved with IRWM and flood management tend to have different regional boundaries with sometimes conflicting goals and objectives. Where the regional boundaries overlap, a great effort of coordination and prioritization will need to occur to put forward multi-benefit projects that will improve public safety, foster environmental stewardship, and support economic stability within the region. 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 integrated water management-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 integrated water management. Table NL-23 provides a list of goals for IRWM groups in the region.

The following are condensed summaries of the IRWM plans in the region. In the Integrated Water Management Plan Summaries under the “Looking to the Future” section, more information is presented about each IRWM plan, such as water supply and demand data, tribal information, and other important issues.

The Tahoe-Sierra IRWM

The Tahoe-Sierra IRWM was formed to represent the diverse interests of the eastern Sierra watersheds from Alpine County through the Lake Tahoe Basin and Truckee areas. The Tahoe-Sierra IRWM Regional Water Management Group (RWMG) members are signatories to an MOU that facilitates the implementation of the Tahoe-Sierra IRWM Plan. The Tahoe-Sierra IRWM Plan integrates a set of coordinated strategies for the management of water resources and for the implementation of projects that protect Tahoe-Sierra communities from drought, protect and improve water quality, and improve local water security.

The Tahoe-Sierra IRWM Plan goals are to:

- Protect and improve water quality.
- Protect the community water supply.
- Manage the groundwater for sustainable yield.
- Contribute to ecosystem restoration.
- Implement integrated watershed management throughout the Tahoe-Sierra region.

Tahoe-Sierra IRWM has obtained a Proposition 50 Implementation Grant, a Supplemental Proposition 50 Implementation Grant, a Proposition 84 Round 1 Implementation Grant, and a Proposition 84 Round 2 Planning Grant. The planned projects in the Proposition 84 Round 1 Implementation Grant are scheduled for completion in 2016 and consist of the following:

- Community watershed planning: Community conservation planning and implementation effort on a sub-watershed level.
- Town of Truckee: Water quality monitoring program.
- Little Truckee River restoration and bridge replacement project.
- Negro Canyon Restoration: Sediment removal in Negro Canyon.
- Regional water conservation program.
- Montgomery Estates erosion control project: Install BMPs in South Lake Tahoe's Montgomery Estates subdivision.
- Griff Creek water quality improvements: Stream environment zone improvements for sediment transport and fish passage.

The Inyo-Mono IRWM

The Inyo-Mono IRWM RWMG's mission is to "research, identify, prioritize, and act on regional water issues, and related social and economic issues, to protect and enhance the region's environment and economy." The Inyo-Mono RWMG members are signatories to an MOU that facilitates the implementation of the Inyo-Mono IRWM Plan.

As stated above, the Inyo-Mono IRWM Plan was recently adopted, and the Inyo-Mono IRWM Program was recently awarded a Round 2 Planning Grant for fulfilling plan standards through focused planning studies and programmatic operations. The focused tasks are to (1) sustain and build upon Inyo-Mono IRWM Program operations; (2) conduct planning studies; (3) enhance integration of climate change information into the Inyo-Mono IRWM planning process; (4) incorporate data management information and GIS data on the Inyo-Mono IRWM Plan Web site; (5) identify and establish stable sources of funding for the Inyo-Mono IRWM Plan; and (6) integrate and update the Inyo-Mono IRWM Plan to meet DWR's 2012 IRWM Plan Standards. The Inyo-Mono IRWM received a $1.08 million Proposition 84 Round 1 Implementation Grant to fund seven projects in the region:

- Safe Drinking Water and Fire Water Supply Feasibility Study for Tecopa.
- Coleville High School Water Project.
- Round Valley Joint Elementary School Water Supply Reliability Enhancement.
- Wheeler Crest Community Services District New Hilltop Well.
- Mammoth Community Water District Well Rehabilitation (Phase I).

Table NL-23 North Lahontan IRWM Plan Group Goals

Goals	Objectives
Increase Participation of Small and Disadvantaged Communities (DACs) in the region's IRWM process	• Engage regional communities and tribes in collaborative water and natural resource management related efforts. • Provide assistance for tribal and DAC consultation, collaboration, and access to funding for development, implementation, monitoring, and long-term maintenance of water resource management projects. • Promote public education and training programs in disadvantaged communities and tribal areas about water resource protection, pollution prevention, conservation, water quality, watershed health, and climate change.
Address Climate Vulnerability	• Increase understanding of impacts of climate change on water supplies and water quality. • Manage and modify water systems to respond to increasing climate variability. • Promote public education about impacts of climate change, particularly as it relates to water resource management in the region.
Protect, Conserve, Optimize, Argument Water Supply	• Improve water supply reliability. • Improve system flexibility and efficiency. • Support compliance with current and future state and federal water supply standards. • Incorporate and implement low-impact development design features, techniques, and practices. • Support and implement state-mandated groundwater and surface water monitoring requirements, and other groundwater monitoring efforts. • Promote efforts to monitor, manage, and mitigate effects of groundwater-dependent projects. • Promote public education about water supply issues and needs. • Optimize existing storage capacity. • Protect water supplies that support public recreational opportunities.
Protect, Restore, Enhance Water Quality	• Support achieving compliance with current and future state and federal water quality standards. • Protect public health and aquatic ecosystem sustainability. • Match water quality to water use. • Support appropriate recreational programs that minimize and/or mitigate impacts to water quality.
Provide Stewardship of the Region's Natural Resources	• Protect, restore, and enhance natural processes, habitats, and threatened and endangered species. • Protect, enhance, and restore ecosystems. • Support science-based projects to protect, improve, assess, and/or restore the region's ecological resources, while providing opportunities for public access, education, and recreation where appropriate. • Identify, develop, and enhance efforts to control invasive species.

Goals	Objectives
Maintain and Enhance Drinking Water, Wastewater, and Stormwater Infrastructure Efficiency and Reliability	• Promote rehabilitation and replacement of aging water and wastewater delivery and treatment facilities in rural communities, including tribal lands. • Ensure adequate water for fire protection and emergency response. • Provide for development and improvement of emergency response plans. • Characterize current storm water and flood management situations and challenges. • Promote region-wide integrated storm water and flood management planning. • Improve existing storm water and flood management infrastructure and operational techniques/strategies.

- Laws, Independence, and Lone Pine Pump Operation Redundancy and Supervisory Control and Data Acquisition (SCADA) Improvements.
- Inyo County CSA-2 Sewer System Upgrade.

The Inyo-Mono IRWM Group is one of five IRWM regions in the state awarded grant funds from DWR to identify and engage DACs in the Inyo-Mono region. This grant will allow Inyo-Mono to seek out and reach out to additional DACs in order to learn about relevant water issues and to encourage involvement in the Inyo-Mono IRWM program. The work performed through the grant will include outreach meetings throughout the region, workshops to provide instruction on proposal development, data management, and climate change, and dissemination of findings back out to the affected communities as well as other interested parties.

Lahontan Basins IRWM

The purpose of the Lahontan Basins IRWM efforts is to expand and enhance the collaborative network of water management agencies to effectively manage all aspects of water use and conservation within the region, and across regions. The Lahontan Basins IRWM region occupies an enclosed watershed in the northern portion of the North Lahontan region. The region includes the Madeline Plains, Honey-Eagle Lake, and the Smoke Creek sub-basins. Lassen County, Honey Lake Valley Resource Conservation District, Lassen Irrigation Company, and the City of Susanville are the four signatories that have signed an MOU.

The Lahontan Basins IRWM received a Proposition 84 Round 2 Planning Grant to develop their IRWM plan. Much of the water management history has been involved in assuring reliable water supplies (including quantity and quality) to support agriculture in the region and in maintaining good water quality in support of local fish populations, some of which are endemic to the basin. Other water management issues include impairments for salinity and metals of the Susan River and Honey Lake, maintaining levels of and nutrient impairments in Eagle Lake, and invasive species and groundwater management in the Long Valley Creek drainage.

Regional Studies

Currently Perazzo Meadows, northeast of Independence Lake and restored in 2011, is being monitored to determine the effects of restoration. There is no controversy about the fact that such restorations generally raise the water table in the area restored, change the vegetation back to what it had been, and eliminates sage brush, but there currently isn't any accepted proof that baseflows are increased in dry months due to the lack of funding for an investigation to gather data to support the hypothesis. There is the argument that water stored in the meadow is not given back during such periods and instead goes to deep percolation and increased transpiration. Judging from more extended experience just over the crest of the Sierra from Honey Lake to the west in Plumas County, a definitive answer to the question of augmentation of baseflow may not be known for more than a decade after project completion. Thus it is beyond the scope of this report.

The University of California, Davis Tahoe Environmental Research Center continues to study the factors affecting the clarity of Lake Tahoe and, in addition, other water quality and environmental factors that weigh on the restoration and sustainable use of the Lake Tahoe basin. One of these factors is the trophic state of the lake. The trophic index of the lake was found to have not changed significantly over the past 30 years. At the same time, trend of the primary production of algae has been increasing over that period, and longer. A study of the Asian clam, an invasive species, infestation was conducted by covering two one-half acre sections of the lake bottom with rubber mats to determine if that would eradicate them. To a large degree, it did. Another invasive species concern, which is being proactively responded to, is whether quagga mussels can reproduce in Lake Tahoe. The pro-active response has been to inspect all boats entering the lake for quagga infestations. Of the 20,446 inspections conducted, quaggas were found on only 10 boats.

In parallel the ability of the quagga to reproduce in Lake Tahoe's relatively cool, relatively calcium-poor water is being studied. DWR studied the occurrence of quaggas in lakes throughout the state and characterized the properties of the lakes in which they can thrive and found that Lake Tahoe is not a good environment for them. University of Nevada, Reno researcher Sudeep Chandra had found that adult quaggas could survive in Lake Tahoe water but, at the time of this report, is not certain that they could reproduce in the lake and therefore establish themselves in that lake even if accidently introduced. More recently, crawfish have become an aquatic invasive species of concern. Scientists estimate there are more than 240 million signal crawfish in Lake Tahoe, and Dr. Chandra believes the species is contributing to algae blooms and declining clarity in the lake's near-shore waters. In July of 2012, the State of Nevada opened their side of the lake to commercial crawfish harvesting and California followed suite in September of 2013, for the primary purpose of reducing the population.

Challenges

Drought and Flood Planning

The TROA contains a detailed scheme for re-operating the reservoirs on the Truckee River that will result in water releases that are better timed to meet needs and, therefore, prevent the wasteful use of water. Additionally, TROA contains specific rules that are effective during drought conditions. In order to achieve the rescheduled releases that are at the heart of TROA, water must be accumulated in the Truckee reservoirs for later release. Each reservoir has accounts for the water being stored in it that will make up the re-scheduled releases. One of the complications is that certain water accounts include evaporative losses and some do not, pursuant to the terms of TROA. The U.S. Watermaster's office in Reno is developing a computer program written in a computer programming environment known as RiverWare. This is an object-oriented program language that is a product of collaboration between USBR and the Center for Advanced Decision Support for Water and the Environment, an adjunct of the University of Colorado at Boulder

RiverWare is a definite improvement over current spreadsheet programs that were used to keep track of the water in the Truckee River. RiverWare allows a diagram of the interconnected river system to be placed on the computer screen; and then the program generates water balance equations for the objects, such as a reservoir, placed on the system diagram. Extensive rule sets are added to the model that then calculates the amounts of water in the various reservoirs and the flows in the channels that connect to the reservoirs and lakes. With the system thus specified, one can project what the state of storage will be in the future, up to 15 months for the operations model version of the TROA RiverWare model. Even more importantly, the TROA RiverWare model will be able to account for all the various forms of water credits that are accumulated given TROA's rules that provide for holding back releases and then releasing them at the most opportune moment. Given the complexities of TROA, it is probable that current methods would not be up to the task of keeping track of all the water in the system. Thus, the application of modern technology and computer tools is leading to the more efficient management of water.

Drought Contingency Plans

Drought periods in the North Lahontan region are inconsistent in their timing and persistence. The area goes through periods of heavy rain/snowfall and extreme drought. The fickleness of the weather and randomness of rainfall illustrate the need for drought plans that manage drought for short- and long-term drought periods. A drought plan is in place for major portions of the region held by the U.S. Bureau of Land Management. TROA contains drought provisions also, but those pertain mostly to operations that affect Nevada entities because the Sierra Nevada in California is their major source of surface water.

The North Lake Tahoe Public Utility District, Placer County Water Agency, South Lake Tahoe Public Utility District, Tahoe City Public Utility District and the Truckee Donner Public Utility District have drought contingency plans in their urban water management plans. In addition, the Squaw Valley Public Service District has conducted an analysis that indicates in an extended drought that its groundwater sources would be inadequate. It is exploring the possibility of receiving imported water. The Tahoe City Public Utility District adopted an ordinance on June 23, 2009, which included a drought preparedness response plan.

Water Supply Reliability

Agriculture in the region is practiced only to the extent water is available. This situation could be considered a perpetual drought because the amount of production is strictly limited by the amount of water available in any given year. For instance, the number of cuttings of alfalfa, the predominate crop, is limited by the amount of water available. In the context of agronomy, as it is practiced in the agricultural portions of the North Lahontan region, reliability of water supply is taken to mean the variation from year to year of the quantity of water available and is set given the amount of precipitation. Water is spread on fields early in the season from surface water sources and then the length of the growing season is determined by the availability of supplemental groundwater. The groundwater in the volcanic groundwater aquifers is often exhausted each year during drier years so the season is cut short. To increase reliability for the growing year, there must be an increase in the quantity of water so that growing season can be extended and is not cut short. In this sense, water reliability for a full growing season would rely on the ability to develop new sources of groundwater that could be accessed economically, assuming that the available water is being used efficiently and put to beneficial use.

Water Transfers

Given that groundwater and surface water sources are likely fully appropriated in neighboring regions from which water might potentially be imported, it is unlikely that any increase in the importation of water would occur, at least for agricultural purposes. This statement applies to the northern and southern portions of the region where the principle use for water is agriculture. The possibility exists for the curtailment of exports, but at a cost, since the export water rights have been well established for a century and more. Curtailing exports is additionally unlikely because the major exports are in the Truckee River and Lake Tahoe basins where there is no agricultural use and water availability is adequate for the near-term future. At the southern border of the North Lahontan region the possibility does exist that the exportation from Virginia Creek could be re-purposed to supplement supplies in the East Walker River watershed. However, the amount of export is only 1,000 af/yr. and that would not significantly increase supplies.

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 comprised of factors related to future population growth and factors related to future climate change. Growth factors for the North Lahontan region are described below. Climate change factors are described in general terms in Volume 1, Chapter 5, “Managing an Uncertain Future.”

Water Conservation

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

North Lahontan Growth Scenarios

Future water demand in North Lahontan region is affected by a number of growth and land use factors including population growth, planting decisions by farmers, and size and type of urban landscapes. Table NL-24 has 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, agricultural, and environmental sectors in the North Lahontan region. Growth factors are varied among 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 different alternative views of future development density. Population growth and development density will reflect how large the urban landscape will become in 2050 and are used to quantify encroachment into agricultural lands by 2050 in the North Lahontan region.

For Update 2013, DWR worked with researchers at the University of California, Davis, to quantify how much growth might occur in the North Lahontan region through 2050. The UPlan model was used to estimate an urban footprint in 2050 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 NL-25 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 3,000 acres under low-population growth scenario (LOP) by 2050 relative to 2006 base-year footprint of about 43,500 acres. The urban footprint under high-population growth scenario (HIP), however, grew by about 13,000 acres. The effect of varying housing density on the urban footprint is also shown.

Table NL-26 describes how future urban growth could affect the land devoted to agriculture in 2050. Irrigated land area is the total agricultural footprint. Irrigated crop area is the cumulative area of agriculture, including multi-crop area, where more than one crop is planted and harvested each year. In the North Lahontan region there is a slight increase in irrigated crop area, even with population growth, due to new lands going into agriculture production. As shown in the table, irrigated crop acreage increases, on average, by about 1,700 acres by year 2050. Even under high population growth, there is an increase in irrigated crop area of about 600 acres.

North Lahontan 2050 Water Demands

In this section, a description is provided for the ways 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 North Lahontan region for the agriculture and urban sectors under 9 growth scenarios and 13 scenarios of future climate

Table NL-24 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

change. The climate change scenarios included the 12 scenarios identified by the Governor's Climate Action Team, (described in Volume 1, Chapter 5, "Managing an Uncertain Future,") and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a "without climate change" condition.

Figure NL-18 shows the change in water demands for the urban and agricultural sectors under 9 growth scenarios, with variation shown across 13 climate scenarios. The nine growth scenarios include three alternative population growth projections and three alternative urban land development densities, as shown in Table NL-24. 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 and the average air temperature. Change in water demand is shown under a repeat of historical climate and under 12 scenarios of future climate change.

Urban water demand increased under all population growth when compared with historical average of 38,000 af. On average, it increased by 29,000 af under the high growth scenario. Under the low and current trend population growth scenarios, the increase was about 14,000 af and 19,000 af, respectively, when compared with the historical average. 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.

When compared with historical average water demand of about 430,000 af, agricultural water demand decreases under most future scenarios. Under some future scenarios with a dry climate, the water demand increases. The average reduction in agricultural water demand across all climate and growth scenarios is about 2,000 af, with a range showing a reduction in demand of 30,000 af to an increase in water demand of 30,000 af. The results primarily reflect variation in agricultural water demand in response to alternative climate scenarios.

Table NL-25 Growth Scenarios (Urban) — North Lahontan Hydrologic Region

Scenario[a]	2050 Population (thousand)	Population Change (thousand) 2006[b] to 2050	Development Density	2050 Urban Footprint (thousand acres)	Urban Footprint Increase (thousand acres) 2006[c] to 2050
LOP-HID	113.1[d]	15.2	High	46.2	2.7
LOP-CTD	113.1	15.2	Current Trends	46.4	2.9
LOP-LOD	113.1	15.2	Low	46.6	3.1
CTP-HID	119.9[e]	22.0	High	48.0	4.5
CTP-CTD	119.9	22.0	Current Trends	48.4	4.9
CTP-LOD	119.9	22.0	Low	48.6	5.1
HIP-HID	159.8[f]	61.9	High	54.8	11.3
HIP-CTD	159.8	61.9	Current Trends	56.5	13.0
HIP-LOD	159.8	61.9	Low	58.5	15.0

Notes:

[a] See Table NL-24 for scenario definitions.

[b] 2006 population was 97.9 thousand.

[c] 2006 urban footprint was 43.5 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.

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 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

Table NL-26 Growth Scenarios (Agriculture) — North Lahontan Hydrologic Region

Scenario[a]	2050 Irrigated Land Area[b] (thousand acres)	2050 Irrigated Crop Area[c] (thousand acres)	2050 Multiple Crop Area[d] (thousand acres)	Change in Irrigated Crop Area (thousand acres) 2006 to 2050
LOP-HID	128.2	128.2	0.0	+1.8
LOP-CTD	128.1	128.1	0.0	+1.7
LOP-LOD	128.1	128.1	0.0	+1.7
CTP-HID	128.0	128.0	0.0	+1.6
CTP-CTD	128.1	128.1	0.0	+1.7
CTP-LOD	128.0	128.0	0.0	+1.6
HIP-HID	127.3	127.3	0.0	+0.9
HIP-CTD	127.0	127.0	0.0	+0.6
HIP-LOD	126.7	126.7	0.0	+0.3

Notes:

[a] See Table NL-24 for scenario definitions.

[b] 2006 Irrigated land area was estimated by the California Department of Water Resources (DWR) to be 126.4 thousand acres.

[c] 2006 Irrigated crop area was estimated by DWR to be 126.4 thousand acres.

[d] 2006 multiple crop area was estimated by DWR to be 0.0 thousand acres.

for Update 2018. This process will also allow for continuous updating of the content of the atlas as new IRWM plans are released or existing IRWM plans are updated.

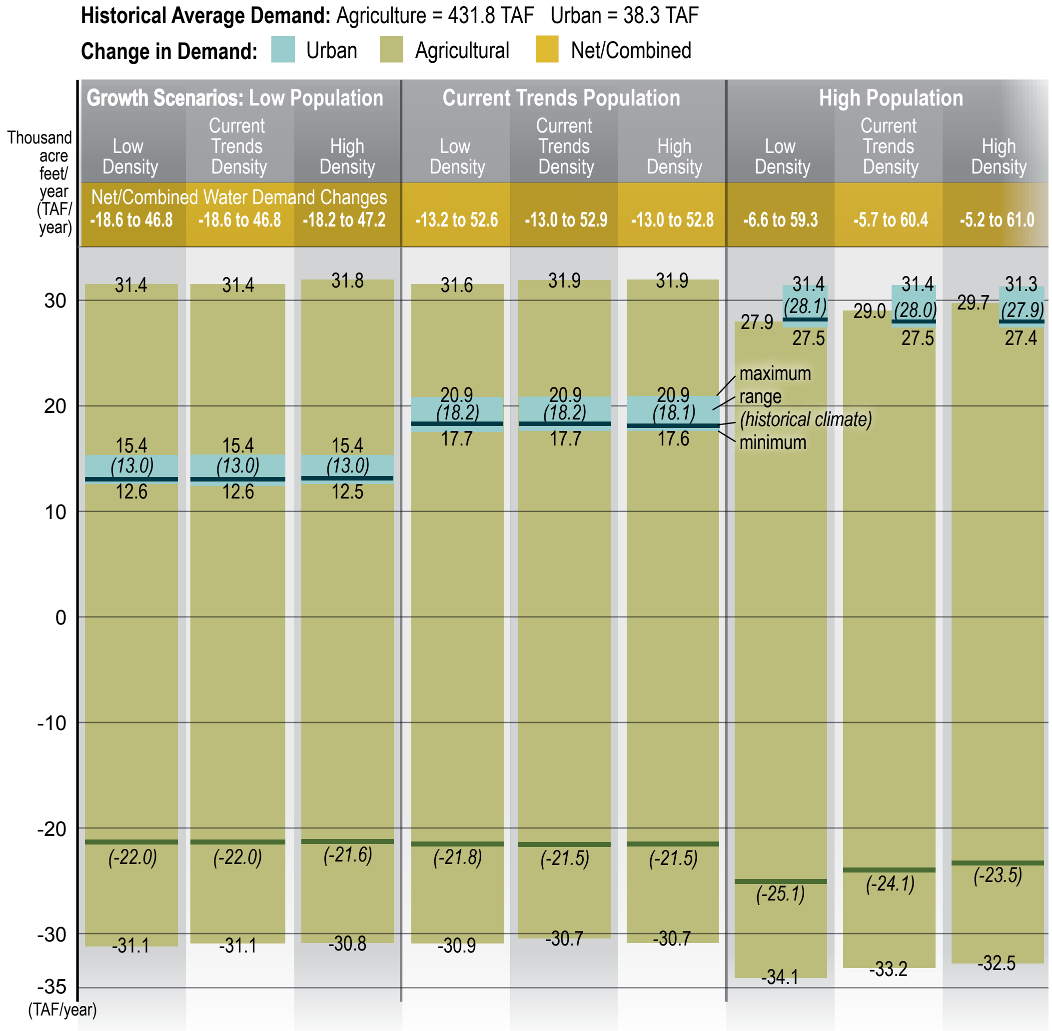
In addition to these summaries, we will provide all of the summary sheets in one IRWM Plan Summary "Atlas" as an article included in Volume 4, *Reference Guide*. This atlas will, under one cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management 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 NL-19, there are three IRWM planning efforts that are ongoing and cover most of the North Lahontan region.

Region Description

As of late 2013, the three IRWM planning efforts in the North Lahontan region have received a total of about $42 million in funding from both State and non-State sources: $18,729,045 from the State and $23,276,443 from non-State sources. Table NL-27 provides a funding breakdown for the region.

Figure NL-18 Change in North Lahontan Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050 (TAF per year)



The following are short descriptions of each of the three IRWM plans in the region.

Inyo-Mono

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

Figure NL-19 Integrated Regional Water Management Planning in the North Lahontan Hydrologic Region

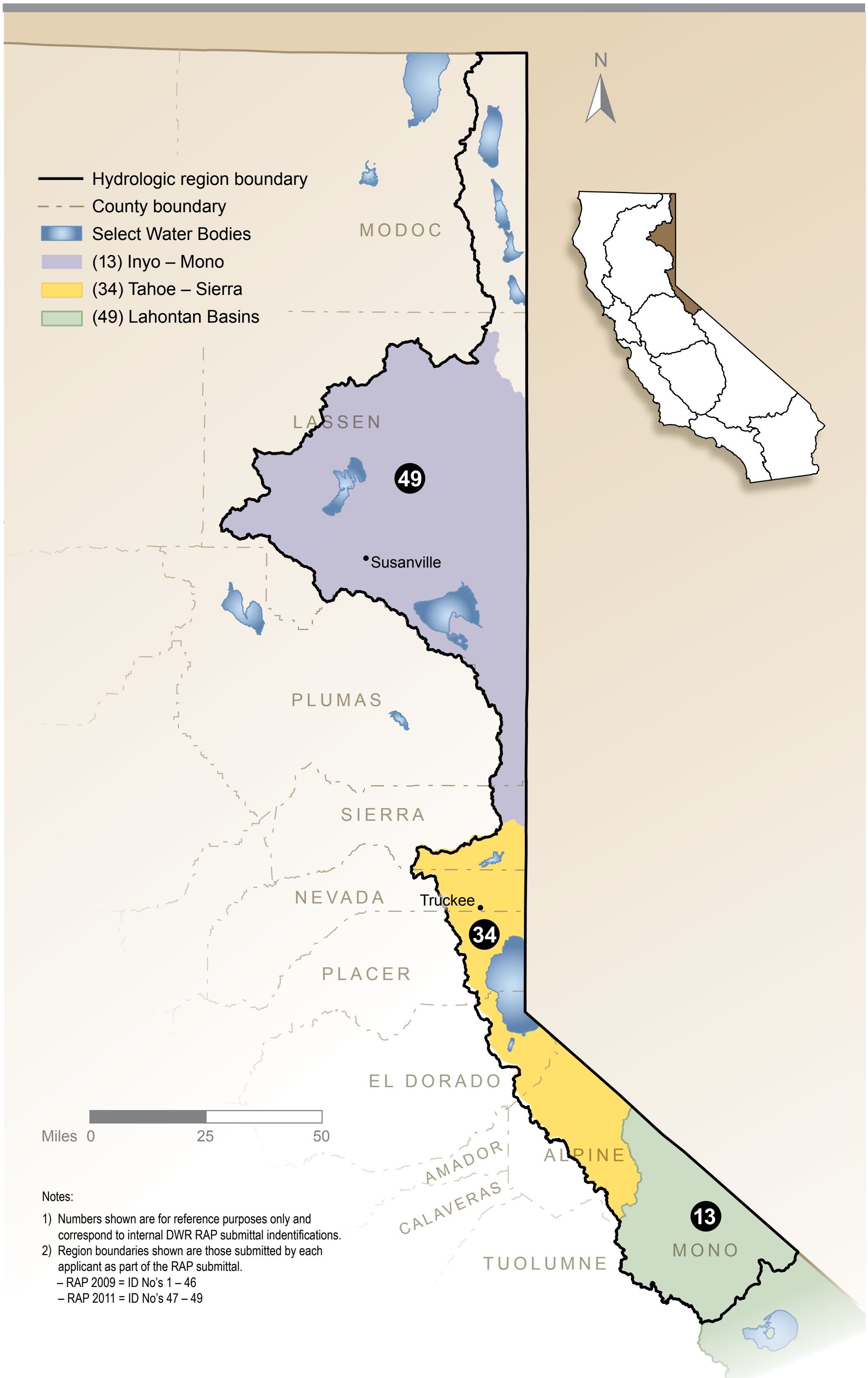


Table NL-27 North Lahontan IRWM Plan Funding

IRWM Region	Prop. 50 Planning Grant	Prop. 50 Implementation Grant	Prop. 84 Planning Grant	Prop. 84 Implementation Grant[a]	Prop. 1E Stormwater Grant	Regional Totals
Inyo-Mono			**$719,885** $657,493	**$1,075,000** $213,559		$2,665,937
Tahoe-Sierra		**$14,512,066** $18,945,538	**$557,480** $195,908	**$1,437,000** $3,116,345		$38,764,337
Lahontan basins			**$427,614** $147,600			$575,214
Total		**$14,512,066** $18,945,538	**$1,704,979** $1,001,001	**$2,512,000** $3,329,904		
Grand Total $42,005,488						

Notes:

This table is up-to-date as of late 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

Tahoe-Sierra

The Tahoe Sierra region includes the California-Tahoe Basin, Truckee River Watershed, and Carson River Watershed. Lake Tahoe and the Truckee River Watershed are connected by the headwaters of the Upper Truckee, which drains into the lake. The Tahoe Sierra region is characterized primarily by its location within the northern reaches of the 380-mile Sierra Nevada. A vast and mountainous rugged area, the region extends from Donner Lake, encompassing the Lake Tahoe Basin, to the rural outpost of Markleeville in Alpine County. Ninety-percent of the region is a forested alpine ecosystem above 5,000 feet in elevation and experiences cold, snowy winters and temperate summers. The communities surrounding Lake Tahoe including South Lake Tahoe, Tahoe City, and King's Beach are economically dependent on visitors to the lake.

Lahontan Basins

The Lahontan Basins region includes the Susan River watershed, Eagle Lake Basins, Madeline Plains, the Smoke Creek watershed adjacent to the Nevada state line, Long Valley Creek watershed, and additional tributaries to Honey Lake in the Janesville/Milford area such as Baxter Creek and Parker Creek among others.

Key Challenges and Goals

Inyo-Mono

The Inyo-Mono region faces the following challenges:

- Water quality.
- Water infrastructure.

- Institutional/human capacity.

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

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

Tahoe-Sierra

The Tahoe-Sierra region faces the following challenges:

- Water quality.
- Aging infrastructure.
- Maintaining healthy ecosystems.

To address the challenges, the Tahoe-Sierra region has identified the following goals/objectives:

- Protect and improve water quality.
- Protect the community water supply.
- Manage groundwater for sustainable yield.
- Contribute to ecosystem restoration.
- Implement integrated watershed management throughout the region.

Lahontan Basins

The Lahontan Basins region faces the following challenges:

- Water quality.
- River and stream channel erosion.
- Hydraulic Functions (flooding, flashy watershed flows, reservoir management; transportation network; stream channelization; and large-scale wildfire impacts).
- Invasive plants and noxious weeds.
- Water use efficiency.
- Forest and rangeland health.
- Aquatic and wildlife habitat.
- Data sharing.

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

- Enhance water supply reliability.
- Improve water quality management.

- Improve flood protection and planning.
- Provide watershed protection and management.
- Improve land use planning and management.

Water Supply and Demand

Inyo-Mono

Much of the water supplies within the region are exported to the City of Los Angeles, which began in the early 1900s. By the 1930s, Owens Lake was completely dry due to diversions. Water use varies within the region, but is relatively low. It is estimated that agriculture in the region uses between 250,000 and 350,000 af/yr. The Mammoth Community Water District supplied 2,691 af in 2010. It is projected that demand will reach 4,200 af/yr. by 2030.

Tahoe-Sierra

Due to hazardous winter conditions and limited road access, the communities in the region are isolated, rural, and, from a water supply perspective, self-sufficient. Communities provide their own water supply and do not rely on imported water. Groundwater is the primary source of drinking water and irrigation water in the region, as well as industrial service supply, wildlife habitat supply, and aquaculture supply waters. Use of the Tahoe Sierra water bodies for water supply sources extends beyond the Tahoe Sierra region boundaries with much of the surface water being exported from the region, either in river channels or pipelines and canals. Current water supply and demand amounts are not explicitly stated in the plan, but supply is currently more than adequate to meet the region's demands. Demand estimates for 2025 are between 29,667 and 30,212 af/yr., which is less than the maximum water source/supply capacities of the region.

Water Quality

Inyo-Mono

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

Tahoe-Sierra

Protecting and improving water quality is a primary objective for the region. Lake Tahoe is renowned for its water clarity and overall water quality, but has steadily deteriorated since the 1960s. Research indicates that Lake Tahoe's clarity will continue to wane at a rate of about one foot per year unless efforts are made to combat non-point-source pollution, especially nutrient and sediment loads in surface runoff. Treated wastewater is exported from the region to protect Lake Tahoe. The Porter-Cologne Act requires the export of all domestic wastewater from the California portion of the Lake Tahoe Basin and an Executive Order of the Governor of Nevada requires export on the Nevada side. Groundwater quality in the region is generally very good; however, groundwater supplies have been lost due to MTBE and arsenic contamination.

Lahontan Basins

The Susan River and Honey Lake appear on the LRWQCB's 303(d) list as being impaired by salinity and the presence of metals. Assessments from the Natural Resources Conservation Service indicate a prevalence of incised channels, sediment deposition, inefficient water diversion and delivery systems and heavy weed encroachment. Surface water users in the lower reaches report relatively high salt content likely accumulated in the tail water of other fields.

Flood Management

Inyo-Mono

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

Tahoe-Sierra

Flooding in the region usually results from rapid surface water runoff from rainfall, snowmelt, or both, that exceeds the capacity of the natural and human-made drainage systems. Localized flooding occurs throughout the urbanized areas of the region. The counties in the Tahoe-Sierra region provide general protection for floodplains and riparian areas through zoning, land use ordinances, and the project review process. As development in floodplains is enforced throughout the region, there will be less need for disaster declarations and hazard mitigation projects. Most flood management efforts in the Tahoe Sierra region have focused restoration of natural flood zones (flood management and wetlands enhancement and creation). To protect current development, projects that maintain and protect riparian habitat, stream environment zones and wetlands will be given priority, especially in historical flooding zones within the region.

Lahontan Basins

Despite the dry weather patterns in recent years, flood and stormwater concerns are not uncommon on the Susan River and nearby watersheds. Damage assessments and project reports associated with flood events in the mid-1990s indicate damage primarily associated with inadequate road and highway culverts, streambank instability and impacts to farm land, and some channel instability near residential structures adjacent to the Susan River in Susanville.

Groundwater Management

Inyo-Mono

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

Tahoe-Sierra

There are four groundwater basins in the region that provide the water supply for the majority of the districts in the region. Groundwater in the region supplies high quality drinking water and irrigation water, as well as industrial service supply, wildlife habitat supply, and aquaculture supply waters. Groundwater in the region also provides a source of fresh water for the replenishment of inland lakes and streams of varying salinity. While most groundwater sources in the region currently are characterized as high quality, some groundwater supplies have been lost due to MTBE and arsenic contamination. The Tahoe Sierra RWMG includes water providers that have developed specific GWMPs that regulate, manage, conserve, and protect the groundwater resources available to the region so that it will remain a viable, potable water resource and be available for the most efficient and beneficial uses. These water providers are authorized groundwater management agencies.

Lahontan Basins

Lassen County adopted a county-wide GWMP for the purpose of guiding the management of the county's groundwater resources and to provide a framework for development of basin management objectives. The plan developed in close association with a board-appointed Groundwater Advisory Committee of local water users and stakeholders, provides detailed descriptions of groundwater resources, current uses, and groundwater hydrographs created by DWR. Twelve groundwater basins and sub-basins have been identified to implement the basin management objectives (BMO) process by Lassen County.

Environmental Stewardship

Inyo-Mono

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

Tahoe-Sierra

The Tahoe Sierra region's economy is highly dependent on visitors to Lake Tahoe and the surrounding areas for the natural beauty of the region. Numerous plant and animal species in the region are listed as threatened or endangered under the federal Endangered Species Act and/or the California Endangered Species Act, or are candidates for such listing. Examples include the Lahontan cutthroat trout and the Lake Tahoe shorezone plant, Tahoe yellowcress. These and many other sensitive species depend directly on aquatic or wetland habitats for survival. The commitment to environmental stewardship in the Tahoe Sierra region is primarily demonstrated through the IRWM plan's Ecosystem Restoration Objectives to enhance and restore degraded stream environment zones, restore wetlands and natural biogeochemical cycles, educate the public about ecosystem services, manage forest health and wildfire risks, and minimize disturbance caused by urban development. The plan also outlines a series of strategies for ecosystem restoration and habitat protection or improvement.

Climate Change

Inyo-Mono

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

Tahoe-Sierra

Climate change is already affecting the Tahoe-Sierra IRWM region and will have significant impacts on water and other resources in the future. Changes in timing, amount, and type of precipitation and runoff will affect the availability of water supplies and hydropower generation. Increasing temperatures, more increased winter runoff, and prolonged droughts will increase flood and wildfire risk, and impact ecosystem services, recreation, and public health in the region. These climate change vulnerabilities will be considered as part of the upcoming IRWM plan update process.

Tribal Communities

Inyo-Mono

Contributing significantly to the economy and culture of the region are several federally recognized tribes and also tribes that are not federally recognized. These groups have also been involved in regional water issues for centuries. As such, it was recognized early in the IRWM planning process that tribal involvement in the RWMG is imperative. Targeted outreach efforts yielded good results: All tribes in the region, except two, are signatories to the Inyo-Mono MOU.

Tahoe-Sierra

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

Lahontan Basins

The Susanville Indian Rancheria is the predominant Native American tribe in the region and is an active participant in watershed planning and management, particularly within the Eagle Lake and Susan River watersheds. The local agencies that comprise the RWMG have a good working relationship with the Susanville Indian Rancheria and will continue to cultivate that relationship as part of the IRWM process.

Disadvantaged Communities

Inyo-Mono

All of Inyo County is classified as a DAC. The Inyo-Mono RWMG has prioritized outreach to and engagement of DACs and tribes since its inception in 2008. The DACs in the Inyo-Mono planning region include unincorporated communities in Inyo, Mono, San Bernardino, and Kern counties, as well as Native American tribes that are recognized and not recognized by the federal government. Throughout the pre-planning and planning phases, effort has been made to reach out to DACs; share information about IRWM Program activities, objectives, and funding opportunities; and, more importantly, listen to their water-related needs and concerns. Program office staff has targeted outreach to DACs both with individual meetings/ presentations and through the larger outreach campaign initiated in 2010.

Tahoe-Sierra

Approximately 58 percent of the region's population resides in the DACs of Kings Beach and the City of South Lake Tahoe. All projects planned and implemented in these areas are to include outreach targeted to underserved populations to attempt to engage them in the stakeholder process. Involvement of DACs in the IRWM process is encouraged through engagement of appropriate local non-profits that can disseminate educational materials and provide resources and opportunities to become involved in planning efforts.

Lahontan Basins

A DAC assessment of the Lahontan Basins region was conducted using 2000 Census data. In order to provide the most accurate determination of the DACs in the Lahontan Basins region, MHI was compared at the census tract level. The analysis shows that all of Lassen County and the City of Susanville are considered DACs. Critical DAC water-related needs were identified in the Lahontan Basins region. As part of the planning process the RWMG will perform targeted outreach to DACs to involve additional underrepresented stakeholders in the IRWM plan development process.

Governance

Inyo-Mono

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

Tahoe-Sierra

The Tahoe Sierra IRWM plan is designed to allow for flexibility in implementation while also guaranteeing that implementation will occur. Sixteen agencies have signed an MOU that recognizes the value of coordinating water management, planning, and implementation activities within the Tahoe Sierra Region of Truckee, the Tahoe Region, and Alpine County. Lead roles are assigned based on agency resources available, level of involvement during implementation phases and ability to serve. Tahoe Resource Conservation District (TRCD) took the lead agency (applicant) role for the Prop 50 IRWM plan implementation grant funding and agreed to ensure plan implementation, execute contract agreements, and track the progress of partners. South Tahoe Public Utilities District (STPUD) agreed to take the lead agency (applicant) role for Prop 50 IRWM Implementation grant funding, Round 2. It is expected that as the Tahoe Sierra plan is implemented and future funding sources develop, other partner agencies will take lead roles as appropriate.

Lahontan Basins

The proposed membership of the RWMG includes the local agencies that are signatories to the IRWM MOU. Specifically, this includes Lassen County, Honey Lake Valley Resource Conservation District, the City of Susanville, Susanville Indian Rancheria, and Lassen Irrigation Company. Collectively, these agencies are actively involved in water management including groundwater management, stormwater and flood control, irrigation water management and distribution, water quality, aquatic habitat, water conservation, and recreation. These local agencies are linked to a broad network of stakeholder agencies and interested public. Each of the proposed members has expressed clear support for moving forward with the IRWM process including the development of an IRWM plan.

Resource Management Strategies

Volume 3, *Resource Management Strategies*, contains detailed information on the various strategies that can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in the available IRWM plans is summarized in Table NL-28.

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

Table NL-28 Resource Management Strategies Addressed in IRWM Plans in the North Lahontan Hydrologic Region

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

Note: Information on the Lahontan basin's use of resource management strategies was not available as of late 2013.

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 NL-2 is a summary of the inventory effort.

The DWR/ACWA survey identified 89 agencies or programs that operate a conjunctive management or groundwater recharge programs; however, none of the programs is located in the North Lahontan Hydrologic Region.

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, *Resource Management Strategies*, Chapter 9 "Conjunctive Management and Groundwater.

Climate Change

For more than two decades, the State and federal governments have been preparing for climate change effects on natural and built water supply systems. Climate change is already impacting many resource sectors in California, including water, transportation and energy infrastructure, public health, biodiversity, and agriculture (U.S. Global Change Research 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 importance of contingency plans, mitigation (reduction) of greenhouse gas (GHG) emissions, and incorporating adaptation strategies; methodologies and infrastructure improvements that benefit the region at present and into the future. While the State is taking aggressive action to mitigate climate change through GHG reduction and other measures (California Air Resources Board 2008), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to impact 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 2012). The most comprehensive report to date on climate change observations, impacts and projections for

Box NL-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 DWR-ACWA survey. The survey requested the following conjunctive use program information:

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

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

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

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

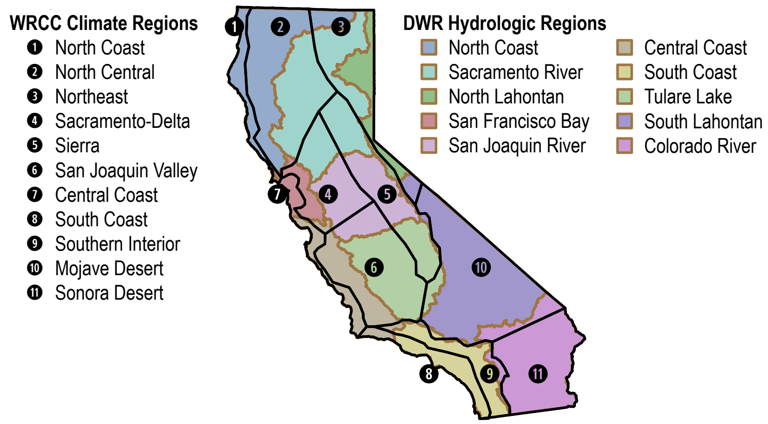
the southwestern United States, including California, is the *Assessment of Climate Change in the Southwest United States* (Garfin et al. 2013).

Observations

The region's observed temperature and precipitation vary greatly due to complex topography. Regionally specific air temperature data was retrieved through the Western Regional Climate Center (Western Regional Climate Center 2013). The WRCC acts as a repository of historical climate data and information. Air temperature records for the past century were summarized by the WRCC into distinct climate regions (Abatzoglou et al. 2009). Although having some similarities, DWR's hydrologic regions do not correspond directly to WRCC's climate regions (see Figure NL-20). A particular hydrologic region may overlap more than one climate region and, hence, have different climate trends in different areas. For the purpose of this regional report, however, climate trends of the major climate regions are considered to be relevant trends for respective portions of the hydrologic region.

Locally in the North Lahontan Hydrologic Region within the WRCC Northeast climate region, mean temperatures have increased by about 0.8 to 2.0 °F (0.5 to 1.1 °C) in the past century, with minimum and maximum temperatures increasing by about 0.9 to 2.2 °F (0.5 to 1.2 °C) and by

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



Note: 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.

0.5 to 2.1 °F (0.3 to 1.2 °C), respectively (Western Regional Climate Center 2013). Lake Tahoe water temperatures are rising at twice the rate of the world's oceans, putting the fragile ecosystem at risk. Since 1980, the Truckee River Basin has experienced a decline in spring snowpack, less precipitation falling as snow, and earlier snowmelt (Lea 2010). Water year runoff trends from the past century are varied throughout the region. For example, runoff in the East Carson River and West Walker River has increased by 2,000 af/yr. from 1922 to 2005, but the Truckee River system has seen no significant runoff trend in the past century (Department of Water Resources 2006).

Projections and Impacts

While historical data is a measured indicator of how the climate is changing, it can't project what future conditions may be like under different GHG emissions scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date. It indicates that by mid-century (2060-2069) temperatures will be 3.4 to 4.9 °F (1.9 to 2.7 °C) higher across the state than they were from 1985 to 1994 (Pierce et al. 2012). Annual mean temperatures by 2060-2069 are projected to increase 4.7 °F (2.6 °C) for the WRCC Northeast climate region, with increases of 3.4 °F (1.9 °C) during the winter months and 6.5 °F (3.6 °C) during summer. Climate projections for this region, from Cal-Adapt indicate that temperatures between 1990 and 2100 will increase by 4.5 °F (2.5 °C) in the winter and 9 °F (5 °C) in the summer (California Emergency Management Agency and California Natural Resources Agency 2012). 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).

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. Most climate model precipitation projections for the state anticipate drier conditions in Southern California, with heavier and warmer winter precipitation in Northern California, including the North Lahontan River Region (Pierce et al. 2012). In addition, extreme precipitation events are projected to increase with climate change (Pierce et al. 2012). Warmer temperatures will result in more precipitation falling as rain instead of snow, decreased snowpack, and increased wildfire risk (California Emergency Management Agency and California Natural Resources Agency 2012). More intense wet and dry periods are anticipated, which could lead to flooding in some years and drought in others. Since there is less scientific detail on localized precipitation changes, there exists a need to adapt to this uncertainty at the regional level (Qian et al. 2010).

Recent computer downscaling techniques 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). A higher proportion of precipitation falling as rain instead of snow and increased storm frequency would impact the system's ability to provide effective flood protection. The North Lahontan Hydrologic Region does not have a well-developed flood control system; with climate change, the region may experience extreme event flood events more frequently.

The Sierra Nevada snowpack is projected to continue to decline as warmer temperatures raise the elevation of snow levels, reduce spring snowmelt, and increase winter runoff. See Box NL-3 for examples of Sierra snow variability. Based upon historical data and modeling, researchers at Scripps Institution of Oceanography project that by the end of this century the Sierra Nevada could experience a 48 to 65 percent reduction of its historical average snowpack (Pierce and Cayan 2013). Snowmelt-dominated watersheds in the region will each have a unique snowmelt response depending on elevation and the amount of warming that occurs. Climate projections indicate that temperatures are likely to continue to rise by the end of the century, diminishing April 1 snowpack (Table NL-29). DWR projects that with a 1 °C (1.8 °F) rise, the Tahoe basin April 1 snow-covered area drops to 55 percent, whereas the Carson and Walker basins are less impacted due to higher mean elevations (2006). A projected temperature rise of 5 °C (9 °F) would leave Truckee and Tahoe basins with 8 percent snow coverage; West Carson, East Carson, and East Walker basins with approximately 25 percent snow coverage; and West Walker basin with 41 percent April 1 snow coverage.

Adaptation

Climate change has the potential to impact this region, which the state depends upon for its economic and environmental benefits. Local ecosystems provide for the timber industry, agriculture and grazing, tourism, and water supply. Projected climate change will increase the vulnerability of natural and built systems in the region.

Impacts to natural systems will challenge aquatic and terrestrial species with changing habitats, diminished water quantity and quality, and invasive species. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystem services such as carbon sequestration, pollution remediation, and habitat for pollinators that are important for human society. With increased atmospheric carbon dioxide concentrations and warmer temperatures, forests will respond with higher productivity. Although short-term gains are expected, reduced water availability, drier conditions, invasive species, more severe pest outbreaks, and wildfire may surmount any gain in productivity. Large increases in wildfire risk are projected for all parts of the region with some having four times more risk than current levels by the end of the century (Westerling et al. 2009; California Emergency Management Agency and California Natural Resources Agency 2012).

Box NL-3 Sierra Snow Variability

Sierra snowpack varies depending upon the year and location. Here are two examples of the same location on different years showing a wide difference in the snowpack.

Photo A Snow Survey at Phillips Station near Highway 50 Approximately 2.5 Miles West of Echo Summit during Early May 2013

Source: Council for Watershed Health

Photo B Photo B Snow Survey at Phillips Station near Highway 50 Approximately 2.5 Miles West of Echo Summit during April 2010

Source: Council for Watershed Health

Built systems will be impacted by changing hydrology and runoff timing, and loss of natural snowpack storage, making the region more dependent on surface storage in reservoirs and groundwater sources. Increased future water demand for both natural and built systems may be particularly challenging with less natural storage and less overall supply. Increased cross-sector collaboration between 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.

Water managers and local agencies must work together determine the appropriate planning approach for their operations and communities. While climate change adds another layer of

Table NL-29 North Lahontan Hydrologic Region Snow Covered Area Changes with Temperature

Basin	Mean Elevation (ft.)	Average Apr. 1 Snow Line (ft.)	Total Area (sq. mi.)	Snow Covered Area	1 °C (1.8 °F) Rise	2 °C (3.6 °F) Rise	3 °C (5.4 °F) Rise	4 °C (7.2 °F) Rise	5 °C (9 °F) Rise
				SNOW COVERAGE IN PERCENT OF BASIN					
Truckee	6,790	5,500	430	100	84	58	35	17	8
Tahoe	7,030	6,000	510	100	55	41	29	18	8
W. Carson	8,050	6,000	70	100	100	100	71	51	25
E. Carson	7,530	6,000	350	86	77	66	54	47	22
W. Walker	8,650	6,500	180	100	94	83	67	53	41
E. Walker	8,250	6,500	360	97	83	69	50	36	26

Source: California Department of Water Resources 2006.

uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (U.S. Environmental Protection Agency and California Department of Water Resources 2011). However, stationarity (the idea that natural systems fluctuate within an unchanging envelope of variability) can no longer be assumed so new approaches will likely be required (Milly et al. 2008).

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

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).

Regionally, the Sierra Climate Change Toolkit, developed by the Sierra Nevada Alliance, is a comprehensive resource for resource managers, local governments, planners, and others that are interested in addressing climate change in Sierra watersheds and communities. The toolkit provides frameworks, specific strategies, and case studies for reducing greenhouse gas emissions and adapting to climate change impacts and additional resources to help planning processes or projects address climate change (Sierra Nevada Alliance 2011).

IRWM planning is 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 and identify adaptation strategies that are most appropriate for their sub-regions. Planning strategies to address vulnerabilities and adaptation to climate change should be both proactive and adaptive, starting with strategies that benefit the region in the present-day while adding future flexibility and resilience under uncertainty.

The region already experiences chronic water shortages; with a continued decrease in snowpack, the region is particularly vulnerable to water supply as less surface water is available during the summer from snowpack fed streams and rivers. Agricultural water use efficiency is a resource management strategy outlined in Volume 3 that can help adapt to water scarcity. The strategy helps the grower to use water in a way that is most effective to the crop, while minimizing yield losses.

With a projected increase in storm events, infrastructure in the region becomes more vulnerable as many residences, commercial facilities, highways, roads, and agricultural land are in the flood zone. A resource management strategy to adapt to increased flooding risk is integrated flood management. This strategy employs several approaches including structural improvement and maintenance of constructed facilities, coordinated flood operations, land use management, and disaster preparedness.

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

- Chapter 2, "Agricultural Water Use Efficiency."
- Chapter 4, "Flood Management."
- Chapter 6, "Conveyance — Regional/Local."
- Chapter 9, "Conjunctive Management and Groundwater Storage."
- Chapter 11, "Precipitation Enhancement."

- Chapter 14, "Surface Storage — Regional/Local."
- Chapter 18, "Pollution Prevention."
- 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."

The myriad of resources and choices available to managers can seem overwhelming, and the need to take action given uncertain future conditions is daunting. However, there are many actions that water managers can take to prepare for climate change, regardless of the magnitude of future warming. These actions often provide economic and public health co-benefits. Water and energy conservation are examples of strategies that make sense with or without the additional pressures of climate change. Conjunctive management projects that manage surface water and groundwater in a coordinated fashion could provide a buffer against variable annual water supplies. Forecast-coordinated operations would provide flexibility for water managers to respond to weather conditions as they unfold.

Mitigation

The myriad of California's water sector consumes about 12 percent of total statewide energy (19 percent of statewide electricity, and about 32 percent of statewide natural gas, and negligible amounts of crude oil). As shown in 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, "The Water Energy Connection" (Volume 1), shows all of the connections between water and energy in the water sector; both water use for energy generation and energy use for water supply activities.

The regional reports in Update 2013 are the first to provide detailed information on the water-energy connection, including energy intensity (EI) information at the regional level. EI information is designed to help inform the public and water utility managers about the relative energy requirements of the major water supplies used to meet demand. Since energy usage is closely related to GHG emissions, this information can support measures to reduce GHGs, as mandated by the State.

Figure NL-21, Energy Intensity of Raw Water Extraction and Conveyance, 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 NL-21. Energy required for water treatment, distribution, and end uses of the water are not included. Not all water types are available in this region. Some water types flow mostly by gravity to the delivery location and may require little or no energy to extract and convey. As a

Figure NL-21 Energy Intensity of Raw Water Extraction and Conveyance in the North Lahontan Hydrologic Region

Type of Water	Energy Intensity (= 1-250 kWh/AF = 251-500 kWh/AF)	Percent of Regional Water Supply*
Colorado (Project)	*This type of water not available*	0%
Federal (Project)	*This type of water not available*	0%
State (Project)	*This type of water not available*	0%
Local (Project)	<250 kWh/AF	44%
Local Imports	*This type of water not available*	0%
Groundwater	<250 kWh/AF	22%

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

*The percent of regional water supply may not add up to 100% 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*, Volume 3. For detailed descriptions of the methodology used to calculate EI in this figure, see Volume 5, *Technical Guide*.

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 NL-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 NL-21. For these reasons, discussion of EI of recycled and desalinated water is found separately in Volume 3, *Resource Management Strategies*. (Energy Intensity is discussed in Box NL-4.)

Box NL-4 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.

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.

California Air Resources Board. 2008. AB32 *Climate Change Scoping Plan: A Framework for Change*. 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.

California Department of Fish and Game. 2012. *A "Growing" Issue: Environmental Impacts of Medical Marijuana in Northern California*. Eureka (CA): California Department of Fish and Game – Northern Region. 6 pp. Viewed online at: http://co.humboldt.ca.us/board/agenda/questys/mg218885/as218921/ai224352/do224464/bosagendaitem.pdf.

California Department of Water Resources. 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.

———. 2006. *Progress on Incorporating Climate Change into Management of California's Water Resources*. Sacramento (CA): California Department of Water Resources. Viewed online at: http://baydeltaoffice.water.ca.gov/climatechange/DWRClimateChangeJuly06.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. Natural Resources Agency. 88 pp. Viewed online at: http://www.water.ca.gov/irwm/grants/docs/Guidelines/GL_2012_FINAL.pdf.

California Department of Water Resources and U.S. Army Corps of Engineers. 2013. *California's Flood Future: Recommendations for Managing the State's Flood Risk*. Sacramento (CA): California Department of Water Resources. U.S. Army Corps of Engineers. 152 pp. Viewed online at: http://www.water.ca.gov/sfmp/resources/California_Flood_Future.pdf.

California Emergency Management Agency and California Natural Resources Agency. 2012. *California Adaptation Planning Guide*. [4 Documents]. Sacramento (CA): California Emergency Management Agency and California Natural Resources Agency. 336 pp. Viewed online at: http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html.

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 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. E*mbedded 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 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.

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.

Fort Bidwell Indian Community Council. 2012. *Assessment of Fort Bidwell Geothermal Well FB-4*. Fort Bidwell (CA): Fort Bidwell Indian Community Council. California Energy Commission. 67 pp. Viewed online at: http://www.energy.ca.gov/2012publications/CEC-500-2012-061/CEC-500-2012-061.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.

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.

Lahontan Regional Water Quality Control Board. 2005. *Project Plan: Susan River, Lassen County*. South Lake Tahoe, (CA): California Regional Water Quality Control Board, Lahontan Region. 11 pp. Viewed online at: http://www.waterboards.ca.gov/lahontan/water_issues/programs/tmdl/susan_river/docs/projectplan.pdf.

———. 2006. *Resolution R6T-2006-0047: Approval of Amendments to the Water Quality Control Plan for the Lahontan Region to Revise Sodium-Related Water Quality Standards for Surface Waters of the Carson and Walker River Watersheds, and Approval of a Substitute Environmental Document*. South Lake Tahoe (CA): Lahontan Regional Water Quality Control Board. 4 pp. Viewed online at: http://www.waterboards.ca.gov/lahontan/board_decisions/adopted_orders/2006/docs/r6t2006_0047.pdf.

Lake Tahoe News. 2012. "Reflections of Angora Fire 5 Years after the Devastation." [Web site]. South Lake Tahoe (CA): Lake Tahoe News. Viewed online at: http://www.laketahoenews.net/2012/06/reflections-of-angora-fire-5-years-after-the-devastation/.

Lea J. 2010. *Snowpack Trends in the Central Sierra Nevada Affecting Water Supply Forecasts in the East Slope Sierra Basins*. Portland (OR): U.S. Department of Agriculture. 9 pp. Viewed online at: http://acwi.gov/sos/pubs/2ndJFIC/Contents/2E_LEA_03_11_10.pdf.

Medellin-Azuara J, Connel CR, Madani K, Lund JR, Howitt RE. 2009. *Water Management Adaptation with Climate Change*. Sacramento (CA): 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.

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, Nanamitsu M, Yoshimura K, Snyder MA, Sloan LC, Franco G, Tyree M. 2012. "Probabilistic Estimates of Future Changes in California Temperature and Precipitation Using Statistical and Dynamical Downscaling." Climate Dynamics. 40 (3-4): 839-856. [Journal.] Viewed online at: http://link.springer.com/article/10.1007%2Fs00382-012-1337-9.

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

Sierra Nevada Alliance. 2011. *Sierra Climate Change Toolkit: Planning Ahead to Protect Sierra Natural Resources and Rural Communities*. South Lake Tahoe (CA): Sierra Nevada Alliance. 126 pp. Viewed online at: http://www.sierranevadaalliance.org/publications/db/pics/1303760072_12034.f_pdf.pdf.

State Water Resources Control Board. 2009. *Resolution No. 2009-0028: Approving an Amendment to the Water Quality Control Plan for the Lahontan Region (Basin Plan) to Establish a Total Maximum Daily Load for Sediment in the Middle Truckee River Watershed*. Sacramento (CA): State Water Resources Control Board. 2 pp. Viewed online at: http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2009/rs2009_0028.pdf.

———. 2011. *Truckee River Sediment TMDL Implementation Status Report*. Sacramento (CA): State Water Resources Control Board. Regional Water Quality Control Board Lahontan Region. 5 pp. Viewed online at: http://www.swrcb.ca.gov/rwqcb6/water_issues/programs/tmdl/truckee/docs/2011statusrpt.pdf.

———. 2013. *Marijuana Cultivation on the North Coast Threatens Water Quality and Wildlife: Fact Sheet*. Sacramento (CA): State Water Resources Control Board. 3 pp. Viewed online at: http://www.waterboards.ca.gov/northcoast/publications_and_forms/available_documents/pdf/2013/130611_MarijuanFactSheet.pdf.

Truckee River Watershed Council. 2013. "Coldstream Canyon Project." [Web site]. Truckee (CA): Truckee River Watershed Council. Viewed online at: http://www.truckeeriverwc.org/projects/coldstream.

U.S. Department of Agriculture. 2011. *Susan River Area: Rapid Watershed Assessment*. Washington D.C.: United States Department of Agriculture. Natural Resources Conservation Service. 69 pp. Viewed online at: http://honeylakevalleyrcd.us/wp-content/uploads/2012/02/NRCS_Final_Draft_-Susan_R_Area_RWA.pdf.

U.S. Department of Justice. 2013. *Memorandum for all United States Attorneys: Guidance Regarding Marijuana Enforcement*. Washington DC: U.S. Department of Justice. 4 pp. Viewed online at: http://www.justice.gov/iso/opa/resources/3052013829132756857467.pdf.

U.S. Environmental Protection Agency. 2012. *Assessing Water System Managerial Capacity*. Washington D.C.: United States Environmental Protection Agency. 34 pp. Viewed online at: http://water.epa.gov/type/drink/pws/smallsystems/upload/epa816k12004.pdf.

U.S. Environmental Protection Agency and Department of Water Resources. 2011. *Climate Change Handbook for Regional Water Planning*. Sacramento (CA): Environmental Protection Agency Region 9. California Department of Water Resources. 246 pp. Viewed online at: http://www.water.ca.gov/climatechange/docs/Climate_Change_Handbook_Regional_Water_Planning.pdf.

U.S. Forest Service. 2007. *Lake Tahoe Basin: Multi-Jurisdictional Fuel Reduction and Wildlife Prevention Strategy – 10 Year Plan*. South Lake Tahoe (CA): United States Forest Service. 74 pp. Viewed online at: http://resources.ca.gov/tahoefirecommission/downloads/Final_Draft_LTB-FUELS-10_YEAR_PLAN.pdf.

United States 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 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.

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.

Zuckerman S. 2013. "Is Pot-Growing Bad for the Environment?" The Nation. [News article]. Viewed online at: http://www.thenation.com/article/176955/pot-growing-bad-environment.

Additional References

California Air Resources Board. 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 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. 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.

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

California Emergency Management Agency and California Natural Resources Agency. 2012. *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.

———. 2012. *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. 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.

Das T, Dettinger MD, Cayan DR, and Hidalgo GH. 2011. "Potential Increase in Floods in California's Sierra Nevada under Future Climate Projections." Climatic Change Vol. 109(1): 71-94 pp. Viewed online at: http://tenaya.ucsd.edu/~dettinge/das_climchg_floods.pdf.

Hanak E, and Lund JR. 2011. "Adapting California's Water Management to Climate Change." Climatic Change [Published online]. [Journal]. 28 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 pp. Viewed online at: http://www.pnas.org/content/101/34/12422.full.pdf+html.

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.

Inyo-Mono Integrated Regional Water Management Program. 2013. "Inyo-Mono Integrated Regional Water Management Program (IRWMP)." [Web site]. Viewed online at: http://inyo-monowater.org/.

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.

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.

Lahontan Regional Water Quality Control Board. 2011. *Truckee River Sediment TMDL Implementation Status Report 2011*. South Lake Tahoe (CA): Lahontan Regional Water Quality Control Board. 5 pp. Viewed online at: http://www.swrcb.ca.gov/lahontan/water_issues/programs/tmdl/truckee/docs/2011statusrpt.pdf.

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.: The National Academies Press. 201 pp. Viewed online at: http://www.nap.edu/catalog.php?record_id=13389.

State Water Resources Control Board. 2009. *Recycled Water Policy*. Sacramento (CA): State Water Resources Control Board. 14 pp. Viewed online at: http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/recycledwaterpolicy_approved.pdf.

———. 2013. *Communities that Rely on a Contaminated Groundwater Source for Drinking Water*. Report to the Legislature. Sacramento (CA): State Water Resources Control Board. 181 pp. Viewed online at: http://www.waterboards.ca.gov/water_issues/programs/gama/ab2222/docs/ab2222.pdf.

Tahoe Sierra Integrated Regional Water Management Plan. 2007. *The Tahoe Sierra Plan*. South Lake Tahoe (CA): Tahoe Resource Conservation District. 104 pp. Viewed online at: http://www.stpud.us/plan_docs_Integrated_Regional_Water_Management_Plan.pdf.

United States Army Corps of Engineers. 2010. *Lake Tahoe EIP 2010-2020: An Economic Analysis of Private Source Stormwater BMP Expenditures on Redevelopment Projects*. Sacramento (CA): United States Army Corps of Engineers. 25 pp. Viewed online at: http://nltra.org/documents/pdfs/Redevelopment%20econ.pdf.

United States Bureau of Reclamation. 2011. *Wes-wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections*. Washington D.C. United States Bureau of Reclamation. 138 pp. Viewed online at: http://www.usbr.gov/WaterSMART/docs/west-wide-climate-risk-assessments.pdf.

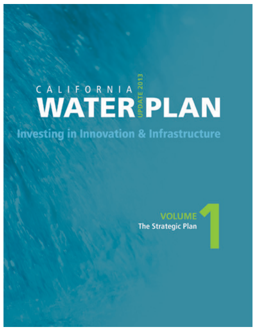
Van Vuuren DP, Edmonds J, Kainuma M, Riahi K, Thomson A, Hibbard K, et al. 2011. "The Representative Concentration Pathways: An Overview." Climatic Change Vol. 109(1-2): 5-31 pp. Viewed online at: http://link.springer.com/article/10.1007%2Fs10584-011-0148-z#.

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.

Zafar M. 2013. "Water Energy Nexus: Energy for Water Related Services." Sacramento (CA). [Presentation]. Viewed online at: http://www.cpuc.ca.gov/NR/rdonlyres/18531E25-8F97-41BA-88F8-C44E7C59A7D0/0/verdexfeb2013mtg_e.pdf.

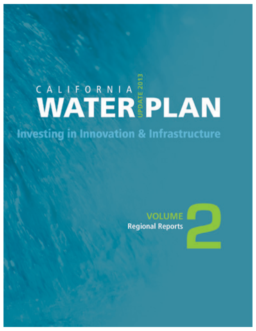
Navigating Water Plan Update 2013

Update 2013 includes a wide range of information, from a detailed description of California's current and potential future conditions to a "Roadmap For Action" intended to achieve desired benefits and outcomes. The plan is organized in five volumes — the three volumes outlined below; Volume 4, *Reference Guide*; and Volume 5, *Technical Guide*.



VOLUME 1, The Strategic Plan

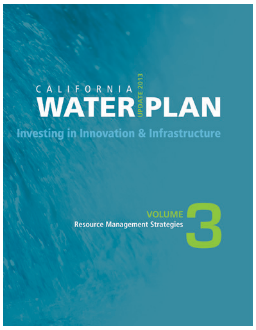
- Call to action, new features for Update 2013, progress toward implementation.
- Update 2013 themes.
- Comprehensive picture of current water, flood, and environmental conditions.
- Strengthening government alignment and water governance.
- Planning (data, analysis, and public outreach) in the face of uncertainty.
- Framework for financing the California Water Plan.
- Roadmap for Action — Vision, mission, goals, principles, objectives, and actions.



VOLUME 2, Regional Reports

- State of the region — watersheds, groundwater aquifers, ecosystems, floods, climate, demographics, land use, water supplies and uses, governance.
- Current relationships with other regions and states.
- Accomplishments and challenges.
- Looking to the future — future water demands, resource management strategies, climate change adaptation.

VOLUME 3, Resource Management Strategies



Integrated Water Management Toolbox,
30+ management strategies to:

- Reduce water demand.
- Increase water supply.
- Improve water quality.
- Practice resource stewardship.
- Improve flood management.
- Recognize people's relationship to water.

All five volumes are available for viewing and downloading at DWR's Update 2013 Web site:
http://www.waterplan.water.ca.gov/cwpu2013/final/ or http://www.waterplan.water.ca.gov/cwpu2013/final/index.cfm.

If you need the publication in alternate form, contact the Public Affairs Office, Graphic Services Branch, at (916) 653-1074.

Integrated water management *is a comprehensive and collaborative approach for managing water to concurrently achieve social, environmental, and economic objectives. In the California Water Plan, these objectives are focused toward improving public safety, fostering environmental stewardship, and supporting economic stability. This integrated approach delivers higher value for investments by considering all interests, providing multiple benefits, and working across jurisdictional boundaries at the appropriate geographic scale. Examples of multiple benefits include improved water quality, better flood management, restored and enhanced ecosystems, and more reliable water supplies.*

Edmund G. Brown Jr.
Governor
State of California

John Laird
Secretary for Natural Resources
Natural Resources Agency

Mark Cowin
Director
Department of Water Resources

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

October 2014