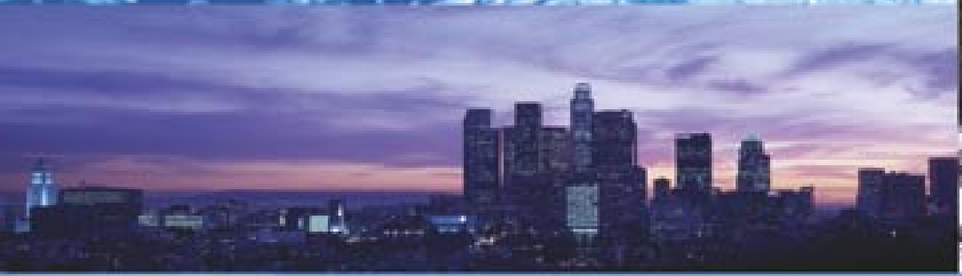

Regional Reports
Volume 3

California WaterPlan Update 2005

A FRAMEWORK FOR ACTION

Department of Water Resources Bulletin 160-05 December 2005

The California Water Plan Update 2005
is organized in five volumes:

Volume 1:	Strategic Plan
Volume 2:	25 Resource Management Strategies
Volume 3:	12 Regional Reports
Volume 4:	Reference Guide (60+ articles)
Volume 5:	Technical Guide (Online documentation)

The final California Water Plan Update 2005 and the Water Plan Highlights briefing book were completed in December 2005. The five volumes of the update, the Highlights document, and the introductory video, "Water for Tomorrow," are contained on the CD and DVD below and also available online at www.waterplan.water.ca.gov.

Printed copies are available. The Highlights briefing book, which contains the CD and DVD, is available at no charge. Volume 1, 2, and 3 are $15 each. Volume 4 is $50. For printed copies, contact:

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The Resources Agency
Department of Water Resources

California Water Plan Update 2005

A Framework for Action

Bulletin 160-05
December 2005

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The Resources Agency

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Volume 3 – Regional Reports

Volume 3

Chapter 1 State Summary

Chapter 1 State Summary

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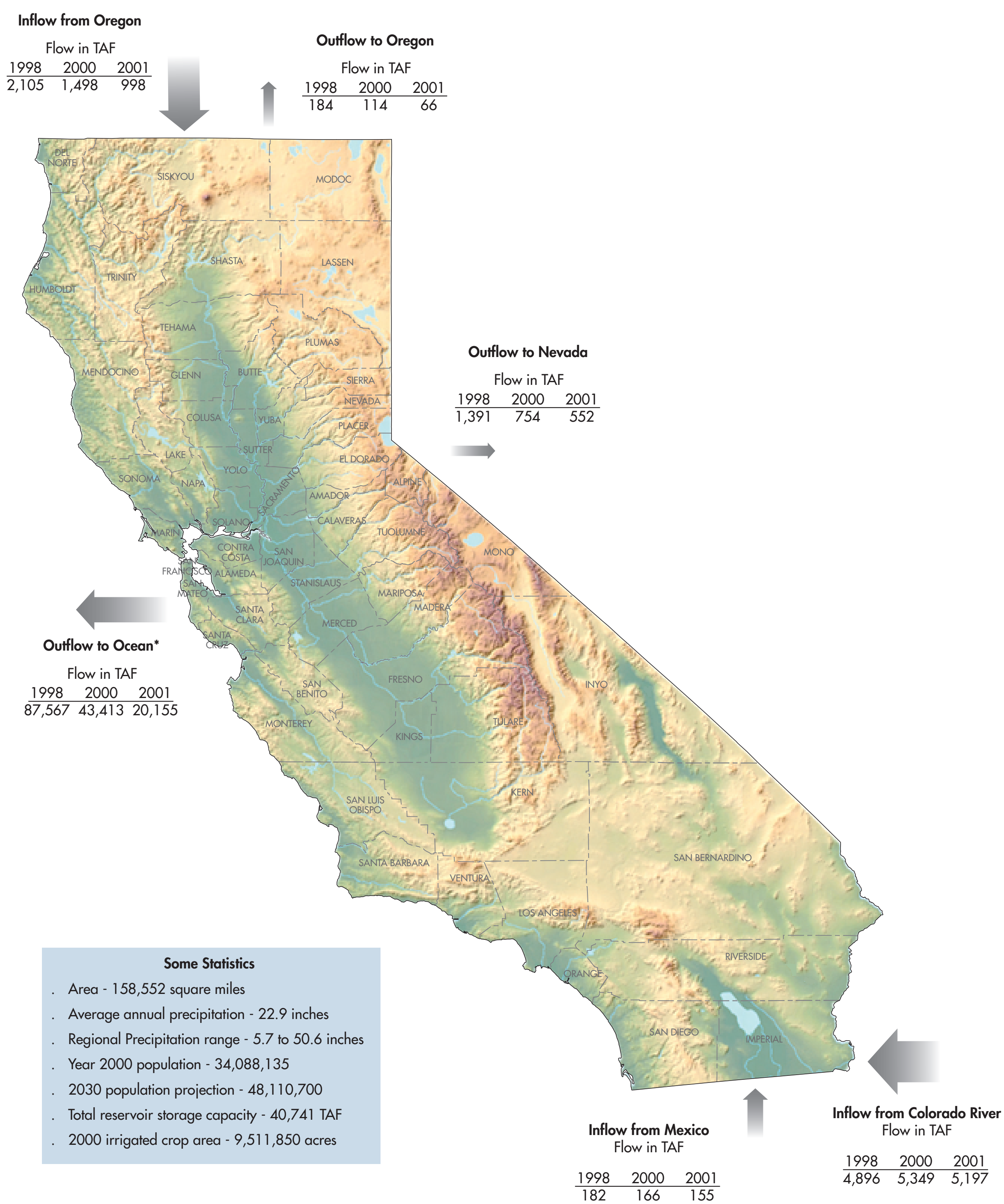
Figure 1-1 State of California



The third largest state, California has a variety of landforms and climates. Annual rainfall ranges from more than 140 inches in the north coast to less than 4 inches in the southeastern part. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

**Outflow to Ocean includes Wild and Scenic Rivers, regulated flows, and estimated wastewater outflows.*

Chapter 1 *State Summary*

This volume contains a statewide summary of water supply and water-use information for 1998, 2000 and 2001, followed by 12 individual regional reports. Ten reports summarize California's hydrologic regions. Two additional reports are included — one for the Mountain Counties region and another for the Sacramento-San Joaquin Delta region. These two reports describe areas with significant water issues that overlay parts of the other hydrologic regions. These 12 regional reports provide information on the current water supplies and uses in each area, as well as a discussion of the water issues, accomplishments, and challenges that are specific to each region of California. Figure 1-1 provides a geographic overview of California and summarizes surface water inflows and outflows with adjoining states.

Hydrologic Regions

California has a variety of climates and landforms. To better understand these diversities and plan for future needs, the Department of Water Resources (DWR) divides the state into 10 hydrologic regions, corresponding to the state's major water drainage basins. Using the drainage basins as planning boundaries allows logical tracking of natural water runoff and accounting of surface and groundwater supplies. See Figure 1-2 and Box 1-1 California's 10 Hydrologic Regions.

Box 1-1 California's 10 Hydrologic Regions

North Coast. Klamath River and Lost River Basins, and all basins draining into the Pacific Ocean from Oregon south through the Russian River Basin.

San Francisco Bay. Basins draining into San Francisco, San Pablo, and Suisun Bays, and into the Sacramento River downstream from Collinsville; western Contra Costa County; and basins directly tributary to the Pacific Ocean below the Russian River watershed to the southern boundary of the Pescadero Creek Basin.

Central Coast. Basins draining into the Pacific Ocean below the Pescadero Creek watershed to the southeastern boundary of Rincon Creek Basin in western Ventura County.

South Coast. Basins draining into the Pacific Ocean from the southeastern boundary of Rincon Creek Basin to the international border with Mexico.

Sacramento River. Basins draining into the Sacramento River system in the Central Valley (including the Pit River drainage), from the Oregon border south through the American River drainage basin.

San Joaquin River. Basins draining into the San Joaquin River system, from the Cosumnes River basin on the north through the southern boundary of the San Joaquin River watershed.

Tulare Lake. The closed drainage basin at the south end of the San Joaquin Valley, south of the San Joaquin River watershed, encompassing basins draining to Kern Lakebed, Tulare Lakebed, and Buena Vista Lakebed.

North Lahontan. Basins east of the Sierra Nevada crest and west of the Nevada state line, from the Oregon border south to the southern boundary of the Walker River watershed.

South Lahontan. The interior drainage basins east of the Sierra Nevada crest, south of the Walker River watershed, northeast of the Transverse Ranges, and north of the Colorado River Region. The main basins are the Owens and the Mojave River Basins.

Colorado River. Basins south and east of the South Coast and South Lahontan regions; areas that drain into the Colorado River, Salton Sea, and other closed basins north of the border with Mexico.

California is a state of contrasts and diversity as illustrated in this satellite image of Central California. Visible to the east are the forested slopes and snow-covered higher peaks of the Sierra Nevada and the light blue Lake Tahoe. The great Central Valley appears in center of the image. Farther west are the Coast Range, the San Francisco Bay and Delta, and the Pacific Ocean. (Photo courtesy of NASA)

For planning and data collection, DWR subdivides the 10 hydrologic regions into 56 planning areas (PAs) plus a more detailed breakdown into 278 detailed analysis units or DAUs (see Box 1-2 for more abbreviations used in this summary). Most of DWR data collection and analyses are started at the DAU level. This water plan update then gathers results into hydrologic regions for presentation.

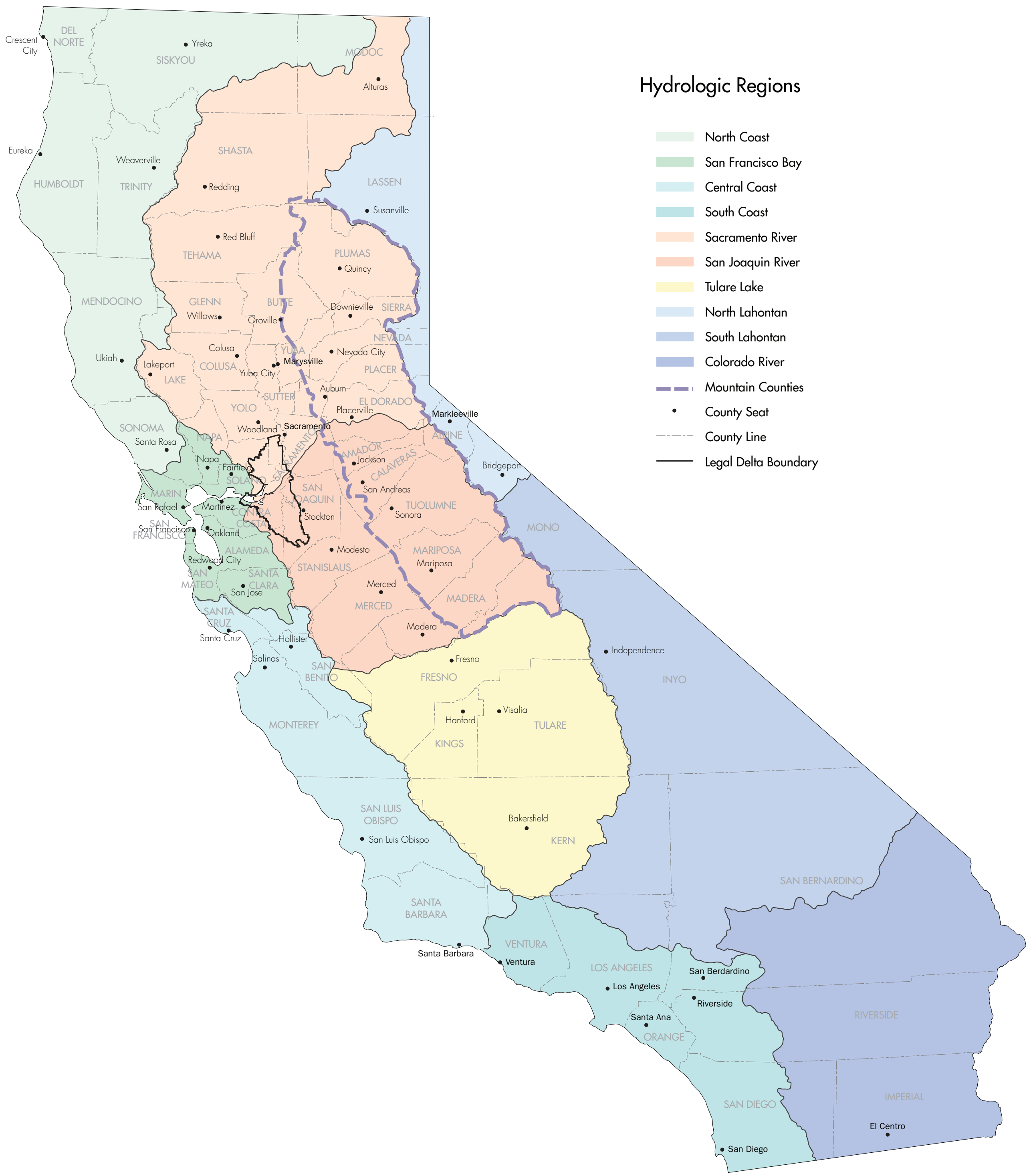
Overlay Areas

Some areas of the state with common water issues or interests often cross the boundaries from one hydrologic region to another. This is the first water plan update in the Bulletin 160 series to describe overlay areas. The two regional overlays in this report are the Mountain Counties region and the Sacra-

Box 1-2 Acronyms Used in State Summary

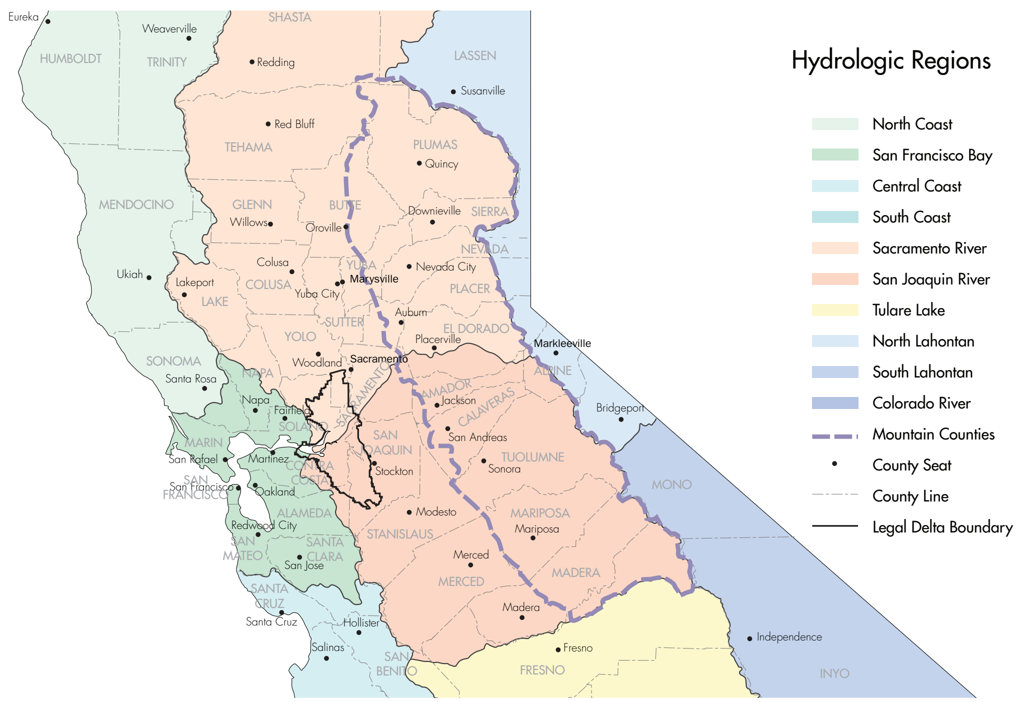
ABAG—Association of Bay Area Governments
CALFED—State and Federal Bay Delta Authority
CBDA—California Bay-Delta Authority
DAU—Detailed Analysis Unit
DWR—California Department of Water Resources
ET—Evapotranspiration
ETAW—Evapotranspiration of Applied Water
maf—million acre-feet
PA—Planning Area
SWP—State Water Project
SWRCB—State Water Resource Control Board
taf—thousand acre-feet

Figure 1-2 Hydrologic regions with Mountain Counties and Legal Delta



The California Department of Water Resources divides the state into 10 hydrologic regions that correspond to its major drainage basins. This water plan update also describes the Mountain Counties and Sacramento-San Joaquin Delta as two overlay areas of special interest.

Figure 1-3 Mountain Counties and Legal Delta overlays



Some areas of California with common water issues or interests span more than one hydrologic region and are called overlay areas. The Sacramento-San Joaquin Delta and the Mountain Counties are two overlay areas described in this water plan update.

mento – San Joaquin Delta region (see Figure 1-3 and Box 1-3 Two Overlay Areas). There are many other regional overlays that could be developed, based on boundaries such as county lines, regional water districts, or integrated regional planning areas. Two examples of other regional agencies that could be distinguished in this manner are the California Bay-Delta Authority's (CBDA) Southern California regional area of influence and the nine-county regional boundary for the Association of Bay Area Governments.

Coordination of Regional Reports

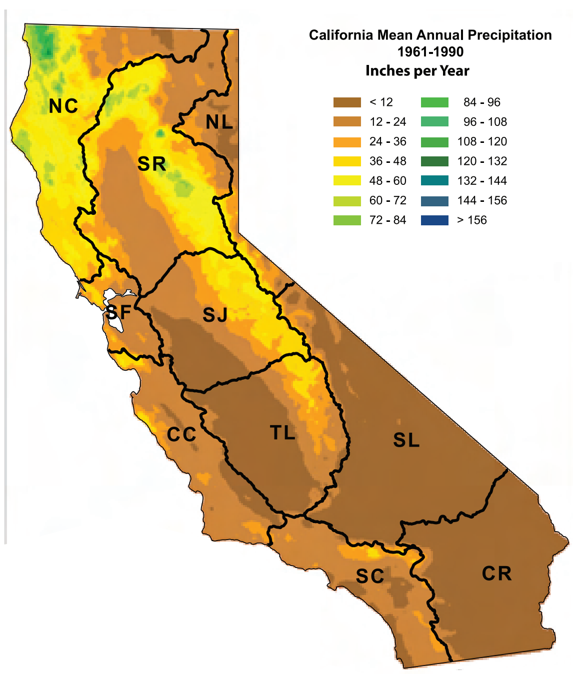
As this California Water Plan Update 2005 was being prepared, CBDA was also preparing multiyear plans for implementation of the CALFED Bay-Delta Plan. As part of that activity, CBDA was preparing a description of regional water management needs as well as regional and state plans to meet those needs for all regions within the CALFED solution area. CBDA is interested in providing the most up-to-date information on how CALFED implementation is being integrated with regional efforts to address both local and state needs.

Box 1-3 Two Overlay Areas

Mountain Counties. The Mountain Counties include the foothills and mountains of the western slope of the Sierra Nevada and a portion of the Cascade Range. The area includes the eastern portions of the Sacramento River and San Joaquin River hydrologic regions. This area shares common water and other resource issues and is the origin for much of the state's developed surface water supply.

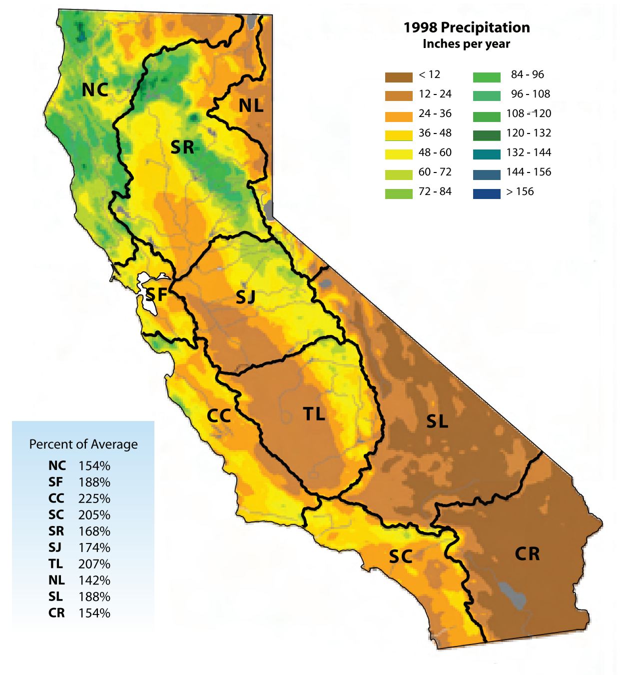
Sacramento-San Joaquin Delta. The Legal Delta includes about 740,000 acres of tidally influenced land near the confluence of the Sacramento and San Joaquin Rivers. While the Delta occupies portions of the Sacramento, San Joaquin and a small part of the San Francisco hydrologic regions, the Delta is described as an overlay area because of its common characteristics, environmental significance, and the important role it has in the State's water systems.

Figure 1-4 Range of average annual precipitation across regions, 1961 - 1990



Color contour map shows 30-year average annual precipitation throughout California. Fourteen colors indicate ranges of precipitation from a low range less than 12 inches per year to a high range greater than 156 inches per year. The 10 hydrologic regions are delineated on the map.

Figure 1-5 Range of actual precipitation across regions, 1998



Color contour map shows range of actual precipitation throughout California in water year 1998. Percentage of average precipitation for each hydrologic region is shown in box. In 1998, an El Nino year, all regions received from 1.5 to 2 times their average precipitation.

In October 2003, DWR and CBDA agreed that the regional reports that fall within the CALFED solution area should be jointly coordinated and prepared. This includes the Sacramento River, San Francisco Bay, San Joaquin River, Tulare Lake, and South Coast hydrologic regions as well as the Sacramento-San Joaquin Delta overlay. As part of this ongoing coordination, CBDA and DWR will work cooperatively to add additional information to these joint reports, regarding local or regional water management needs and plans to meet those needs as it becomes available.

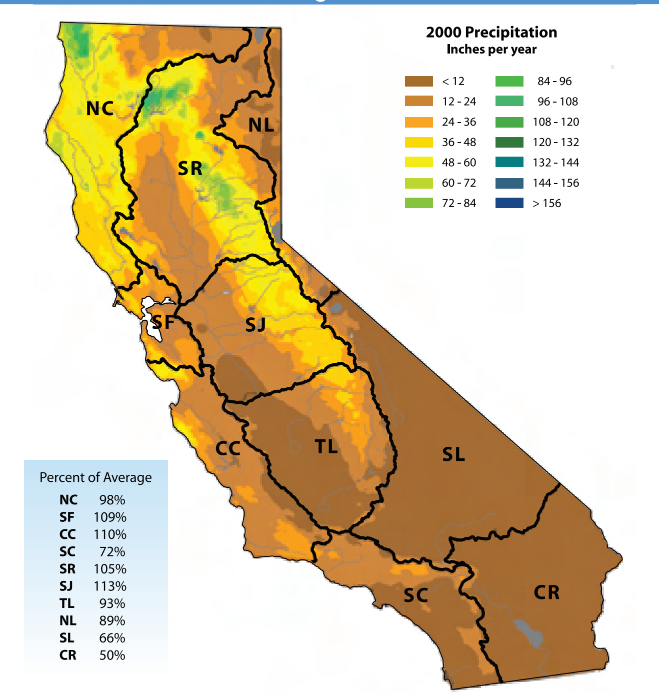
Hydrology for Current Conditions

Previous updates to the California water plan presented information about current water use and supplies by using a process that statistically "normalized" all water year data to represent average conditions. For Bulletin 160-98, year 1995 was chosen to represent current conditions and levels of water use. However, water year 1995 was actually classified as a wet year. Thus to develop information about average water year uses and supplies, the actual annual water supply and use data was statistically adjusted (also called normalized) based on historical trends, so that the 1995 level of all water uses represented what would be expected to occur in a statistically average water supply year. In the same way, a drought scenario was calculated to represent 1995 level water uses under drought water supply conditions.

As a result of significant public advisory committee input and recommendations for California Water Plan Update 2005, the previous process was changed. The advisory committee and the public requested that data for current levels of water use be prepared and presented from recent actual years, without any statistical adjustments. Three years were selected to show the range of actual water supplies and uses, based on a range of hydrologic conditions:

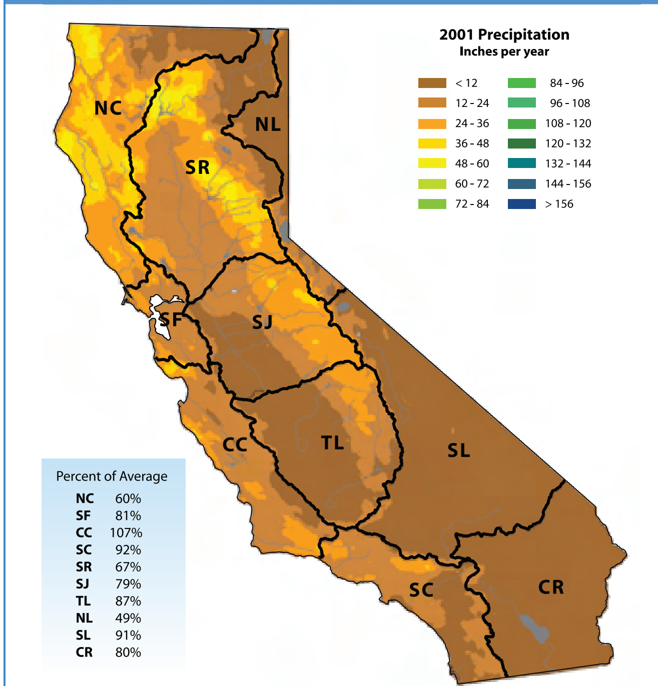
- 1998, which was a wet water-supply year statewide
- 2000, an overall average or normal water year
- 2001, a below average or dry year for most of the state

Figure 1-6 Range of actual precipitation across regions, 2000



Color contour map shows range of actual precipitation throughout California in water year 2000. Percentage of average precipitation for each hydrologic region is shown in box. In 2000, most regions received near average precipitation, while the South Coast, South Lahontan, and Colorado River regions received significantly less.

Figure 1-7 Range of actual precipitation across regions, 2001



Color contour map shows range of actual precipitation throughout California in water year 2001. Percentage of average prec ipitation for each hydrologic region is shown in box. In 2001, northern regions received significantly less than average precipitation, while more southern regions received just below average precipitation.

A consequence of this new method is that the actual data presented in this report is not directly comparable to the type of data presented in previous Bulletin 160 updates. The three recent years reflect the supplies and uses at a certain time and under specific conditions. Similarly, the data for 2001 do not constitute drought conditions, but only present actual conditions for a single dry water year.

In addition, these generally wet, average, and dry conditions for the entire state are not universally the same for all regions of the state. Figure 1-4 presents a map depicting long-term (based on years 1961 – 1990) average annual precipitation amounts throughout the state. For comparison, Figures 1-5, 1-6, and 1-7 show the range of actual precipitation across the different regions of the state for individual years 1998, 2000, and 2001 respectively. These maps were developed using data from National Weather Service's California Normal Stations. See Volume 5 Technical Guide for further information.

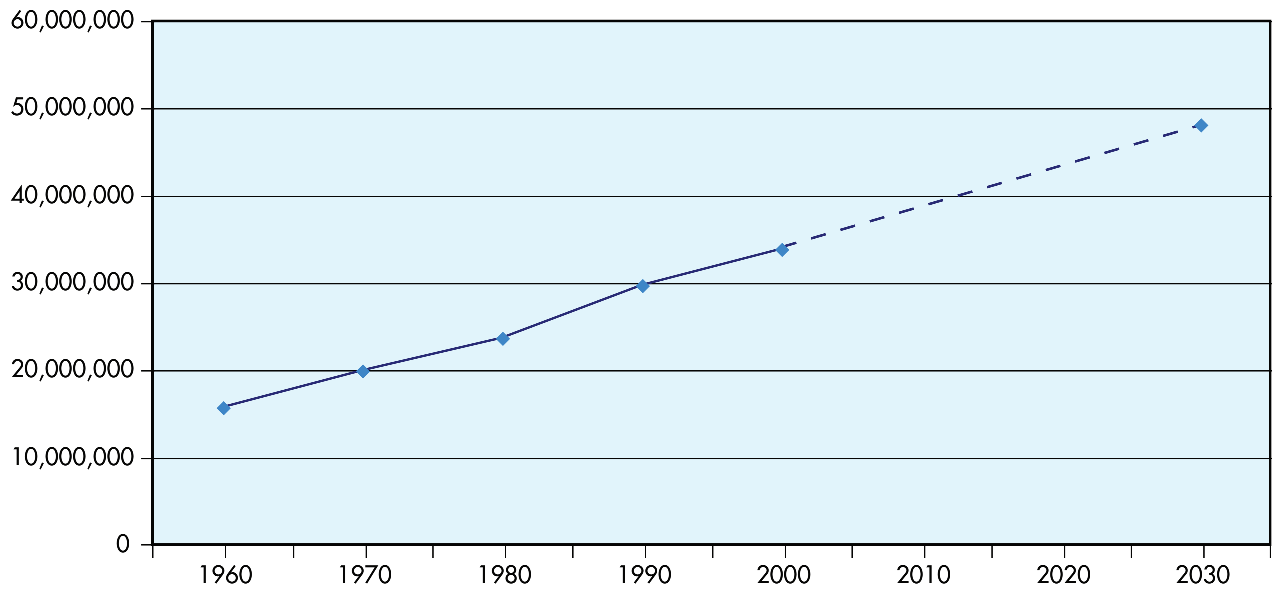
Population growth is a major factor that influences current and future water uses. California's population increased from about 30 million in 1990 to about 36.5 million in 2005. The California Department of Finance projects that the population could exceed 48 million by 2030 (Figure 1-8).

Water Portfolios

Previous updates to the California water plan have only provided regional and statewide water information for the developed water supplies and identified uses, but not for the entire water supply of the whole state. For California Water Plan Update 2005, a new concept was developed (nicknamed the water portfolio) to describe and evaluate the entire water resources of the state. The reasons for documenting this expanded water portfolio concept are to:

- identify and evaluate all of the statewide water supply sources whether or not they are currently developed and used,
- provide better information on the disposition of our source waters statewide by including additional categories of water supply and use,
- present water balances using accepted accounting principles,

Figure 1-8 State of California population



The nation's most populous state is now growing by about 600,000 people per year. The California Department of Finance projects that the state's population may exceed 48 million by 2030 and 55 million by 2050.

- provide insight where there may be underutilized "assets" (supply) and unmet "liabilities" (uses),
- provide insight about natural, physical (infrastructure) and institutional constraints, and water management decisions, by combining water balances with narrative discussions,
- identify 'data gaps' where additional information is needed to evaluate supplies and uses, and
- include key supplemental information such as water quality, water rights, and water contracts.

This new concept was derived from a comparison with the principles of a traditional financial accounting portfolio, and is intended to identify all of the state's water assets whether or not they are currently developed and used.

The water portfolios are based on the concept of the hydrologic cycle, and identify all possible categories of statewide water supplies and uses for each of the three specified years (1998, 2000, and 2001). On a statewide and regional basis, the portfolio diagrams also show the routing of water from initial source of supply to final disposition. The basic data and assumptions that are presented in these portfolio diagrams have been assembled for smaller local and regional areas (PAs and DAUs), and then accumulated to compile water portfolio totals for each hydrologic region and statewide. All of the information presented in the portfolio diagrams has also been cross-referenced by number codes to the tabular versions of the data. For consistency in each of the subsequent regional reports within Volume 3, the same portfolio format and data tables are used (see Box 1-4 Water Portfolio Components).

The primary reason for using these new water portfolio tables and flow diagrams is to provide an accounting of all water that enters and leaves the state and that is exchanged between the regions. This is important to all water planning activities. (See Figure 1-9 for regional inflows and outflows and further discussion under Statewide Water Portfolio Results later in this chapter). One shortcoming of this expanded process is that there are many regions of the state where some of the water portfolio data categories have never been measured. The resulting water portfolio tables show many categories where inadequate data are available. However, the ability to identify what data are needed is an important byproduct of this process. Another disadvantage resulting from the use of real data from three specific years is that those years provide no information about how supplies and demands would change during a drought sequence of several dry years. The collection of water supply and water use data for a series of 10 or more actual years would be very helpful toward the development of representative conditions for both average and extended droughts.

Applied Water Methodology

As previously developed in Bulletin 160-98, Bulletin 160-05 computes dedicated water supplies and uses on the basis of applied water data. Applied water refers to the total amount of water that is diverted from any source to meet the demands of water users, without adjusting for water that is used up, returned to the developed supply or irrecoverable. Within Volume 3, Tables 1-1 and 1-2 and Figure 1-10 present total statewide information on an applied water basis (see next section for discussion of Figure 1-10 and Tables 1-1 and 1-2). However, for the remaining statewide tables and each of the individual regional reports (Chapters 2 through 13), the information has been expanded to also present net water uses and water depletion. Net water supply and net water use data are smaller than applied water use. Net water use consists of water that is consumed in the system, irrecoverable water and outflow, while applied water also includes reuse of surface and groundwater supplies. Water depletion is net water use minus water that can be later recovered, such as deep percolation and return flow to developed supply (see Box 1-5 Key Water Supply and Use Definitions). Water supply information that is presented using applied water methodology is easier for local water agencies to evaluate because applied water use information is closer in concept to agency water system delivery data.

Box 1-4 Water Portfolio Components

The water portfolios for the California Water Plan Update consist of the following items

Flow Diagrams

The flow diagrams presented in Update 2005 are an expanded version of the diagram that originally appeared in Bulletin 160-83 on page 88. The flow diagram begins with the sources of water, such as precipitation and inflows into the state, and attempts to track all the water as it flows through many different uses until it reaches its ultimate destination in the ocean, an inland sea or as evaporation to the atmosphere. Diagrams have been prepared for each of the 10 hydrologic regions, Mountain Counties, and statewide totals by year.

Flow Diagram Table Format

The Flow Diagram Table provides additional detail for 1998, 2000 and 2001, by presenting each of the components of the flow diagram by number and category (inputs or withdrawals). In addition, the web portal for this Water Plan update includes the Flow Diagram Tables by Planning Area in each region.

Developed / Dedicated Water Balances

As previously in Bulletin 160-98, water balances are computed for applied water use, net water use and depletion for each region and planning area within a region, Mountain Counties, and for statewide totals. The balances include measured water supplies that are applied to the following dedicated or developed uses within a region:

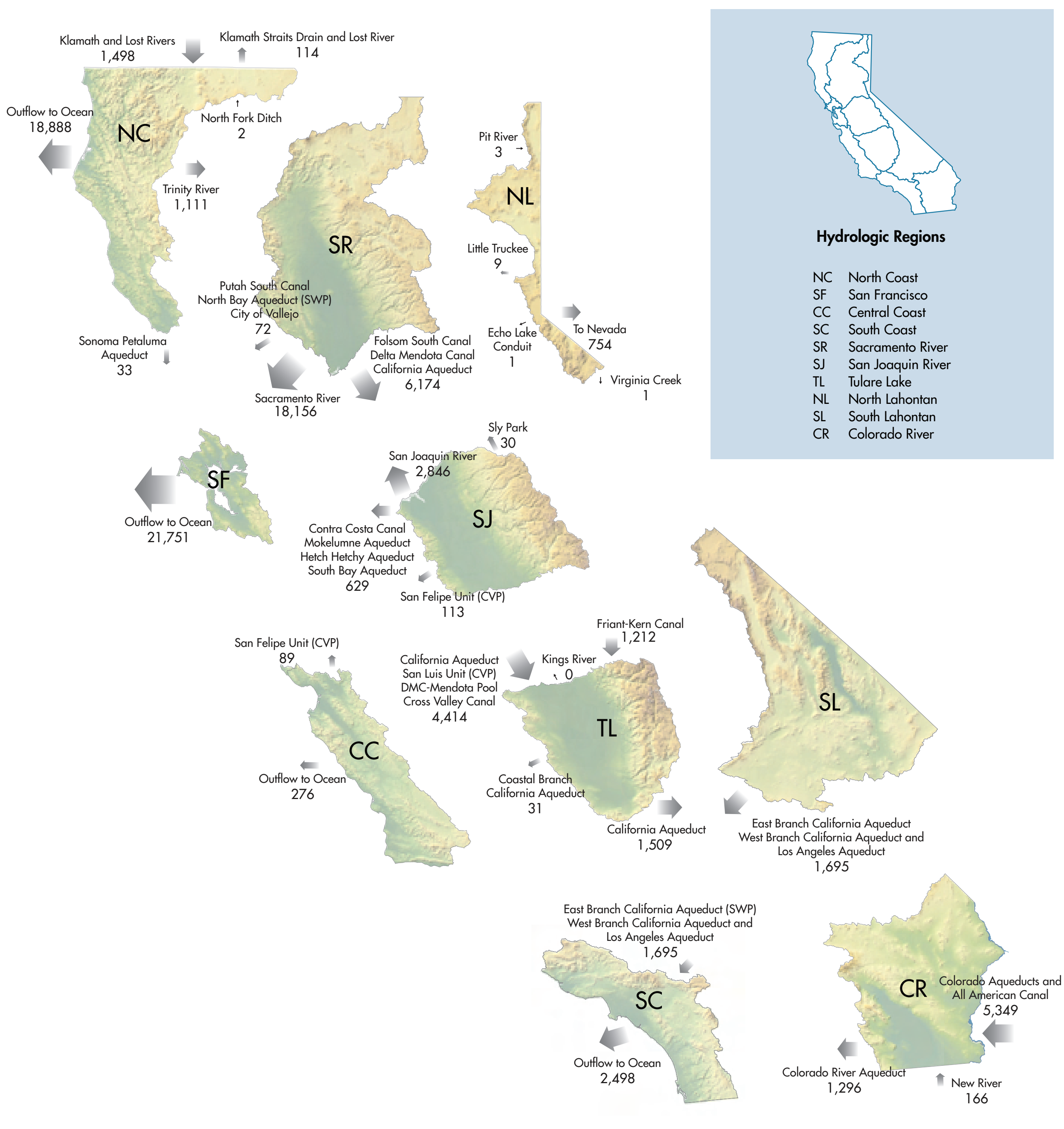
- Agricultural
- Urban (including commercial and industrial)
- Wildlife refuges (managed wetlands)
- Instream flow requirements
- Wild and scenic river requirements
- Required Delta outflow

These tables include reuse of water within a region, but not show water exported from a region.

Water Quality

Existing water quality basin plans prepared by the SWRCB and RWQCB will eventually become part of the California Water Plan. In the future, those basin plans along with other water quality reports will be integrated regionally into the water portfolios.

Figure 1-9 Regional inflows and outflows, year 2000 (an average water year)



Water moves great distances within and between California's 10 hydrologic regions, some through natural waterways and some through constructed water systems. Shown are the volumes of water in million acre-feet that flowed from one region to another in 2000, an average water year.

**Outflow to Ocean includes Wild and Scenic Rivers, regulated flows, and estimated wastewater outflows.*

Statewide Water Balance Summary

In average water years like 2000, California receives close to 200 million acre-feet of water from precipitation and imports from Colorado, Oregon and Mexico. Of this total supply, about 50 to 60 percent 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 Oregon, Nevada, the Pacific Ocean, and salt sinks like saline groundwater aquifers and Salton Sea. The remaining 40 to 50 percent, called the dedicated or developed supply, is distributed among urban and agricultural uses, water for protecting and restoring the environment, or storage in surface water and groundwater reservoirs for later use. In any year, some of the dedicated supply includes water that is used multiple times (reuse) and water held in storage from previous years. Ultimately, about a third of the dedicated supply flows out to the Pacific Ocean or to other salt sinks, in part to meet environmental water requirements for designated Wild and Scenic rivers.

Table 1-1 summarizes the total supply and distribution of the dedicated supply to various uses within California for the three years evaluated. As indicated for wet (1998) and dry (2001) years, the total supply and the distribution of the dedicated supply to various uses do change significantly, compared to the average year 2000 values.

Box 1-5 Key Water Supply and Use Definitions

The water portfolio tables presented throughout Volume 3 summarize California's water supplies and urban, agricultural and environmental water uses for 1998, 2000 and 2001. Certain key concepts, defined below, provide an essential foundation for understanding and evaluating the water supplies and water uses presented in these tables.

Applied Water. The amount of water from any source needed to meet the demand of the user. Examples would include the quantity of water that is delivered at any of the following locations:

- The intake to a city water system or a factory.
- The farm headgate or other point of measurement for agricultural use.
- The diversion point to a managed wetland, either directly or from other drainage flows.

For instream use, applied water is quantified as the amount of stream flow dedicated to instream purposes (or reserved under federal or State wild and scenic rivers legislation). It is also identified as the amount of stream flow required for maintaining flow and water quality in the Sacramento - San Joaquin Delta per the SWRCB's Decision 1630 or previous standards.

Net Water. The amount of water needed in a water service area to meet all demands. It is the sum of several components including (1) evapotranspiration of applied water within an area, (2) the irrecoverable water from the distribution system, and (3) the agricultural return flow or treated urban wastewater leaving the area.

Irrecoverable Water. The amount of water that flows to a salt sink, is used by the growth process of plants (evapo transpiration), or evaporates from a conveyance facility or drainage canal.

Evapotranspiration. ET is the amount of water transpired (given off), retained in plant tissues, and evaporated into the atmosphere from plant tissues and the surrounding soil surfaces.

Evapotranspiration of Applied Water. ETAW is the portion of total ET which was provided from the applied irrigation water.

Depletion. The amount of water consumed within a service area that is no longer available as a source of supply. For agricultural and environmental wetlands water use, depletion is the sum of irrecoverable water and the ETAW due to crops, wetlands vegetation, and flooded water surfaces. For urban water use, depletion is the ETAW due to landscaping, wastewater outflow to a salt sink, and incidental ET. For environmental instream use, depletion is the amount of dedicated flow that proceeds to a salt sink.

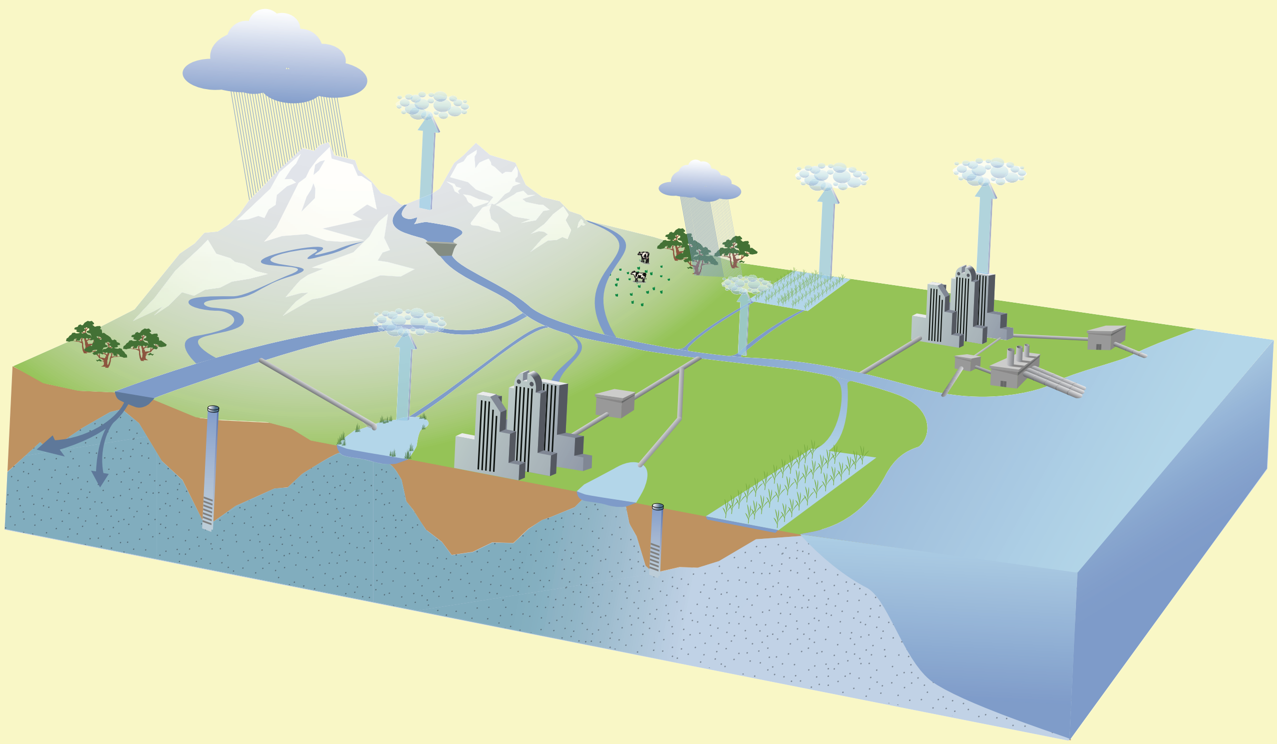
Table 1-1 California water summary - MAF

	1998 (171% of normal)[a]		2000 (97% of normal)[a]		2001 (72% of normal)[a]	
Total supply (precipitation & imports)	336.9		194.7		145.5	
Total uses, outflows, & evaporation	331.5		200.4		159.9	
Net storage changes in state	5.5		-5.7		-14.3	
Distribution of dedicated supply (includes reuse) to various applied water uses						
Urban uses	7.8	(8%)	8.9	(11%)	8.6	(13%)
Agricultural uses	27.3	(29%)	34.2	(41%)	33.7	(52%)
Environmental water[b]	59.4	(63%)	39.4	(48%)	22.5	(35%)
Total dedicated supply	**94.5**		**82.5**		**64.8**	

maf = million acre-feet

a. Percent of normal precipitation. Water year 1998 represents a wet year; 2000, average water year; 2001, drier water year.

b. Environmental water includes instream flows, wild and scenic flows, required Delta outflow, and managed wetlands water use. Some environmental water is reused by agricultural and urban water users.



Key components of the illustrated flow diagram are shown as characteristic elements of the hydrologic cycle. This volume has flow diagrams for statewide water summary in this chapter and for regional water summaries in their respective chapters.

Table 1-2 State of California water balance summary - MAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (171%)	2000 (97%)	2001 (72%)
Water Entering the State			
Precipitation	329.6	187.7	139.2
Inflow from Oregon/Mexico	2.3	1.7	1.1
Inflow from Colorado River	5.0	5.3	5.2
Imports from Other Regions	N/A	N/A	N/A
Total	**336.9**	**194.7**	**145.5**
Water Leaving the State			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	22.5	27.9	27.8
Outflow to Oregon/Nevada/Mexico	1.6	0.9	0.7
Exports to Other Regions	N/A	N/A	N/A
Statutory Required Outflow to Salt Sink	43.8	28.0	13.9
Additional Outflow to Salt Sink	73.0	37.1	17.7
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	190.5	106.5	99.7
Total	**331.4**	**200.4**	**159.8**
Storage Changes in State			
[+] Water added to storage			
[–] Water removed from storage			
Change in Surface Reservoir Storage	7.2	-1.3	-4.6
Change in Groundwater Storage **	-1.7	-4.4	-9.7
Total	**5.5**	**-5.7**	**-14.3**
Applied Water * (compare with Consumptive Use)	33.9	41.8	41.2

***Footnote for applied water**

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

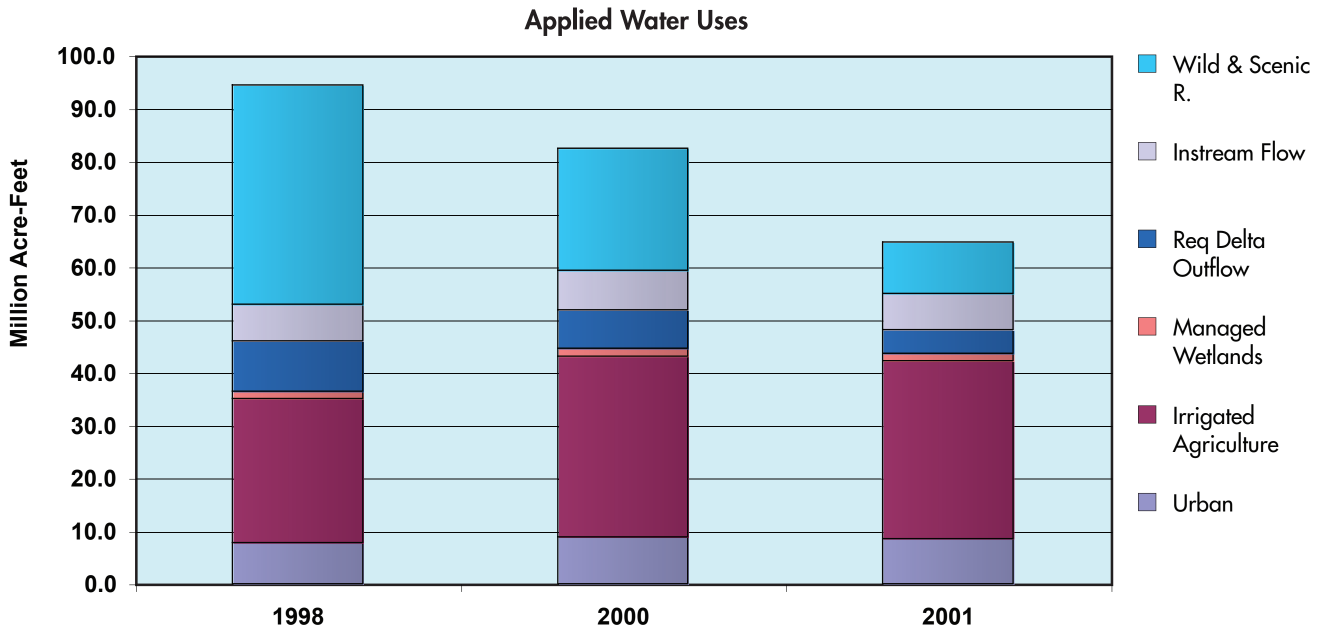
****Footnote for change in Groundwater Storage**

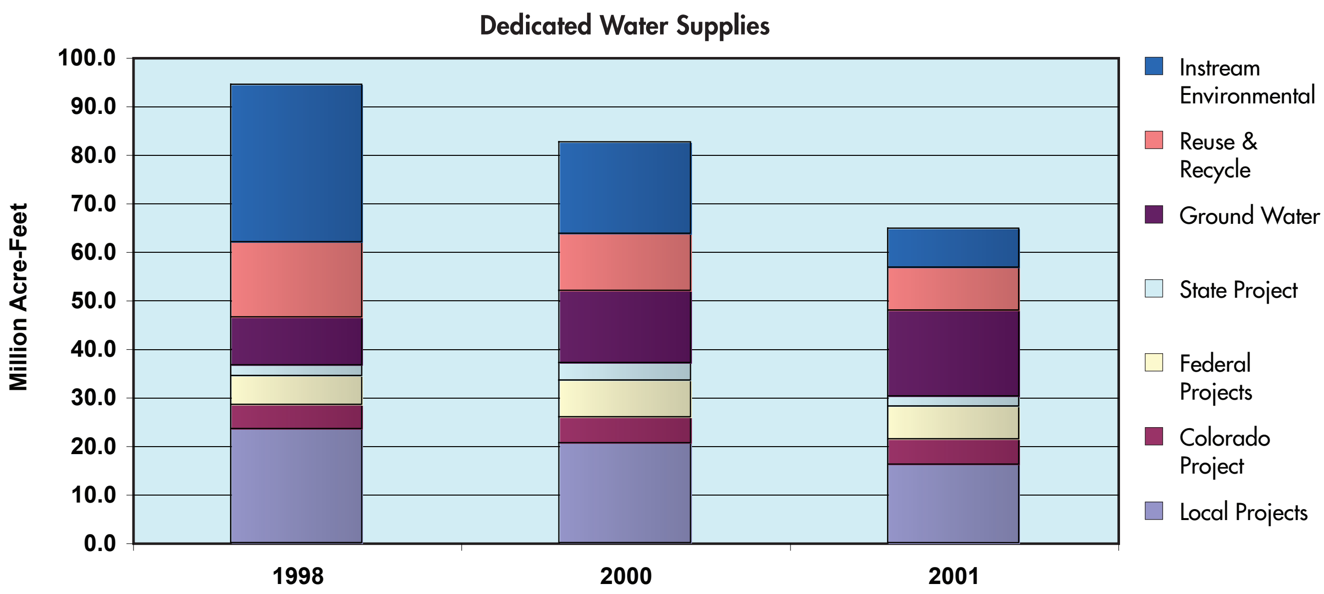
Change in Groundwater Storage is based upon best available information. Basins in the north part of the state (North Coast, San Francisco, Sacramento River and North Lahontan regions and parts of Central Coast and San Joaquin River regions) have been modeled – spring 1997 to spring 1998 for the 1998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

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

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

Figure 1-10 California water balance for water years 1998, 2000, 2001





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

Table 1-3 California water use and distribution of dedicated supplies - MAF

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	0.6			0.7			0.6		
Commercial	1.3			1.6			1.6		
Industrial	0.5			0.6			0.6		
Energy Production	0.1			0.1			0.1		
Residential - Interior	2.9			3.3			3.1		
Residential - Exterior	2.0			2.3			2.3		
Evapotranspiration of Applied Water		2.3	2.3		2.7	2.7		2.6	2.6
E&ET and Deep Perc to Salt Sink		0.6	0.6		0.7	0.7		0.7	0.7
Outflow		3.1	3.1		3.6	3.6		3.5	3.5
Conveyance Applied Water	0.2			0.2			0.2		
Conveyance Evaporation & ETAW		0.2	0.2		0.2	0.2		0.2	0.2
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.2			0.1			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**7.8**	**6.3**	**6.3**	**8.9**	**7.2**	**7.2**	**8.6**	**7.0**	**7.0**
Agriculture									
On-Farm Applied Water	24.1			31.1			31.2		
Evapotranspiration of Applied Water		16.8	16.8		21.6	21.6		21.8	21.8
E&ET and Deep Perc to Salt Sink		0.8	0.8		0.8	0.8		0.8	0.8
Outflow		3.7	1.5		4.0	1.8		4.0	2.1
Conveyance Applied Water	2.1			2.4			2.2		
Conveyance Evaporation & ETAW		0.7	0.7		0.9	0.9		0.8	0.8
Conveyance Deep Perc to Salt Sink		0.2	0.2		0.2	0.2		0.2	0.2
Conveyance Outflow		0.3	0.3		0.4	0.3		0.4	0.3
GW Recharge Applied Water	1.1			0.7			0.3		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**27.3**	**22.6**	**20.4**	**34.2**	**27.8**	**25.6**	**33.7**	**27.9**	**26.0**
Environmental									
Instream									
Applied Water	6.9			7.5			6.8		
Outflow		2.2	2.2		2.1	2.1		2.2	2.2
Wild & Scenic									
Applied Water	41.6			23.1			9.8		
Outflow		32.1	32.1		18.2	18.2		6.9	6.9
Required Delta Outflow									
Applied Water	9.5			7.2			4.5		
Outflow		9.5	9.5		7.2	7.2		4.5	4.5
Managed Wetlands									
Habitat Applied Water	1.4			1.5			1.3		
Evapotranspiration of Applied Water		0.5	0.5		0.6	0.6		0.6	0.6
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.5	0.3		0.4	0.3		0.4	0.3
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	1.4	1.0	0.8	1.5	1.1	1.0	1.3	1.0	0.9
Total Environmental Use	**59.4**	**44.8**	**44.7**	**39.4**	**28.7**	**28.5**	**22.5**	**14.7**	**14.5**
TOTAL USE AND OUTFLOW	**94.5**	**73.8**	**71.4**	**82.5**	**63.6**	**61.3**	**64.8**	**49.7**	**47.5**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	22.5	22.5	21.1	19.8	19.5	18.2	15.3	15.3	14.3
Local Imported Deliveries	1.0	1.0	0.9	0.8	0.8	0.8	0.8	0.8	0.8
Colorado River Deliveries	5.0	5.0	4.7	5.3	5.3	5.0	5.2	5.2	4.8
CVP Base and Project Deliveries	5.3	5.3	4.9	6.7	6.7	6.3	6.1	6.1	5.7
Other Federal Deliveries	0.7	0.7	0.6	0.8	0.8	0.7	0.7	0.7	0.6
SWP Deliveries	2.1	2.1	2.0	3.6	3.6	3.4	2.1	2.1	1.9
Required Environmental Instream Flow	32.4	32.4	32.4	18.7	18.7	18.7	8.0	8.0	8.0
Groundwater									
Net Withdrawal	4.4	4.4	4.4	7.8	7.8	7.8	11.0	11.0	11.0
Deep Percolation of Surface and GW	5.6			7.0			6.7		
Reuse/Recycle									
Reuse Surface Water	15.1			11.5			8.5		
Recycled Water	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
TOTAL SUPPLIES	**94.5**	**73.8**	**71.4**	**82.5**	**63.6**	**61.3**	**64.8**	**49.7**	**47.5**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

Table 1-2 provides more detailed information about total statewide water supply sources and provides estimates for the primary uses of the state's supplies for these three years. As indicated, a large component of the statewide water supply is used by natural processes, such as evaporation, evapotranspiration from native vegetation and forests, and percolation to groundwater. This water is generally not counted as part of the dedicated water supplies. Each of the regional reports within Volume 3 presents the same tabular information at the regional level. For some of the items presented in Table 1-2, the numerical values were developed by estimation techniques, because measured data are not available on a statewide basis.

A statewide summary of dedicated water supplies and uses is presented in Table 1-3, which provides a more detailed breakdown of the components of developed supplies used for agricultural, urban, and environmental purposes. For each of the three water years, information is presented as both applied water and net water usage, as well as the calculated total water depletion. As previously mentioned, much of the environmental water usage in this table is actually dedicated to instream flow requirements and Wild and Scenic rivers, which in some cases can later be reused for other downstream purposes. Figure 1-10 identifies all of the water supply sources used to meet the developed and dedicated water uses statewide for years 1998, 2000 and 2001 and also summarizes all of the corresponding urban, agricultural and environmental water uses for the three years. In each of the following regional report chapters, similar regional bar charts are provided, which can be compared to Figure 1-10 to understand how each individual region compares to the statewide distribution.

Statewide Water Portfolio Results for Years 1998 (Wet), 2000 (Average), and 2001 (Dry)

Statewide summaries of water supplies and applied water uses are presented graphically in the portfolio flow diagram (Figures 1-11 and 1-12), and numerically for years 1998, 2000 and 2001 in the accompanying water portfolio data Table 1-4. These figures and tables are large-format and placed in the back of this chapter; similar regional graphics are placed in the back of the regional chapters. The primary purpose of these diagrams and tables is to present information for comparison about how water supplies and uses can vary between the wet, average, and dry hydrologic conditions that are represented by these three specific years. It is important to remember that actual water supply and water use information from these three years is only a snapshot of a single year's hydrology and water uses. It would not be appropriate to assume that other past or future years with similar hydrology (wet, average, or dry) would produce the same levels of water use as summarized in Table 1-4.

The statewide information has been assembled from the 10 individual hydrologic regions. The organization of the portfolio diagrams and the numerical identification for the data categories are consistent between the 10 regional reports and these statewide summaries. However, note that when water supply and water-use information from the regional reports is accumulated for the statewide totals, some categories, such as interregional water transfers between one hydrologic region and an adjoining region, are not applicable, so they are not shown in the statewide tables. Figure 1-9 presents a map of California's hydrologic regions with all interregional transfers shown, using data from average water year 2000. In the statewide diagrams and tables presented in this chapter, several categories indicate "incomplete" or "unknown" data for components of water supply and water use where information is either not available, or only partially available from some regions of the state. Within the data tables, the code "N/A" is used to identify categories where data are not available, and the symbol "-" is used to identify water data categories that are not applicable on a statewide basis.

On a statewide basis, Figure 1-12 shows a detailed flow diagram for water supplies and uses, with numerical references to data in Table 1-4 for 1998, 2000, and 2001. Companion Figure 1-11 presents the same information in an illustrated picture to graphically show the identified components of water supply, movement, and use. In the statewide and all of the regional portfolio flow diagrams throughout Volume 3, the information is consistently organized to show sources of water supply on the left side, water uses in the middle, and the ways that water leaves the state on the right side. To assist the reader in following the movement of water from initial sources to final disposition in these diagrams, water supplies, called deposits, are consistently shown in blue boxes, water uses are summarized in green boxes, and water withdrawals (how water leaves the state) are shown in yellow boxes. The numerical identification numbers in the small circles on the diagram correspond to the tabular presentation of the data in Table 1-4.

The flow diagram data (Table 1-4) presents the statewide water portfolio information from the flow diagram, with 61 major categories of water supply and water use identified. This statewide table is different from the regional data tables in the following chapters, in that there is only one column shown for each year with the water supply and applied water use values aggregated together. The regional tables in the following chapters are more detailed, because they also present water-use information on a net-water basis and tabulate water depletions where appropriate. In addition, there are several water data categories that are accounted for at the regional level, but which lose their relevance at the statewide level, such as interregional water transfers.

Statewide Water Data Needs

When the concept of developing water portfolios with information about all of California's supplies and uses was first discussed, it was noted that there would be insufficient information available for many of the data categories and several of the less developed regions of the state. However, identifying the categories where inadequate information is available is a necessary first step toward making improvements in the types and amount of water data that needs to be collected.

The types of necessary technical information can be grouped into three categories:

- Data – factual or observed information, such as measurements or statistics including gauged flows in a river, population as measured by census, and salinity of a water sample. Sets of data can be raw as taken from a measurement device, elaborated by modifying it slightly as part of quality assessment and quality control measures, or supplemented to address missing measurements.
- Relationships or system interactions – descriptions of how the social, physical, and environmental systems affect or are affected by the status of water supply and water use in California. Examples include (1) how releases from a reservoir affect water temperature at a point in a river downstream, (2) the crop mix in a region and the expected market conditions for each crop, and (3) mountain snowpack conditions in February as used to forecast the delivery of State Water Project water.
- Estimates – inferred, derived or forecasted quantities based on available data, defined relationships, and other assumptions. Examples include population forecasts for the Los Angeles area in 2030, groundwater flows between adjacent regions, future available water deliveries, and the projected cost to implement water conservation best management practices.

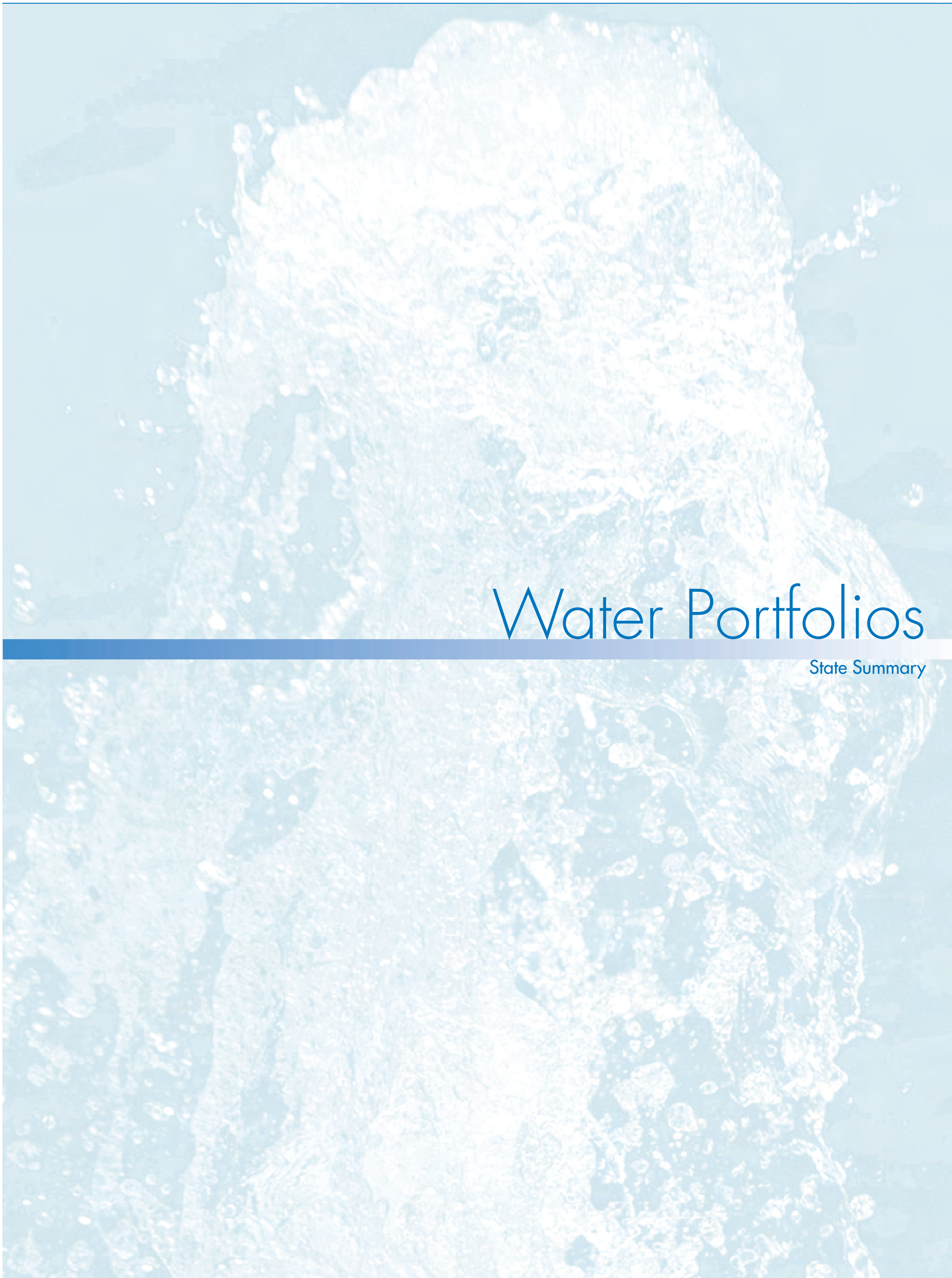
There are a number of categories where data are simply not available or else it is very expensive to compile. The Data and Analytical Tools section of the Volume 4 Reference Guide contains additional information about these types of data needs in the article titled "Future Quantitative Analysis for California Water Planning." In addition, many types of data are available for the developed regions of the state, but significant gaps exist in the undeveloped parts of California, so that statewide summaries cannot be generated. Significant categories with insufficient data include:

- Statewide land use data, for example, delineation and acreage for native vegetation, urbanized regions and boundaries, areas with nonirrigated agriculture, and irrigated agriculture acreage and crop-type delineation
- Groundwater, including total natural recharge, subsurface inflow and outflow, recharge and extractions, water levels, and water quality
- Surface water, including natural and incidental runoff, local diversions, return flows, total stream flows, conveyance recoverable and irrecoverable water, and runoff to salt sinks
- Amounts of water consumed by evaporation from water surfaces, evapotranspiration from native vegetation, wetlands, urban runoff and nonirrigated agricultural production

A number of data items are necessary to calculate or estimate these categories. Some of the major data items needed to complete the water portfolio flow diagram and the water balances are listed below. These include the measurement and calculation of information needed to identify the differences between applied water use and consumptive water use. The major data items are:

- Information on the source of water supply - surface, groundwater, or amounts from both
- Data for the amounts of surface outflow leaving any identified region
- Water level data for depth to groundwater
- Groundwater recharge rates
- Water needed to maintain designated natural riparian habitats
- Evapotranspiration rates for all types of vegetation, which vary by the geographic region of the state
- Detailed surface water return flow information
- More detailed physical information about the water infrastructure for all watersheds, water systems and groundwater basins in the state

A significant increase in the amount of data collected and evaluated will be needed, before California can fully quantify and understand the state's water supplies and plan for future water needs.



Water Portfolios

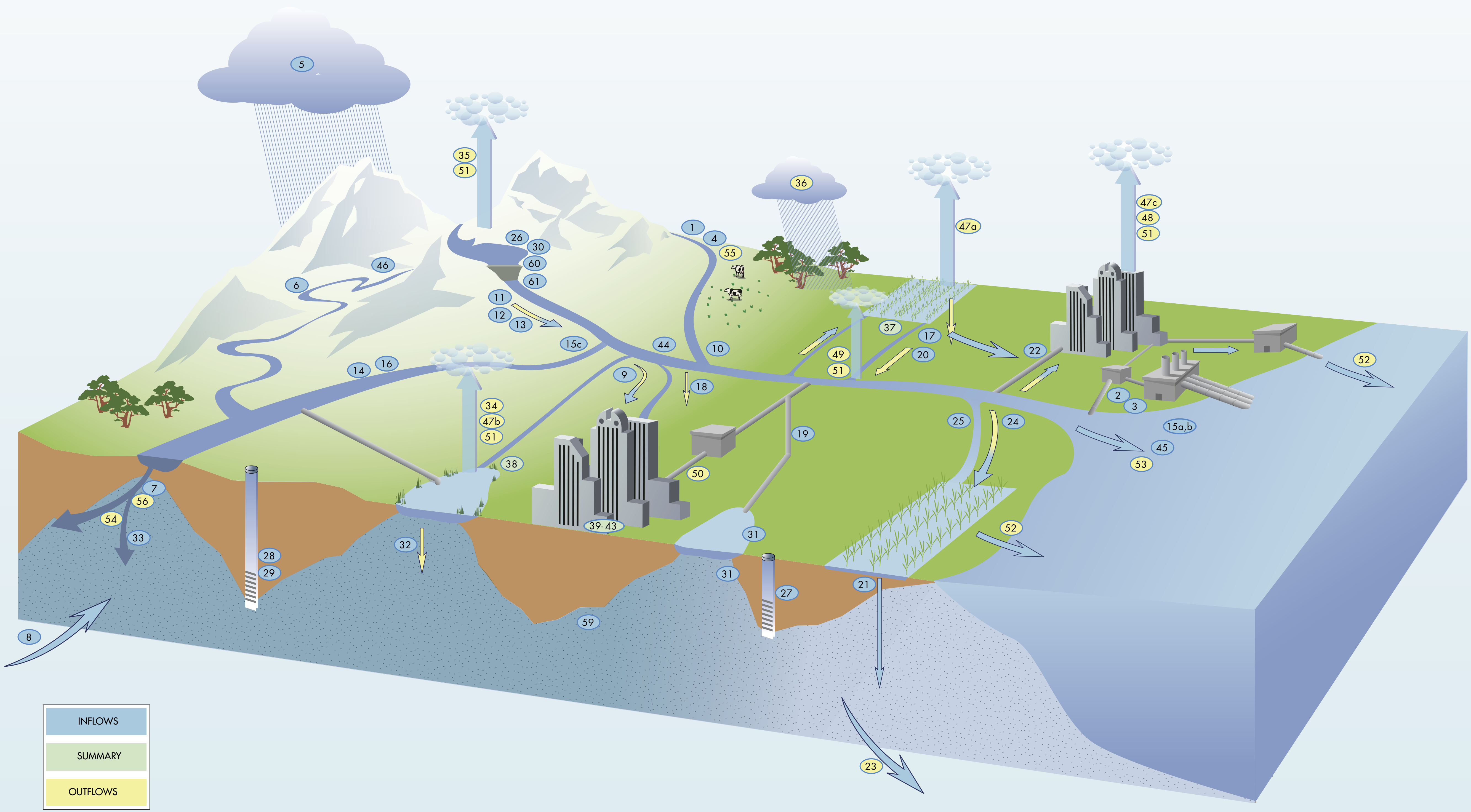
State Summary

Table 1-4 California water portfolios (TAF)

ID Number:	Flow Diagram Component (see legend)	CA 1998	CA 2000	CA 2001
1	Colorado River Deliveries	4,986.4	5,349.0	5,197.1
2	Total Desalination	0.0	0.0	0.0
3	Water from Refineries	0.0	0.0	0.0
4a	Inflow From Oregon	2,104.5	1,498.0	988.0
b	Inflow From Mexico	182.4	165.6	154.7
5	Precipitation	329,588.3	187,742.9	139,182.6
6a	Runoff - Natural	53,812.0	no data	no data
b	Runoff - Incidental	no data	no data	no data
7	Total Groundwater Natural Recharge	no data	no data	no data
8	Groundwater Subsurface Inflow	0.0	0.0	0.0
9	Local Deliveries	22,538.3	19,770.7	15,342.3
10	Local Imports	955.2	810.7	828.4
11a	Central Valley Project :: Base Deliveries	1,585.1	1,925.7	2,014.8
b	Central Valley Project :: Project Deliveries	3,706.7	4,790.1	4,106.0
12	Other Federal Deliveries	692.8	799.3	667.4
13	State Water Project Deliveries	2,130.4	3,629.3	2,086.4
14a	Water Transfers - Regional	1.0	1.0	0.2
b	Water Transfers - Imported	0.0	0.0	0.0
15a	Releases for Delta Outflow - CVP	0.0	0.0	0.0
b	Releases for Delta Outflow - SWP	0.0	0.0	0.0
c	Instream Flow Applied Water	6,903.7	7,523.0	6,842.6
16	Environmental Water Account Releases	0.0	264.0	242.0
17a	Conveyance Return Flows to Developed Supply - Urban	0.0	0.0	0.0
b	Conveyance Return Flows to Developed Supply - Ag	60.0	44.5	45.4
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	0.0	0.0	0.0
18a	Conveyance Seepage - Urban	0.0	0.0	0.0
b	Conveyance Seepage - Ag	219.2	283.3	279.0
c	Conveyance Seepage - Managed Wetlands	23.8	24.5	13.4
19a	Recycled Water - Agriculture	28.4	28.2	28.2
b	Recycled Water - Urban	270.7	253.9	261.7
c	Recycled Water - Groundwater	8.3	43.3	42.4
20a	Return Flow to Developed Supply - Ag	2,182.1	2,167.2	1,930.7
b	Return Flow to Developed Supply - Wetlands	139.7	133.4	140.6
c	Return Flow to Developed Supply - Urban	2.6	2.6	2.6
21a	Deep Percolation of Applied Water - Ag	2,152.9	3,753.7	3,964.9
b	Deep Percolation of Applied Water - Wetlands	211.2	209.5	190.1
c	Deep Percolation of Applied Water - Urban	1,282.0	1,530.5	1,531.3
22a	Reuse of Return Flows within Region - Ag	593.8	825.0	635.7
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	14,287.7	10,351.9	7,558.0
24a	Return Flow for Delta Outflow - Ag	0.0	0.0	227.9
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	1,565.8	1,414.8	966.5
c	Return Flow for Delta Outflow - Urban Wastewater	0.0	0.0	0.0
25	Direct Diversions	0.0	0.0	0.0
26	Surface Water in Storage - Beg of Yr	23,996.2	27,062.6	25,745.6
27	Groundwater Extractions - Banked	0.0	0.0	0.0
28	Groundwater Extractions - Adjudicated	847.8	926.8	903.1
29	Groundwater Extractions - Unadjudicated	9,121.6	13,926.5	16,785.4
23	Groundwater Subsurface Outflow	0	0	0
30	Surface Water Storage - End of Yr	31,190.3	25,745.6	21,099.0
31	Groundwater Recharge-Contract Banking	85.1	108.2	-12.8
32	Groundwater Recharge-Adjudicated Basins	0.0	0.0	0.0
33	Groundwater Recharge-Unadjudicated Basins	0.0	0.0	0.0
34a	Evaporation and Evapotranspiration from Native Vegetation	0	0	0
b	Evaporation and Evapotranspiration from Unirrigated Ag	0	0	0
35a	Evaporation from Lakes	2527.3	2574.9	2556.7
b	Evaporation from Reservoirs	2189.3	2414.5	2292.9
36	Ag Effective Precipitation on Irrigated Lands	6212.5	3646.2	3203.1
37	Agricultural Applied Water Use	25,171.7	31,777.2	31,530.2
38	Managed Wetlands Applied Water Use	1,354.9	1,472.9	1,284.6
39a	Urban Residential Use - Single Family - Interior	1,746.7	2,123.8	1,996.0
b	Urban Residential Use - Single Family - Exterior	1,698.1	1,918.5	1,925.9
c	Urban Residential Use - Multi-family - Interior	1,123.4	1,132.3	1,120.8
d	Urban Residential Use - Multi-family - Exterior	307.5	364.3	385.3
40	Urban Commercial Use	1,263.3	1,581.2	1,583.1
41	Urban Industrial Use	542.2	590.0	596.3
42	Urban Large Landscape	579.7	677.5	610.7
43	Urban Energy Production	137.1	137.4	137.2
44	Instream Flow Net Use	2198.9	2216	2249.9
45	Required Delta Outflow Net Use	9505	7231.6	4486.2
46	Wild and Scenic Rivers Net Use	32139.8	18254.8	6945.3
47a	Evapotranspiration of Applied Water - Ag	16826.6	21676	21785.85
b	Evapotranspiration of Applied Water - Managed Wetlands	501	646.5	580
c	Evapotranspiration of Applied Water - Urban	2331.784	2669.591	2610.971
48	Evaporation and Evapotranspiration from Urban Wastewater	0.4	0.3	0.4
49	Return Flows Evaporation and Evapotranspiration - Ag	345.7	352	334.8
50	Urban Waste Water Produced	3015.74	3475.14	3375.04
51a	Conveyance Evaporation and Evapotranspiration - Urban	414.52	435.42	431.11
b	Conveyance Evaporation and Evapotranspiration - Ag	767.3	884	773.1
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	12.3	17	15.8
d	Conveyance Outflow to Mexico	0	0	0
52a	Return Flows to Salt Sink - Ag	2431.1	2810.1	2831.7
b	Return Flows to Salt Sink - Urban	3570.38	4103.09	3987.1
c	Return Flows to Salt Sink - Wetlands	184.04	169.5	174.4
53	Remaining Natural Runoff - Flows to Salt Sink	66786.8	30012	10718.5
54a	Outflow to Nevada	1390.6	753.9	551.9
b	Outflow to Oregon	183.7	113.7	66.4
c	Outflow to Mexico	0	0	0
55	Regional Imports	n/a	n/a	n/a
56	Regional Exports	n/a	n/a	n/a
59	Groundwater Net Change in Storage	-1,695.0	-4,407.4	-9,679.7
60	Surface Water Net Change in Storage	7,194.1	-1,317.0	-4,646.6
61	Surface Water Total Available Storage	39,690.0	40,740.9	40,740.9

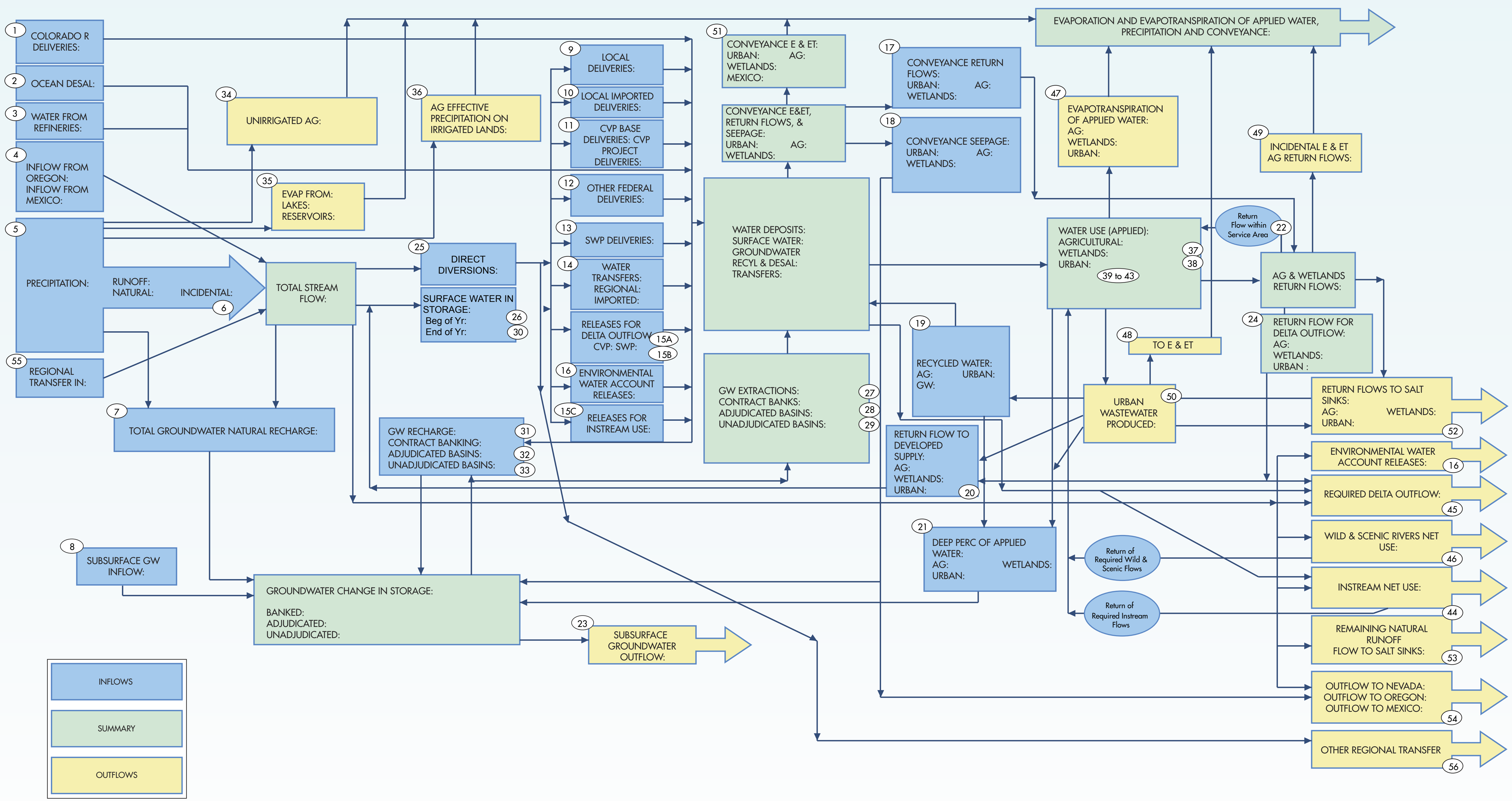
Inflows — Outflows — Green number signifies included in summary boxes

Figure 1-11 California - illustrated water flow diagram

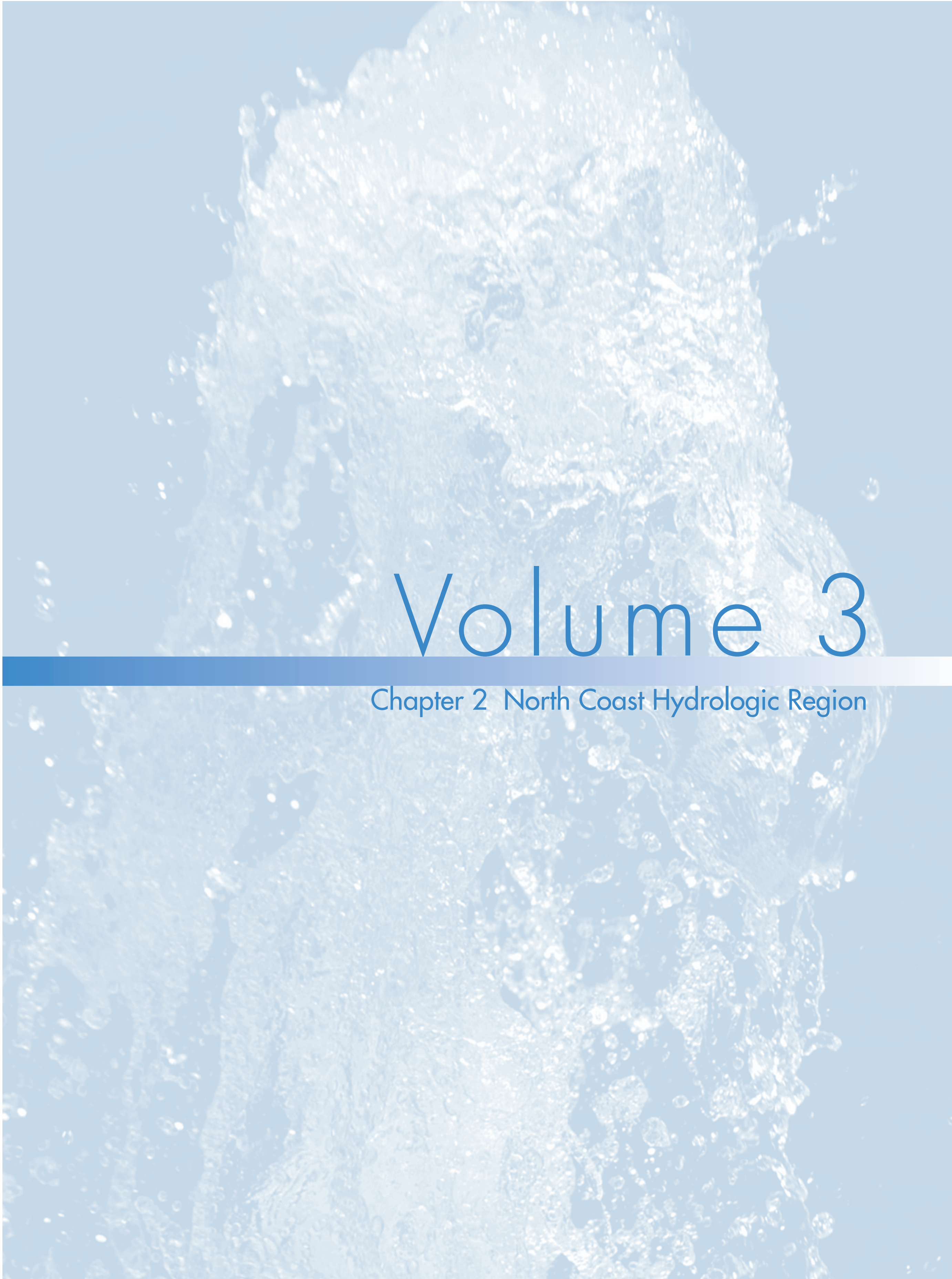


In this illustration of Table 1-4, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of the table's flow diagram components; color indicates whether the component is water input, output, or summary.

Figure 1-12 California - schematic water flow diagram



In schematic of Table 1-4, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether component is water input, output, or summary.



Volume 3

Chapter 2 North Coast Hydrologic Region

Chapter 2 North Coast Hydrologic Region

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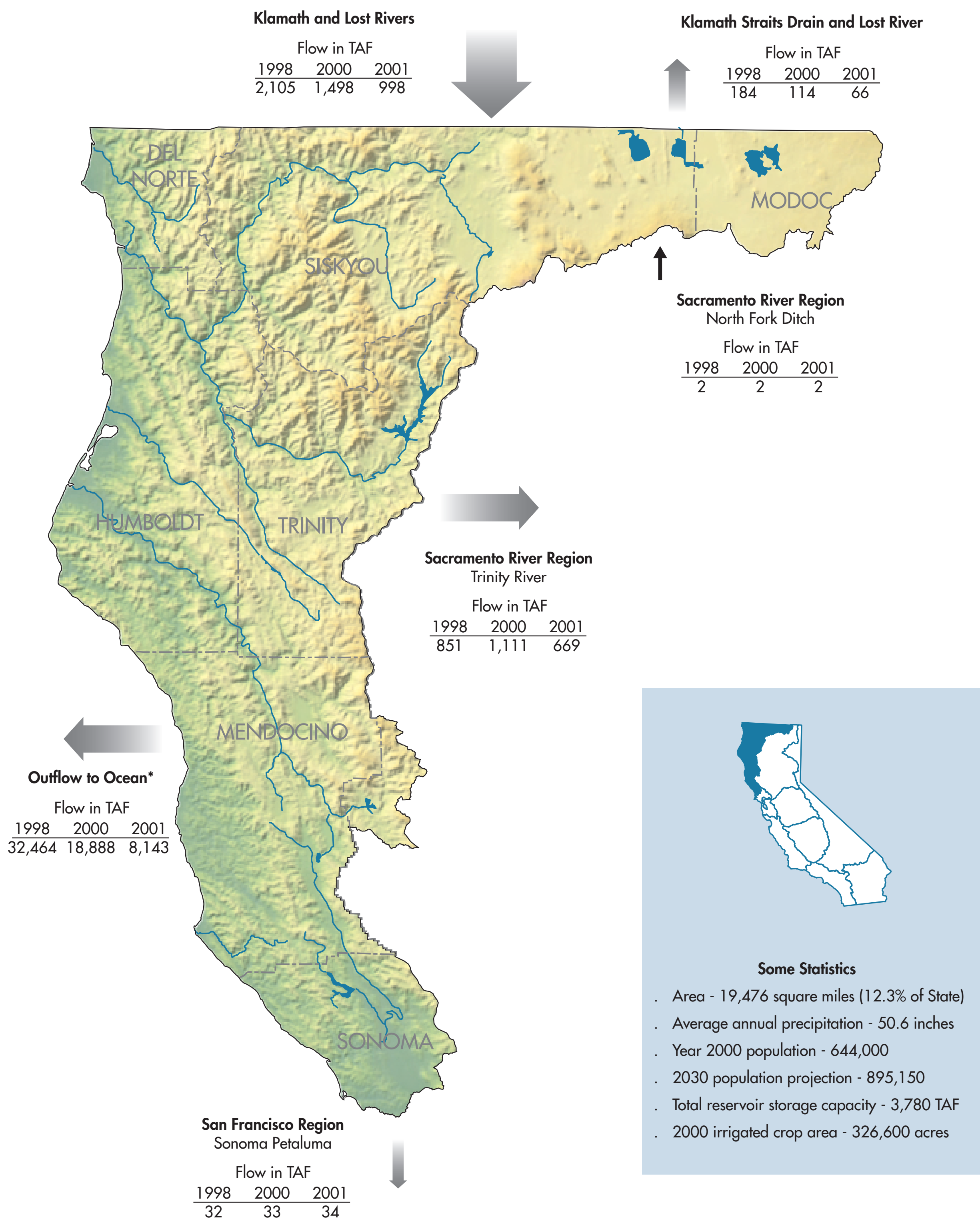
Figure 2-1 North Coast Hydrologic Region



North Coast Hydrologic Region is in the northwestern corner of California and includes redwood forests, inland mountain valleys, and the arid Modoc Plateau. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

**Outflow to Ocean includes Wild and Scenic Rivers, regulated flows, and estimated wastewater outflows.*

Chapter 2 *North Coast Hydrologic Region*

Setting

The North Coast Hydrologic Region encompasses redwood forests, inland mountain valleys, and the arid Modoc Plateau. The region includes all or large portions of Modoc, Siskiyou, Del Norte, Trinity, Humboldt, Mendocino, Lake, and Sonoma counties (Figure 2-1). It also includes small areas of Shasta, Tehama, Glenn, Colusa, and Marin counties. The region includes the Pacific Ocean coastline from Tomales Bay to the Oregon border, and then extends east along the border to the Goose Lake Basin. This region covers roughly 19,500 square miles, or more than 12 percent of California's land area. Most of the region is mountainous and rugged. The mountain crests, which form the eastern boundary of the region, are about 6,000 feet elevation with a few peaks higher than 8,000 feet. Only 13 percent of the land is classified as valleys or mesas, and more than half of that is in the higher northeastern part of the region in the upper Klamath River Basin.

Climate

Weather conditions and temperatures vary dramatically from the cooler coastal areas to the arid inland valleys in Siskiyou and Modoc counties. In the western coastal portion of this region, average temperatures are moderated by the influence of the Pacific Ocean and range from highs in the mid-80s in the summer to lows in the mid-30s during the winter. In the inland regions of Siskiyou and Modoc counties, temperatures are more variable, where summer high temperatures usually reach the 100-degree mark and winter low temperatures are often in the low-30-degree range. Heavy rainfall in the coastal mountain ranges makes the North Coast region the most water-abundant area of California, producing about 41 percent of the state's total natural runoff. Average annual precipitation varies from more than 100 inches in the north coast mountains of Del Norte County to less than 15 inches in the Lost River drainage area of Modoc County. Region-wide, average precipitation is about 51 inches per year. Relatively little snow is in this region, and it usually stays on the ground only a short time at elevations of 4,000 feet or higher. As a result of the abundant rainfall, the average annual runoff for the rivers of this region is about 29 million acre-feet per year, which is the largest volume compared to all other hydrologic regions of California.

Population

The population of the entire North Coast region was about 644,000 in year 2000, which is less than 2 percent of California's total population. More than half of this region's population lives in the southern part, primarily in Santa Rosa and the surrounding communities of Rohnert Park, Windsor, and Healdsburg along the Russian River watershed. Urban growth in the Santa Rosa area, 147,500 people in year 2000, is heavily influenced by the overall urban expansion of the adjacent San Francisco Bay region. Other smaller communities in the northern portions of this region include Eureka, 26,000 people in 2000; Ukiah, 15,500; Arcata, 16,600; Crescent City, 7,300; and Yreka, 7,200.

When compared with the 1990 regional population of 571,750, the 644,000 in 2000 represents a growth rate of 12.6 percent over the 10 years, which is slightly lower that the statewide growth rate of nearly 14 percent over the same period. Projections today indicate that the regional population is expected to grow to about 895,000 by year 2030, which represents a 39 percent increase from year 2000 totals. Figure 2-2 provides a graphical depiction of the North Coast region's total population from year 1960 through year 2000, with current projections to year 2030. More than half of this projected growth is anticipated to occur in the Santa Rosa region, as urban populations from the San Francisco Bay area continue to expand north. Population increases in the rural communities in the northern half of this region are projected to grow more slowly.

The North Coast region encompasses redwood forests, inland mountain valleys, and the arid Modoc Plateau. The region covers roughly 19,500 square miles, or more than 12 percent of California's land area. (DWR Photo)

Land Use

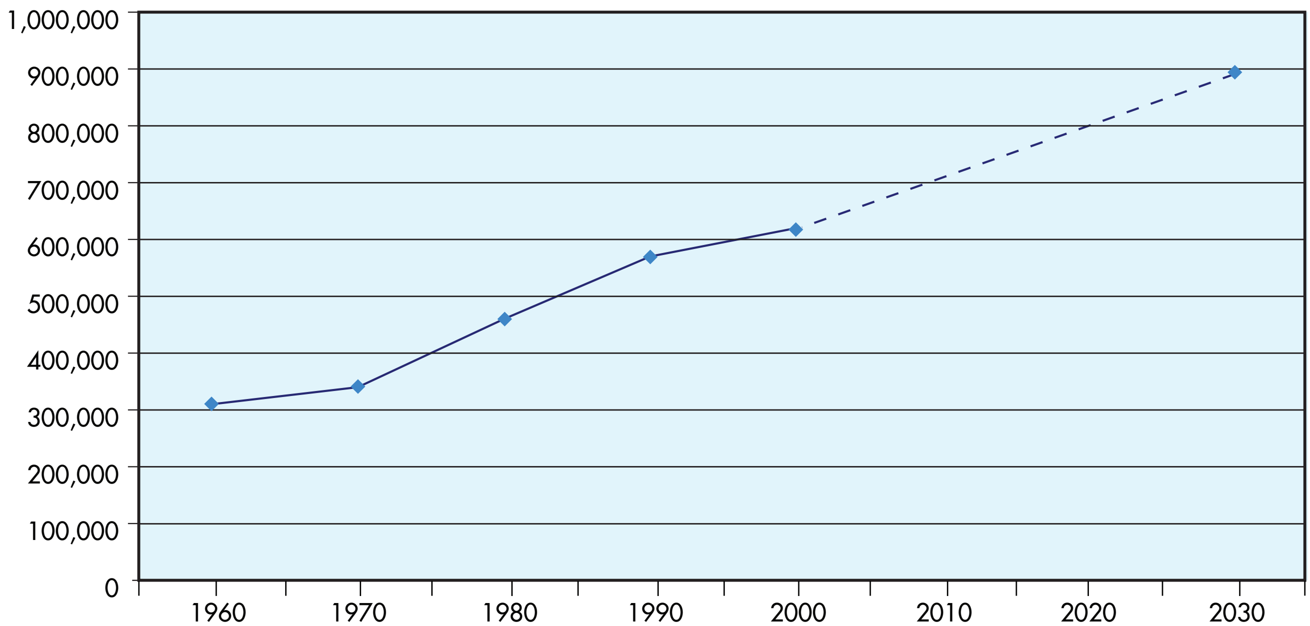
Forest and rangeland represent about 98 percent of this region's land area. Much of the region is identified as national forests, state and national parks, under the jurisdiction of the federal Bureau of Land Management, and American Indian lands such as the Hoopa Valley and Round Mountain reservations. The major land uses in the North Coast region consist of timber production, agriculture, fish and wildlife management, parks, recreational areas, and open space. However, in recent years the timber industry has declined as a result of timber over-cutting, economic issues, and the expansion of environmental regulations.

Vacationers, boaters, anglers, and sightseers are attracted to the region's 400 miles of scenic ocean shoreline, including nearby forests with more than half of California's redwoods. The inland regions are mountainous and include 10 wilderness areas run by the U.S. Forest Service. More than 40 state parks, numerous Forest Service campgrounds, the Smith River National Recreation Area and the Redwood National Park are within this hydrologic region. It is an area of rugged natural beauty with some of the most renowned fishing in North America.

Climate, soils, water supply, and remoteness from markets are factors that limit the types of agricultural crops that can be grown in the North Coast region. In the inland valley areas, there is more irrigable land than can be irrigated with existing water. The agricultural trend in the past decade has been one of land consolidation and the conversion of prime agricultural land to urban growth. This trend is a result of low crop values, the lack of additional inexpensive surface water, and the ability to use only the most economically developable groundwater.

Irrigated agriculture in the North Coast region uses most of the region's developed water supplies. Irrigation today accounts for about 81 percent of the region's water use, while municipal

Figure 2-2 North Coast Hydrologic Region population



Data from California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for the North Coast region.

and industrial use is about 19 percent. About 326,600 acres, or about 2 percent of the region, is irrigated. Of that, 225,900 acres are in the Upper Klamath River Basin where the main irrigated crops are pasture and alfalfa, grain, and potatoes. The highest value crops in the region are the substantial acres of grapes and orchards in the Russian River Basin and ornamental flowers, including bulbs, in Del Norte County.

The total acreage of fruit and nut orchards has decreased over the past several decades. For example, in Sonoma County, orchards declined from 20,000 acres in 1971 to fewer than 3,500 acres in 2001. However, the amount of irrigation water used on orchards did not decrease in the same proportion because many of the apple, prune, and walnut orchards taken out of production were not irrigated. As the acreage of orchards declined, the acreage planted in vineyards increased. Most of the newer vineyards use drip irrigation systems for plant irrigation, but overhead sprinklers are also used for frost protection in the spring and for post-harvest irrigation in the fall.

The North Coast Hydrologic Region also contains roughly 280 dairy farms with 60,000 milk cows, according to the 2002 Census of Agriculture. The majority of these dairy farms are in Humboldt County (140 farms) and Sonoma County (110 farms).

Many of the region's watersheds support threatened and endangered species of plants and animals, and many North Coast streams and rivers support anadromous fish runs of salmon and steelhead trout. The principal reaches of the Klamath, Eel, and Smith rivers have been designated wild and scenic under federal and State law and therefore are protected from additional large-scale water development.

Water Supply and Use

Many of the smaller communities and rural areas in the North Coast region are generally supplied by small local surface water and groundwater systems. Larger water supply projects in this region include the U.S. Bureau of Reclamation's Klamath Project, the U. S. Army Corps of Engineers' Russian River Project (Lake Mendocino and Lake Sonoma), and the Humboldt Bay Municipal Water District's Ruth Reservoir, which serves coastal communities from Eureka to McKinleyville. Because the Upper Klamath River watershed is in both California and Oregon, the federal Klamath Project includes water supply facilities in both states. Facilities within the California portion include Clear Lake Reservoir for water supply, Tule Lake and Lower Klamath Lake as waterfowl refuges, and Iron Gate Reservoir as a hydroelectric facility of Pacific Power and Light

Company. The primary water supply facilities on the Oregon side are Gerber Reservoir and Upper Klamath Lake. The Klamath Project is the largest agricultural irrigation project in the region, and supplies water to about 240,000 acres, of which 62 percent is in Oregon and 38 percent is in California. To maintain adequate instream fishery flows for the lower Klamath River, water releases must be coordinated among the various reservoirs operated by different agencies within both states.

Two of the largest water supply reservoirs in the North Coast region are the U.S. Bureau of Reclamation's 2.437 million acre-foot Trinity Lake on the Trinity River, and the U.S. Corps of Engineer's 380,000 acre-foot Lake Sonoma in the Russian River watershed. These facilities provide water for instream flows, recreation, hydropower, and water supply purposes. Water from Trinity Lake is exported from the North Coast region to the Sacramento River region through the U.S. Bureau of Reclamation's Clear Creek Tunnel. Lake Sonoma is operated to provide flood control and instream flows in the Lower Russian River in Sonoma County. Another intrabasin water transfer system known as the Potter Valley Project has been in existence since 1908 and diverts water from the upper reaches of the Eel River at Cape Horn Dam through a tunnel to the East Fork Russian River upstream from Lake Mendocino. The water stored behind Coyote Dam (Lake Mendocino, built in 1958) is used to meet instream flow requirements, as well as urban and agricultural needs in the lower Russian River watershed and the Santa Rosa area.

Groundwater development is sporadic throughout the mountainous areas of the region, and wells are generally along the valleys of rivers and streams. As described in "California's Groundwater" (California Department of Water Resources Bulletin 118-03), there are very few significant aquifers in the coastal mountains that are capable of providing reliable water. In the coastal areas, most groundwater is developed from shallow wells that are typically installed in the sand and gravel beds adjacent to the region's rivers. Significant groundwater basins do exist in the upper Klamath River valley along the border with Oregon and also in the southern tip of this region underlying the Santa Rosa area.

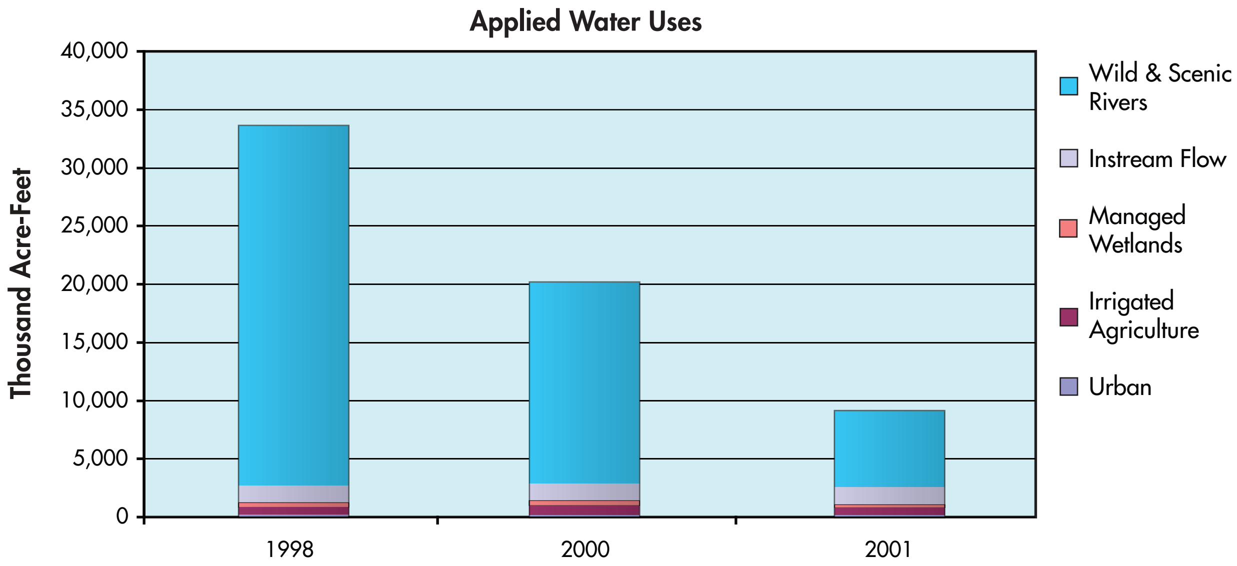
The principal developed uses of environmental water occur in the Lower Klamath Lake, Tule Lake, and Clear Lake National Wildlife Refuges, and the Butte Valley and Shasta Valley Wildlife Areas. In Butte Valley, most of the water for wildlife comes from about 3,000 acre-feet of groundwater. As a result of the passage of both federal and State wild and scenic rivers acts in 1968 and 1972, many of the major rivers in the North Coast region have been preserved to maintain their free-flowing character and provide for environmental uses. Most of the Eel, Klamath, Trinity and Smith rivers are designated as wild and scenic, which preserves these river resources and protects them from new water development. On the Trinity River, efforts to restore the fishery led to a federal Record of Decision in year 2000 to increase the fishery flow releases from Trinity Lake. After several years of legal challenges, this decision was upheld by a July 2004 federal court decision. The water allocated to downstream fishery flows is now being increased from the previous 340,000 acre-feet per year, to a new schedule that ranges between 368,600 acre-feet in a critically dry year to more than 700,000 acre-feet per year in a wet water year. Biologists and Central Valley Project operators are still working on the development of daily, weekly and monthly water release schedules that will make the best use of these new water allocations.

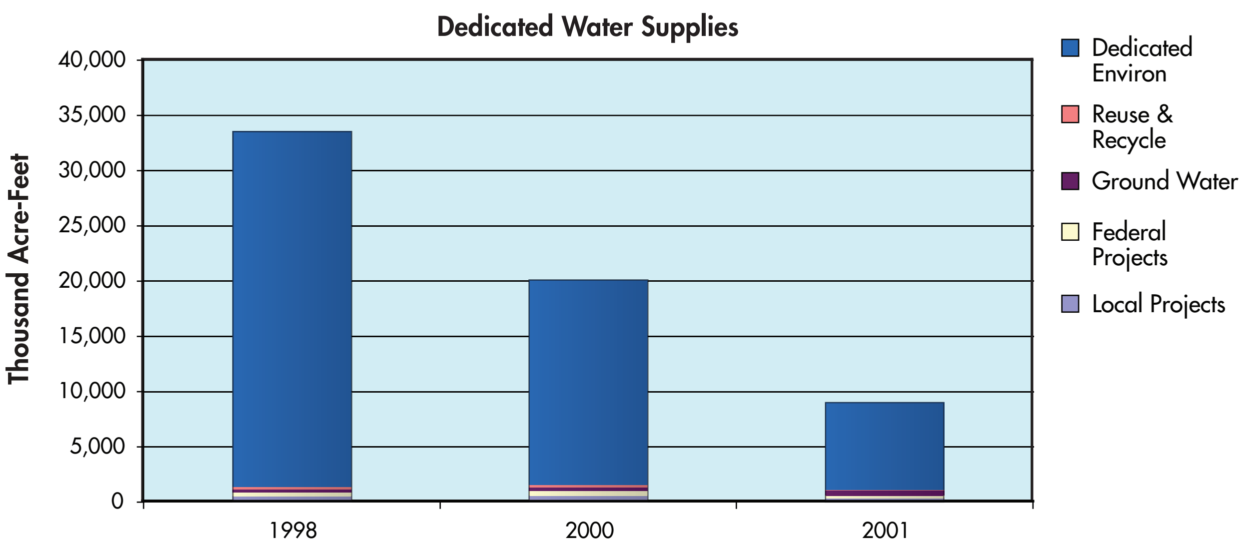
The water balance tables and the narrative discussion at the end of this chapter provide a detailed summary of the actual region-wide water supplies and water uses from years 1998, 2000, and 2001 for the entire North Coast region. Figure 2-3 summarizes the dedicated and developed urban, agricultural and environmental water uses in the region for 1998, 2000, and 2001. The figure also provides a graphical presentation of all of the water supply sources that are used to meet the developed water uses within this hydrologic region for these three years. As shown on the first graph, the volume of water dedicated to wild and scenic rivers, called "statutory required outflows," is the largest component of dedicated water uses in the region. The information presented in Table 2-1 at the end of the chapter also indicates that the volume of water exported to other regions is generally greater than all the water consumptively used for urban, agriculture and wildlife refuges within the North Coast region.

State of the Region

The North Coast region generally has the most abundant water resources of any region of the State. The high volumes of precipitation and natural river runoff are a key component for most of the beneficial uses of its water bodies, including commercial and recreational fishing, shellfish harvesting, urban and agricultural use, and recreation. Many of the region's forests and watersheds support threatened and endangered species of plants and animals, and the major rivers and streams contain significant anadromous fishery resources. This region also features important coastal resources, including Bodega Harbor and Humboldt Bay, and many small estuaries.

Figure 2-3 North Coast water balance for water years 1998, 2000, 2001





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

Challenges

The region faces many water quality and water supply challenges. The North Coast Regional Water Quality Control Board's water quality priorities highlight the need for control of nonpoint source runoff from logging, rural roads, agriculture, and urban areas. In fact, sediment, temperature, and nutrients are the primary focus of the RWQCB's 303(d) list of impaired water bodies. Along the coast, nonpoint-source pollution can cause microbial contamination of shellfish growing areas, especially oysters. Much of the region is characterized by rugged, steep, forested lands, with highly erodable, loosely consolidated soils; taken together with wildfires, extensive timber harvesting, and heavy precipitation primarily in the form of rain, the watershed is highly susceptible to erosion and landslides. Such heavy runoff in turn causes stream sedimentation that impacts habitat for spawning and rearing of anadromous fish. Channel modifications and water diversions have radically changed water-quality conditions in many water bodies in the region, reducing natural flows that dilute contaminant concentrations and lessen their impacts. In the southern portion of the region, the development of new hillside vineyards is an increasing source of erosion and pesticides.

Fisheries can be adversely affected by a number of factors related to both water quality and water quantity. The Eel, Mad, Trinity, Klamath and Russian rivers, as well as many other streams, suffer from sedimentation, which can smother salmonid spawning areas. The North Coast region's basin plan sets turbidity restrictions to control erosion impacts from logging and related activities, such as road building. Timber harvests can also decrease the canopy shading rivers and streams, thereby increasing water temperatures to levels that are detrimental to cold water fisheries. The basin plan also specifically establishes temperature objectives for the Trinity River, in which reduced flows have disrupted temperature and physical cues for anadromous fish runs. Because of water diversions, summer temperatures in the Trinity as well as the Klamath can be lethal to salmonids. Fisheries can be further affected by the lack of woody debris for pool habitat and sediment metering.

The North Coast RWQCB's basin plan requires tertiary treatment of wastewater discharges to the Russian River, a major source of domestic water, and establishes limits on bacteriological contamination of shellfish-growing areas along the coast. The plan also prohibits or strictly limits waste discharges to the Klamath, Trinity, Smith, Mad, and Eel rivers, as well as estuaries and other coastal waters. Nonpoint source runoff, especially after heavy precipitation, has resulted in contamination and closure of shellfish harvesting beds in Humboldt Bay. In the lower Russian River watershed storm water runoff also might be contributing to high ammonia and low dissolved oxygen levels in Laguna de Santa Rosa, which is threatening aquatic life. Mercury in fish tissue is a water quality concern in Lakes Pillsbury, Mendocino, and Sonoma; a health advisory for mercury has been issued for Lake Pillsbury.

Groundwater quality problems in the North Coast region include contamination from seawater intrusion and nitrates in shallow coastal groundwater aquifers; high total dissolved solids and alkalinity in groundwater associated with the lake sediments of the Modoc Plateau basins; and iron, boron, and manganese in the inland groundwater basins of Mendocino and Sonoma counties. Septic tank failures in western Sonoma County, at Monte Rio and Camp Meeker, and along the Trinity below Lewiston Dam, are a concern because of potential impacts to groundwater wells and recreational water quality.

Other water quality concerns include the impacts of boating fuel constituents such as MTBE to recreational water use at Trinity, Lewiston, and Ruth lakes. Abandoned mines, forest herbicide application, and historical discharge of wood treatment chemicals at lumber mills, including Sierra Pacific Industries near Arcata and Trinity River Lumber Company in Weaverville, also are regional issues of concern. Of note, according to the 305(b) report, only the Russian River Basin has a long-term water quality data set in this region, which is necessary to evaluate quality changes over time.

Even though the North Coast region produces a substantial share of California's surface water runoff, only about 10 percent of this runoff occurs in the summer and water supplies are limited throughout much of the area. Small surface-water supply projects generally have limited carryover capacity that cannot supply adequate water during extended months of low rainfall. The drinking water for many of the communities on the North Coast, such as Klamath, Smith River, Crescent City, and most of the Humboldt Bay area, is supplied by Ranney collectors (horizontal wells adjacent to or under the bed of a stream). Erosion is undercutting some of these collectors, such as those in the Mad River supplying the Humboldt Bay Municipal Water District (which serves Eureka, Arcata, and McKinleyville). As such, these "wells" may actually be under the direct influence of surface water, which would then require filtration. The city of Willits has had chronic problems with turbidity, taste, and odor with water from Morris Reservoir, and high arsenic, iron, and manganese levels in its well supply. Organic chemical contamination has closed municipal wells in the cities of Sebastopol and Santa Rosa. The town of Mendocino typifies the problems related to groundwater development in the shallow marine terrace aquifers; surveys in the mid-1980s indicate about 10 percent of wells go dry every year and up to 40 percent go dry during droughts.

The Klamath River Basin is an interstate watershed with surface storage facilities in both California and Oregon and competing water needs for agriculture, Indian tribal rights, waterfowl refuges, and endangered fish. The primary water storage facilities belong to the federal Klamath Project, which is operated by the U.S. Bureau of Reclamation, in conjunction with other dams and diversion structures operated by local irrigation districts, wildlife management agencies, and electric power companies. In 2001, the lack of rainfall generated a severe drought, which aggravated water disputes and caused harsh effects to agriculture, waterfowl refuges and the downstream fisheries. The endangered fish populations include listed species such as the Lost River and shortnose suckers, coho salmon, and steelhead trout. During 2001, the U.S. Bureau of Reclamation was able to deliver only about 75,000 acre-feet of water to agriculture in California, which is about 25 percent of normal. In the Tule Lake and Lower Klamath Lake subbasins, this translated to a drought disaster for both agriculture and the wildlife refuges. In 2002, about 33,000 adult salmon died due to water quality and quantity problems while trying to swim up the Klamath.

Federal agencies have taken a lead role in conducting studies and developing proposals to resolve the competing water needs in the Klamath Basin, with assistance from state agencies in Oregon and California, and several local governments and interest groups. The U.S. Bureau of Reclamation is developing a new Klamath Project Operations Plan intended to establish specific allocation procedures to best meet the needs of agriculture, fishery restoration per the Endangered Species Act, waterfowl refuges, and tribal water rights. The U.S. Geological Survey has initiated a four-phase Klamath Basin groundwater study to document water levels, water quality, and groundwater flow patterns; and to identify potential opportunities for future groundwater conjunctive use. The U.S. Natural Resources Conservation Service has developed an adaptive management program that allocates federal funds for agricultural conservation programs, fish and wildlife habitat, water quality improvements, and water storage improvements, which are intended to increase water use efficiencies and achieve long-term reductions in total water use. Other federal agencies in the Klamath Basin Working Group include the U.S. Forest Service, the Fish and Wildlife Service, the Bureau of Land Management, and the National Marine Fisheries Service. Many of these programs and studies will take several years to develop and implement, so the overall ability to successfully meet all competing water needs will not be known for several years. In the meantime, below-normal water supply conditions during the past three years continue to aggravate the water management issues, disputes, and negative effects to basin resources.

As part of the efforts to restore the Trinity River fishery, the Secretary of the Interior in December 2000 approved a significant change in use of Trinity River Basin water. As part of an effort to restore Trinity River fish habitat, the river's instream flows were increased from 340,000 acre-feet per year (roughly 25 percent of average annual flow at the Central Valley Project diversion point on the Trinity River) to an average of 595,000 acre-feet per year. This decision, which would reduce the amount of water available for export from the Trinity River to the Central Valley, was challenged by water and power interests in U.S. District Court in 2001. On July 13, 2004, the 9th U.S. Circuit Court of Appeals overturned the injunction imposed by the district court, and ruled that the original year 2000 Record of Decision was adequate. The water allocated to downstream fish flows is now being increased to the new flow schedule, which ranges from a minimum of 368,600 acre-feet in a critically dry year up to 815,000 acre-feet in an extremely wet year.

The Eel River and its tributaries are the largest river system draining to the coast of Humboldt County, and it is characterized by significant water quality problems during winter storm events due to massive sediment loads from unstable soils. The Eel River is also host to Humboldt County's largest fisheries of salmon and steelhead, which depend on access to upstream tributaries for spawning. The only major water storage in the upper reaches of the Eel River is the Potter Valley Project, which consists of Lake Pillsbury and a downstream diversion dam and tunnel to the Russian River. The project was originally built in 1908 by Snow Mountain Water and Power Company. Lake Pillsbury was constructed in 1922 for hydropower production, and the project was acquired by Pacific Gas and Electric Company in 1930.

In recent years fishery interest groups have argued that the amount of water diverted to the Russian River has adversely affected salmon and steelhead in the Eel River. The water needs of the Eel River fishery have been evaluated and disputed during the recent Federal Energy Regulatory Commission hydropower license amendment proceeding of the Potter Valley Project. In June 2004, FERC approved PG&E's relicense amendment of the Potter Valley Project and its associated water diversions to the Russian River. However, fishery groups are litigating the FERC decision, so the future distribution of project water between the Eel and Russian rivers is not yet resolved.

Accomplishments

In early 1998, the city of Santa Rosa selected an alternative plan to recharge depleted geothermal fields in the Geysers area with treated wastewater as part of its long-term wastewater-recycling program. Under this alternative, the Santa Rosa Subregional Sewage System will pump about 11-million gallons per day of treated wastewater to the Geysers for injection into the steam fields. This amount is a little less than half the flow the treatment system is expected to produce when finished. The project is intended to eliminate weather-related problems of the city's disposal system and minimize treated wastewater discharges into the Russian River.

The communities around Humboldt Bay support programs intended to achieve the dual goals of flood control and habitat enhancement. The region is committed to restoring the natural functioning of urban streams and wetlands. The city of Arcata has many programs to acquire conservation easements and deeds to wetlands, for the re-establishment of a natural floodplain for storm water management, and for the restoration of fish and wildlife habitat. In the past 10 years, Arcata has collaborated with government agencies, nonprofit organizations, community groups, and schools for development of these restoration activities, and has spent millions of dollars on programs. Additional financial support has been obtained through grants from the California Department of Water Resources, Department of Fish and Game, the Wildlife Conservation Board, and the U.S. Fish and Wildlife Service.

The Russian River Action Plan, first prepared in 1997, was updated by Sonoma County Water Agency in 2003 and provides a regional assessment of ongoing efforts to restore the salmonid fishery and improve the riparian habitat in the Russian River watershed. The plan describes 17 current and pending restoration activities, followed by an extensive list of additional habitat restoration projects that are in need of funding. In 1997, the National Marine Fisheries Service listed steelhead trout as threatened and in 2002 listed coho salmon as endangered along part of the Central California coast that includes the Russian River Basin. The Sonoma County Water Agency, the U.S. Army Corps of Engineers, and the National Marine Fisheries Service signed an agreement to establish a framework for consultation under Section 7 of the Endangered Species Act. Under that agreement, the Army Corps and the Sonoma County agency jointly review and coordinate information on their respective Russian River activities to determine effects to critical salmonid habitat. The Eel-Russian River Commission, composed of county supervisors from Humboldt, Mendocino, and Sonoma counties, also provides a regional forum for agencies and groups to stay informed about projects and issues affecting the Eel and Russian rivers.

Relationship with Other Regions

As shown on the regional map (see Figure 2-1) the Klamath River Basin straddles the border with Oregon, such that water from the upper basin flows into Oregon and eventually returns to California above Iron Gate Reservoir. On the Oregon side of this interstate basin, two surface water diversions export an average of 29,600 acre-feet per year from Klamath River tributaries into the Rogue River system in Oregon. The Klamath River Basin also receives a small amount of imported water (about 2,000 acre-feet per year) from the upper reaches of the Sacramento River Hydrologic Region through a canal called the North Fork Ditch.

The North Coast region exports a large volume of water from the upper reaches of the Trinity River into the Sacramento River region through the US Bureau of Reclamation's Central Valley Project at Lewiston Dam and the Clear Creek Tunnel. For 1998, 2000, and 2001, the Trinity River exports were 851,000 acre-feet per year, 1.11 million acre-feet per year, and 669,000 acre-feet per year, respectively. In future years these Trinity River exports are likely to be reduced due to the increased instream flows established for the Trinity River fishery. Elsewhere, a smaller regional export of roughly 33,000 acre-feet per year is transported from the lower Russian River into the northern portion of the San Francisco Bay region through the Sonoma-Petaluma Aqueduct, to supply communities in northern Marin County and southern Sonoma County.

Looking to the Future

When compared to the more developed regions of the state, urban and agricultural water use in the North Coast region use a relatively small part of the total available water. However, localized water supply problems are expected to continue for communities with limited surface water and groundwater, particularly during extended droughts. While significant water supplies exist throughout most of the North Coast region, the ability to acquire funding to upgrade and expand water systems is a major problem for the rural communities.

Along the coast, the Humboldt Bay Municipal Water District system might expand to serve the Trinidad-Moonstone area, which is experiencing local water deficiencies. The Eureka-

Arcata area may undergo construction of a regional water treatment plant and is investigating groundwater development as an alternative source, which would not require the same level of water treatment.

Crescent City has an adequate supply from the Smith River but needs to increase system transmission and storage capacity and might build a new water treatment facility. The city of Rio Dell might also begin construction of a surface water treatment facility. Ranney wells will be installed in the Eel River as a primary water supply for Rio Dell. Trinity County Waterworks District No. 1, which serves the town of Hayfork from the 800 acre-foot Ewing Reservoir, has plans to enlarge the reservoir and expand its surface water system.

In the Klamath River Basin, the U.S. Bureau of Reclamation is leading efforts to balance water needs between the historical agricultural uses of the Klamath Project, the instream needs of endangered fish, as well as other system water uses. The recent dry hydrologic conditions have intensified these issues, and federal funding was approved in 2002 to provide relief through the development of conservation programs and the availability of new groundwater. The U.S. Bureau of Reclamation is continuing to update the Klamath Project long-term operations plan, but difficult issues have delayed its completion. The Klamath River Compact Commission also provides a forum for discussions on management of interstate water resources between Oregon, California, and the federal agencies, and promotes intergovernmental cooperation on water allocation issues. A few additional groundwater wells are likely to be constructed to augment irrigation supplies in the Butte Valley and Tule Lake areas. Pressure for additional groundwater development in areas like Scott and Shasta valleys will be greater since the 2002 listing of the coho salmon. The new listing, along with stricter applications of California Department of Fish and Game instream regulations, will reduce the supplies available for irrigation from existing water developments and from natural runoff.

The lower Russian River watershed and the adjoining Santa Rosa area are projected to experience the most significant urban growth for any part of the North Coast Hydrologic Region. This growth will continue to stress the available water and accentuate the need balance urban water uses with environmental water needs. The Sonoma County Water Agency has a central role in maximizing the use of existing water supplies, and is actively developing conservation, water recycling, and groundwater conjunctive use. The Sonoma County Water Agency is also restoring and preserving the Russian River fishery and habitat and is the lead agency for developing and implementing a Russian River Action Plan.

Restoration and protection of salmonid habitat will continue to be a prominent fishery issue for all of the major coastal rivers. The federal listing of coho salmon and steelhead under the Endangered Species Act and the State listing of the coho salmon generate additional regulatory requirements that affect all surface water uses on these rivers. The California Department of Fish and Game has prepared a coho salmon Recovery Plan to guide actions directed at the recovery of this species. Existing and planned water projects will need to be operated in ways that do not affect the fishery, which might alter methods and schedules for water diversions, hydropower operations, and wastewater discharges. Surface water quality issues such as sediment loads, nutrients, and warm water can also affect the fishery, and these fall under the jurisdiction of the North Coast RWQCB, which is developing basin plans to address water quality problems and protect the coastal rivers.

Regional Planning

The forum and focus of regional planning activities varies significantly from north to south across the North Coast region because of the diversity of water issues and the involved water agencies. In the far north interstate Klamath River watershed, much of the planning is being done by federal agencies such as the U.S. Bureau of Reclamation, the Natural Resources Conservation Service, and the U.S. Fish and Wildlife Service, among others. These federal agencies are working to balance the needs of the federal Klamath Project with water for fish, tribal interests, and interests of communities affected by the federal project. Planning and issue resolution for the Trinity River also have a significant federal lead role because of the federal Central Valley Project at Trinity and Lewiston lakes. In general, many of the Northern California counties lack funding at the level available to federal agencies to conduct regional planning.

In the central portion of the region, the communities and water issues in Humboldt, Trinity, and Mendocino counties tend to be organized at the local or county levels, partly because these areas are geographically separated from other developed regions. Planning activities of Humboldt Bay Municipal Water District and the Humboldt County general plan update are one of the primary forums for regional planning for the Arcata and Eureka areas. The Mendocino Council of Governments and the Mendocino Community Services District are among the lead water planning agencies for the county, which includes Ukiah and portions of the upper Russian River wine country.

Sonoma County is the southernmost county in the North Coast Hydrologic Region, and water planning is closely associated with those of the adjoining San Francisco Bay region. Water planning is strongly focused on meeting the urban needs of Santa Rosa and the surrounding communities served by Sonoma County Water Agency. The agency coordinates with and is a member of several San Francisco Bay area regional planning groups, such as the Bay Area Water Agencies Coalition that provides significant direction and guidance for regional planning. Much of Sonoma County regional planning also focuses on the competing uses of the Russian River, which is the largest river in this part of the North Coast region. The Russian River Action Plan has been updated by Sonoma County Water Agency, as a coordinated effort among federal, State, and local agencies to protect and restore salmonid fishery populations and habitat.

The State agency with the most significant influence on regional water planning activities in the North Coast region is the North Coast RWQCB. Although headquartered in Santa Rosa, this agency has key responsibilities for surface water quality and regulations for all of the rivers in the region. The board oversees several water quality programs and issues related to timber operations, vineyard runoff, nonpoint source pollution, the development of total maximum daily load limits, and the development of water quality objectives for individual basin plans.

Water Portfolios for Water Years 1998, 2000, and 2001

The tables in this chapter present actual information about the water supplies and uses for the North Coast Hydrologic Region for the three selected years. Water year 1998 was a wet year for this region, with annual precipitation at 154 percent of average, while the statewide annual precipitation was 171 percent of average. Year 2000 represents normal hydrologic conditions with annual precipitation at 98 percent of average for the North Coast region. Year 2001 reflected drier water year conditions with annual precipitation at 60 percent of average. For comparison, statewide average precipitation in year 2001 was 72 percent of normal.

Table 2-1 provides detailed information about the total water supplies available to this region for these three years from precipitation, imports, and groundwater, and also summarizes the uses of all of the water supplies. As shown in this table, the largest component of overall water use for this region is by evapotranspiration from the forest lands (native vegetation). The second largest component of water use consists of the river flows into the ocean from designated wild and scenic rivers, labeled as "statutory outflow to salt sinks." The North Coast region has the highest total volume of water that is used by natural forests and the river outflows, compared to any of the other regions of California. Table 2-1 also indicates that water exports to other regions are generally greater than the volume of water that is consumed for agricultural and urban purposes within this region.

A more detailed tabulation of the portion of the total available water that is dedicated to urban, agricultural and environmental purposes is presented in Table 2-2. Because most of the North Coast region is largely undeveloped, dedicated environmental water uses for wild and scenic rivers are a larger component of the total dedicated water uses in this region. Less than 10 percent of the dedicated water is used for urban and agricultural purposes within this region. The section at the bottom of Table 2-2 also provides detailed information about the sources of the dedicated water supplies, which are primarily from surface water. Although groundwater is an important source of supply for many small, rural communities, the total amount of groundwater used in the region is small compared to surface water use.

More detailed information about how available supplies are distributed and used on a region-wide basis is shown in Table 2-3 and the companion water portfolio flow diagrams (Figures 2-4 and 2-5).

Selected References

Water Quality Control Plan, Regional Water Quality Control Board

Watershed Management Initiative Chapter, Regional Water Quality Control Board

2002 California 305(b) Report on Water Quality, State Water Resources Control Board

Bulletin 118 (Draft), California's Groundwater, Update 2003, Department of Water Resources

Nonpoint Source Program Strategy and Implementation Plan, 1998-2013, State Water Resources Control Board, California Coastal Commission, January 2000

Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001

Del Norte, Mendocino, and Siskiyou counties

Mendocino County Russian River Flood Control and Water Conservation Improvement District

Table 2-1 North Coast Hydrologic Region water balance summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (154%)	2000 (98%)	2001 (60%)
Water Entering the Region			
Precipitation	79,216	50,755	31,254
Inflow from Oregon	2,105	1,498	988
Inflow from Colorado River	0	0	0
Imports from Other Regions	2	2	2
Total	**81,323**	**52,255**	**32,244**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	646	791	647
Outflow to Oregon	184	114	66
Exports to Other Regions	883	1,144	703
Statutory Required Outflow to Salt Sink	32,348	18,763	8,021
Additional Outflow to Salt Sink	115	125	122
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	46,491	31,592	23,323
Total	**80,667**	**52,529**	**32,882**
Storage Changes in the Region			
[+] Water added to storage			
[-] Water removed from storage			
Change in Surface Reservoir Storage	703	-246	-491
Change in Groundwater Storage **	-47	-28	-147
Total	**656**	**-274**	**-638**
Applied Water * (compare with Consumptive Use)	1,166	1,353	1,018

***Footnote for applied water**

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

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

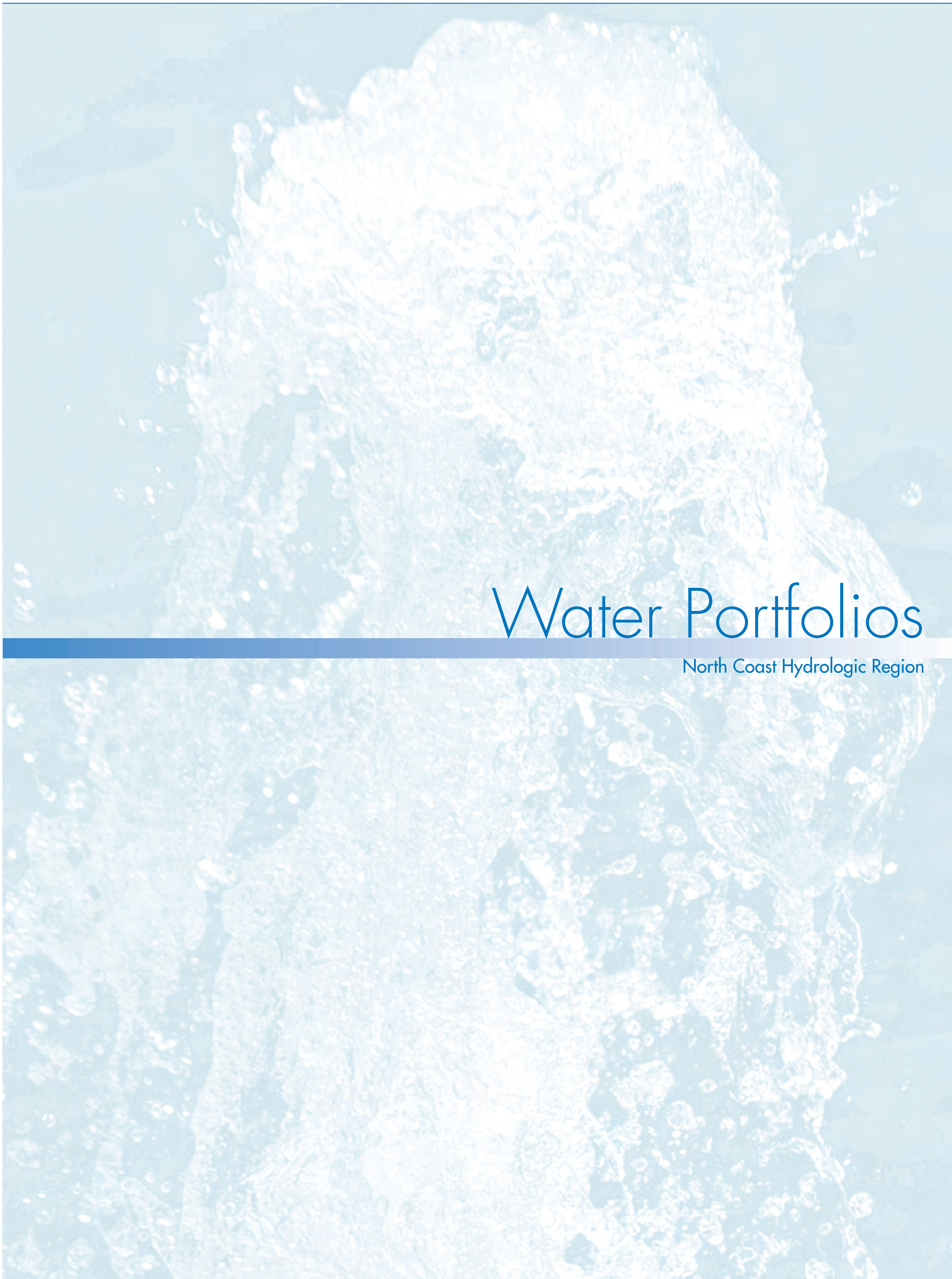
Change in Groundwater Storage is based upon best available information. Basins in the north part of the state (North Coast, San Francisco, Sacramento River and North Lahontan regions and parts of Central Coast and San Joaquin River regions) have been modeled – spring 1997 to spring 1998 for the 1998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

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

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

Table 2-2 North Coast Hydrologic Region water use and distribution of dedicated supplies - TAF

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	11.0			12.4			12.7		
Commercial	17.1			17.2			17.5		
Industrial	30.2			31.7			31.1		
Energy Production	0.0			0.0			0.0		
Residential - Interior	42.7			44.1			43.3		
Residential - Exterior	38.9			44.6			44.8		
Evapotranspiration of Applied Water		41.2	41.2		45.9	45.9		47.7	47.7
E&ET and Deep Perc to Salt Sink		0.2	0.2		0.2	0.2		0.2	0.2
Outflow		76.3	76.3		80.8	80.8		79.5	79.5
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**139.9**	**117.7**	**117.7**	**150.0**	**126.9**	**126.9**	**149.4**	**127.4**	**127.4**
Agriculture									
On-Farm Applied Water	634.6			778.9			614.6		
Evapotranspiration of Applied Water		449.2	449.2		551.1	551.1		444.1	444.1
E&ET and Deep Perc to Salt Sink		29.6	29.6		33.5	33.5		26.4	26.4
Outflow		41.4	35.4		47.0	40.1		48.4	41.3
Conveyance Applied Water	24.0			27.5			17.9		
Conveyance Evaporation & ETAW		6.9	6.9		7.1	7.1		4.2	4.2
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		2.0	2.0		2.0	2.0		0.0	0.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**658.6**	**529.1**	**523.1**	**806.4**	**640.7**	**633.8**	**632.5**	**523.1**	**516.0**
Environmental									
Instream									
Applied Water	1,445.3			1,444.5			1,473.5		
Outflow		1,425.1	1,425.1		1,441.9	1,441.9		1,473.5	1,473.5
Wild & Scenic									
Applied Water	30,923.0			17,321.1			6,547.6		
Outflow		30,923.0	30,923.0		17,321.1	17,321.1		6,547.6	6,547.6
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	391.4			424.4			254.3		
Evapotranspiration of Applied Water		155.7	155.7		194.4	194.4		155.3	155.3
E&ET and Deep Perc to Salt Sink		0.4	0.4		0.4	0.4		0.1	0.1
Outflow		111.0	111.0		115.4	115.4		67.9	67.9
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	391.4	267.1	267.1	424.4	310.2	310.2	254.3	223.3	223.3
Total Environmental Use	**32,759.7**	**32,615.2**	**32,615.2**	**19,190.0**	**19,073.2**	**19,073.2**	**8,275.4**	**8,244.4**	**8,244.4**
TOTAL USE AND OUTFLOW	**33,558.2**	**33,262.0**	**33,256.0**	**20,146.4**	**19,840.8**	**19,833.9**	**9,057.3**	**8,894.9**	**8,887.8**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	537.9	537.9	534.2	592.7	592.7	588.6	340.6	340.6	336.5
Local Imported Deliveries	2.0	2.0	2.0	3.1	3.1	3.1	17.8	17.8	17.6
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Federal Deliveries	334.5	334.5	332.2	408.7	408.7	405.9	238.2	238.2	235.4
SWP Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Required Environmental Instream Flow	32,187.9	32,187.9	32,187.9	18,583.6	18,583.6	18,583.6	7,933.7	7,933.7	7,933.7
Groundwater									
Net Withdrawal	187.7	187.7	187.7	240.7	240.7	240.7	352.5	352.5	352.5
Deep Percolation of Surface and GW	76.6			94.2			100.2		
Reuse/Recycle									
Reuse Surface Water	219.6			211.4			62.2		
Recycled Water	12.0	12.0	12.0	12.0	12.0	12.0	12.1	12.1	12.1
TOTAL SUPPLIES	**33,558.2**	**33,262.0**	**33,256.0**	**20,146.4**	**19,840.8**	**19,833.9**	**9,057.3**	**8,894.9**	**8,887.8**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***



Water Portfolios

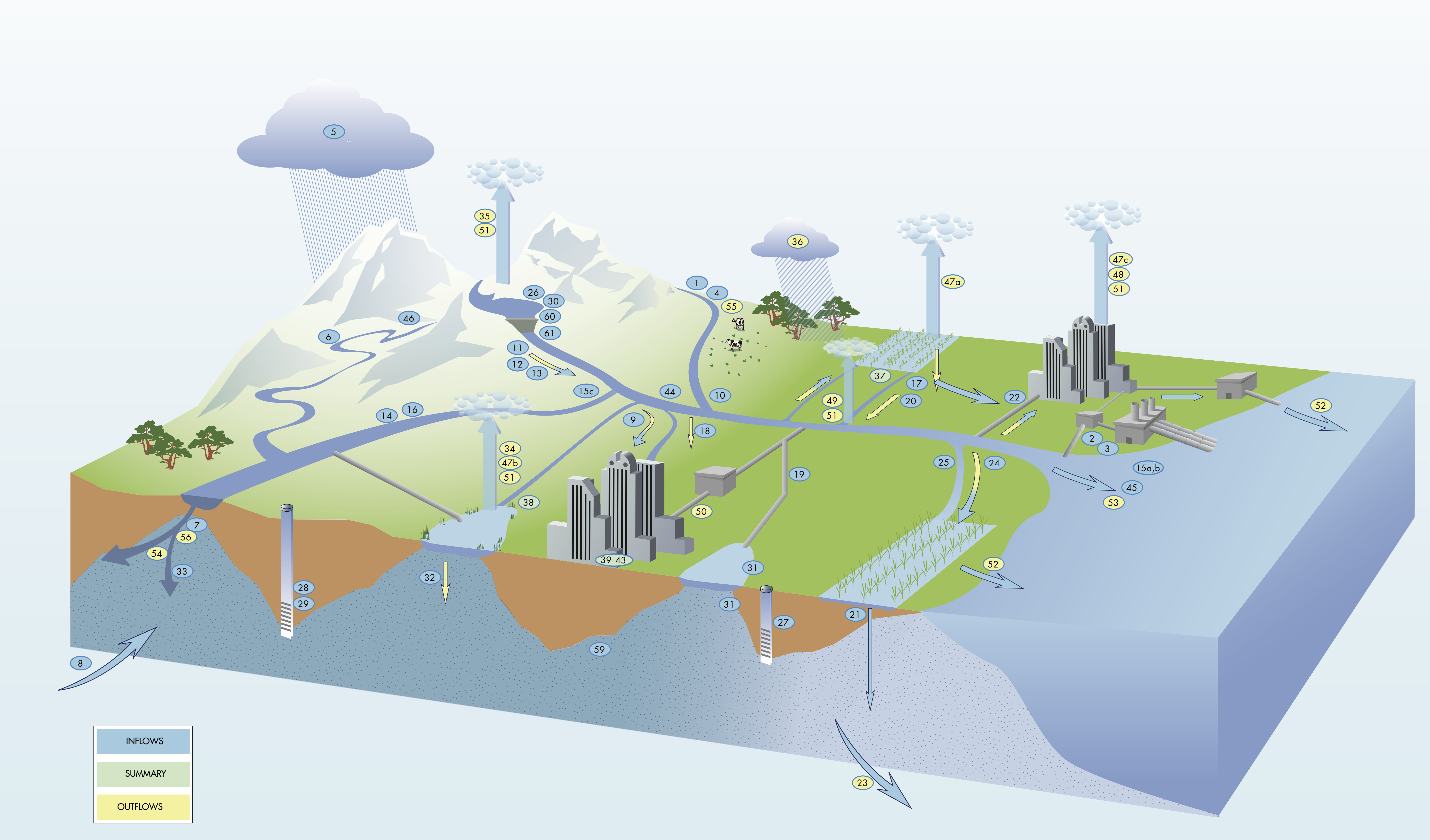
North Coast Hydrologic Region

Table 2-3 North Coast water portfolios (TAF)

ID Number:	Flow Diagram Component (see legend)	North Coast 1998	North Coast 2000	North Coast 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	2,104.5	1,498.0	988.0
b	Inflow From Mexico	-	-	-
5	Precipitation	79,216.3	50,755.1	31,254.4
6a	Runoff - Natural	53,812.0	N/A	N/A
b	Runoff - Incidental	N/A	N/A	N/A
7	Total Groundwater Natural Recharge	N/A	N/A	N/A
8	Groundwater Subsurface Inflow		N/A	N/A
9	Local Deliveries	537.9	592.7	340.6
10	Local Imports	2.0	3.1	17.8
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	-	-	-
12	Other Federal Deliveries	334.5	408.7	238.2
13	State Water Project Deliveries	-	-	-
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	1,445.3	1,444.5	1,473.5
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	5.3	6.4	4.9
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	11.7	11.7	11.7
b	Recycled Water - Urban	0.3	0.3	0.4
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	6.0	6.9	7.1
b	Return Flow to Developed Supply - Wetlands	-	-	-
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	46.9	61.2	72.2
b	Deep Percolation of Applied Water - Wetlands	1.2	1.3	0.7
c	Deep Percolation of Applied Water - Urban	18.7	19.7	18.5
22a	Reuse of Return Flows within Region - Ag	67.5	86.1	23.5
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	143.3	115.5	30.3
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	-	-	-
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions	N/A	N/A	N/A
26	Surface Water in Storage - Beg of Yr	2,236.3	2,740.7	2,495.0
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	264.3	334.9	452.7
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	2,938.8	2,495.0	2,003.9
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation	N/A	N/A	N/A
b	Evaporation and Evapotranspiration from Unirrigated Ag	N/A	N/A	N/A
35a	Evaporation from Lakes	38.9	45.2	42.4
b	Evaporation from Reservoirs	167.5	181.3	162.7
36	Ag Effective Precipitation on Irrigated Lands	271.1	183.2	144.3
37	Agricultural Water Use	634.6	778.9	614.6
38	Managed Wetlands Water Use	391.4	424.4	254.3
39a	Urban Residential Use - Single Family - Interior	29.4	30.4	29.1
b	Urban Residential Use - Single Family - Exterior	35.2	40.8	40.9
c	Urban Residential Use - Multi-family - Interior	13.3	13.7	14.2
d	Urban Residential Use - Multi-family - Exterior	3.7	3.8	3.9
40	Urban Commercial Use	17.1	17.2	17.5
41	Urban Industrial Use	30.2	31.7	31.1
42	Urban Large Landscape	11.0	12.4	12.7
43	Urban Energy Production	-	-	0
44	Instream Flow	1425.1	1441.9	1473.5
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	30923	17321.1	6547.6
47a	Evapotranspiration of Applied Water - Ag	449.2	551.1	444.1
b	Evapotranspiration of Applied Water - Managed Wetlands	155.7	194.4	155.3
c	Evapotranspiration of Applied Water - Urban	41.2	45.9	47.7
48	Evaporation and Evapotranspiration from Urban Wastewater	0.2	0.2	0.2
49	Return Flows Evaporation and Evapotranspiration - Ag	29.6	33.5	26.4
50	Urban Waste Water Produced	75.8	79.8	78.6
51a	Conveyance Evaporation and Evapotranspiration - Urban	-	-	-
b	Conveyance Evaporation and Evapotranspiration - Ag	6.9	7.1	4.2
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	0.4	0.4	0.1
d	Conveyance Outflow to Mexico	N/A	N/A	-
52a	Return Flows to Salt Sink - Ag	37.4	42.1	41.3
b	Return Flows to Salt Sink - Urban	76.3	80.8	79.5
c	Return Flows to Salt Sink - Wetlands	1.7	1.7	1.5
53	Remaining Natural Runoff - Flows to Salt Sink	32348.1	18763	8021.1
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	183.7	113.7	66.4
c	Outflow to Mexico	-	-	-
55	Regional Imports	2.0	2.0	2.0
56	Regional Exports	883.4	1143.5	702.5
59	Groundwater Net Change in Storage	-46.9	-28.4	-146.8
60	Surface Water Net Change in Storage	702.5	-245.7	-491.1
61	Surface Water Total Available Storage	3,779.9	3,779.9	3,779.9

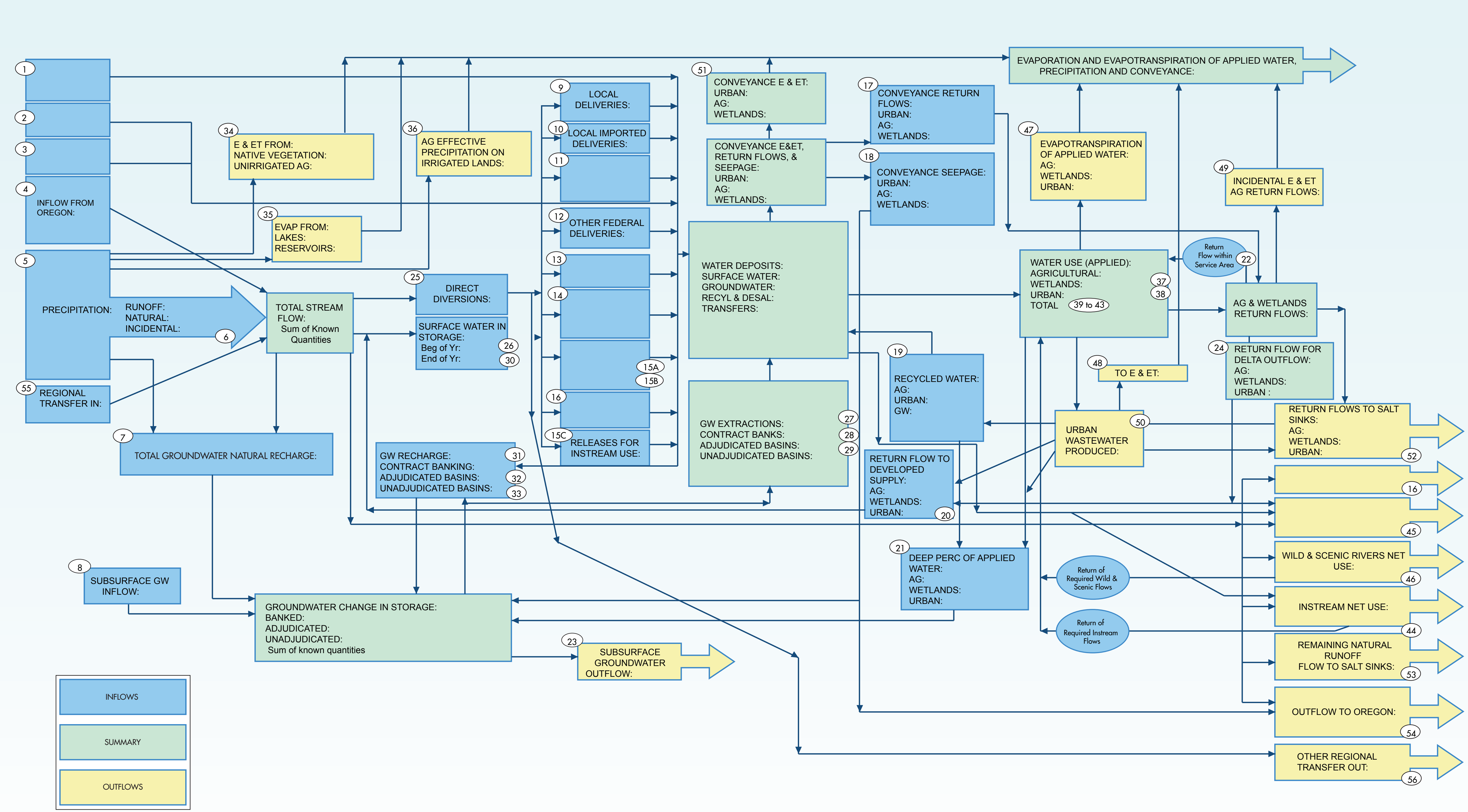
Inflows | Outflows | Green number signifies included in summary boxes

Figure 2-4 North Coast region - illustrated water flow diagram

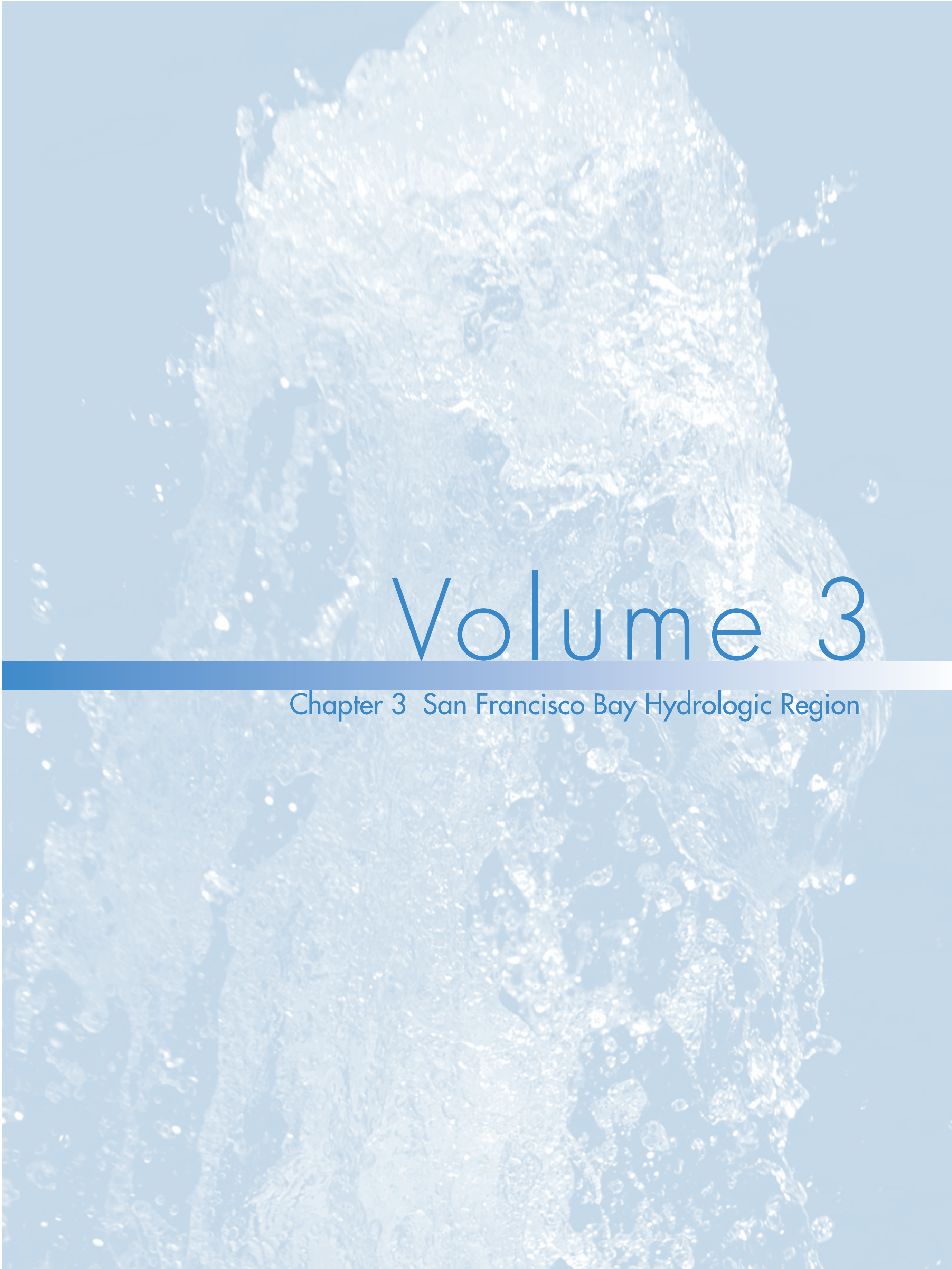


In this illustration of Table 2-3, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of the table's flow diagram components; color indicates whether the component is water input, output, or summary.

Figure 2-5 North Coast region - schematic flow diagram



In schematic of Table 2-3, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.



Volume 3

Chapter 3 San Francisco Bay Hydrologic Region

Chapter 3 San Francisco Bay Hydrologic Region

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Figure 3-1 San Francisco Bay Hydrologic Region

North Coast Region
Sonoma Petaluma Aqueduct

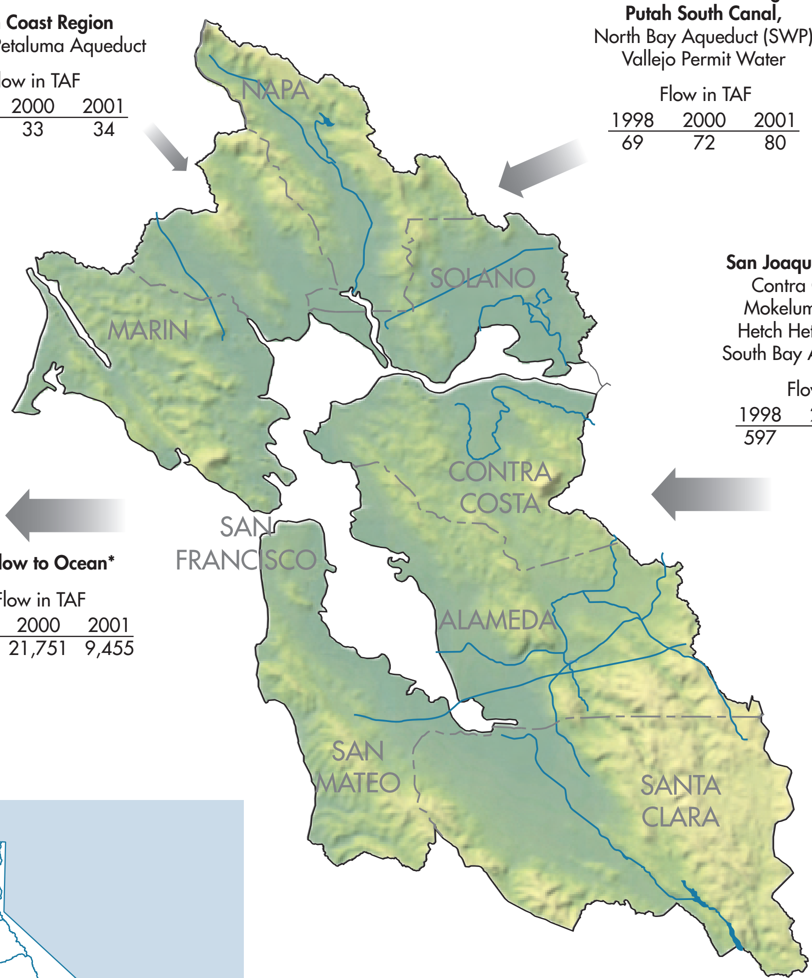
Flow in TAF

1998	2000	2001
32	33	34

Sacramento River Region
Putah South Canal,
North Bay Aqueduct (SWP)
Vallejo Permit Water

Flow in TAF

1998	2000	2001
69	72	80



San Joaquin River Region
Contra Costa Canal
Mokelumne Aqueduct
Hetch Hetchy Aqueduct
South Bay Aqueduct (SWP)

Flow in TAF

1998	2000	2001
597	629	625

Outflow to Ocean*

Flow in TAF

1998	2000	2001
52,665	21,751	9,455

Central Coast Region
San Felipe Unit CVP

Flow in TAF

1998	2000	2001
66	89	133

Some Statistics

- Area - 4,506 square miles (2.8% of State)
- Average annual precipitation - 25.4 inches
- Year 2000 population - 6,105,650
- 2030 population projection - 7,857,360
- Total reservoir storage capacity - 746 TAF
- 2000 irrigated crop area - 70,300 acres

The San Francisco Bay Hydrologic Region includes the San Francisco and Suisun bays and Suisun Marsh and their drainage areas. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

**Outflow to Ocean includes Wild and Scenic Rivers, regulated flows, and estimated wastewater outflows.*

Chapter 3 San Francisco Bay Hydrologic Region

Setting

The San Francisco Bay Hydrologic Region, which occupies parts of nine counties, extends from southern Santa Clara County north to Tomales Bay in Marin County, and inland to the confluence of the Sacramento and San Joaquin rivers near Collinsville (Figure 3-1). The eastern boundary follows the crest of the Coast Range, the highest peaks of which are more than 3,000 feet above sea level. Streams in the region flow into the bay-estuary or to the Pacific Ocean. The climate within the region varies significantly from west to east. Coastal areas are typically cool and often foggy, and inland valleys are warmer with a Mediterranean-like climate. Rainfall amounts vary among subregions and can be highly influenced by vegetative cover and marine influences. Although there are several small reservoirs and groundwater basins throughout this region, the primary water supplies are imported from other regions of the state.

The bay region boasts significant Pacific Coast marshes such as Pescadero marsh and Tomales Bay marshes as well as San Francisco Bay itself. San Francisco Bay is an estuary with a deep central channel, broad mudflats, and fringing marsh. The bay is commonly divided in to the South, Central, and North Bay. The North Bay is more brackish while the South and Central bays are more marine dominated. Suisun Marsh in between the North Bay and the Delta is the largest contiguous brackish water marsh remaining on the west coast of North America, providing more than 10 percent of California's remaining wetlands.

The combined flows of the Sacramento and San Joaquin watersheds flow through the Delta and into the San Francisco Bay. Delta outflow interacts with tides to determine how far salt water intrudes from the ocean into the San Francisco Bay Estuary. The resulting salinity gradients influence the distribution of many estuarine fishes and invertebrates as well as plants, birds, and animals in wetlands areas. Delta outflow varies with hydrology, reservoir releases, and diversions upstream.

Land Use

Portions of the region are highly urbanized and include the San Francisco, Oakland, and San Jose metropolitan areas. Agricultural acreage occurs mostly in the north and northeast in Napa, Marin, Sonoma, and Solano counties. Santa Clara and Alameda counties also have significant agricultural acreage at the edge of the urban development. The predominant crops are grapes along with fruit and nut trees, hay production, and dairy and livestock operations. In the area along the ocean coastline south of the Golden Gate, more than half of the irrigated acres are in high-value specialty crops, such as artichokes, strawberries, or flowers.

Population and Water Use

The bay region is a heavily urbanized region. From California Department of Finance figures, the total population of this hydrologic region in year 2000 was 6,106,000, with approximately half of the people residing in Alameda and Santa Clara counties. The Association of Bay Area Governments projects that even with the implementation of "Smart Growth" policies by local government, the nine counties that include the bay region will add 2 million people, 750,000 households and create 1.5 million jobs by year 2030. Figure 3-2 provides a graphical depiction of the San Francisco Bay hydrologic region's total population from year 1960 through year 2000, with current projections to year 2030. Water use in the bay region is predominantly urban with more than 50 percent of the use residential. There are also numerous industrial users around the bay. Agricultural water use is a much smaller percentage of total water use in this region compared to other inland regions, such as the Sacramento River region, San Joaquin River region, and the Tulare Lake region. For example, in the San Francisco Bay region part of the Santa Clara Valley Water District service area, agricultural use is less than one percent of total water use of 383,000 acre-feet per year. However SCVWD does deliver about 29,000 acre-feet of agricultural water to customers in the Central Coast Hydrologic Region.

Portions of the San Francisco Bay Region are highly urbanized and include the San Francisco (skyline in photo above), Oakland, and San Jose metropolitan areas. Agricultural acreage occurs mostly in Napa, Marin, Sonoma, and Solano counties and also in Santa Clara and Alameda counties. (DWR Photo)

Figure 3-1; provides a graphical presentation of all of the water supply sources that are used to meet the developed water uses within this hydrologic region for years 1998, 2000, and 2001.

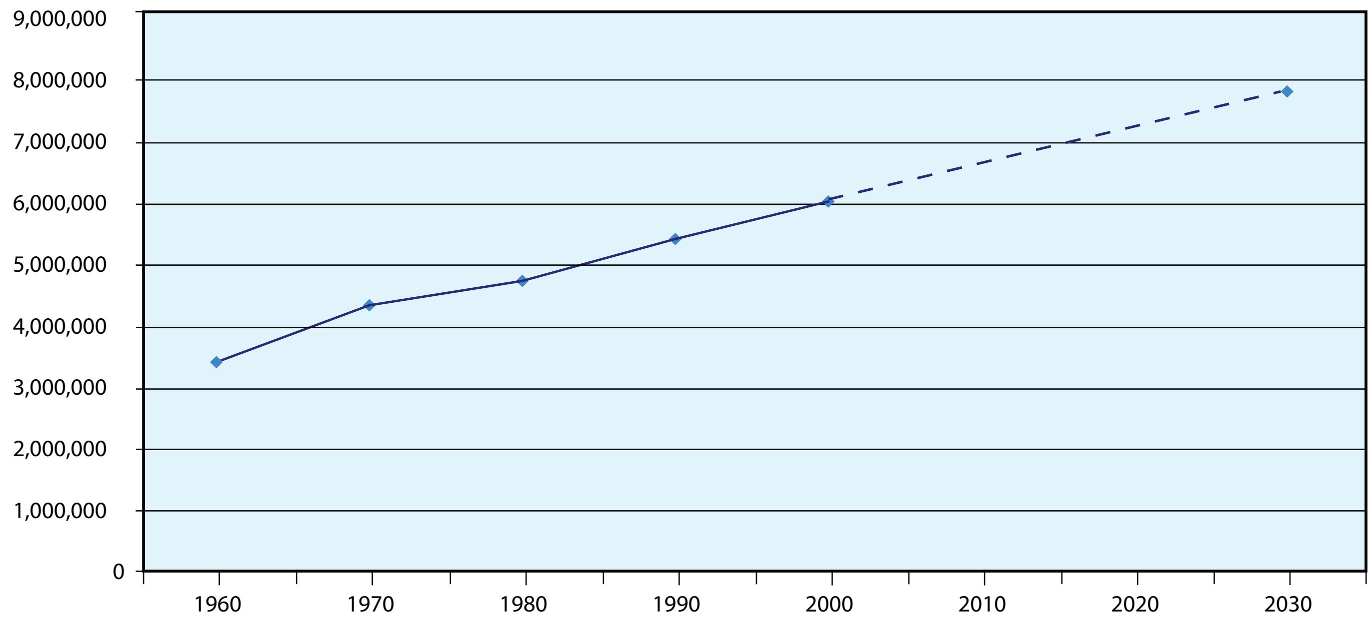
Water Supplies

In the early 1900s, local water agencies developed significant imported water supplies from the Mokelumne and Tuolumne rivers to meet the anticipated demands. At the same time, local reservoirs and watersheds were being developed to capture surface supplies, to recharge the groundwater basins, and to act as terminal reservoirs for the larger projects. Later, State and federal water projects brought water to the northern, eastern, and southern parts of the region through a number of canals. Table 3-1 shows the sources of surface water imported. As additional information, Figure 3-3 presents bar charts that summarize all of the dedicated and developed urban, agricultural and environmental water uses and supplies within this hydrologic region for years 1998, 2000 and 2001.

Groundwater

Local groundwater accounts for only about 5 percent of the region's average water year supply. The more heavily used basins include the Santa Clara Valley, Livermore Valley, Westside, Niles Cone, Napa-Sonoma Valley, and Petaluma Valley groundwater basins. For agencies like SCVWD, Alameda County Water District (ACWD), and Alameda County Flood Control and Water Conservation District-Zone 7 (Zone 7), groundwater is a critically important local supply that helps offset dependence on imported water supplies. (See Box 3-1 for list of acronyms used in this chapter.) Conjunctive use programs have also been implemented by these agencies to optimize the use of groundwater and surface water resources, and water quality programs are in place to monitor and protect groundwater quality. Throughout the region additional groundwater resources continue to be investigated and developed to expand the role of conjunctive use programs.

Figure 3-2 San Francisco Bay Hydrologic Region population



Data from the California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for the San Francisco region.

Recycled Water

Recycled water in the bay region is used in a full spectrum of applications, including landscape irrigation, industrial cooling, agricultural needs and as a supply to the areas many wetlands. Currently, nearly 50-million gallons per day of recycled water is produced in the bay region, and future planned projects have the potential to increase this amount to 100 mgd by the year 2020.

Role of Conservation

Urban water districts in the bay region generally are signatories to the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU) that commits them to make a good faith effort to implement Best Management Practices (BMPs). In 2001, the California Urban Water Agencies issued a report that projected net water savings for the bay region based on implementation of the MOU at about 105,000 acre-feet. These numbers are being updated and revised by the CALFED Bay-Delta Water Use Efficiency Program as part of its planning process.

The seven agencies that participate in the Bay Area Water Agencies Coalition—SCVWD, ACWD, Zone 7, San Francisco Public Utilities Commission (SFPUC), Contra Costa Water District (CCWD), East Bay Municipal Utilities District (EBMUD), and Bay Area Water Supply and Conservation Agency (BAWSCA)—recently completed a study on conservation advancement that showed that as a whole, their members had reduced the per capita water use by 16 percent since 1986 and decreased total water use by 1.4 percent despite a 17 percent increase in population served during the same period. Individual agency results varied around these numbers.

Water Quality

The San Francisco Bay Hydrologic Region is centered on the San Francisco Estuary and its water quality. The estuary's immediate watershed is highly urbanized, resulting in contaminant loads from both point and nonpoint sources, as well as pollutants from the Napa, Petaluma, and Guadalupe rivers, the Sacramento-San Joaquin Delta, and the Central Valley. Bay Area residents generally receive good quality drinking water that varies by source and treatment. Sources range from high quality Hetch Hetchy and Mokelumne River supplies, local surface and groundwater, and variable-quality Delta water. Utilities that depend on the Delta for all or part of their domestic water supplies do meet the current drinking water standards, although they remain concerned about issues such as microbial contamination, salinity, and organic carbon.

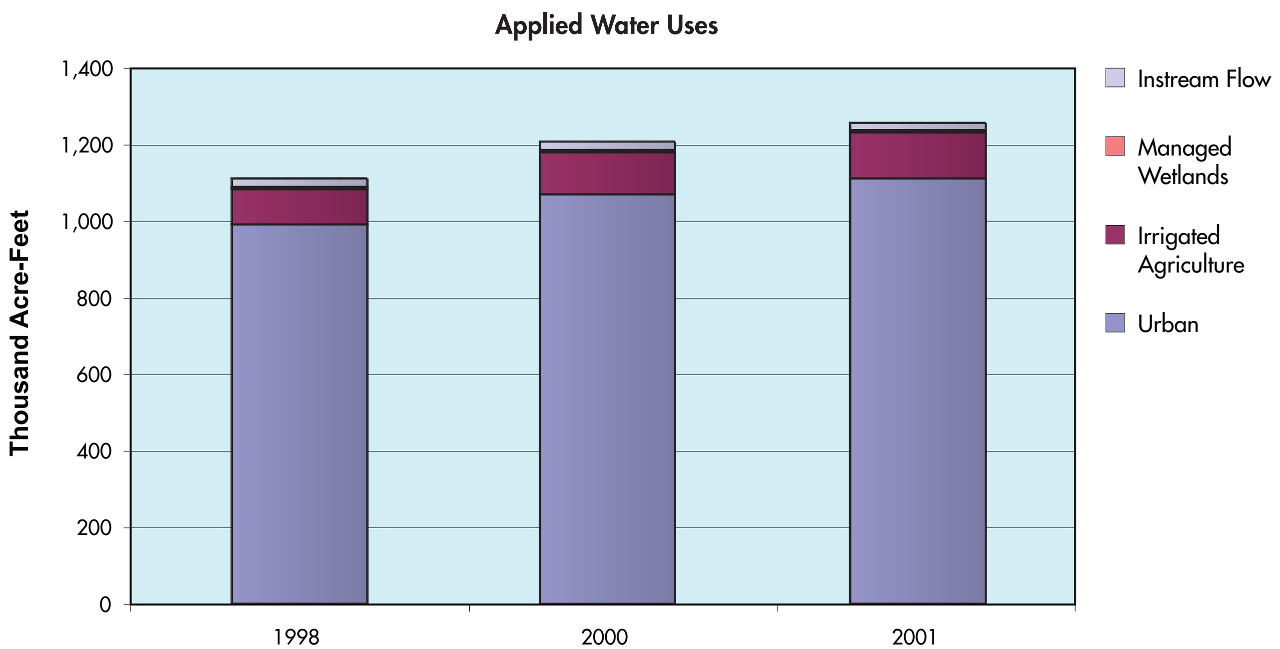
Table 3-1 Sources of surface water imported

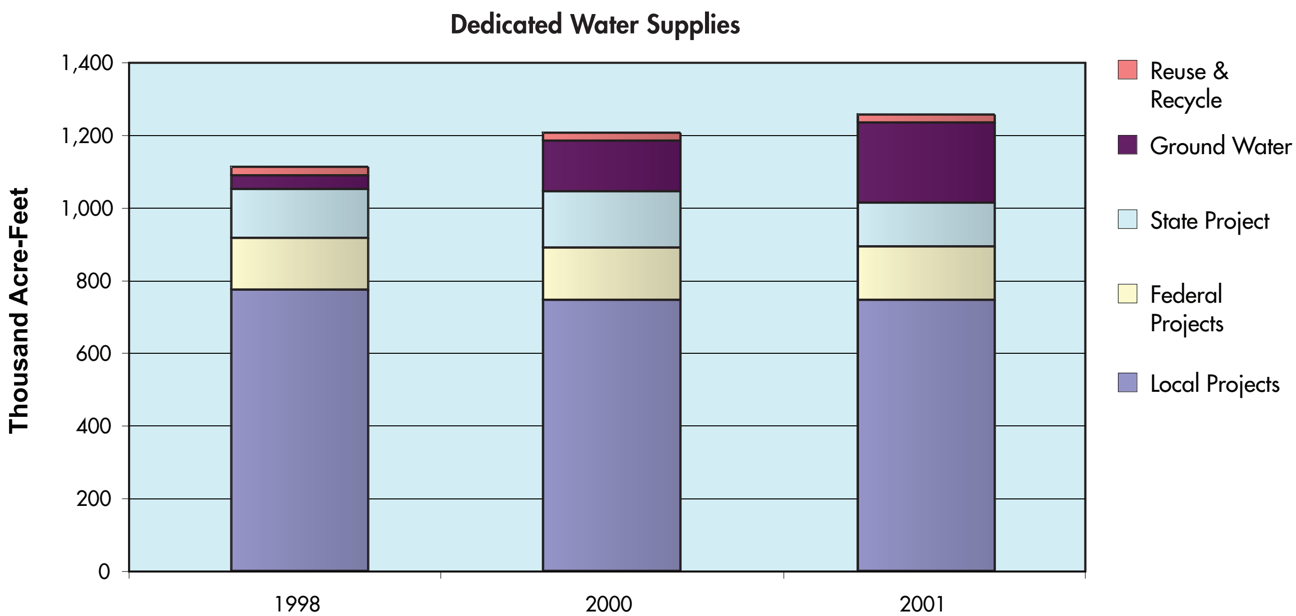
Water Conveyance Facility	Water source	Operator	Counties Served	Water supplied to the Bay Region via facility in 2000
Hetch Hetchy Aqueduct	Tuolumne River	SFPUC	San Francisco, San Mateo, Alameda, and Santa Clara counties	259 TAF (29%)
Mokelumne Aqueduct	Mokelumne River	EBMUD	Alameda, Contra Costa counties	206 TAF (23%)
South Bay Aqueduct	Delta	DWR (SWP)	Alameda, Santa Clara counties	119 TAF (13%)
Contra Costa Canal	Western Delta	CCWD/ CVP	Contra Costa County	117 TAF (13%)
San Felipe Unit	Delta via San Luis Reservoir	USBR (CVP)	Santa Clara County	89 TAF (10%)
North Bay Aqueduct	Northern Delta	DWR (SWP)	Solano, Napa counties	36 TAF (4%)
Putah South Canal	Lake Berryessa	USBR	Solano County	35 TAF (4%)
Sonoma Petaluma Aqueduct	Russian River	SCWA	Sonoma County	33 TAF (4%)

Box 3-1 Acronyms Used in the San Francisco Bay Regional Report

ACWD	Alameda County Water District
BAWSCA	Bay Area Water Supply and Conservation Agency
BACWA	Bay Area Clean Water Agencies
bay region	San Francisco Bay Region
BMPs	Best Management Practices
CALFED	State and Federal Bay- Delta Authority
CCMP	Comprehensive Conservation and Management Plan
CCWD	Contra Costa Water District
CVP	Central Valley Project
EBMUD	East Bay Municipal Utility District
mgd	million gallons per day
MMWD	Marin Municipal Water District
MOU	Memorandum of Understanding Regarding Urban Water Conservation in California
SCVWD	Santa Clara Valley Water District
SCWA	Sonoma County Water Agency
SFPUC	San Francisco Public Utilities Commission
SIP	Seismic Improvement Program
SMPA	Suisun Marsh Preservation Agreement
SLLPIP	San Luis Low Point Improvement Project
SWP	State Water Project
Zone 7	Alameda County Flood Control and Water Conservation District-Zone 7

Figure 3-3 San Francisco Bay region water balance for water years 1998, 2000, 2001





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

Delta water constitutes about one-third of the domestic water in the bay region.

Wetlands and Watershed Management

The San Francisco Bay is one of the most modified estuaries in the United States. The topography, ebb and flow of the tides, patterns of freshwater inflows locally and from the Delta, and the availability and types of sediment have all been altered. Many new species of plants and animals have been introduced. These exotic and invasive species, such as the Chinese mitten crab and Asian clam, threaten to undermine the estuary's food web and alter its ecosystem.

Water quality has also changed over time. The character of the wetlands around the bay has changed dramatically. Over 75 percent of the bay's historical wetlands have been lost or altered through a variety of land use changes around the bay including filling for urban and industrial uses and the construction of dikes for agricultural uses. There used to be 190,000 acres of tidal marsh; now there are 40,000 acres with only 16,000 of these having been tidal marsh historically. Tidal flats have been reduced from 50,000 acres to 29,000 acres due to bay fill, erosion, tidal marsh evolution, and other factors. The total area covered by the bay at high tide was historically about 516,000 acres. Now the bay covers about 327,000 acres at high tide. There are about 500 species of fish and wildlife associated with the bay lands, 20 of which are now threatened or endangered. In recent decades, filling of the bay has slowed significantly due to regulatory changes and the creation of the Bay Conservation and Development Commission, a State agency charged with permitting activities along the shore of the bay.

State of the Region

Some of the major water related challenges facing the San Francisco Bay region include improving water supply reliability to sustain water supplies in drought periods and other emergency outages, maintaining and improving drinking water quality across the region by continuing to meet and exceed current and anticipated drinking water quality standards and protecting drinking water sources, and improving the ecosystem health of San Francisco Bay. Other challenges include linking local land use planning with water system planning and improving water management planning on a regional level.

Many projects and programs are already under way to address these needs. However, the various parties concerned with water-related issues in the bay region are increasingly recognizing that there is also a need to develop solutions on a more collaborative regional or subregional basis (Box 3-2 Bay Area Water Agency Forums). Some of the longstanding regional planning efforts within the bay region are described in this section, including projects under way to improve water supply reliability, water quality and ecosystem restoration through regional partnerships. In addition, some of the newer water management and drinking water quality regional planning initiatives are described in the next section, "Looking to the Future."

Box 3-2 Bay Area Water Agency Forums

ABAG-CALFED Task Force. Regional body of elected officials from local government and water districts, staff, and nongovernmental organizations that was formed to link planning for water supply and water supply reliability, water quality, and environmental protection for the Bay; support the objectives of the CALFED Record of Decision; and explore opportunities to improve regional cooperation.

Bay Area Water Agencies Forum (formerly known as the Six Agencies Group). First convened in 2000 to provide a regular opportunity for water agency policymakers to discuss regional water policy issues and explore cooperative approaches to improving the quality and reliability of Bay Area water supplies.

Bay Area Water Agencies Coalition. Established in 2002 to provide a forum and a framework for water agency general managers to discuss water management planning issues and coordinate projects and programs to improve water supply reliability and water quality.

Northern California Salinity Coalition. Created in 2003 to advance the interests of the eight member water agencies in the development of local and regional efforts that will use desalination or salinity management technologies, practices, and approaches to improve water supply reliability for coalition members and to reduce salinity-related problems affecting the water supplies of the member agencies.

Water Supply Reliability

Generally, water districts in the San Francisco Bay region have sufficient supplies to meet the needs of their customers in normal water years now and for some time into the future. The major water supply reliability challenges occur during droughts and other emergencies. Currently, during drought periods, locally developed water supplies are very limited, and imported water supplies can be short of water users needs. This problem is expected to worsen over time as the region's urban use grows and because these imported supplies may be more at risk due to various other factors. For example, area of origin communities outside the San Francisco Bay region will also need more water as they grow. Water could be reallocated for environmental needs or Delta outflow and operational requirements could change, affecting the San Francisco Bay regions' imported water supply.

Some examples of future shortfall estimates are:

- Using year 2020 demand projections, SCVWD estimates a shortfall of approximately 66,000 acre-feet in a very dry year (a repeat of 1977 drought conditions), or approximately 15 percent of the projected demand.
- EBMUD, without the Freeport Project, could face projected dry period customer rationing of 68 percent based on 2020 projected demand. With the proposed intake from the Sacramento River at Freeport, rationing would be reduced to 28 percent during dry periods.

The exact magnitude of drought year shortfalls and the best water management tools to be used to address them are controversial. Each district has different assumptions and policies that guide their planning. Different systems rely on water from different watersheds, so even the definition of a drought for planning purposes varies somewhat. However, drought supply reliability will continue to be a major challenge for water supply planning in the bay region.

The region is also prone to major earthquakes and other natural disasters that could damage and interrupt water delivery. Critical seismic reliability upgrades are required for some facilities that cross or are located on any of the three active earthquake fault systems (that is, San Andreas, Hayward, and Calaveras faults). According to SFPUC, a major earthquake could disrupt water supplies for up to 60 days in its system, which serves 2.4 million people in the bay region. In other areas, significant progress has already been made on seismic vulnerability but challenges remain.

Each water district has plans under way to address these drought shortfalls and to ensure that their systems will provide a certain level of water service in the event of an earthquake or natural disaster. Details such as future projected water demands, supplies, and planned capital expenditures can be found in each district's plans. However, there are no statistics that summarize the current and future expenditures planned region-wide or the amount of water expected to be developed for droughts or the expected performance region-wide in the event of a seismic event. This is the type of information that may become available through integrated resources planning.

Some examples of projects under way to address future reliability needs are described in the following sections. In addition to the example projects listed here, there are numerous other efforts under way.

Seismic Vulnerability and Drought Supply Planning

- SFPUC is implementing a $4.3 billion capital improvement program to replace or repair aging facilities, provide seismic upgrades and improve water supply reliability.
- EBMUD is nearing completion of a 10-year seismic improvement program. The program is a $189 million program to improve post-earthquake firefighting capability and water service within the EBMUD service area.
- Zone 7 is updating its Well Master Plan so that it can more readily rely on groundwater to meet its normal demands if a seismic event disrupts the imported water delivery system.
- SCVWD is implementing and updating its integrated water resources plan to address water supply shortfalls and preparing a comprehensive water utility infrastructure management program to address seismic and security hazards.
- CCWD recently completed the major components of its $120 million Seismic Reliability Improvements program, including a 21-mile Multi-purpose Pipeline, a new pumping plant at its Mallard Slough Intake, interties, and seismic valves. These facilities improve reliability and fire-fighting flows after a major earthquake.

Groundwater

- ACWD, SCVWD, and Zone 7 have implemented conjunctive use programs within their service areas to optimize the combined use of groundwater and surface water resources. Objectives of these programs include the prevention of groundwater overdraft and subsidence, the prevention of salt water intrusion, and the development of an emergency groundwater storage supply.

- To ensure that the quality of local groundwater supplies is not degraded, bay region water agencies actively monitor water quality and have implemented several groundwater protection measures.
- To date, the CALFED Bay-Delta Program has invested $2.4 million in eight local groundwater projects in areas like Santa Clara County.
- Solano County Water Agency, ACWD, SCVWD, and Zone 7 have entered into agreements with groundwater banks outside the region. Currently 425,000 acre-feet of water is stored under these programs, as an additional water supply for droughts. Other Bay Area agencies are studying the potential of out-of-region groundwater banking options, as well as new conjunctive use programs.

Conveyance and Interconnections

- EBMUD, in conjunction with the Sacramento County Water Agency, is preparing preliminary design documents to divert water from the Sacramento River to reduce customer rationing during multi-year droughts (Freeport Project).
- A 40-mgd intertie between the SCVWD system and the SFPUC system was completed recently in the City of Milpitas. EBMUD and SFPUC are also constructing another 30-mgd treated water intertie between their systems.
- Studies are under way on the San Luis Low Point Improvement Project to address water quality and conveyance issues for South Bay water users and to improve the reliability of water supplies from San Luis Reservoir for the customers of the San Felipe Unit of the Central Valley Project including SCVWD. Additional details on the SLLPIP including schedule and budget can be found in the CALFED Bay-Delta Program Plan for the Conveyance Program.

Water Conservation and Recycling

Many different wastewater reclamation/recycling projects are under way in the Bay Region, and others are in the planning and environmental documentation stages. The Bay Area Regional Water Recycling Program (BARWRP) Water Recycling Project Master Plan, prepared in 1999, analyzed recycling for the counties of San Francisco, San Mateo, Santa Clara, Alameda and Contra Costa and developed a plan to achieve 125,000 acre-feet/year of water recycling over the next 10 years.

BARWRP also had a number of recommendations to make regional reclamation and recycling projects more implementable including increasing public acceptance and dealing with environmental impacts regionally. Many of the near-term recycling projects identified in the plan are now being developed, some through the use of $43 million in Bay-Delta program funding. BARWRP members are reviewing progress and updating program objectives and recommendations. A similar coordinated water recycling program is under way in the northern portion of the San Francisco Bay region.

Water conservation is generally included as a component of each water agency's planning programs. Agencies are actively involved in implementing water conservation measures and raising public awareness about the need to conserve water supplies through more efficient practices. Water conservation efforts are helping to reduce water demands and conserve the bay region's water supplies. To date, the CALFED Bay-Delta Program has invested over $15 million in 35 local water conservation programs.

Surface Storage

Water agencies are also studying several surface storage projects within the region and in other regions to help with drought relief, emergency storage, and water quality management. Some of the surface water storage projects under consideration in the region include expansion of Calaveras, Pacheco, and Los Vaqueros reservoirs. Calaveras Reservoir expansion is being studied as part of the CALFED Bay Area Water Quality and Supply Reliability Program to provide water supply reliability to SFPUC customers and potential regional partners in the Bay Area. Los Vaqueros expansion is being evaluated as part of the CALFED Program. This project is being studied both as a way to improve drought supply reliability and water quality for the Bay Region, and to provide environmental benefits to the Bay-Delta. Studies of the potential for expansion of Los Vaqueros are under way. Additional details on the schedule and budget for this project can be found in the CALFED Bay-Delta Program Plan for Storage. Expansion of Pacheco Reservoir is being considered by CALFED as an alternative under the SLLPIP. Additional information on this project can be found in the CALFED Bay-Delta Program Plan for Conveyance.

Desalination

With recent advances in technology, several water agencies in the Bay Region are investigating desalinization as a source to improve water supply reliability. Marin Municipal Water District is proposing a major new desalination project for Marin County using water from San Rafael Bay. EBMUD, CCWD, SCVWD and SFPUC are conducting a joint feasibility study for a desalinization plant to serve the Bay Region as an emergency or dry-year supply. ACWD has built a brackish water desalination plant to produce potable water from brackish water taken from local aquifers.

Environmental Water Quality

The San Francisco Bay/Delta Estuary is the main focus of water quality issues in this region. Water and sediment in the estuary meet quality guidelines for most contaminants, with constituents in water meeting toxicity and chemical guidelines about 87 percent of the time. Sediment concentrations, though, are more problematic, due to legacy pollutants, with only about 60 percent of the sediment samples meeting chemical guidelines and passing toxicity tests. Over time, estuary water quality has significantly improved, for instance, with fewer toxic episodes and decreased silver concentrations in the south bay. Implementation of secondary treatment of domestic wastewater has dramatically improved the quality, especially the oxygen content, of the San Francisco Estuary, as has the reduction in the use of organophosphate pesticides.

Major water quality issues include control of storm water, urban, and construction site runoff, as well as runoff and discharges from the vast Central Valley and Delta watershed. Legacy pollutants, such as polychlorinated biphenyls (PCBs) and mercury, contaminate fish in the estuary. Other water quality concerns include copper and nickel in the South Bay, selenium from Contra Costa refineries, erosion from vineyards in Napa and Sonoma valleys, pesticides in urban creeks generally, and toxicity of water and especially sediment. Habitat in the Suisun Marsh is threatened by increasing sedimentation. Exotic and invasive species, such as the Chinese mitten crab and Asian clam, threaten to undermine the estuary's food web and alter its ecosystem. Because San Francisco Bay has several active seaports, discharge of ballast water and vessel wastes and maintenance dredging and disposal of contaminated sediments are water quality concerns. New contaminants are emerging that may be causing impacts to the aquatic ecosystem, including PBDEs (polybrominated diphenyl ethers), pyrethroid insecticides, and compounds from pharmaceuticals and personal care products.

The bay acts as a sediment repository, so persistent, sediment-bound contaminants, such as mercury, dioxins, PCBs, and organochlorine pesticides have accumulated over time. These compounds also bioaccumulate in the food chain, causing contamination of bay fish and endangering their consumers, including humans and wildlife. Happily, new inputs of the persistent sediment contaminants in the estuary are controlled as the use of most organochlorine pesticides and PCBs are banned, and the concentrations in the sediments and in organisms appear to be declining. The San Francisco Regional Water Quality Control Board is developing new regulatory requirements to address the mercury sources to the estuary, most significantly, the New Almaden mine, as well as the thousands of abandoned mercury and gold mine tailings in the Central Valley watershed. Mercury contamination in rstuary fish, such as the striped bass, has remained high for more than 30 years. Wetland restoration could increase mercury methylation processes and cause higher contamination in fish. State and federal agencies, working through the CALFED Bay Delta Program and other organizations, have funded a number of studies to determine potential effects of restoration and explore management actions that would decrease methyl mercury production and bioaccumulation.

Since 1993, the San Francisco Regional Monitoring Program has been providing monitoring, and evaluation of the monitoring results, on water, sediment, and fish contamination issues in the bay. The annual conference and publication "Pulse of the Estuary" is produced by the San Francisco Estuary Institute and summarizes what is known about the estuary's water quality issues. In addition to the mercury research mentioned previously, the CALFED Bay Delta Program has funded $10 million in projects related to water quality in the bay, including watershed management, pesticide use reduction, and toxicity studies.

Outside of the San Francisco Estuary, Tomales Bay is one of only four commercial shellfish growing areas on the entire west coast. Some of the coastal watersheds of Marin and San Mateo counties provide important habitat for listed species of coho salmon and steelhead. Sediment threatens water quality and habitat in Bolinas Lagoon, the only wetland on the West Coast designated as a Wetland of International Significance by the U.S. Fish and Wildlife Service.

Drinking Water Quality

The quality of domestic water supplies in the San Francisco Bay Region is generally excellent, but does vary by source of supply and method of water treatment. For instance, the source water quality of SFPUC's Tuolumne River supply, EBMUD's Mokelumne River supply, and local surface and groundwater supplies is generally better than that of water diverted from the Sacramento-San Joaquin Delta. However, even with a high quality water source, San Francisco recently implemented chloramine disinfection of drinking water, in order to reduce disinfection byproducts. In the CCWD service area, the storage of higher quality Delta water in Los Vaqueros Reservoir, as well as the implementation of advanced water treatment systems, has significantly improved water quality in that area.

Utilities that divert and deliver water from the Sacramento–San Joaquin Delta are pursuing a range of projects to protect and improve the quality of the water, including storing Delta water when it has relatively good quality, managing the watersheds, blending water from different sources, and applying advanced water treatment technology. For example, CCWD is continuing to work with local and regional agencies and CALFED to improve its source water quality. Projects include using CALFED funding to relocate agricultural drains and to line portions of the Contra Costa Canal that may be impacted by poor quality local groundwater. Utilities in Solano County use water blending methods to combine high quality local surface water with Delta water of variable quality from the North Bay Aqueduct. SCVWD, ACWD, and Zone 7 utilize a diversified portfolio of water sources, including Delta water, Hetch Hetchy supplies, local surface water, and groundwater. Starting in 2002, the SVCWD initiated major renovations to each of its three regional water treatment plants in order to provide higher quality drinking water to the residents of Santa Clara County. When these projects are completed in year 2010, the systems will switch from the current method of disinfection by chlorination to the use of ozone technology for water disinfection.

The CALFED Bay-Delta Program has funded several efforts to improve water quality in the region, including the feasibility of expanding Los Vaqueros Reservoir and the San Luis Low Point Improvement Project (previously discussed under "Surface Storage" and "Water Supply Reliability/Conveyance," respectively). The Bay Area Water Quality and Supply Reliability project is evaluating a broad array of cooperative regional projects to benefit ACWD, Zone 7, SFPUC, CCWD, SCVWD, EBMUD, and the Bay Area Water Supply and Conservation Agency (BAWSCA - representing the 28 wholesale water customers of the SFPUC). Some of the regional project concepts being considered in this study include the expansion of storage in Calaveras and Los Vaqueros reservoirs, additional recycling, additional conservation beyond existing urban BMPs, and desalination.

In general, groundwater quality throughout most of the region is suitable for most urban and agricultural uses with only local impairments, such as leaking underground storage tanks. Groundwater in the Livermore Valley and Niles Cone (southern Alameda County) basins has high levels of total dissolved solids, chloride, boron, and hardness; such that both Zone 7 and ACWD are implementing wellhead demineralization projects to improve the quality of this groundwater supply. In the Santa Clara Valley region, some of the underlying groundwater supplies are threatened by pollutants from various industrial activities and historical agriculture. SCVWD works to protect the quality of these supplies by aggressively responding to pollution threats such as MTBE, PCE, TCE, and prechlorate. These pollution threats are individually identified and evaluated in order to prevent or mitigate groundwater contamination. Elsewhere, groundwater in Petaluma Valley and the Gilroy-Hollister Valley has high levels of nitrate, which adversely impacts the ability to use domestic wells for drinking water purposes. Groundwater recharge projects and the use of imported water have effectively halted land subsidence in most areas, and have successfully stopped or reversed seawater intrusion into aquifers around the bay.

Wetlands and Watershed Management

Although there are serious problems facing San Francisco Bay, its wetlands, and watershed, there has been a concerted effort over the last 20 years to restore the Bay. Some of the major planning and implementation efforts are described here. Expenditures to date on ecosystem restoration include $32 million in Bay-Delta Program funding, along with significant local, state and federal funding.

The Comprehensive Conservation and Management Plan, completed by the San Francisco Estuary Project in 1993, presents a blueprint of 145 specific actions to restore and maintain the chemical, physical, and biological integrity of the bay and Delta. The CCMP has been implemented over time by a wide variety of local, state and federal partners including the CALFED Bay-Delta Program. The Estuary Project regularly updates the priorities for CCMP implementation and prepares a report on the state of the estuary. In addition, the Estuary Project prepares Bay-Delta Report card that identifies many of the restoration projects under way to track progress implementing the CCMP. The most recent list of priorities identified by Estuary Project is:

- Reduce the impact of invasive species on the estuary through prevention, control, eradication, and education.
- Expand, restore, and protect bay and Delta wetlands and contiguous habitats. (These two items were both identified as top priorities.)
- Protect and restore watersheds, including promoting creek restoration, throughout the estuary.
- Create "incentives" that motivate governments, landowners, businesses and communities to protect and restore the estuary.
- Minimize or eliminate pollution of the estuary from all sources.

- Increase public interaction with the estuary's natural resources, encourage stewardship, and promote the values ecological processes provide to human activities and the effects of human activities on them.
- Continue, sustain, and expand the regional monitoring program to address all key CCMP issues including pollution;, wetlands including mitigation measures, watersheds, dredging, and sediment transport, biological resources, land use and flows and integrate scientific monitoring results into management and regulatory actions.
- Promulgate baseline inflow standards for San Francisco, San Pablo, and Suisun bays to protect and restore the estuary.

The Baylands Ecosystem Habitat Goals Report, prepared by the Habitat Goals Project in 1999, is a guide for restoring and improving the bay lands and adjacent habitats of the San Francisco Estuary. It provides recommendations for the kinds, amounts, and distribution of wetlands and related habitats that are needed to sustain diverse and healthy communities of fish and wildlife resource in the Bay. The CCMP originally identified the need for these types of habitat goals. The recommendations are being implemented over time through voluntary restoration efforts that include many local, state and federal partners.

The Implementation Strategy for The San Francisco Bay Joint Venture, prepared in 2001, identifies actions in the Habitat Goals Report that are consistent with the Joint Venture's objectives. The State and federal partners in the Joint Venture are implementing these actions.

State, federal, and local governments, landowners, and nonprofit agencies have been working cooperatively to restore the San Francisco Bay estuary for a number of years in conjunction with these and other planning processes. Because the restoration and watershed management projects around the bay are so numerous, each one is not listed individually. Additional information can be found on websites for groups active in restoration such as the San Francisco Bay Joint Venture (www.sfbayjv.org/), the Wetlands Regional Monitoring Program's Wetlands Tracker (www.wrmp.org) or the Estuary Project's Report Card (www.abag.ca.gov/bayarea/sfep.org). A few of the largest efforts are described here.

The Napa Sonoma Marsh Project is joint State, federal, and local project to restore 10,000 acres of wetlands and associated habitats within the former Cargill salt pond complex in the North Bay. It includes habitat restoration, beneficial use of recycled water, and improved water quality in the Napa River and the bay. The Bel Marin Keys and Hamilton Airfield projects will collectively restore over 2,400 acres of diked historical wetlands in the North Bay along the Marin County shoreline. These three projects, along with many smaller North Bay projects, will provide significant restoration of wetlands and associated uplands. In 2003, the State of California and the federal government approved the purchase and restoration of 15,100 acres of Cargill's salt ponds in the South San Francisco Bay.

Acquisition of the South Bay salt ponds provides an opportunity for landscape-level wetlands restoration, improving the physical, chemical, and biological health of the San Francisco Bay. The South Bay Salt Pond Restoration Project will integrate restoration with flood management, while also providing for public access, wildlife-oriented recreation, and education opportunities. The project will restore and enhance a mosaic of wetlands, creating a vibrant ecosystem. Restored tidal marshes will provide critical habitat for the endangered California clapper rail and the salt marsh harvest mouse. Large marsh areas with extensive channel systems will also provide habitat for fish and other aquatic life and haul out areas for harbor seals. In addition, the restored tidal marshes will help filter out and eliminate pollutants. Many of the ponds will remain as managed ponds and be enhanced to maximize their use as feeding and resting habitat for migratory shorebirds and waterfowl traveling on the Pacific Flyway.

Flood management will be integrated with restoration planning, to ensure flood protection for local communities. Where feasible, flood capacities of local creeks, flood control channels, and rivers will be increased by widening the mouths of the waterways and reestablishing connections to historical floodplains. As ponds are opened to the tide, levees between the newly created tidal marsh and local communities will need to be built or enhanced to provide flood protection.

The acquisition of such a large area of open space in the South Bay will allow for the provision of public access, wildlife-oriented recreation, and education opportunities, to be planned concurrently with restoration and flood management. Public uses could include creation of Bay Trail segments for biking and hiking, and provision of hunting and angling opportunities, bird watching, environmental education, and other recreational opportunities.

In the Suisun Marsh, the Suisun Marsh Charter Group was formed in 2001 to resolve issues including recovery of endangered species, amendment of the Suisun Marsh Preservation Agreement (SMPA), issuance of a U.S. Army Corps of Engineers Regional General Permit, and implementation of a Suisun Marsh Levee Program. The Charter Group was charged with developing and analyzing a plan for the Suisun Marsh that would outline the actions necessary to preserve and enhance managed seasonal wetlands, restore tidal marsh habitat, implement a comprehensive levee protection/improvement program, and protect ecosystem and drinking water quality, consistent with the CALFED Bay-Delta Program's goals and objectives. The proposed Suisun Marsh Plan would balance the goals and objectives of the Bay-Delta Program, SMPA, federal and State Endangered Species Acts, and other management and restoration programs within the Suisun Marsh in a manner that is responsive to the concerns of all stakeholders and is based upon voluntary participation by private landowners. The proposed Suisun Marsh Plan also would provide for simultaneous protections and enhancement of: (1) The Pacific Flyway and existing wildlife values in managed wetlands, (2) endangered species, (3) tidal marshes and other ecosystems, and (4) water quality, including, but not limited to the maintenance and improvement of levees.

Restoration efforts focused on the upper watershed lands above the baylands are also under way. A wide variety of local groups and agencies have watershed management initiatives under way. These are aimed at controlling pollution at the source, identifying contaminants of concern, and protecting watershed habitat. These are usually multi-objective efforts to address needs such as flood control, storm water management, habitat restoration, recreation, and open space. Local government agency and region-wide efforts are under way to control storm water runoff to Bay Region waterways, to initiate innovative land use development and agricultural practices and to improve wastewater discharges—leading to higher water quality for human and livestock consumption.

The Santa Clara Basin Watershed Management Initiative (SCBWMI) is one example of a collaborative, stakeholder driven effort among representatives from regional and local public agencies; civic, environmental, resource conservation and agricultural groups; professional and trade organizations; business and industrial sectors; and the general public, to protect and enhance the Santa Clara Basin watershed, creating a sustainable future for the community and the environment. The State Watershed Task Force recognized the SCBWMI as one of the top 10 watershed partnerships in California through Assembly Bill 2117. Its successes include the adoption of achievable and protective numeric standards for copper and nickel for lower South San Francisco Bay, adoption of wastewater discharge permits and multi-year stream maintenance permits, watershed education and outreach programs and collaborative efforts to address linkages between watershed management, flood protection and other land use and development activities.

Box 3-3 Ongoing Planning Organizations

- The Association of Bay Area Governments (ABAG) CALFED Task Force
- Bay Area Water Agencies Coalition (BAWAC)
- Bay Area Wetlands Restoration Program
- Bay Area Regional Water Recycling Program (BARWRP)
- Fish Passage Improvement Program
- San Francisco Estuary Institute
- Audubon Society – S.F. Bay Restoration Program
- S.F. Bay Area Pollution Prevention Group (BAPPG)
- Bay Area Stormwater Management Agencies Association (BASMAA)
- Bay Area Clean Water Agencies (BACWA)
- San Francisco Bay Conservation and Development Commission (BCDC)
- San Francisco Estuary Project (SFEP)
- SF Bay Area Regional Water Quality Control Board (RWQCB) – SF Bay Basin Plan
- Northern California Salinity Coalition (NCSC)

Looking to the Future

The San Francisco Bay Hydrologic Region is home to a multitude of planning organizations that seek to identify future trends and the challenges that accompany them (Box 3-3 Ongoing Planning Organizations). These groups are working on issues of land use, housing, environmental quality, and economic development, wetlands, water reliability, watershed management, groundwater management, water quality, fisheries, and ecosystem restoration.

Most, if not all, of the water supply agencies in the bay region have undergone integrated water resource planning processes involving stakeholders in their regions including local land use planners and are implementing the adopted strategies to improve water supply reliability. These strategies call for the implementation of a diverse portfolio of water management actions including: conservation, recycling, desalination, conjunctive use, dry year transfers, banking, and storage development.

Many local governments are now routinely evaluating or considering water supply plans as they conduct their land use planning through cooperative efforts with the agencies responsible for water supply. However, until recently, integrated water management planning has not been coordinated among the various subregions of the bay region and has not systematically combined water supply reliability, water quality, storm water and wastewater management, and environmental restoration planning together. A number of regional associations, including BAWAC, North Bay water districts, and BACWA are working under a Letter of Mutual Understandings that sets up a planning framework to develop such an integrated regional water management plan for the entire nine-county Bay Area. Parties involved in developing the report sections focusing on water supply and drinking water quality expect it to be completed by winter 2006 while efforts to compile other sections of the report will continue.

This effort to develop a broad based multi-regional integrated water management plan for the nine-county bay region is very broad in its vision and scope. Although some of the regional agencies and organizations responsible for various aspects of water management have not been able to participate, others have joined BAWAC in this effort.

These efforts at integrating regional water management and planning can benefit the bay region in many ways by facilitating implementation of innovative, cost-effective and efficient multi-objectives water management solutions. For instance, by demonstrating how recycling and water use efficiency are being incorporated, they can increase public support for the plan as a whole. Through an integrated plan, the Bay Region may also better compete for funding from broader sources such as state bond funds or federal appropriations. Some of the largest projects in the region will likely require multiple agencies to agree to participate and finance the effort. These types of regional agreements may be more easily reached with regional planning.

Efforts to develop a regional approach to water management can also benefit the state. As regional water management planning moves forward, regional information on current conditions and future planning is expected to become more readily available. This regional information will complement the information being developed for future California water plans and will be an important part of measuring the performance of the CALFED Bay-Delta Program at meeting water quality and supply reliability goals. It will also help the State and federal governments target expenditures at the highest priority regional needs.

Future bay region regional profiles are expected to incorporate information from integrated regional water management plans (IRWMP). The focus of the integrated regional water management plan within the San Francisco Bay Hydrologic Region covers the nine Bay Area counties. Areas outside the hydrologic boundary are developing separate plans. Proposition 50, Chapter 8 provides funds to assist agencies in developing the IRWMPs. Implementation proposals were submitted in July 2005 for projects that are part of the water supply–water quality section of the draft IRWMP.

Water Quality

Bay region water agencies have made significant investments in programs and projects to actively protect municipal water quality including facility upgrades, advanced treatment methods, watershed monitoring, groundwater monitoring and protection, demineralization projects, and nonpoint water source evaluations. More monitoring and studies are needed to determine the effects of contaminants, including the emerging contaminants, on the aquatic ecosystem of the San Francisco Bay. As the population continues to grow in the Bay Area, the control of storm water runoff, particularly from urban areas, will need to be improved in order to reduce contaminant loads to the estuary. Stricter regulatory requirements are being developed to address the major bay contaminants such as PCBs and mercury. However, even if all the sources of these contaminants were abated, it would take a very long time before sediment contaminants were reduced by degradation, transport to the

Table 3-2 San Francisco Bay Hydrologic Region Water Balance Summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (188%)	2000 (109%)	2001 (81%)
Water Entering the Region			
Precipitation	11,438	6,644	4,908
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions ***	764	823	872
Total	**12,202**	**7,467**	**5,780**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	363	394	415
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	0	0	0
Required Outflow to Salt Sink	23	22	20
Additional Outflow to Salt Sink	664	727	759
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	11,146	6,234	4,795
Total	**12,196**	**7,377**	**5,989**
Storage Changes in the Region [+] Water added to storage [–] Water removed from storage			
Change in Surface Reservoir Storage	76	-25	-56
Change in Groundwater Storage **	-70	115	-153
Total	**6**	**90**	**-209**

Applied Water * (compare with Consumptive Use)	1,060	1,158	1,214

***Footnote for applied water**

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

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

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

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

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

ocean or atmosphere, or burial under new sediment deposits. Continued monitoring is needed to evaluate the effectiveness of management actions, detect long-term trends and investigate emerging issues from new contaminants.

Wetlands and Watershed

With the large scale wetlands restoration under way around the bay, there will need to be ongoing monitoring and adaptive management to ensure that projects are meeting environmental objectives and integrating well with other water management objectives.

Water Portfolios for Water Years 1998, 2000, and 2001

The following tables present actual information about the water supplies and uses for the San Francisco Bay Hydrologic Region. Water year 1998 was a wet year for this region, with annual precipitation at 188 percent of average, while the statewide annual precipitation was 171 percent of average. Year 2000 represents nearly normal hydrologic conditions with annual precipitation at 109 percent of average for the San Francisco Bay region, and year 2001 reflected drier water year conditions with annual precipitation at 81 percent of average. For comparison, statewide average precipitation in year 2001 was 72 percent of normal. Table 3-3 provides more detailed information about the total water supplies available to this region for these three specific years from precipitation, imports and groundwater, and also summarizes the uses of all of the water supplies. The three-year Water Portfolio table, Table 3-4, and companion Water Portfolio flow diagrams, Figures 3-4 and 3-5, provide more detailed information about how the available water supplies are distributed and used throughout this region.

Table 3-3 presents the portion of the total available water that is dedicated to urban, agricultural and environmental purposes. Because most of the San Francisco Bay region is largely urbanized, more than 85 percent of the developed water is supplied for urban use. By comparison, agricultural use consumes roughly 10 percent of the developed water supply and instream flows and managed wetlands use only 2 to 3 percent of the total dedicated water supply in this region. Table 3-3 also provides detailed information about the sources of the developed water supplies, which are primarily from surface water systems. For the years 1998, 2000 and 2001, this table shows that more than 65 percent of the region's developed water supplies were imported from other hydrologic regions of the state.

Selected References

Water Quality Control Plan, Regional Water Quality Control Board

Watershed Management Initiative Chapter, Regional Water Quality Control Board

2002 California 305(b) Report on Water Quality, State Water Resources Control Board

Bulletin 118, California's Groundwater, Update 2003, Department of Water Resources

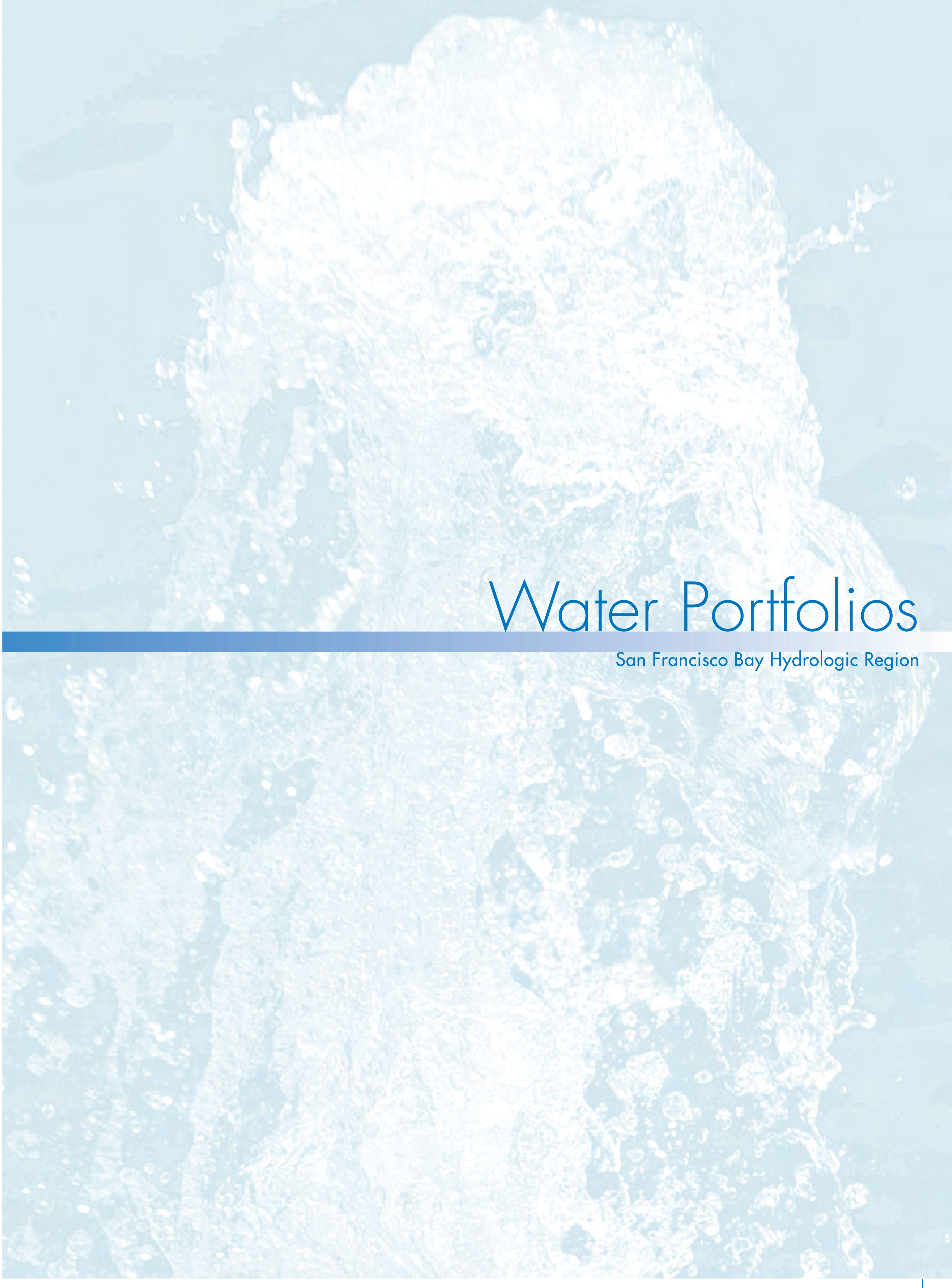
Nonpoint Source Program Strategy and Implementation Plan, 1998-2013, State Water Resources Control Board, California Coastal Commission, January 2000

Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001

"2003 Pulse of the Estuary," San Francisco Estuary Institute

Table 3-3 San Francisco Bay Region Water Use and Distribution of Dedicated Supplies- TAF

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	83.7			90.8			94.6		
Commercial	206.4			223.2			233.0		
Industrial	59.4			63.5			66.1		
Energy Production	0.0			0.0			0.0		
Residential - Interior	291.6			315.4			329.4		
Residential - Exterior	322.8			350.6			365.4		
Evapotranspiration of Applied Water	290.7	290.7		306.9	306.9		320.0	320.0	
E&ET and Deep Perc to Salt Sink	0.0	0.0		0.0	0.0		0.0	0.0	
Outflow	632.8	632.8		692.7	692.7		722.6	722.6	
Conveyance Applied Water	12.4			12.2			11.2		
Conveyance Evaporation & ETAW	6.2	6.2		6.1	6.1		5.6	5.6	
Conveyance Deep Perc to Salt Sink	0.0	0.0		0.0	0.0		0.0	0.0	
Conveyance Outflow	6.2	6.2		6.1	6.1		5.6	5.6	
GW Recharge Applied Water	14.4			13.6			10.4		
GW Recharge Evap + Evapotranspiration	0.0	0.0		0.0	0.0		0.0	0.0	
Total Urban Use	**990.7**	**935.9**	**935.9**	**1,069.3**	**1,011.8**	**1,011.8**	**1,110.1**	**1,053.8**	**1,053.8**
Agriculture									
On-Farm Applied Water	90.1			108.3			119.2		
Evapotranspiration of Applied Water	69.4	69.4		83.7	83.7		91.8	91.8	
E&ET and Deep Perc to Salt Sink	0.0	0.0		0.0	0.0		0.0	0.0	
Outflow	20.7	20.7		24.6	24.6		27.4	27.4	
Conveyance Applied Water	1.4			1.4			1.2		
Conveyance Evaporation & ETAW	0.7	0.7		0.7	0.7		0.6	0.6	
Conveyance Deep Perc to Salt Sink	0.0	0.0		0.0	0.0		0.0	0.0	
Conveyance Outflow	0.7	0.7		0.7	0.7		0.6	0.6	
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration	0.0	0.0		0.0	0.0		0.0	0.0	
Total Agricultural Use	**91.5**	**91.5**	**91.5**	**109.7**	**109.7**	**109.7**	**120.4**	**120.4**	**120.4**
Environmental									
Instream									
Applied Water	23.1			21.5			20.0		
Outflow	23.1	23.1		21.5	21.5		20.0	20.0	
Wild & Scenic									
Applied Water	0.0			0.0			0.0		
Outflow	0.0	0.0		0.0	0.0		0.0	0.0	
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow	0.0	0.0		0.0	0.0		0.0	0.0	
Managed Wetlands									
Habitat Applied Water	6.2			6.2			6.2		
Evapotranspiration of Applied Water	3.1	3.1		3.1	3.1		3.1	3.1	
E&ET and Deep Perc to Salt Sink	0.0	0.0		0.0	0.0		0.0	0.0	
Outflow	3.1	3.1		3.1	3.1		3.1	3.1	
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW	0.0	0.0		0.0	0.0		0.0	0.0	
Conveyance Deep Perc to Salt Sink	0.0	0.0		0.0	0.0		0.0	0.0	
Conveyance Outflow	0.0	0.0		0.0	0.0		0.0	0.0	
Total Managed Wetlands Use	**6.2**	**6.2**	**6.2**	**6.2**	**6.2**	**6.2**	**6.2**	**6.2**	**6.2**
Total Environmental Use	**29.3**	**29.3**	**29.3**	**27.7**	**27.7**	**27.7**	**26.2**	**26.2**	**26.2**
TOTAL USE AND OUTFLOW	**1,111.5**	**1,056.7**	**1,056.7**	**1,206.7**	**1,149.2**	**1,149.2**	**1,256.7**	**1,200.4**	**1,200.4**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	273.7	273.7	273.7	244.0	244.0	244.0	216.4	216.4	216.4
Local Imported Deliveries	501.2	501.2	501.2	502.9	502.9	502.9	529.8	529.8	529.8
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	104.7	104.7	104.7	108.6	108.6	108.6	109.4	109.4	109.4
Other Federal Deliveries	37.7	37.7	37.7	34.5	34.5	34.5	37.5	37.5	37.5
SWP Deliveries	134.2	134.2	134.2	155.0	155.0	155.0	121.3	121.3	121.3
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	-17.2	-17.2	-17.2	81.8	81.8	81.8	163.6	163.6	163.6
Deep Percolation of Surface and GW	54.8			57.5			56.3		
Reuse/Recycle									
Reuse Surface Water	0.0			0.0			0.0		
Recycled Water	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4
TOTAL SUPPLIES	**1,111.5**	**1,056.7**	**1,056.7**	**1,206.7**	**1,149.2**	**1,149.2**	**1,256.7**	**1,200.4**	**1,200.4**
Balance = Use - Supplies	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*



Water Portfolios

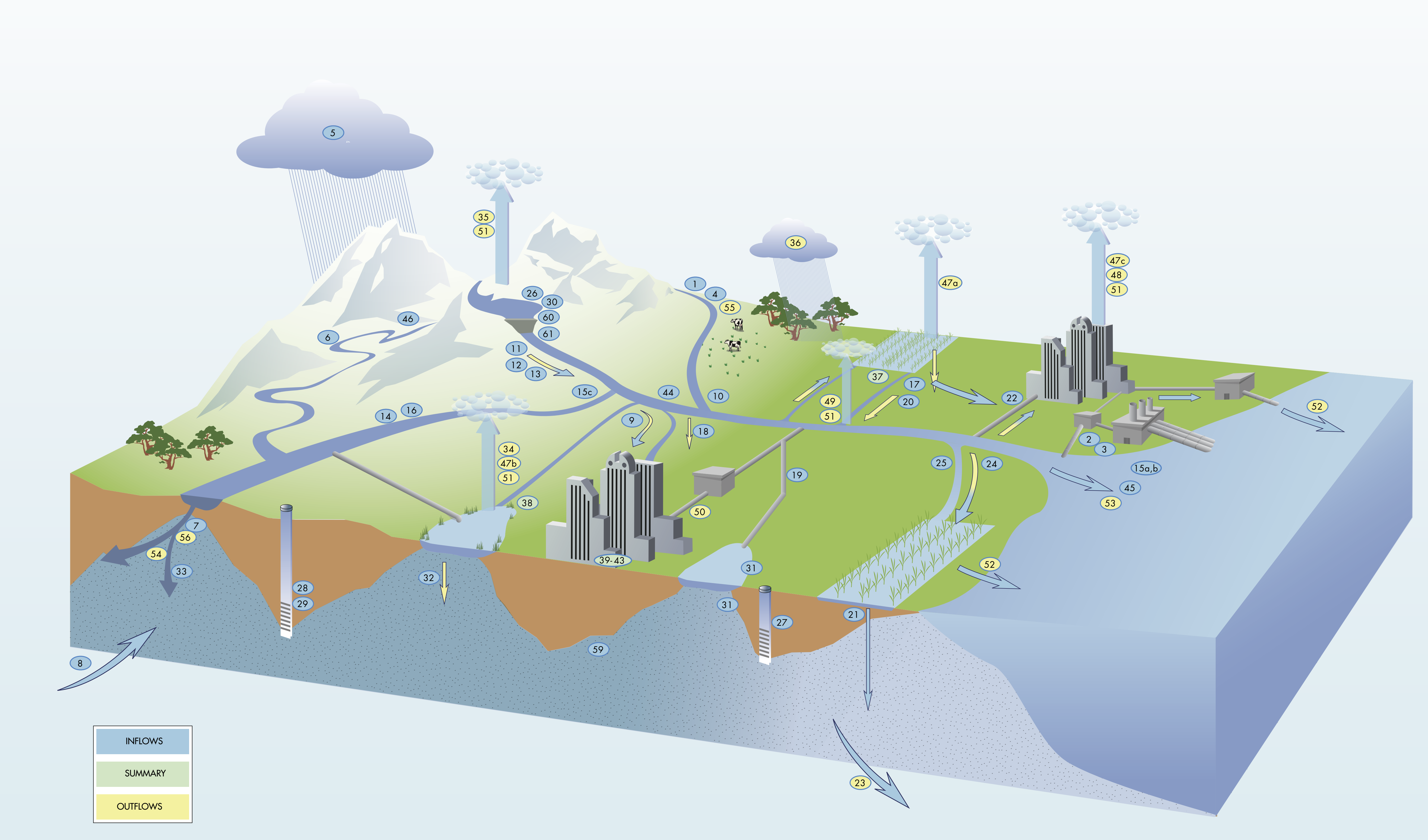
San Francisco Bay Hydrologic Region

Table 3-4 San Francisco Bay region water portfolios (TAF)

ID Number:	Flow Diagram Component (see legend)	San Francisco 1998	San Francisco 2000	San Francisco 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	11,438.0	6,643.7	4,908.0
6a	Runoff - Natural			
b	Runoff - Incidental			
7	Total Groundwater Natural Recharge			
8	Groundwater Subsurface Inflow			N/A
9	Local Deliveries	273.7	244.0	216.4
10	Local Imports	501.2	502.9	529.8
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	104.7	108.6	109.4
12	Other Federal Deliveries	37.7	34.5	37.5
13	State Water Project Deliveries	134.2	155.0	121.3
14a	Water Transfers - Regional	1.0	1.0	0.2
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	23.1	21.5	20.0
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	-	-	-
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	10.5	10.3	10.3
b	Recycled Water - Urban	5.7	5.9	5.9
c	Recycled Water - Groundwater	6.2	6.2	6.2
20a	Return Flow to Developed Supply - Ag	-	-	-
b	Return Flow to Developed Supply - Wetlands	-	-	-
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	-	-	-
b	Deep Percolation of Applied Water - Wetlands	-	-	-
c	Deep Percolation of Applied Water - Urban	40.4	43.9	45.9
22a	Reuse of Return Flows within Region - Ag	-	-	-
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	-	-	-
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	-	-	-
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions			
26	Surface Water in Storage - Beg of Yr	491.3	530.5	505.7
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	37.6	139.3	219.9
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	567.6	505.7	449.4
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation			
b	Evaporation and Evapotranspiration from Unirrigated Ag			
35a	Evaporation from Lakes	10.1	10.1	9.8
b	Evaporation from Reservoirs	104.4	103.4	98.8
36	Ag Effective Precipitation on Irrigated Lands	35.4	36.2	34.1
37	Agricultural Water Use	90.1	108.3	119.2
38	Managed Wetlands Water Use	6.2	6.2	6.2
39a	Urban Residential Use - Single Family - Interior	120.3	130.4	135.9
b	Urban Residential Use - Single Family - Exterior	280.0	304.3	317.0
c	Urban Residential Use - Multi-family - Interior	171.3	185.0	193.5
d	Urban Residential Use - Multi-family - Exterior	42.8	46.3	48.4
40	Urban Commercial Use	206.4	223.2	233.0
41	Urban Industrial Use	59.4	63.5	66.1
42	Urban Large Landscape	83.7	90.8	94.6
43	Urban Energy Production	-	-	-
44	Instream Flow	23.1	21.5	20
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	-	-	-
47a	Evapotranspiration of Applied Water - Ag	69.4	83.7	91.8
b	Evapotranspiration of Applied Water - Managed Wetlands	3.1	3.1	3.1
c	Evapotranspiration of Applied Water - Urban	290.7	306.9	320
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	-	-	-
50	Urban Waste Water Produced	560	605	631.5
51a	Conveyance Evaporation and Evapotranspiration - Urban	6.2	6.1	5.6
b	Conveyance Evaporation and Evapotranspiration - Ag	0.7	0.7	0.6
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	-	-	-
d	Conveyance Outflow to Mexico			
52a	Return Flows to Salt Sink - Ag	21.4	25.3	28
b	Return Flows to Salt Sink - Urban	639	698.8	728.2
c	Return Flows to Salt Sink - Wetlands	3.1	3.1	3.1
53	Remaining Natural Runoff - Flows to Salt Sink	23.1	21.5	20
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	763.8	822.9	871.1
56	Regional Exports	0.0	0.0	0.0
59	Groundwater Net Change in Storage	-70.4	114.5	-153.2
60	Surface Water Net Change in Storage	76.3	-24.8	-56.3
61	Surface Water Total Available Storage	746.1	746.1	746.1

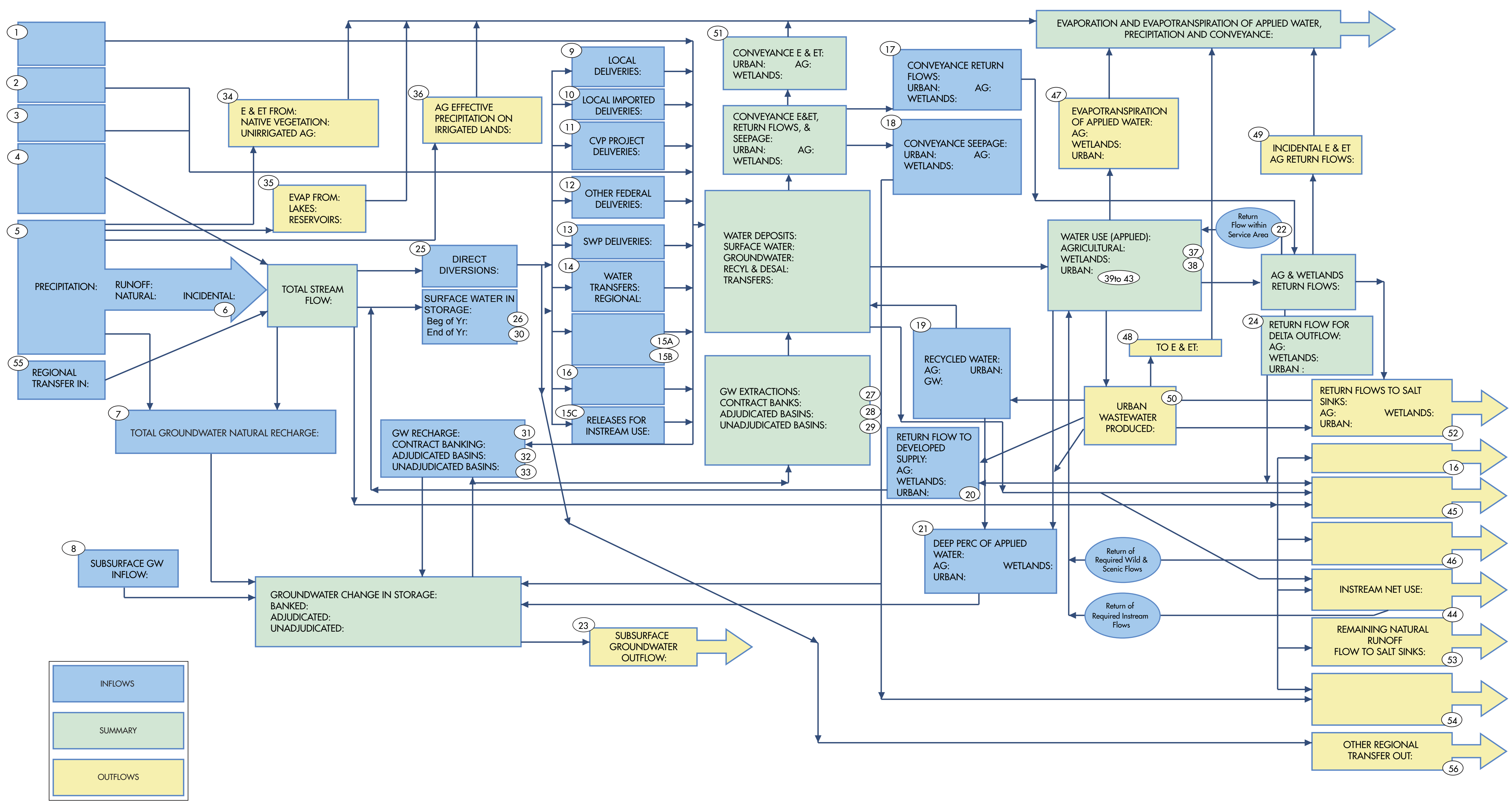
Inflows — Outflows — Green number signifies included in summary boxes

Figure 3-4 San Francisco Bay region - illustrated water flow diagram



In this illustration of Table 3-4, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of the table's flow diagram components; its color indicates whether the component is water input, output, or summary.

Figure 3-5 San Francisco Bay region - schematic flow diagram



In schematic of Table 3-4, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.

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Chapter 4 Central Coast Hydrologic Region

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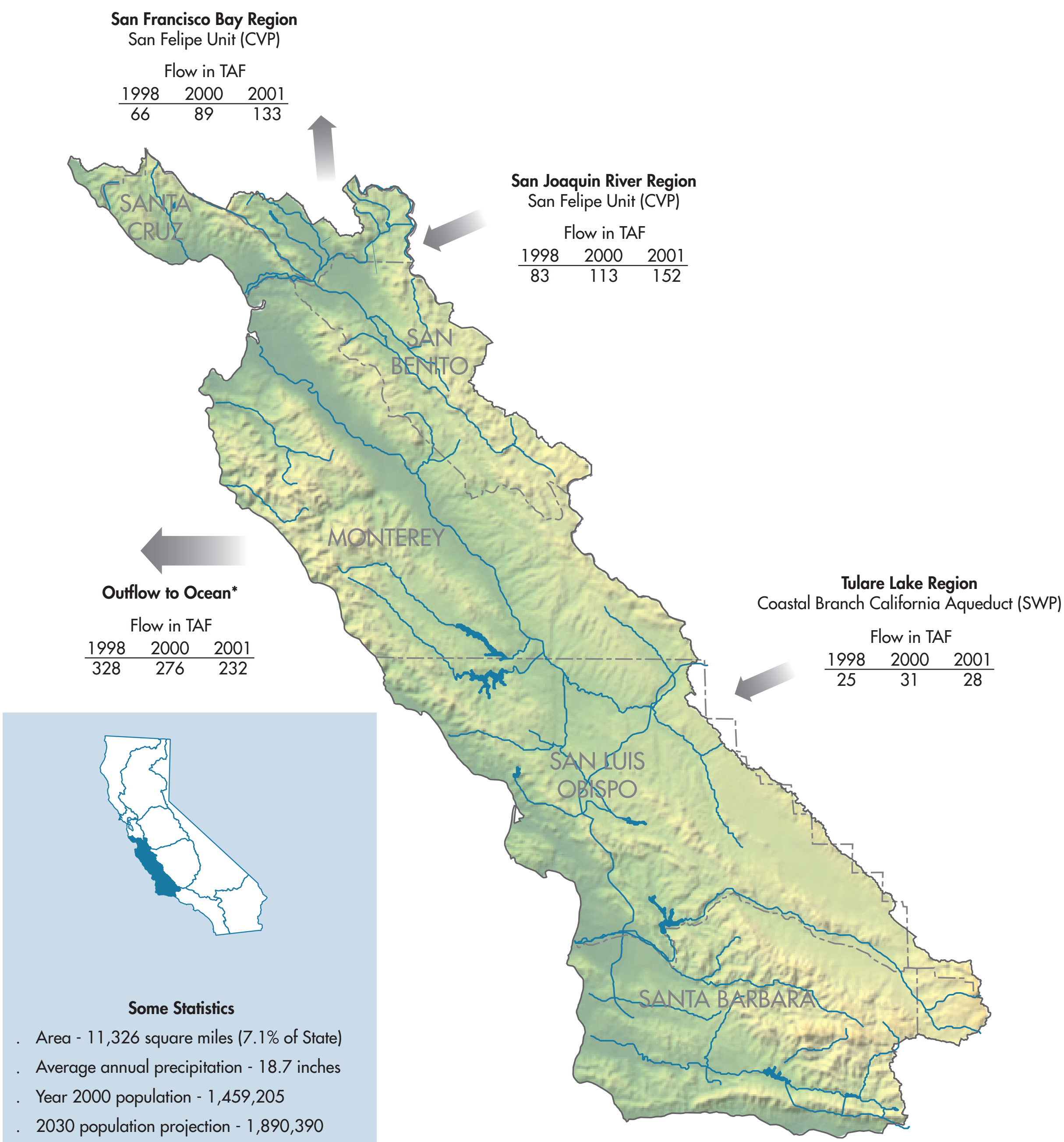
Figure 4-1 Central Coast Hydrologic Region



Some Statistics

- Area - 11,326 square miles (7.1% of State)
- Average annual precipitation - 18.7 inches
- Year 2000 population - 1,459,205
- 2030 population projection - 1,890,390
- Total reservoir storage capacity - 1,227 TAF
- 2000 irrigated crop area - 603,620 acres

The Central Coast Hydrologic Region extends from San Mateo to Santa Barbara counties and is within the Coast Range. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

**Outflow to Ocean includes Wild and Scenic Rivers, regulated flows, and estimated wastewater outflows.*

Chapter 4 *Central Coast Hydrologic Region*

Setting

The Central Coast Hydrologic Region extends from southern San Mateo County in the north to Santa Barbara County in the south (see Figure 4-1). The region includes all of Santa Cruz, Monterey, San Benito, San Luis Obispo and Santa Barbara counties and parts of San Mateo, Santa Clara, and Ventura counties. Many attributes define the Central Coast region including: the topography, many microclimates, the variety of agricultural products, and the picturesque coastline, valleys and communities that drive a thriving tourism economy.

Most of the Central Coast region is within the coastal mountain ranges, which stretch from the northern part of the region into San Luis Obispo and Santa Barbara counties. The portion of the Coast Ranges nearest to the ocean is the Santa Lucia Range, where elevations of a few peaks exceed 4,000 feet. Inland Coast Ranges are composed of the Gabilan and Diablo ranges in the north, the Cholame Hills in the center, and the Temblor and La Panza ranges in the south. The San Rafael and Sierra Madre mountains cover nearly three-quarters of Santa Barbara County. The southernmost quarter of Santa Barbara County is covered by the Santa Ynez Mountains, which are a component of another landform, the east-west trending Transverse Ranges. The mountains in eastern Santa Barbara County attain elevations of about 7,000 feet.

Lowlands in the region include narrow streambeds winding to the coast, coastal terraces and plains of varying sizes, and a few larger river valleys. The largest lowland near the coast is the Salinas Valley. Although less than 10 miles wide for most of its length, it stretches for 120 miles from the community of Moss Landing on Monterey Bay southeastward to near the community of Santa Margarita in San Luis Obispo County. Pajaro Valley is a smaller coastal valley adjacent to the Salinas Valley on the north side of Monterey Bay. Another large lowland near the coast is Santa Maria Valley, which straddles the Santa Maria River. Most of this valley is in Santa Barbara County, but a portion is also in San Luis Obispo County. The Salinas and Santa Maria valleys are the premier agricultural production areas of the Central Coast. Other significant interior lowlands include San Benito Valley in the far north, the inland Cuyama Valley shared by San Luis Obispo and Santa Barbara counties, and the Lompoc and Santa Ynez valleys in Santa Barbara County. The single largest lowland in the region is the Carrizo Plain in the eastern backcountry of San Luis Obispo County. The Carrizo Plain is a very wide basin on the otherwise fairly narrow but notorious San Andreas Fault Zone, which runs the length of the region.

The Central Coast's rivers generally have a northwest-southeast alignment, reflecting the topographic trend of the region's mountains and hills. The Pajaro, Carmel, and Salinas rivers drain the northern part of this region, the Estrella River and San Juan Creek are in the central portion, and the Cuyama, Santa Maria, and Santa Ynez rivers are in the southern portion. All of the rivers within this hydrologic region drain into the Pacific Ocean.

Climate

The climate of the Central Coast region remains temperate all year due to its location adjacent to the Pacific Ocean. The Central Coast has a Mediterranean climate characterized by mild, wet winters, and warm, dry summers. The regional climate is dominated by a strong and persistent high-pressure system that frequently lies off the Pacific coast. This Pacific high shifts northward or southward in response to seasonal changes or the presence of cyclonic storms. Prevailing winds carry cool, humid marine air onshore. These northwest winds cause frequent fog and low clouds near the coast, particularly at night and in the morning in the late spring and early summer. San Benito County is the only county in the region that does not have a coastline. As a result, temperatures are often higher and fog is prevalent than in the other coastal counties.

Most of the Central Coast region is within the coastal mountain ranges, which stretch from the northern part of the region into San Luis Obispo and Santa Barbara counties. Lone Cypress is a landmark on the Monterey Peninsula. (DWR Photo)

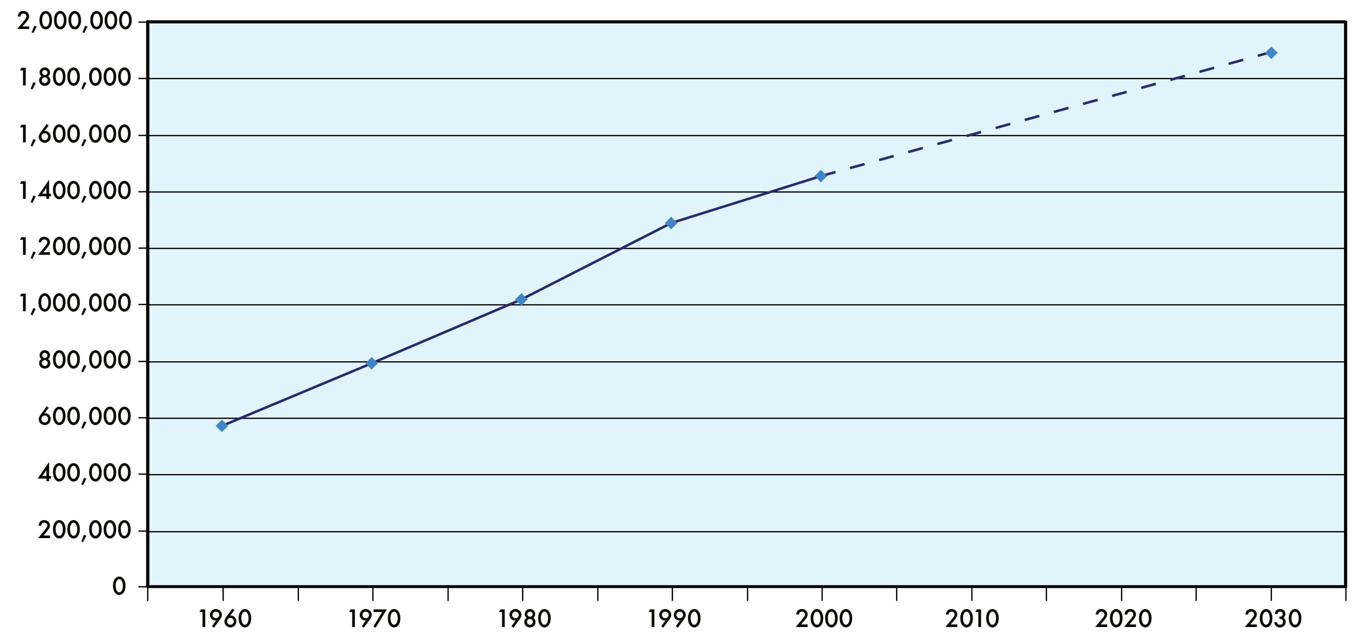
January is the coolest month with an average high temperature of 59 degrees and low temperature of 41 degrees. September is the warmest month with 72 degrees as the average high temperature and 52 degrees lowest. In the northern part of the region, the best weather occurs in September and extends through the middle of November with a few days getting into the 80s and 90s. Summer temperatures are cool along the coast and warmer inland. In the winter, temperatures remain cool along the coast but become cooler inland. The year-round, frost-free climate of the coastal valleys makes them ideal for specialty crops such as strawberries and artichokes.

Annual precipitation—usually rain—in the region ranges from 14 to 45 inches. Most of the rain occurs between late November and mid-April. The average annual precipitation near Salinas is about 14 inches. The southern interior basins usually receive 5 to 10 inches per year, with the mountain areas receiving more rainfall than the valley floors. The vineyard-growing areas throughout the region generally have summers that are long and cool due to the influence of the ocean. High-quality wine grapes thrive in this environment with very moderate climate all summer, with foggy mornings, bright sunshine through the afternoon, and very windy afternoons and early evenings.

The Monterey area, in general, enjoys the mildest climate with the fewest hot and cold days of any place in the continental United States. A prevailing feature of summer weather is the coastal fog or stratus overcast. The low overcast or fog usually burns off in the late morning and moves back in before midnight. During the winter, the coolest areas are inland away from the ocean. Winds are lightest in the winter and strongest in the summer, except for occasional storms.

The most prominent feature in the region is the floor of the Salinas Valley, which is about 7 miles wide at Chualar, 9 miles wide at Greenfield, and 4 miles wide at King City. The microclimate in these coastal areas (Salinas, Pajaro, and Santa Maria val-

Figure 4-2 Central Coast Hydrologic Region population



Data from California Department of Finance provide decadal population from 1960 to 2000, and population projection for 2030 for the Central Coast region.

leys) is ideal for growing truck crops and are well known for growing lettuce, broccoli, mushrooms, strawberries, citrus, and several other crops. The microclimate in these coastal areas is also ideal for the floral industry and grape vineyards.

At the very southern end of the region is Santa Barbara County. Summers are warm and dry; the winters are cool and often wet. The county has a unique physical orientation, with a series of east-west transverse mountain ranges. This can sometimes produce a profound orographic effect when storms approach the county from the Pacific Ocean. Most rain occurs between November and March. For the most part, Santa Barbara County receives relatively gentle but steady rainfall during storm events. Moist air from the Pacific Ocean moderates temperatures in the coastal areas, and somewhat lower winter minimums and higher summer maximums prevail in the inland valleys.

Population

The population of the Central Coast Region was about 1,459,200 in 2000, slightly more than 4 percent of California's population. About 65 percent of the Central Coast population lives in incorporated cities, which include Salinas (143,800), Santa Barbara (89,600), Santa Maria (77,400), Santa Cruz (54,600), San Luis Obispo (44,200), Lompoc (41,100), Watsonville (44,300), Hollister (34,400), Seaside (33,500), Monterey (29,700), Atascadero (26,400), and Paso Robles (24,300). There are several communities in the region with populations of fewer than 20,000.

California experienced a population increase approaching 14 percent from 1990 to 2000, while the growth in Central Coast Region was nearly 14 percent. Most of the counties in the Central Coast region reached double-digit population growth rates during these 10 years. The only county with a growth rate below double digits, according to Department of Finance population statistics, was Santa Barbara County, which grew by slightly less than 9 percent. San Benito County exceeded all other counties by recording a 46 percent increase during the decade. The population growth rates for Monterey County, San Luis Obispo County and Santa Cruz County were 13 percent, 14 percent, and 12 percent, respectively. Looking to the future, California Department of Finance estimates that the population of this hydrologic region will grow to roughly 1,890,400 by year 2030, which represents a 30 percent increase from 2000. Figure 4-2 provides a graphical depiction of the Central Coast Region's population from year 1960 through 2000, with projections to year 2030.

Population growth in the region is largely constrained by land-use policies, which limits the development of new housing. The cost of homes in most of the region is well above the national average, with the most costly real estate near the Santa Cruz and Monterey bays, Santa Barbara and greater Salinas area. As with most communities facing high real estate prices, there is a lack of entry and mid-level housing. Prices have been driven up by a lack of new development combined with a high demand by people moving into this region. The high cost of housing in the city of Santa Barbara is resulting in a 'flight to affordability,' as more workers are commuting into the city from nearby Santa Maria and the Santa Ynez Valley. Likewise, workers also commute to jobs in the major metropolitan areas from communities such as Salinas, Hollister, and some locations in the San Joaquin Valley, including Tracy, Los Banos, Patterson, and Modesto.

Land Use

The busy topography of the Central Coast Region and distance from California's major population centers have resulted in a landscape that is primarily pastoral and agricultural. Major economic activities include tourism, agricultural-related processing, as well as government and service-sector employment. Oil production and transportation sites onshore and offshore are important to the economy.

Agriculture in the Central Coast region can be divided into two distinct categories. One is irrigated vegetable and specialty crops grown on coastal terraces and valleys and in some inland valleys; and the other category is range pasture and dry-farmed grain in the inland valleys. The acreage planted in wine grape is expanding rapidly and now represents the region's highest-value individual agricultural commodity. Vineyard acreage region-wide grew 34 percent between 1998 and 2001. Although wine grapes are the highest-value individual agricultural commodity in the region, the category of vegetable crops still generates the highest dollar value. Livestock operations, mainly cattle, also are significant in the region.

Total irrigated land acreage in the Central Coast region has increased slightly from 422,000 acres in 1990 to 438,800 acres in 2000, or about 4 percent. However, because of the significant increase in the practice of growing multiple crops in a single year on the same piece of land, the total crop acreage increased from 534,400 acres in 1990 to 605,000 acres in 2000, a 13 percent increase. This increase in farm productivity through multi-cropping is a practice that is applied primarily to vegetable crops because of their relatively short growing season.

The acreage of field crops in the region has been declining for several years. It is now rare to find sugar beets grown in the region, and the two processing plants in Spreckles and Santa Maria that once took delivery of local sugar beets have both closed. Other field crops whose production has declined are corn, alfalfa, and irrigated pasture. However, the loss of field crop acreage has been offset by the increases in vegetable and truck crops. According to Monterey County Agricultural Commission statistics, lettuce acreage was 58,000 acres in 1990, and by year 2000 it had increased to 106,000 acres. Value-added products such as packaged salads, baby lettuce mixes, and specialty bag mixes have created a large demand for the many types of lettuce grown in the region, as well as for specialty greens.

The two premier vegetable-growing centers in the Central Coast region are the highly productive Salinas Valley in the north and the smaller Santa Maria Valley in the south. Year-round multiple cropping of vegetables is the predominant farm practice in these areas. The results from a multiple cropping field study conducted by the Department of Water Resources in the Salinas Valley in 1997 indicated that more than 100,000 acres was multiple cropped, which is about 40 percent of the irrigated land in the northern half of this hydrologic region.

From 1992 to 1998, the region lost more than 14,400 acres of agricultural land to urban uses (California Department of Conservation figures). However, growers have compensated for the loss of agricultural land through increased use of multi-cropping and the use of nonirrigated pasture lands. In 2001 over 250,000 acres of land was devoted to the production of irrigated vegetables and specialty crops. However, because of multi-cropping practices, over 400,000 acres of specialty crops were harvested.

Citrus and subtropical fruit crops, chiefly avocados and lemons, are grown on nearly 14,000 acres in the southern parts of this region. More than three-quarters of this acreage is near Santa Barbara. Nearly 14,000 acres of irrigated deciduous fruit trees, mostly walnuts, are also grown in the region, primarily in San Luis Obispo and San Benito counties. Vineyard acreage is evenly distributed between the northern and southern parts of the region. However, the vineyard acreage in the southern areas has grown rapidly from 27,100 acres in 1998 to 46,500 acres in 2001. Total grape acreage for the full hydrologic region grew from 68,100 to 95,600 acres between 1998 and 2001. Wineries with tasting rooms have become an important part of the region's travel and tourism industry.

Publicly owned lands, including military reservations, federally managed areas, and parks, make up about 28 percent of the Central Coast region. One of the main environmental water uses in the region is for the Salinas River National Wildlife Refuge, which is on 366 acres where the Salinas River empties into Monterey Bay. The refuge is part of the San Francisco Bay National Wildlife Refuge Complex, headquartered in Fremont. Refuge lands include a range of terrestrial and aquatic habitats, including coastal dunes and beaches, grasslands, wetlands, and riparian scrub. Because this wildlife refuge is within the Pacific Flyway, it is used by a variety of migratory birds for breeding, wintering, and rest stops during migration. It also provides habitat for several threatened and endangered species.

Water Supply and Use

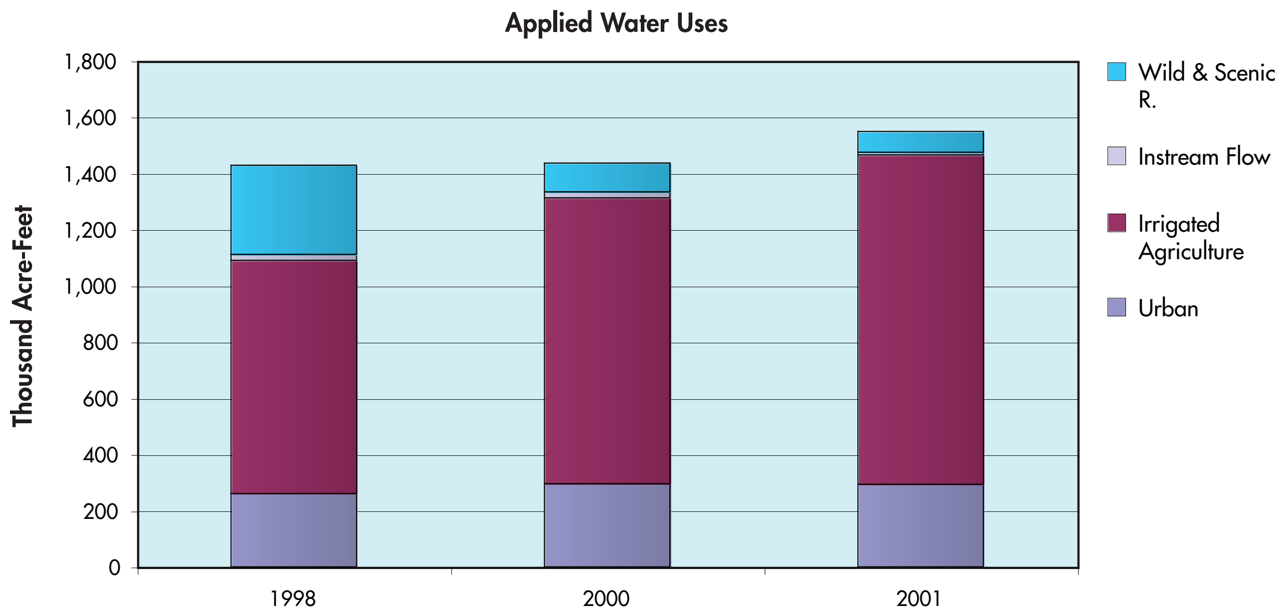
Groundwater is the primary source of water in the region, accounting for roughly 75 percent of the annual supply in 2000. Local and some imported surface water supplies make up the rest of the available water for this region. A significant amount of groundwater recharge is provided by the Pajaro, Salinas, and Carmel rivers, and by the Arroyo Seco, which flows into the Salinas River. Also, some water from local reservoirs is used to recharge groundwater. San Clemente and Los Padres dams on the Carmel River in Monterey County, San Antonio Dam on the San Antonio River, also in Monterey County, and Nacimiento Dam on the Nacimiento River in San Luis Obispo County are the region's main reservoirs. Figure 4-3 shows all of the water supply sources used to meet developed water uses in the region for 1998, 2000, and 2001 and summarizes all of the dedicated and developed urban, agricultural and environmental water uses within this hydrologic region for those years.

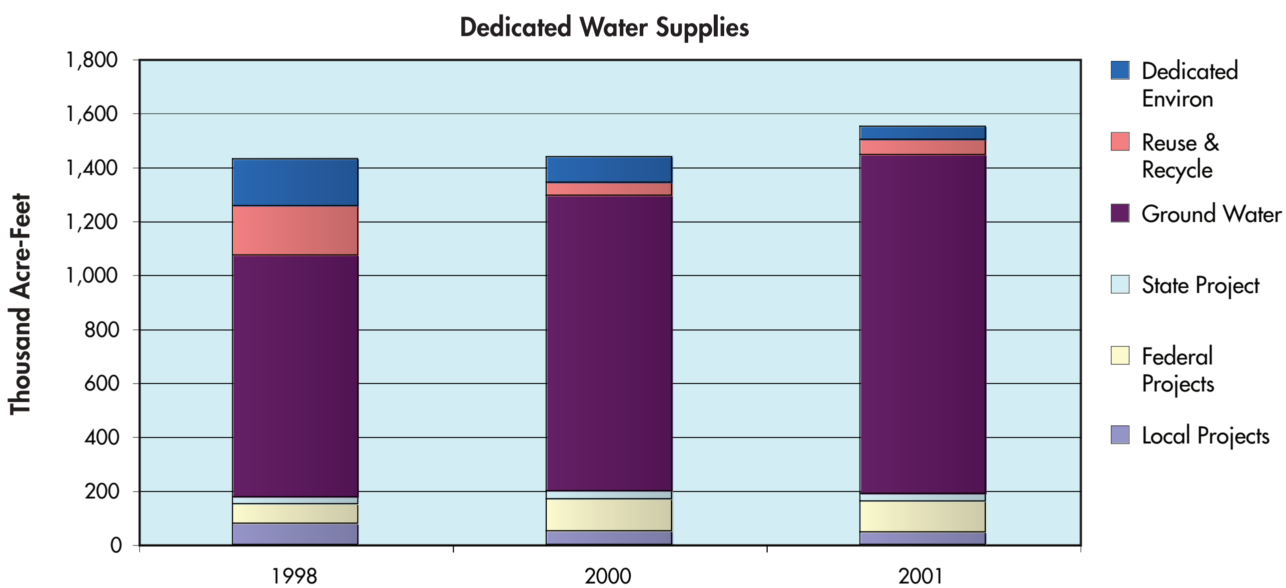
Water agencies in the northern half of this region include Monterey County Water Resources Agency, Monterey Peninsula Water Management District, Marina Coast Water District, California American Water, California Water Service Co., Sunnyslope County Water District, Pajaro Valley Water Management Agency, the City of Santa Cruz, San Benito County Flood Control and Water Conservation District, and a portion of the Santa Clara Valley Water District (Llagas subbasin). Water agencies in the southern parts of the region include the San Luis Obispo County Flood Control and Water Conservation District and the Santa Barbara County Flood Control and Water Conservation District and numerous cities, special districts, community services districts, and public utility companies. The Central Coast Water Authority is a larger regional agency that includes many of the individual water entities as members.

Historically, almost all of the applied irrigation water was developed from groundwater until the San Felipe Unit of the U.S. Bureau of Reclamation's Central Valley Project began importing surface water for irrigation in June 1987. The CVP's contracts for deliveries to the Santa Clara Valley Water District and the San Benito County Water District from the San Luis Reservoir total 196,300 acre-feet per year, which includes 138,250 acre-feet per year for municipal use and 58,050 acre-feet per year for agricultural uses. There are two other USBR projects in the region. The Cachuma Project provides Santa Ynez River water to the communities of Carpinteria, Goleta, Montecito, Santa Barbara, and Santa Ynez from the 190,000 acre-foot Cachuma Reservoir through the Tecolote Tunnel and South Coast Conduit. The USBR also operates the Santa Maria Project, which provides water from Twitchell Reservoir on the Cuyama River for irrigation purposes in the Santa Maria area. Another federal reservoir, the U.S. Army Corps of Engineer's 26,000 acre-foot Santa Margarita Lake provides water to the city of San Luis Obispo. The 40,700 acre-foot Whale Rock Reservoir near Cayucos is owned by the Whale Rock Commission and provides water to the City of San Luis Obispo and surrounding communities. Surface water is also imported into the region through the State Water Project's Coastal Branch Aqueduct, which was completed in 1997 and can deliver up to 70,500 acre-feet per year into San Luis Obispo and Santa Barbara counties.

California American Water, which is the primary urban water supplier to about 100,000 residents on the Monterey Peninsula area, currently (year 2004) obtains about 75 percent of its water from wells in the Carmel Valley alluvial aquifer. The remaining 25 percent is supplied from wells in Seaside Basin groundwater aquifers. No water is produced by direct diversion from San Clemente Reservoir on the Carmel River as a result of operational changes due to dam seismic safety concerns. In recent years, the State Water Resources Control Board regulation has limited available supplies, such that new water supply sources must be developed before additional regional growth can be supported. Although California-American Water Company had previously proposed building a new dam on the Carmel River, the company is now study-

Figure 4-3 Central Coast region water balance for water years 1998, 2000, 2001





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

ing an alternative plan called the Coastal Water Project. This project proposes an ocean desalination plant in the Monterey Bay region and development of a conjunctive groundwater storage program for the aquifer in the Seaside area. Additional planning studies, environmental impact analysis, and regulatory agency approvals must be completed before new water supply facilities can be completed.

Desalination of seawater is another source of water within this region. The 1987-1992 drought resulted in the construction of several small seawater desalting plants. The city of Santa Barbara built an 8-million gallons per day plant that was to provide water during water shortages. However, this plant is now inactive, and most of its equipment has been removed. A small plant also was built for the California Department of Parks and Recreation at the San Simeon Beach State Park to serve the Hearst Castle Visitor's Center. That plant was removed when a surface water alternative was later acquired. The city of Morro Bay built a seawater desalting plant and still operates it intermittently during water shortages.

Today, there are seven small seawater-desalting plants along the Central Coast. Of these, only one, Marina Coast Water District, provides municipal water, but it is currently not being used. The other six provide water for offshore islands or for industrial use. There are several large (greater than 1-million gallons per day) seawater desalting proposals under consideration by agencies in the Monterey-Santa Cruz area. If approved and constructed, the total capacity of these proposed plants could be about 20,000 acre-feet per year. Farther to the south, there is also a smaller desalting plant under study to supplement water supplies for the Cambria area.

Water recycling is also becoming a more important water resource. For example, Santa Barbara County has three wastewater treatment plants that recycle wastewater for irrigation, and dust control and compaction at construction sites. In addition, Laguna Sanitation District is designing wastewater treatment and recycled water distribution plants that will be used to serve a golf course and several other irrigation water customers in the city of Santa Maria.

Monterey County has two major wastewater recycling projects. The Castroville Seawater Intrusion Project provides approximately 19,000 acre-feet per year to replace coastal groundwater pumping for irrigating vegetables and fruit crops. The Carmel Area Wastewater District/Pebble Beach Community Services District Reclamation Project replaces approximately 700 acre-feet of potable water for golf courses and other open space in Pebble Beach.

Table 4-1 provides information about the water and its uses in the region for 1998 (a very wet year), 2000 (a year with slightly above normal precipitation), and 2001 (a below average precipitation year for most of the state, but slightly above average for the Central Coast region). Agriculture is the main user of water in this region, accounting for roughly 71 percent of the region's total water use in year 2000. Environmental water use consists primarily of the river flows from two federally designated wild and scenic rivers, the Big Sur River and the Sisquoc River. Because the flow of these two rivers varies considerably depending on the type of water year, total environmental water use can be as much as 24 percent of all uses in a wetter year (1998), or as little as 5 percent of the total water use in a drier year. Urban water use is about 21 percent of the total developed and dedicated water uses in the Central Coast region.

Per capita urban water use in many parts of the region remains at or below urban usage levels from the late 1980s. This decline can be traced to the aggressive use of water conservation programs and mandatory water use reductions during the 1987-1992 drought. The city of Santa Barbara is a good example. Shortages from one of its major supplies, the Cachuma Reservoir Project, forced the city to intensify its conservation and rationing. In 1988, the average daily per capita water use for Santa Barbara was estimated at 164 gallons per day. That value dropped to 94 gallons per capita day during the worst part of the drought in 1990. More recently, year 2000 estimated water use was 133 gallons per day, which is still about 20 percent lower than per capita usage in 1988. Similar trends toward improved water conservation and lower per capita water use have occurred in many other urban areas of the Central Coast region.

State of the Region

Challenges

With the Central Coast's limited surface water supply and few large surface water storage facilities, the growing demand for water is leading to more dependence on groundwater. In some of the coastal groundwater basins, groundwater is pumped at a higher rate than the underground supply can be replenished, such that seawater has pushed into some coastal freshwater aquifers and is degrading groundwater quality. There are some places, such as the Seaside Groundwater Basin and the Carmel River Groundwater Basin in the Monterey Peninsula Water Management District, where seawater intrusion has been prevented by rigorous monitoring and management to limit groundwater well production to safe yields. However, in

Table 4-1 Central Coast Hydrologic Region water balance summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (225%)	2000 (110%)	2001 (107%)
Water Entering the Region			
Precipitation	25,202	12,596	11,848
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions	108	144	180
Total	**25,310**	**12,740**	**12,028**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	622	754	860
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	66	89	133
Statutory Required Outflow to Salt Sink	174	95	49
Additional Outflow to Salt Sink	154	181	183
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	24,502	12,362	11,688
Total	**25,518**	**13,481**	**12,913**
Storage Changes in the Region [+] Water added to storage [-] Water removed from storage			
Change in Surface Reservoir Storage	401	8	-14
Change in Groundwater Storage **	-609	-749	-871
Total	**-208**	**-741**	**-885**
Applied Water * (compare with Consumptive Use)	1,074	1,291	1,442

***Footnote for applied water**

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

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

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

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

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

other coastal areas such as the mouth of the Salinas River, seawater intrusion into the groundwater aquifer is a major threat to water quality.

Unique coastal resources, such as Morro Bay and Monterey Bay, as well as the Salinas Valley, are the focus of water quality issues. Sedimentation poses the greatest water quality threat to Morro Bay, one of 28 estuaries in the National Estuary Program. The bay is also contaminated by pathogens from agriculture, boats, and urban runoff; nutrients from fertilizers, animal wastes, and urban runoff; heavy metals from abandoned mines in the upper watershed; and offshore boatyards that contaminate sediment. Elevated levels of bacteria have closed many of the shellfish growing beds in Morro Bay, and have occasionally closed beaches in Santa Cruz County and southern Santa Barbara County. To protect special areas of biological significance, waste discharges are prohibited or limited in portions of Monterey Bay, a National Marine Sanctuary, and other specific coastal and ocean waters of the region. In its triennial review, the Central Coast Regional Water Quality Control Board also identified the need to incorporate new microbiological standards for water-contact recreation in this region.

In the southern portion of Santa Clara County, elevated concentrations of nitrate and perchlorate have been detected. The Santa Clara Valley Water District continues to implement a Nitrate Management Program to monitor nitrate occurrence, reduce nitrate exposure, and reduce nitrate loading throughout Santa Clara County. The district also provides in-field technical assistance to the regions agricultural growers about nitrate and irrigation management. In late 2002, perchlorate (a chemical used in the manufacture of rocket fuel, road flares, and fireworks), emerged as a significant groundwater contaminant in the southern end of Santa Clara County. The known extent of this groundwater chemical plume extends 10 miles, and more than 800 water supply wells have been affected. The Santa Clara Valley Water District is working with the Regional Water Quality Control Board, local agencies, and affected communities to develop and implement a long-term corrective action plan.

The Salinas River watershed has significant nitrate contamination related to agriculture, the valley's main land use. Groundwater overdraft is also a problem in the area, and seawater has now intruded 6 miles inland into the shallow groundwater aquifer around Castroville. The nearby Pajaro River watershed faces a variety of water quality threats, such as erosion (primarily from agricultural practices), urban runoff, sand and gravel mining, flood control projects, off-road vehicles, and historical mercury mining in the Hernandez Lake area. Coastal wetlands in Elkhorn Slough, a tributary to Monterey Bay between the Salinas and Pajaro rivers, suffer from erosion on strawberry and other cropped lands in its watershed. Elevated bacterial levels in the slough may be associated with a large dairy and waste operation in the watershed as well as septic tanks. In addition, more than 600 year-round vessels use the Moss Landing Harbor, which increases the waste load to the slough. The accumulated effects of these water quality problems, along with the resuspension of pesticides in sediments, have restricted shellfish growing in Elkhorn Slough.

Other regional water quality concerns include one of the nation's worst oil spills at Unocal's Guadalupe Oil Field in the Santa Maria River watershed. Nutrients and pathogens impact the San Lorenzo River Basin, from septic systems, horse corrals, and urban runoff, as well as erosion from logging, urban development, and road maintenance. Groundwater basins that are impacted by salinity include the Hollister area, the Carrizo Plain, the Santa Maria and Cuyama valleys, San Antonio Creek Valley, portions of the Santa Ynez Valley, and the Goleta and Santa Barbara areas.

California American Water is the primary water supplier to most of the Monterey Peninsula, and the Carmel River is its primary source of water. In 1995, a major State Water Resources Control Board order ruled that the company did not have a legal right to roughly 70 percent of the surface water it had been diverting from the Carmel River. As a result, California American Water has been forced to take more water from wells that draw from groundwater below the lower valley, in order to keep as much water as possible in the river. Essentially no surface water is now taken from the river's two reservoirs behind the San Clemente and Los Padres dams for municipal supply purposes. To offset this lack of surface water, California American Water and the Monterey Peninsula Water Management District have each made separate proposals for seawater desalination plants that would produce enough water to satisfy the state order and put a minimum of 8,000 acre-feet of water a year back into the Carmel River. However, as proposed neither project will be able to supply water for future urban growth and in-fill housing needs.

Accomplishments

Many water districts have programs to monitor, evaluate, and better manage their groundwater resources. Watershed programs are under way to reduce nonpoint pollution, reduce stream erosion, and improve riparian vegetation. For example, the Coastal Watershed Council was formed in response to the declining health of the watersheds of the Monterey Bay. Its mission is to restore the watersheds of the region and teach its residents how to become stewards of their creeks and streams.

The Carmel River Basin, though small compared to other watersheds, supports a key run of steelhead, a federally listed species. The Monterey Peninsula Water Management District has a program to offset the environmental effects of diversions from the Carmel River that are required to meet the peninsula's water needs. Activities include steelhead rescues when the river is dry, fish rearing and release, restoring riparian habitat, and protecting riverbanks. MPWMD works with others, including the Carmel River Steelhead Association and the Carmel River Watershed Conservancy.

In January 2003, the Pajaro Valley Water Management Agency attempted to negotiate a $25 million agreement for water to be acquired from the Central San Joaquin Valley's Broadview Water District near the city of Firebaugh in Fresno County. Because of agricultural drainage and economic problems, Broadview Water District farmers have allowed about one-third of their 9,100 acres to lie fallow in recent years, while selling part of their contracted CVP water deliveries. The proposed agreement was intended to implement part of the Pajaro Valley Water Management Agency's plan to use imported surface water as an alternative source, which would reduce groundwater over-pumping and, thus, seawater intrusion. The negotiations between Pajaro Valley and Broadview Water District continued into 2004; but unfortunately the deadline to complete an agreement passed without a final pact being negotiated. Subsequently, Westlands Water District initiated discussions with Broadview Water District for the purchase of district lands and the CVP water. In a notice it sent to district landowners in September 2004, Westlands stated that the negotiations had been completed, and it hoped to finalize the agreement by February 2005.

In 1998, the Monterey County Water Resources Agency and the Monterey Regional Water Pollution Control Agency (RWPCA) completed a $78 million Salinas Valley reclamation project and Castroville seawater intrusion project. These two projects consist of a 19,500 acre-feet per year tertiary treatment plant and a distribution system that provides about 13,000 acre-feet of recycled water to 12,000 acres of Castroville area farms. During periods of the low irrigation demand in the winter, early spring and late fall, this recycled water supplies most of the water needed for irrigation. These projects will reduce groundwater pumping in the project area, and thus are expected to reduce seawater intrusion. Another project that will help alleviate Salinas Valley's seawater intrusion is the $18.8 million Salinas Valley Water Project. The project has two parts: (1) a seasonal rubber dam on the Salinas River near Marina to deliver more fresh water to the saltwater-plagued areas near Castroville and (2) the modification of upstream river operations at San Antonio and Nacimiento lakes to provide higher summer flows to recharge Salinas Valley aquifers. Final planning, financing, and permit approvals are being obtained, and it is anticipated that this project will be constructed in year 2005.

A regional approach to water supply development has been evolving in recent years in San Luis Obispo County. By setting aside regional disagreements the City of San Luis Obispo and Paso Robles, as well as the County of San Luis Obispo, Atascadero Mutual Water Company, and the Templeton Community Services District have agreed to build the Nacimiento Water Project to convey water via pipeline from Lake Nacimiento to the City of San Luis Obispo and locations in between. The county has had rights to 17,500 acre-feet of water per year from Lake Nacimiento since 1959, and recently approached various water agencies and public entities within its boundaries to discuss use of this untapped supply. Currently, the cost of construction for this proposed project is estimated to be about $150 million. Proposed water purchases to fund this project currently anticipate (1) $51 million from Paso Robles for 4,000 acre-feet per year, (2) $ 30 million from Atascadero Mutual for 2,000 acre-feet per year, (3) $ 64 million from City of San Luis Obispo for 3,380 acre-feet per year, and (4) $ 3.6 million from Templeton CSD for 250 acre-feet per year. The project design is now under way, and the proposed schedule anticipates that construction would start in early 2007 and be completed by the end of year 2009.

Relationship with Other Regions

Historically, the communities of the Central Coast region have relied on local surface water and groundwater supplies to meet their needs. The northern part of the region first received imported water with completion of the San Felipe Unit of the federal CVP in 1987. This facility delivers water to San Benito County users primarily for agricultural purposes from San Luis Reservoir in the San Joaquin River Hydrologic Region. Ten years later, the Coastal Branch of the SWP was completed to import water to San Luis Obispo and Santa Barbara Counties from the California Aqueduct in the Tulare Lake Hydrologic Region. There are no other water imports into the Central Coast region. Because there is seldom any excess surface water in this region's watersheds, there are no water exports from this region to other parts of the state.

Looking to the Future

Local water agencies in the Central Coast Hydrologic Region are continually maintaining, servicing, expanding, and updating their water systems (Box 4-1 Ongoing Planning Efforts). Because groundwater is the primary water source for the Central Coast region, water agencies are actively combining groundwater and surface water components into conjunctive use projects. In addition to the implementation of water conservation programs, other water management strategies that are under consideration include recycling, groundwater recovery, water marketing, and desalination.

Regional Planning

Several water agencies, including Marina Coast Water District and Scotts Valley Water District, are developing groundwater management plans and conducting groundwater studies to fill in information gaps about local groundwater conditions.

In its effort to implement its Basin Management Plan (BMP) Alternative B, the Pajaro Valley Water Management Agency (PVWMA) has purchased rights to CVP water from the Mercy Springs Water District (6,250 acre-feet). The PVWMA has also begun pipeline construction to deliver Harkins Slough Project and supplemental well water to coastal growers whose wells have been contaminated by seawater, and is pursuing more than $50 million in State and federal grants to implement the BMP. The BMP includes new wells, as a supplemental supply and as a source of blend water for wastewater reclamation, and an injection/recovery program for CVP water.

The Monterey Peninsula Water Management District has carried out a multiyear aquifer storage and recovery test program, where excess winter flow from the Carmel River is treated and injected into the Seaside Basin for recovery during dry periods. MPWMD has also funded several hydrogeologic studies of the Seaside Basin, and is in the process of developing a Seaside Basin Groundwater Management Plan.

Many projects and studies are under way in the Central Coast Region to enhance water quality and supply. Several new ocean desalination plants, such as the desalination project in the Sand City area being studied by Monterey Peninsula Water Management District, are being investigated as potential sources of new water supplies. Many agencies are also considering recycled water projects in conjunction with the construction of new or expanded municipal wastewater treatment plants. Local water users are proposing to raise the height of USBR's Bradbury Dam (Cachuma Reservoir) up to 3 feet to provide more water supply for the enhancement of downstream fish habitat. Additionally, many watershed programs are under way to remediate pollution and sedimentation, to help flood control, and to protect and restore ecosystems.

Water Portfolios for Water Years 1998, 2000, and 2001

Water Year 1998

California experienced a very wet winter in 1998 related to the El Nino weather pattern. Because of the extensive damage caused by El Nino storms, the winter of 1998-99 ranked as the 10th costliest in California history. Particularly hard hit were the coastal valleys, where many agricultural fields remained wet and soggy for the first six months of 1998. Annual rainfall in the Santa Cruz area exceeded 30 inches (193.5 percent of normal), and in the southern part of this region the Santa Barbara NWS station measured almost 47 inches of rainfall (167 percent of normal). For the entire hydrologic region, average annual precipitation was 225 percent of normal amounts, compared to a statewide average of 171 percent of normal annual precipitation.

Total agricultural production in the region was $3.65 billion (Monterey, Santa Cruz, San Benito, San Luis Obispo, and Santa Barbara counties) in 1998 from 564,600 acres of harvested irrigated crops. This is only a modest increase over 1997, but it is significant considering some of the challenges that the agri-

Box 4-1 Ongoing Planning Efforts

- Carmel River Management Plan
- Carmel River Watershed Council
- Coastal Watershed Council
- Pajaro River Watershed Council
- Pajaro Valley Groundwater Management Plan
- Salinas Valley Water Plan
- Santa Clara Valley Water District Groundwater Management Plan
- Seaside Basin Groundwater Management Plan
- Upper Salinas River Watershed CRMP

cultural industry faced. Most of the farming along the Central Coast involves vegetable crops, and vegetable crop acreage accounted for 72 percent of all irrigated crop acreage. The next largest crop is grapes comprising 12 percent of irrigated crop acreage. The Salinas Valley area produces the majority of the spring and summer vegetable crops, particularly lettuce.

The impact of the wet El Nino phenomenon on the Central Coast region's precipitation was very significant. Growers had little need to irrigate crops during the first four to five months of 1998. The very wet conditions prevented the timely planting of many acres of truck crops. Spring rains delayed planting and negatively affected growing conditions, especially for head lettuce production. There was also a decrease in the value of wine grapes due to the cool wet conditions, even though the acreage of grapes planted continued to increase. Strawberry acreage was slightly less than the prior year, but total strawberry crop value rose due to a shortage early in the season, resulting in higher prices once the berries were harvested. The most significant crop increase in 1998 was attributed to value-added salad products, for which the product value increased by about $70 million as consumer demand grew. Head lettuce value significantly dropped, primarily as a result of wet spring conditions.

As shown in Table 4-2 the 1998 total on-farm agricultural applied water use in the Central Coast Region was 816,300 acre-feet while total agriculture water use (including conveyance losses) was 829,000 acre-feet, or 58 percent of all uses, which is lower than normal as a result of the heavy precipitation. On a per acre basis, the average on-farm unit applied water was only 1.4 acre foot per acre in 1998. For comparison, year 1995 applied water was over 2 acre-feet per acre. As would be expected, this information verifies that the amount of water needed to irrigate crops is generally much less than normal during wetter years, due to utilization of the effective rainfall. The total agricultural evapotranspiration of applied water, or ETAW, in 1998 amounted to 556,900 acre-feet. The regional average unit ETAW was one acre-foot per acre.

Total urban applied water, including residential, commercial, industrial, and landscape uses, in the region was 261,500 acre-feet for the year. As shown in Table 4-2, urban water use accounted for roughly 18 percent of the region's total water use. Based on available water agency information, the average per capita water use was about 164 gallons per day during this wet year. Since a significant portion of urban water is used for outdoor landscapes, parks and golf courses, the per capita water use is lower than normal during a wet year. Total urban ETAW was 64,800 acre-feet.

Total environmental water demand, including instream flows, wild and scenic rivers, and refuge water diversions, for the region was about 339,000 acre-feet in 1998. This accounted for about 24 percent of total developed water uses for this year. Within the Central Coast region, most of this environmental water is dedicated to the wild and scenic river flow requirements for the Big Sur River and the Sisquoc River.

Total water supplies for the Central Coast region, including local and imported (CVP and SWP) surface water, groundwater, and reuse, amounted to 1.4 million acre-feet.

Water Year 2000

The weather and rainfall amounts for water year 2000 in the Central Coast region were slightly wetter than normal average conditions. Rainfall amounts for representative locations include Santa Cruz with 118 percent of average (36.4 inches), Salinas at 110 percent of average (16.5 inches), Santa Maria at 113 percent of average (14.6 inches) and Santa Barbara at 121 percent of average (21.3 inches). For the entire hydrologic region, average annual precipitation was 110 percent of normal, compared to a statewide average of 97 percent of normal.

Water storage in the Central Coast watersheds was reported as above normal. Average reservoir storage on May 1 was 115 percent of normal with runoff to May 1 measured at 105 percent of normal. The land acreage used for irrigated agriculture continued the past trend of remaining relatively stable. Crop acreage, however, increased 7 percent from 1998 to 2000 to a total of 605,000 acres. This increase in crop acreage is due to expanded use of the practice of growing multiple crops per season on the same piece of land. The estimated amount of multiple cropping in 2000 increased 5 percent and is reflected in the increased acreage of truck crops of 7 percent above 1998 amounts. Truck crops comprised about 72 percent of total crop acreage in this region, while the next largest crop category, vineyard, comprised 15 percent of total acreage.

The year 2000 on-farm agricultural applied water use in the Central Coast region was 999,400 acre-feet , while total agricultural water use was 1,016,300 acre-feet, or 71 percent of all water uses. This amounts to 23 percent more applied water than was estimated in 1998 and is considered to be more representative of agricultural water use under normal hydrologic conditions. Average on-farm unit applied water in 2000 was 1.7 acre-feet per acre, compared to 1.4 acre-feet per acre in 1998. The total agricultural evapotranspiration of

Table 4-2 Central Coast Region Water Use and Distribution of Dedicated Supplies - TAF

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	13.7			10.4			10.3		
Commercial	47.7			52.6			50.0		
Industrial	23.7			24.0			23.7		
Energy Production	14.3			14.3			14.3		
Residential - Interior	101.9			121.2			121.1		
Residential - Exterior	56.3			69.0			70.1		
Evapotranspiration of Applied Water		64.8	64.8		73.3	73.3		74.2	74.2
E&ET and Deep Perc to Salt Sink		24.3	24.3		26.8	26.8		25.8	25.8
Outflow		103.7	103.7		116.7	116.7		113.9	113.9
Conveyance Applied Water	3.9			4.2			4.4		
Conveyance Evaporation & ETAW		3.9	3.9		4.2	4.2		4.4	4.4
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**261.5**	**196.7**	**196.7**	**295.7**	**221.0**	**221.0**	**293.9**	**218.3**	**218.3**
Agriculture									
On-Farm Applied Water	816.3			999.4			1,152.1		
Evapotranspiration of Applied Water		556.9	556.9		681.0	681.0		785.9	785.9
E&ET and Deep Perc to Salt Sink		3.0	3.0		4.2	4.2		4.9	4.9
Outflow		33.6	33.6		45.3	45.3		50.3	50.3
Conveyance Applied Water	12.7			16.9			18.7		
Conveyance Evaporation & ETAW		11.8	11.8		14.7	14.7		16.7	16.7
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		1.0	1.0		1.0	1.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**829.0**	**605.3**	**605.3**	**1,016.3**	**746.2**	**746.2**	**1,170.8**	**858.8**	**858.8**
Environmental									
Instream									
Applied Water	20.3			21.4			10.8		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Wild & Scenic									
Applied Water	318.6			103.2			73.9		
Outflow		173.5	173.5		94.7	94.7		48.5	48.5
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	0.1			0.1			0.1		
Evapotranspiration of Applied Water		0.1	0.1		0.1	0.1		0.1	0.1
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Environmental Use	**339.0**	**173.6**	**173.6**	**124.7**	**94.8**	**94.8**	**84.8**	**48.6**	**48.6**
TOTAL USE AND OUTFLOW	**1,429.5**	**975.6**	**975.6**	**1,436.7**	**1,062.0**	**1,062.0**	**1,549.5**	**1,125.7**	**1,125.7**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	79.2	79.2	79.2	51.1	51.1	51.1	46.0	46.0	46.0
Local Imported Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	18.1	18.1	18.1	56.8	56.8	56.8	59.7	59.7	59.7
Other Federal Deliveries	54.1	54.1	54.1	61.4	61.4	61.4	54.6	54.6	54.6
SWP Deliveries	24.8	24.8	24.8	30.9	30.9	30.9	28.0	28.0	28.0
Required Environmental Instream Flow	173.4	173.4	173.4	94.7	94.7	94.7	48.4	48.4	48.4
Groundwater									
Net Withdrawal	608.5	608.5	608.5	749.0	749.0	749.0	870.5	870.5	870.5
Deep Percolation of Surface and GW	288.5			344.8			387.6		
Reuse/Recycle									
Reuse Surface Water	165.4			29.9			36.2		
Recycled Water	17.5	17.5	17.5	18.1	18.1	18.1	18.5	18.5	18.5
TOTAL SUPPLIES	**1,429.5**	**975.6**	**975.6**	**1,436.7**	**1,062.0**	**1,062.0**	**1,549.5**	**1,125.7**	**1,125.7**
Balance = Use - Supplies	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

applied water, or ETAW, in 2000 amounted to 681,000 acre-feet, which was 22 percent greater than 1998. The regional average unit ETAW was 1.1 acre-feet per acre.

Total urban applied water use for the Central Coast region was 295,700 acre-feet, which was 13 percent higher than the total applied water for 1998. Average per capita water use was about 181 gallons per day, which is about 10 percent higher than 1998 usage. Urban applied water accounted for about 21 percent of the total water use in the region. Total population in the region during year 2000 was 1,459,200, which is an increase of about 3.6 percent over the 1998 population. When compared to the 1998 wet year, the above increases in urban water use are primarily due to significantly less rainfall in year 2000 than in 1998, which means that more urban water was needed for outdoor landscape, parks and golf courses. Total urban ETAW was 73,300 acre-feet, which is 13 percent more than in 1998.

Total environmental water demand (instream, wild and scenic, and refuges) for this region in year 2000 was about 124,700 acre-feet, a significant 63 percent less than 1998. This accounted for about 8 percent of total developed and dedicated water uses during year 2000. This is water that is reserved for instream and wild and scenic river flows, which are generally higher in the wetter years (like 1998) and decline to lower flow levels in average and drier years.

Total water supplies, including local and imported (CVP and SWP) surface water, groundwater, and reuse, amounted to 1.4 million acre-feet, about the same as 1998.

Water Year 2001

The weather and precipitation for water year 2001 in the Central Coast Region varied considerably from north to south. The total rainfall recorded in Santa Cruz was 82 percent of average (25.4 inches), Salinas was at 90 percent of average (13.5 inches), King City was at 116 percent of average (12.8 inches) and Santa Barbara received 146 percent of average precipitation (23.5 inches). For the entire hydrologic region, average annual precipitation was 107 percent of normal, compared to a statewide average of 72 percent. The winter season 2001 was characterized by a lack of rainfall across the region during October through December.

Surface water runoff in the watersheds of the Central Coast region was reported as below average, with accumulated runoff to May 1 measured at 70 percent of average amounts. However, reservoir storage on May 1 was 135 percent of average because of significant storage carryover from the previous year. Total cropped acreage in 2001 was 601,900 acres, which was very similar to year 2000. In 2000, the prices of many of the core crops grown in the region had increased significantly. However, in 2001, many of these same crops had lower production amounts and price declines. Head lettuce, broccoli, cauliflower, and celery production all experienced decreases in 2001.

Year 2001 on-farm agricultural applied water use in the Central Coast region was 1,152,100 acre-feet, while the total agriculture water use was 1,170,800 acre-feet or 76 percent of all water uses. This amounted to 41 percent more agricultural water use than 1998 and 15 percent more than 2000. Average on-farm unit applied water use per acre also increased in 2001 to 1.9 acre-feet per acre compared to 1.4 acre-feet per acre in 1998 and 1.7 in 2000. As the above data confirms, the need for agricultural applied water increases as the amount of winter precipitation decreases from 1998 (wet) to 2000 and 2001. The total unit ETAW in 2001 was 785,900 acre-feet, which is 41 percent more than 1998 and 15 percent more than 2000. The regional average unit ETAW was 1.3 acre-feet per acre.

In 2001, total urban applied water for the region was 293,900 acre-feet, which was about 12 percent more than 1998 and 1 percent less than year 2000. Average per capita water use was around 176 gallons per day. Urban water use accounted for about 19 percent of the total water use in the region. Total population in the region in 2001 was about 1,476,800, an increase of 1.2 percent from the year 2000 population. Total urban ETAW was 74,200 acre-feet, 15 percent more than 1998 and 1 percent more than in year 2000.

Dedicated environmental water use (instream, wild and scenic flows, and refuges) for the region dropped to 84,800 acre-feet in 2001, 75 percent less than 1998 and 32 percent less than 2000. This accounts for about 5 percent of total developed water uses during this year, and reflects the lower wild and scenic flow volumes in the Big Sur River and the Sisquoc River.

Total available water supplies, including local and imported (CVP and SWP) surface water, groundwater, and reuse, amounted to 1.5 million acre-feet in 2001, which is an 8 percent increase from 1998 and 2000.

Water Portfolio Table 4-3 and the companion Water Portfolio flow diagrams (Figures 4-4 and 4-5) provide more information about how the available water supplies are distributed and used on a region-wide basis.

Selected References

Water Quality Control Plan, Regional Water Quality Control Board

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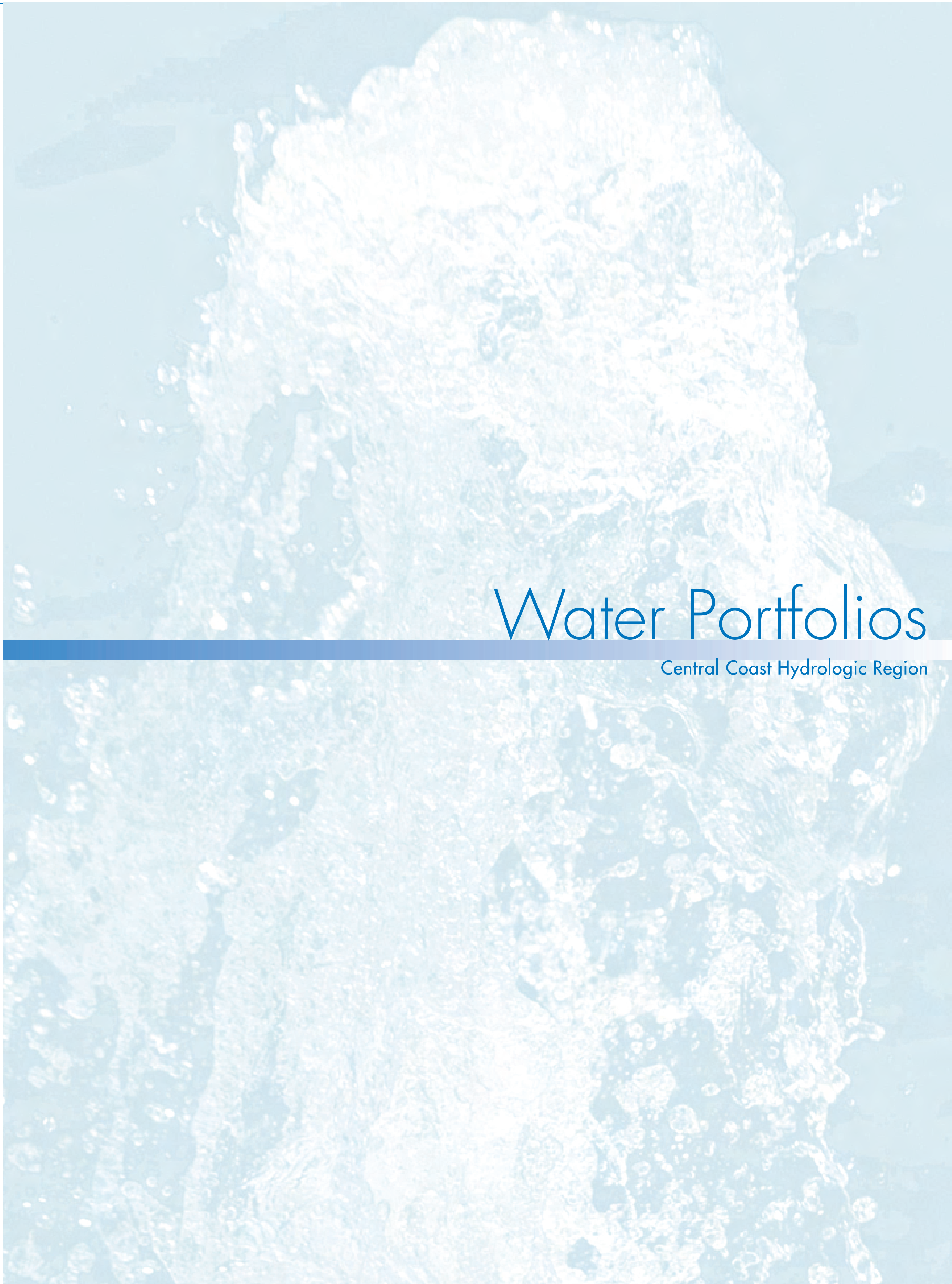


Water Portfolios

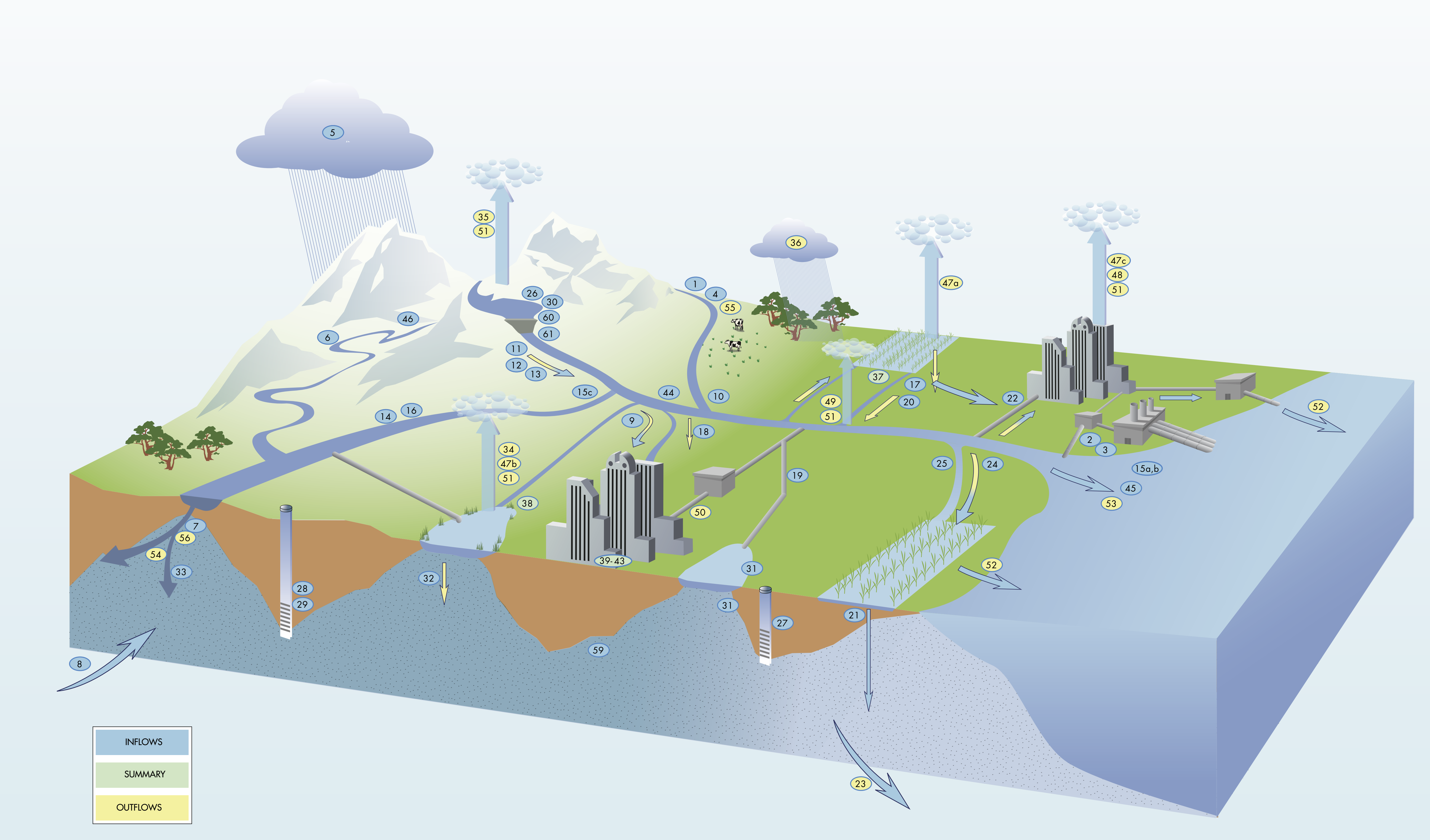
Central Coast Hydrologic Region

Table 4-3 Central Coast region water portfolios - TAF

ID Number:	Flow Diagram Component (see legend)	Central Coast 1998	Central Coast 2000	Central Coast 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	25,201.6	12,596.4	11,847.9
6a	Runoff - Natural			N/A
b	Runoff - Incidental			N/A
7	Total Groundwater Natural Recharge			N/A
8	Groundwater Subsurface Inflow			N/A
9	Local Deliveries	79.2	51.1	46.0
10	Local Imports	-	-	-
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	18.1	56.8	59.7
12	Other Federal Deliveries	54.1	61.4	54.6
13	State Water Project Deliveries	24.8	30.9	28.0
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	20.3	21.4	10.8
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	-	-	-
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	-	-	-
b	Recycled Water - Urban	17.5	18.1	18.5
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	-	-	-
b	Return Flow to Developed Supply - Wetlands	-	-	-
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	210.7	254.0	295.9
b	Deep Percolation of Applied Water - Wetlands	-	-	-
c	Deep Percolation of Applied Water - Urban	76.9	89.6	90.7
22a	Reuse of Return Flows within Region - Ag	-	-	-
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	165.4	29.9	36.2
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	-	-	-
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions			
26	Surface Water in Storage - Beg of Yr	589.1	770.2	778.5
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	897.0	1,093.8	1,258.1
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	990.1	778.5	764.5
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation			
b	Evaporation and Evapotranspiration from Unirrigated Ag			
35a	Evaporation from Lakes	10	11.6	10.9
b	Evaporation from Reservoirs	74.2	75.9	71.5
36	Ag Effective Precipitation on Irrigated Lands	214	170.6	156.8
37	Agricultural Water Use	816.3	999.4	1,152.1
38	Managed Wetlands Water Use	0.1	0.1	0.1
39a	Urban Residential Use - Single Family - Interior	69.3	83.7	87.1
b	Urban Residential Use - Single Family - Exterior	42.9	53.1	54.5
c	Urban Residential Use - Multi-family - Interior	32.6	37.5	34.0
d	Urban Residential Use - Multi-family - Exterior	13.4	15.9	15.6
40	Urban Commercial Use	47.7	52.6	50.0
41	Urban Industrial Use	23.7	24.0	23.7
42	Urban Large Landscape	13.7	10.4	10.3
43	Urban Energy Production	14.3	14.3	14.3
44	Instream Flow	-	-	-
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	173.5	94.7	48.5
47a	Evapotranspiration of Applied Water - Ag	556.9	681	785.9
b	Evapotranspiration of Applied Water - Managed Wetlands	0.1	0.1	0.1
c	Evapotranspiration of Applied Water - Urban	64.8	73.3	74.2
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	3	4.2	4.9
50	Urban Waste Water Produced	68	79.7	75
51a	Conveyance Evaporation and Evapotranspiration - Urban	11.3	12.7	12.4
b	Conveyance Evaporation and Evapotranspiration - Ag	11.8	14.7	16.7
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	-	-	-
d	Conveyance Outflow to Mexico			
52a	Return Flows to Salt Sink - Ag	33.6	46.3	51.3
b	Return Flows to Salt Sink - Urban	120.6	135	131.7
c	Return Flows to Salt Sink - Wetlands	-	-	-
53	Remaining Natural Runoff - Flows to Salt Sink	173.5	94.7	48.5
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	108.2	149.1	142.3
56	Regional Exports	65.8	88.9	132.7
59	Groundwater Net Change in Storage	-608.5	-749.0	-870.5
60	Surface Water Net Change in Storage	401.0	8.3	-14.0
61	Surface Water Total Available Storage	1,226.8	1,226.8	1,226.8

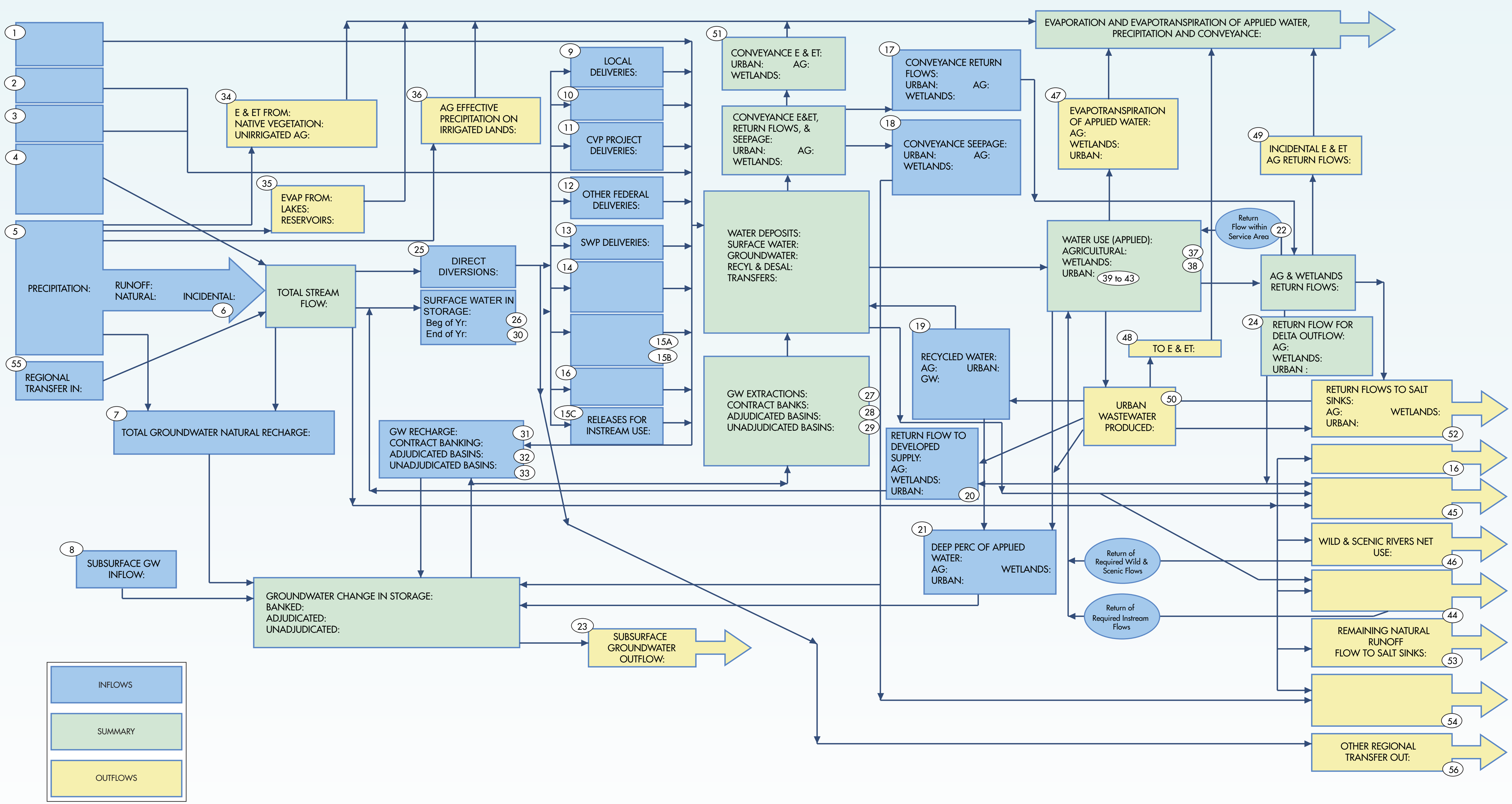
Inflows   Outflows   Green number signifies included in summary boxes

Figure 4-4 Central Coast region - illustrated water flow diagram



In this illustration of Table 4-3, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 4-5 Central Coast region - schematic flow diagram



In schematic of Table 4-3, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.

Volume 3

Chapter 5 South Coast Hydrologic Region

Chapter 5 South Coast Hydrologic Region

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Figure 5-1 South Coast Hydrologic Region

South Lahontan Region
Los Angeles Aqueduct
West Branch California Aqueduct (SWP)

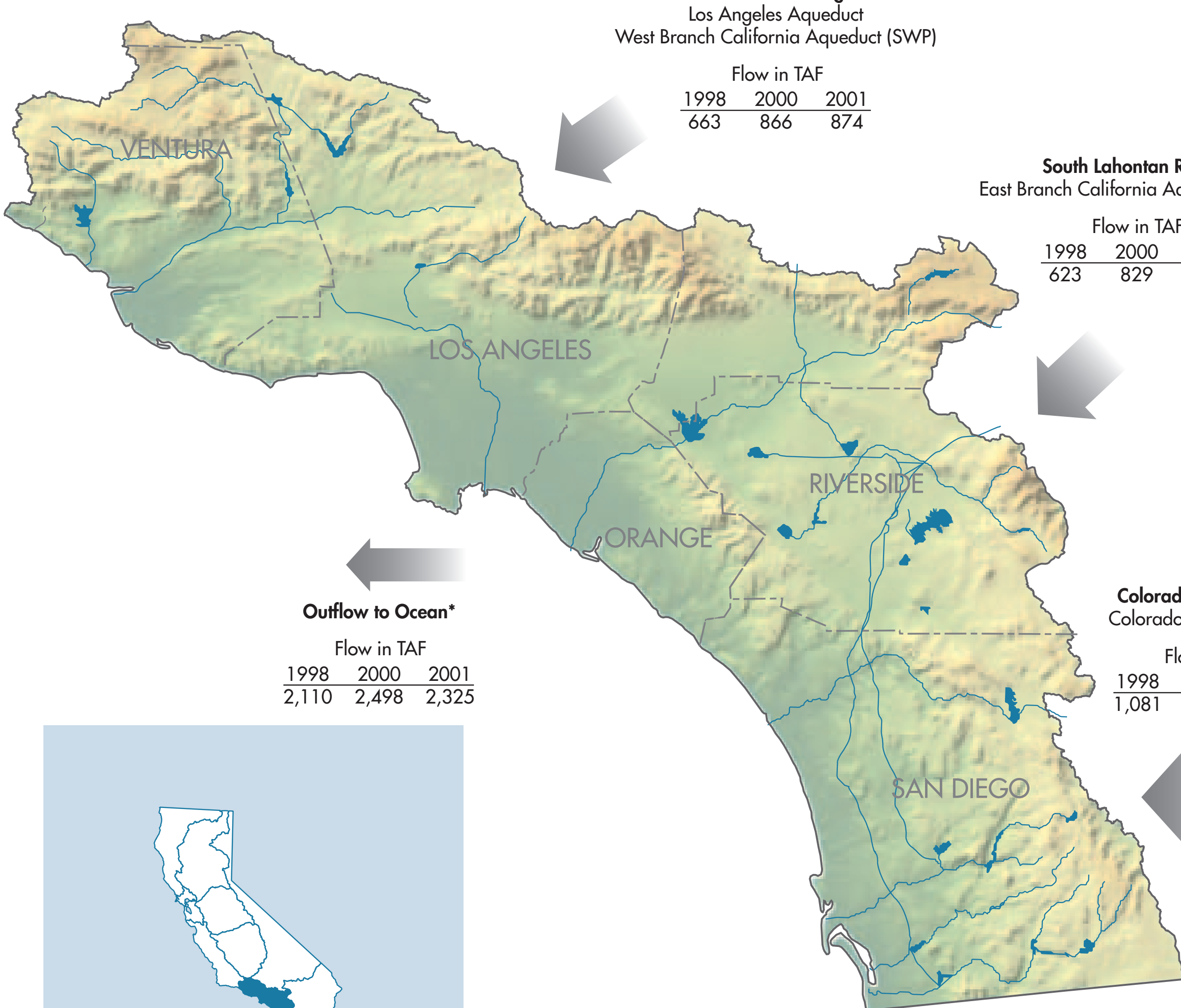
Flow in TAF

1998	2000	2001
663	866	874

South Lahontan Region
East Branch California Aqueduct (SWP)

Flow in TAF

1998	2000	2001
623	829	381



Outflow to Ocean*

Flow in TAF

1998	2000	2001
2,110	2,498	2,325

Colorado River Region
Colorado River Aqueduct

Flow in TAF

1998	2000	2001
1,081	1,296	1,250

Some Statistics

- Area - 110,925 square miles (6.9% of State)
- Average annual precipitation - 17.6 inches
- Year 2000 population - 18,223,425
- 2030 population projection - 23,827,075
- Total reservoir storage capacity - 3,059 TAF
- 2000 irrigated crop area - 280,260 acres

The South Coast Hydrologic Region in the southwestern corner of California is the most urbanized and populous region. Arrows indicate annual water flows entering and leaving the region for water years 1998, 2000, and 2001.

**Outflow to Ocean includes Wild and Scenic Rivers, regulated flows, and estimated wastewater outflows.*

Chapter 5 *South Coast Hydrologic Region*

Within the South Coast Hydrologic Region, water wholesalers and retailers, groundwater agencies, and watershed planners and managers are becoming increasingly successful in working together to implement a large and diverse array of local water supply and water quality projects. In turn, this increased level of cooperation and integrated planning is making the region more flexible and less dependent on imported water, particularly during dry years (see Box 5-1).

This regional profile, after describing the characteristics of the region, provides examples of the South Coast's challenges, accomplishments, and plans to meet the water needs of the future. There are many more examples of water issues and accomplishments than are presented in this chapter. It is important to note that in the highly developed South Coast region there are now many major water interest groups and agencies with important roles to fulfill in providing reliable, affordable, high quality water. The jurisdictions and common areas of interest for these stakeholder interest groups often overlap, such that shared communication and integrated regional planning are becoming increasingly important to successful water planning and management.

Setting

The South Coast Hydrologic Region comprises the southwest portion of the state and is California's most urbanized and populous region. It contains slightly more than half of the state's population (54 percent) but covers only 7 percent of the state's total land area. The topography includes a series of nearly flat coastal plains and valleys, many broad but gentle interior valleys, and several mountain ranges of low and moderate elevation.

The region extends about 250 miles along the Pacific Coast from the Ventura-Santa Barbara County line in the north to the international border with Mexico in the south (Figure 5-1). The region includes all of Orange County and portions of Ventura, Los Angeles, San Bernardino, Riverside, and San Diego counties.

There are several prominent rivers in the region including the Sespe, Ventura, Santa Clara, Los Angeles, San Gabriel, Santa Ana, San Jacinto, Santa Margarita, San Luis Rey, San Dieguito, Sweetwater, and Otay rivers. Segments of some of these rivers have been extensively lined and in other ways modified for flood control. Natural runoff of the region's streams and rivers averages about 1.2 million acre-feet annually.

Box 5-1 Integrated Resource Planning

The Metropolitan Water District of Southern California adopted its Integrated Resource Plan in 1996 and recently has revised that plan with the adoption of the 2004 Update. The new 2004 Update accomplishes the three objectives of reviewing goals and achievements of the 1996 Integrated Resource Plan, identifying changed conditions for water resource development, and updating the resource targets through 2025.

The Santa Ana Water Project Authority recently completed its 2002 Integrated Water Resource Plan. It provides information on water demand and supply planning, water resource plans from member agencies, balancing and integrating available resources, and identifying regional problems and issues and potential long-term solutions.

The South Coast region comprises the southwest portion of the state and is California's most urbanized and populous region. The photo depicts the Los Angeles skyline. (DWR Photo)

Climate

The region has a mild, dry subtropical climate where summers are virtually rainless, except in the mountains where late summer thunderstorms sometimes occur. About 75 percent of the region's precipitation falls from December through March. The coastal plains and the interior valleys receive on average 12 to 18 inches of annual precipitation, depending on location, but the climate allows for a much wider variation from year to year. Much of the 20 to 40 inches of annual average precipitation in the higher mountains falls as snow.

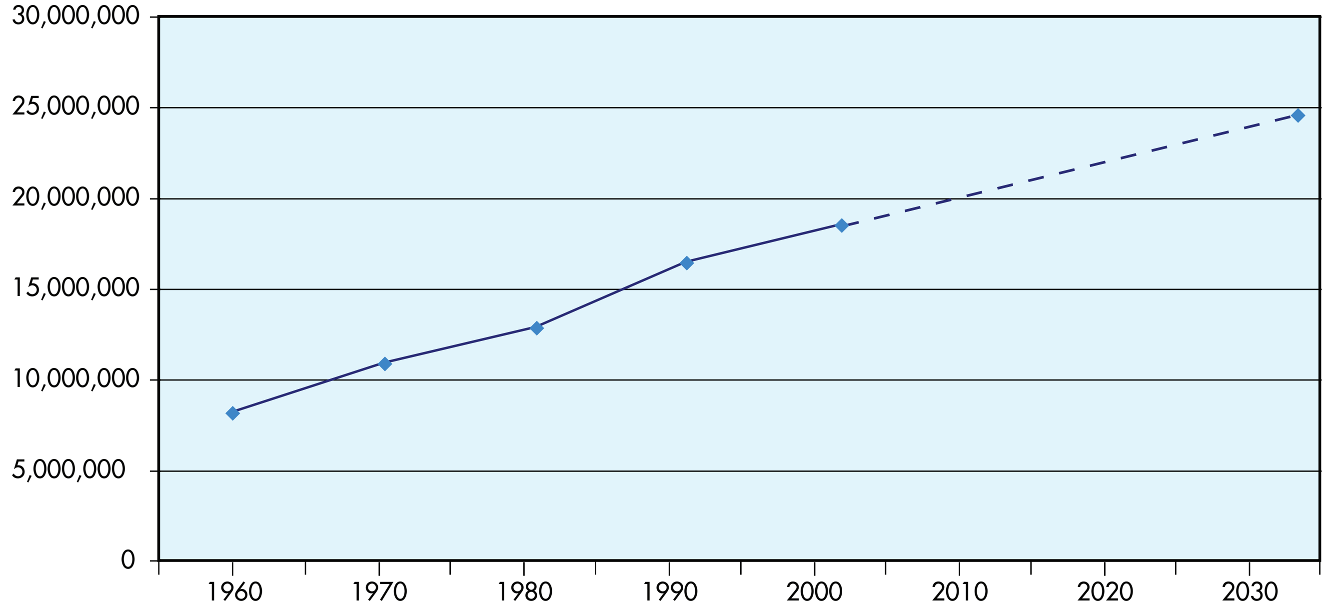
Population

The region's 2000 population was 18,223,000. The fastest growing portion of the South Coast region is that known as the Inland Empire, which includes the inland valleys of Riverside and San Bernardino counties. The region contains seven of the state's fastest-growing cities, in terms of percentage change in growth (Temecula, Chula Vista, Irvine, Riverside, Fontana, Rancho Cucamonga, and Murietta). The city of Los Angeles is the state's biggest city. Its population grew from 3,486,000 in 1990 to 3,645,000 in 2000. The population in San Diego County is concentrated along the coastal terraces and valleys, and south of CampPendleton, the U.S. Marine base. In 2000, the city of San Diego was America's seventh largest city, and California's second largest, with 1,223,000 persons. Figure 5-2 provides a graphical depiction of the South Coast region's total population from 1960 through 2000, with current projections to year 2030.

Land Use

The mild climate and ample expanse of gentle landscapes in the South Coast region have encouraged a variety of land uses since the first great development boom of the late 1880s. The expansion of new single- and multi-family homes, commercial services, businesses, and highway systems into the warmer

Figure 5-2 South Coast Hydrologic Region population



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

sections of the region continues onto lands that were historically pastoral, if not agricultural. Although pockets of open space and agricultural uses still exist, the urban area now extends southward from Ventura County to the international border with Mexico and eastward from the coast to beyond Riverside and San Bernardino. Irrigated agriculture now occupies only one-seventh as much land as urban uses. Environmental water uses are mostly limited to relatively small, managed wetland areas, wildlife areas, lakes, and riparian habitats.

Although the acreage has continued to decline in recent years, agriculture is still economically important for the region. In 2000, the total value of agricultural products in San Diego County was $1.3 billion. The total crop acreage in year 2000 was about 280,000 acres, which produced a variety of crops that included high-valued citrus and subtropical fruits, fresh-market vegetable crops, and assorted nursery products. Although agricultural uses occur throughout the region, the major areas continue to be the Oxnard Plain (for vegetables) and the adjacent hills and valleys (for citrus and subtropical fruits) in Ventura County; the coastal (for nursery) and interior valleys (for citrus and avocado fruits) in San Diego County; and the Chino area (for dairies) in San Bernardino County.

Water Supply and Use

The region has developed a diverse mix of both local and imported water supply sources. Local water resources development over the last 15 years has included water recycling, groundwater storage and conjunctive use, conservation, brackish water desalination, water transfer and storage, and infrastructure enhancements to complement imported water supplies. The region imports water through the State Water Project (SWP), the Colorado River Aqueduct (CRA), and the Los Angeles Aqueduct (LAA) (see Box 5-2 for acronyms used in this report). This diverse mix of sources provides flexibility in managing supplies and resources in wet and dry years. Figure 5-3 provides a graphical presentation of all of the water supply sources that are used to meet the developed water uses within this hydrologic region for 1998, 2000, and 2001. Figure 5-3 also presents a bar chart that summarizes all of the dedicated and developed urban, agricultural and environmental water uses within this hydrologic region for 1998, 2000 and 2001.

The Metropolitan Water District of Southern California (MWD) imported an average of 703,000 acre-feet per year of water from the SWP from 1972 to 2003 (the contracted amount is currently 1,811,000 acre-feet per year; actual imports have been closer to this amount for the last few years), and 680,000 acre-feet or more of water from the CRA (depending on the availability of surplus water). MWD wholesales the water to a consortium of 26 cities, water districts, and a county authority that serve 18 million people living in six counties stretching from Ventura to San Diego.

Fifteen percent of the region's water supply is developed by water agencies located outside of the service area of MWD and its members agencies. These agencies also import water from the SWP, or use local supplies, usually groundwater. Agencies that import SWP water include Castaic Lake Water Agency, San Bernardino Valley Municipal Water District (SBVMWD), Ventura County Flood Control District, San Gorgonio Pass Water Agency, and the San Gabriel Valley Municipal Water District.

Groundwater and groundwater agencies are important to the water supply picture of the region, meeting about 23 percent of water demand in normal years and about 29 percent in drought years (see Box 5-3). There are 56 groundwater basins in the region. In some California groundwater basins, as the demand for groundwater exceeded supply, landowners and other parties turned to the courts to determine how much groundwater can rightfully be extracted by each user. In a process known as court adjudication, the courts study available data to arrive at a distribution of groundwater that is available each year, usually based on the California law of overlying use and appropriation. There are 19 court adjudications for groundwater basins in California, mostly in Southern California. In 15 of these adjudications, the court judgment limits the amount of groundwater that can be extracted by all parties based on a court-determined safe yield of the basin. The basin boundaries are also defined by the court.

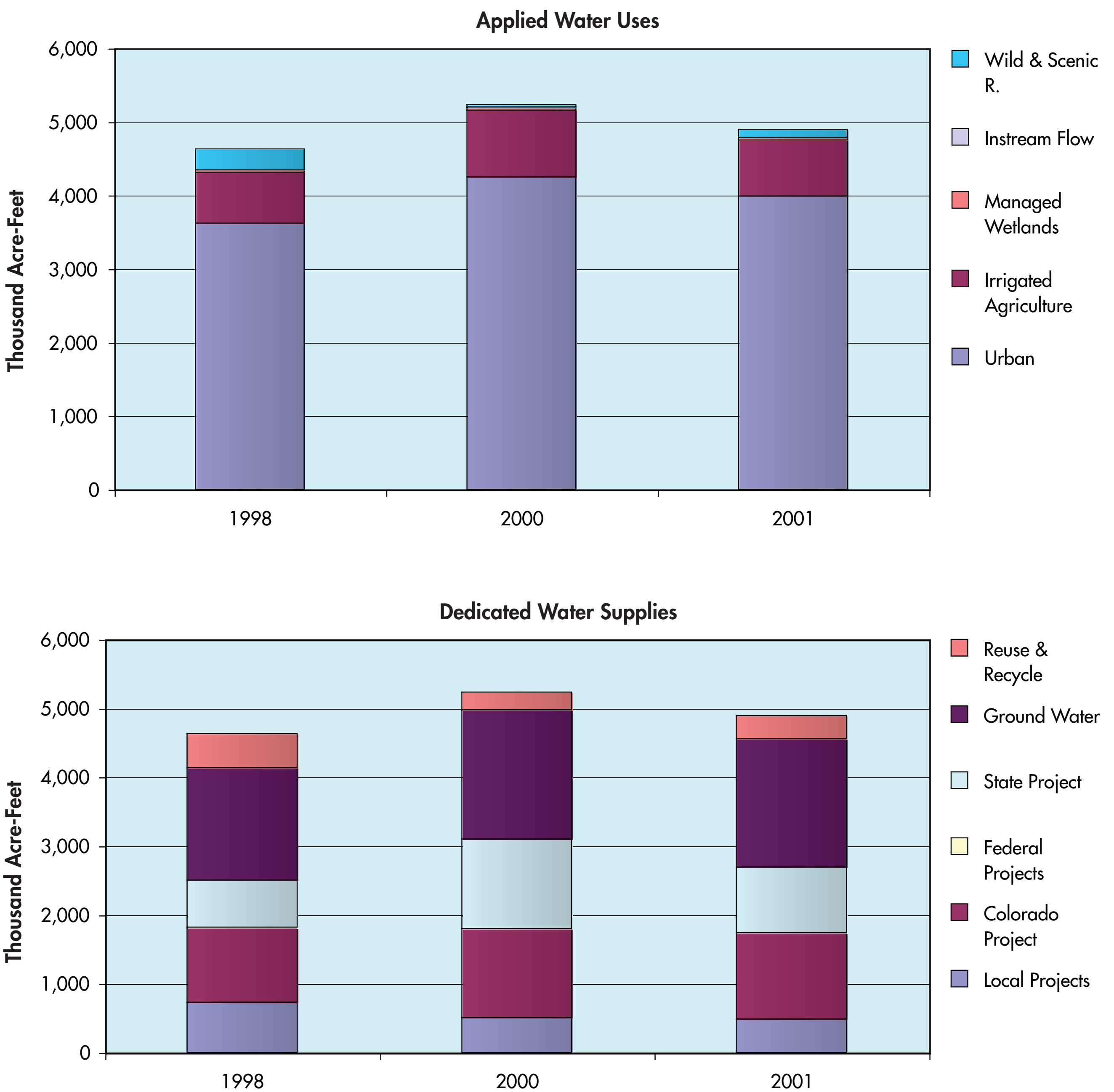
Most basin adjudications have resulted in either a reduction or no increase in the amount of groundwater extracted. As a result, agencies often import surface water to meet increased demand. The original court decisions provided watermasters with the authority to regulate extraction of the quantity of groundwater; however, they omitted authority to regulate extraction to protect water quality or to prevent the spread of contaminants in the groundwater. Because water quantity and water quality are inseparable, watermasters are recognizing that they must also manage groundwater quality.

The use of recycled water, which brings wastewater agencies into partnerships with surface and groundwater managers, is playing an increasingly significant role in meeting the region's water needs. The best recent data is from the 2002 Statewide Recycled Water Survey by the State Water Resources Control

Box 5-2 Acronyms Used in the South Coast Regional Report

CBDA	California Bay-Delta Authority
CRA	Colorado River Aqueduct
CVWD	Coachella Valley Water District
DBPs	disinfection byproducts
DWR	California Department of Water Resources
IID	Imperial Irrigation District
LAA	Los Angeles Aqueduct
LACDPW	Los Angeles County Department of Public Works
LADWP	Los Angeles Department of Water and Power
mgd	million gallons per day
MTBE	methyl tertiary butyl ether
MWA	The Mojave Water Agency
MWD	The Metropolitan Water District of Southern California
NDMA	nitrosodimethylamine
OCWD	Orange County Water District
QSA	Quantification Settlement Agreement
RWQCB	Regional Water Quality Control Board
SAWPA	Santa Ana Water Project Authority
SBVMWD	San Bernardino Valley Municipal Water District
SCCWRRS	Southern California Comprehensive Water Reclamation and Reuse Study
SWRCB	State Water Resources Control Board
SDCWA	San Diego County Water Authority
SWP	State Water Project
TDS	total dissolved solids
USBR	United States Bureau of Reclamation
VOCs	volatile organic compounds
WBMWD	West Basin Municipal Water District

Figure 5-3 South Coast region water balance for water years 1998, 2000, 2001



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

Board (SWRCB), which estimated that recycled municipal water delivery was about 275,000 acre-feet per year in Southern California. According to the MWD's 2003 Annual Progress Report, about 204,000 acre-feet of recycled water was developed within its service area in fiscal year 2003. By the year 2010, MWD expects that its service area will produce about 410,000 acre-feet of water through water recycling, groundwater recovery, or seawater desalination.

West Basin Municipal Water District (WBMWD), the largest water recycler in the region, has developed more than 31,000 acre-feet of recycled water. Within the San Diego County Water Authority (SDCWA) service area there is roughly 13,000 acre-feet per year of incidental groundwater recharge resulting from wastewater disposal operations, of which 95 percent is used for agriculture and landscape irrigation.

Water use efficiency measures, which are partnering wastewater treatment agencies with wholesale and retail water districts, will continue to have important impacts on the region's supplies and demands. A combination of active and passive measures has contributed to decreases in urban demands in the region. Recent examples of active water use efficiency programs include the installation of ultra-low-flush toilets and other water efficient appliances for residential, industrial, and institutional uses and the promotion of water efficient landscaping and irrigation. Even greater water supply savings are being achieved from passive water use efficiency measures. Passive water measures involve changes in the water code that require manufacturers to offer customers water-saving devices. MWD reports that its member agencies have urban programs that conserve about 65,000 acre-feet annually through active programs, and inclusion of passive conservation measures would make the total savings much larger.

About 15 percent of the South Coast region's developed water is used for agricultural activities. The sources of water supplies that are available for irrigation operations differ throughout the region. Groundwater is the primary source of water for the agricultural activities on the coastal plain of Ventura County. In the middle segment of the region, combinations of groundwater and imported water are used. In the southern portion, primarily San Diego County, imported water supplies and a small amount of local surface water are the primary sources.

MWD initiated several agricultural water conservation and transfer programs, including a program with the Imperial Irrigation District (IID) that conserved 105,130 acre-feet in 2003 and a crop rotation and water supply program with Palo Verde Irrigation District that saved about 186,000 acre-feet of water from 1992 through 1994. In addition, SDCWA is in the initial stage of an agreement with IID in which IID delivers conserved water to SDCWA. SDCWA received 10,000 acre-feet in 2003 and 20,000 acre-feet in 2004. Thirty thousand acre-feet will be delivered in 2005, and deliveries will increase annually toward 200,000 acre-feet of conserved water by 2021.

In the major agricultural areas in the region, most on-farm irrigation operations remain very efficient. Farmers are continuing to use the latest equipment to handle crop irrigations and conserve water. Micro-jet sprinklers and drip emitters are being used for the irrigation operations of most citrus and subtropical fruit orchards in San Diego and Ventura counties. Although furrow systems are still in use, drip irrigation systems are also used to irrigate the fresh market vegetables produced in Ventura County.

The regional water balance table (Table 5-1) provides a detailed accounting for all of the water that enters and leaves the South Coast region. As shown in the table, the nonquantifiable water uses (Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, etc.) are about the same as total precipitation, and outflows to the ocean are relatively small. Imports are a large part of the applied water in the region. For comparison, Table 5-2 presents information on

Box 5-3 Water Use During Latter Stages of 1987-1992 Drought

During the latter stages of the 1987-1992 drought and for several years afterward, water supply deliveries and municipal and industrial uses for many retail water districts in the South Coast Hydrologic Region were slightly less than in the late 1980s. The City of Los Angeles, exemplifies this trend. For water year 1990, the city used 677.1 thousand acre-feet (taf) of water from various supplies. In 1998 and 2000, the totals were 596.7 taf and 679.5 taf, respectively. The increase in water supplies in 2000 was less than 1 percent over the 1990 quantities despite a net increase in the population served of more than 400,000.

Table 5-1 South Coast Hydrologic Region Water Balance Summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (205%)	2000 (72%)	2001 (92%)
Water Entering the Region			
Precipitation	20,873	7,522	9,327
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	1,081	1,296	1,250
Imports from Other Regions	1,286	1,695	1,255
Total	**23,240**	**10,513**	**11,832**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	1,468	1,819	1,628
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	0	0	0
Statutory Required Outflow to Salt Sink	0	0	0
Additional Outflow to Salt Sink	2,110	2,498	2,325
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	20,514	7,441	8,947
Total	**24,092**	**11,758**	**12,900**
Storage Changes in the Region			
[+] Water added to storage			
[–] Water removed from storage			
Change in Surface Reservoir Storage	372	128	332
Change in Groundwater Storage **	-1,224	-1,373	-1,400
Total	**-852**	**-1,245**	**-1,068**

Applied Water * (compare with Consumptive Use)	4,184	5,041	4,633

***Footnote for applied water**

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

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

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

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

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

Table 5-2 South Coast Hydrologic Region water use and distribution of dedicated supplies - TAF

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	165.7			242.8			187.5		
Commercial	699.5			914.1			885.5		
Industrial	186.0			209.8			209.8		
Energy Production	39.8			39.8			39.8		
Residential - Interior	1,593.9			1,795.9			1,654.3		
Residential - Exterior	776.1			891.8			860.0		
Evapotranspiration of Applied Water		941.8	941.8		1,134.6	1,134.6		1,047.5	1,047.5
E&ET and Deep Perc to Salt Sink		518.1	518.1		594.5	594.5		570.1	570.1
Outflow		1,678.1	1,678.1		1,976.7	1,976.7		1,850.2	1,850.2
Conveyance Applied Water	160.0			154.6			153.0		
Conveyance Evaporation & ETAW		160.0	160.0		154.6	154.6		153.0	153.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**3,621.0**	**3,298.0**	**3,298.0**	**4,248.8**	**3,860.4**	**3,860.4**	**3,989.9**	**3,620.8**	**3,620.8**
Agriculture									
On-Farm Applied Water	691.9			908.4			758.4		
Evapotranspiration of Applied Water		494.8	494.8		645.8	645.8		542.9	542.9
E&ET and Deep Perc to Salt Sink		11.2	11.2		15.0	15.0		12.3	12.3
Outflow		100.1	100.1		135.1	135.1		110.1	110.1
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**691.9**	**606.1**	**606.1**	**908.4**	**795.9**	**795.9**	**758.4**	**665.3**	**665.3**
Environmental									
Instream									
Applied Water	3.5			3.5			3.5		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Wild & Scenic									
Applied Water	284.2			34.3			108.2		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	31.2			38.1			37.2		
Evapotranspiration of Applied Water		31.2	31.2		38.1	38.1		37.2	37.2
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	31.2	31.2	31.2	38.1	38.1	38.1	37.2	37.2	37.2
Total Environmental Use	**318.9**	**31.2**	**31.2**	**75.9**	**38.1**	**38.1**	**148.9**	**37.2**	**37.2**
TOTAL USE AND OUTFLOW	**4,631.8**	**3,935.3**	**3,935.3**	**5,233.1**	**4,694.4**	**4,694.4**	**4,897.2**	**4,323.3**	**4,323.3**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	292.1	292.1	292.1	211.4	211.4	211.4	217.1	217.1	217.1
Local Imported Deliveries	442.0	442.0	442.0	294.0	294.0	294.0	272.0	272.0	272.0
Colorado River Deliveries	1,081.3	1,081.3	1,081.3	1,296.0	1,296.0	1,296.0	1,250.5	1,250.5	1,250.5
CVP Base and Project Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Federal Deliveries	4.2	4.2	4.2	0.6	0.6	0.6	0.0	0.0	0.0
SWP Deliveries	687.7	687.7	687.7	1,300.1	1,300.1	1,300.1	958.7	958.7	958.7
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	1,223.5	1,223.5	1,223.5	1,372.5	1,372.5	1,372.5	1,400.0	1,400.0	1,400.0
Deep Percolation of Surface and GW	408.8			500.9			462.2		
Reuse/Recycle									
Reuse Surface Water	287.7			37.8			111.7		
Recycled Water	204.5	204.5	204.5	219.8	219.8	219.8	225.0	225.0	225.0
TOTAL SUPPLIES	**4,631.8**	**3,935.3**	**3,935.3**	**5,233.1**	**4,694.4**	**4,694.4**	**4,897.2**	**4,323.3**	**4,323.3**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

the developed and dedicated components of the total supply, which is a summary of water that is actively stored, managed and used for urban, agricultural and environmental purposes.

State of the Region

Over the past decade, the region has improved water supply reliability in the face of reduced imported supplies from the Owens Valley and Mono Basin and reduced uncertainty regarding the amount of imports available from the SWP (see Box 5-4). Water agencies have been proactive in continuous planning to manage the changing water supply and demand conditions in the region. While dependent on imported water for at least 50 percent of its water supplies, the region's water agencies have compiled a wide range of water management tools and water planning practices designed to improve and optimize local water resources in relation to the imported water needs.

Challenges

Like many regions in the state, water quality and water supply challenges are intertwined. The South Coast region must manage for uncertainties caused by population and economic growth. Growth will not only affect demand, but it will add contamination challenges from increases in wastewater discharges and urban runoff, as well as increased demand for water-based recreation. Outside the region, environmental and water quality needs in the Delta and Owens River/Mono Basin systems affect imported water supply reliability and quality. The region must also assess and plan for impacts of climate variations and global climate change, as well as the cost of replacing aging infrastructure.

Given the size of the region and the diverse sources of water supply, the challenges to the region's water quality are varied. Surface water quality issues in the South Coast are dominated by storm water and urban runoff, which contribute contaminants (including trash) to local creeks and rivers. These pollutant sources, as well as sanitary sewer overflows, ocean outfalls, tidal input, and even wildlife, can degrade coastal water quality, closing beaches and increasing the health risks from swimming. These sources also specifically affect water quality in the major bays—Santa Monica, Newport, and San Diego. Newport Bay, for instance, suffers from algal blooms (due to excess nutrients), toxicity to aquatic life, high bacterial counts, and sedimentation. Shipping can also influence water quality, especially at the U.S. Navy base in San Diego Bay and the Long Beach and Los Angeles harbors, where there are toxic sediment hot spots. Harbors, marinas, and recreational boating threaten water quality via ballast water discharges, which can introduce invasive species, petroleum and sewage discharges and spills, biocides from boat hulls, boat cleaning and fish wastes, trash, and reduced water circulation. The South Coast Wetlands Recovery Project works to restore wetland habitat and eradicate exotic species in many watersheds of the region. Several dedicated wildlife and ecological reserves are located along the South Coast as well.

Constructed wetland projects in Hemet/San Jacinto, San Diego Creek, and Prado Basin remove large loads of nitrogen from wastewater and urban runoff. Salinity, nitrogen, and microbes are the major contaminants in the Santa Ana River, affecting downstream beneficial uses such as swimming and groundwater recharge for domestic use. Because of upstream irrigation diversions, flows in the middle and lower Santa Ana River are composed mostly of recycled water, creating a year-round flow that is high in salinity. The Santa Ana River suffers as well from an invasive exotic species, the giant reed Arundo donax. Other nonnative, invasive species of concern in this region include the marine alga Caulerpa taxifolia along the San Diego coast, and salt cedar (Tamarix sp.) in various streams and rivers; both, like Arundo donax, have the potential to wreak havoc with native ecosystems (see Box 5-5).

Box 5-4 SWRCB Decision 1631

In 1994, State Water Resources Control Board adopted Water Right Decision 1631 amending the City of Los Angeles' water rights for diverting water from the Mono Basin. The decision restricts diversions from the basin in order to increase and maintain Mono Lake's level to 6,391 feet above sea level. During the period of Mono Lake's transition to the 6,391-foot level (estimated to take about 20 years), the maximum amount of water that Los Angeles can divert from the basin is 16 thousand acre-feet per year. Long-term Los Angeles diversions from the Mono Basin are projected to be about 31 thousand acre-feet per year after Mono Lake has reached the 6,391-foot level, or one-third of the city's historical diversions from the Mono Basin.

Lake Elsinore, the largest natural freshwater lake in southern California, experiences nuisance algae blooms from excess nutrients, impairing its ecological and recreational beneficial uses. Local groups have implemented many wetland and river restoration projects to improve water quality, for example, at Bolsa Chica and in Ballona Creek, as well as along the Los Angeles and San Gabriel rivers. The United States and Mexico jointly built the International Wastewater Treatment Plant to treat a portion of the sewage from Tijuana, which flows across the international boundary into the San Diego Basin.

The Chino Basin hosts the highest concentration of dairy animals in the United States. In a 40 square-mile area, well over 300,000 animals are maintained on about 300 dairies. Because of a lack of sufficient land to dispose of manure, as well as flooding from expanding suburban development, dairy runoff contributes nitrate, salts, and microorganisms to groundwater as well as surface water. Since 1972, the Santa Ana Regional Water Quality Control Board (RWQCB) has issued waste discharge requirements to the dairies in this basin. In addition, pilot projects to develop sewer systems for dairies and for treating dairy wash water have also recently been completed. Water utilities can use desalters to recover groundwater from brackish aquifers such as the Chino Basin, but only if they have access to a regional brine line (the Santa Ana River Interceptor in this area). Groundwater quality in this basin is integrally related to the surface water quality downstream in the Santa Ana River, which in turn serves as a source for groundwater recharge in Orange County. Orange County Water District and to the north West Basin Municipal Water District operate groundwater injection programs to form hydraulic barriers, to protect aquifers from seawater intrusion.

Public health and environmental and economic concerns have grown with the expansion of water recycling programs in the South Coast region. Some concerns are related to the total dissolved solids (TDS) content of wastewater and the presence in treated wastewater of pharmaceuticals, household products, and other emerging contaminants. The high salinity of imported Colorado River water limits the number of times water can be reused before the salt content becomes too high and wastewater can only be discharged to the ocean. Increased use of recycled water and marginal quality groundwater supplies during droughts can result in water quality problems for some local supplies that endanger future water management projects. For instance, groundwater recharge potential may be restricted because the RWQCB has established TDS requirements for recharge water in some groundwater basins in order to protect existing basin water quality.

The average TDS concentration of MWD's CRA water is about 600 to 700 mg/L, and the average TDS content of SWP supplies is about 300 mg/L. The water supply from the LAA has a significantly lower TDS concentration, typically about 160 mg/L. TDS levels in local groundwater supplies in the region vary considerably, ranging from 200 mg/L (Cucamonga Basin near Upland) to more than 1,000 mg/L (Arlington Basin near Corona). Local water uses also contribute significantly to overall salinity levels. For example, municipal and industrial use of water adds between 250 and 500 mg/L of TDS to wastewater. Key sources of local salts include water softeners (typically contributing from 5 to 10 percent of the salt load) and industrial processes.

The long-term salt balance of the region's groundwater basins is an increasingly critical management issue. Smaller basins like the Arlington and Mission groundwater basins were abandoned as municipal supplies because of high salinity levels. Some of these basins have only recently been restored through brackish water desalting projects. The Mission Basin has not been restored, but water is being recovered and treated to drinking water standards by the City of Oceanside's Mission Basin Groundwater Repurification Facility. Blending SWP and CRA supplies, or using the SWP's relatively low TDS supplies for groundwater replenishment, is a strategy in some areas. However, some inland water districts that use recycled water

Box 5-5 Two Examples of Ongoing Ecosystem Restoration

The Matilija Dam Ecosystem Restoration Feasibility Study evaluated alternatives and has provided a draft recommendation for removing the 160-foot high dam, including stored sediment, to restore the Ventura River ecosystem. The Public Draft Report was released in July 2004.

The Santa Ana River Trail and Parkway Project includes planning of recreational uses that showcase the river and provide a place for people to enjoy this important resource.

have salt accumulation problems in their groundwater basins because they lack an ocean outfall or stream discharge. To dispose of these salts, some districts have developed access to a brine pipeline that exports salt and concentrated wastes to a coastal treatment plant and ocean outfall. However, there are situations where agencies have not constructed a brine pipeline due to the high cost of this alternative.

Beyond salinity, several established and emerging contaminants of concern to the region's drinking water supplies include disinfection byproducts (DBPs), perchlorate, arsenic, nitrosodimethylamine (NDMA), hexavalent chromium, and methyl tertiary butyl ether (MTBE). Historically, industrial solvents have extensively impacted the groundwater underlying the San Gabriel Valley. Imported water from the Owens Valley is of excellent water quality, and imported Delta water quality is generally good. Nonetheless, arsenic is a concern in the Owens Valley supply, and Delta water can contain precursors (such as organic carbon and bromide) of potentially carcinogenic DBPs, if treated with certain disinfection processes necessary to inactivate pathogens in drinking water.

Perchlorate, a component of rocket fuel that can disrupt thyroid gland function, has particularly impacted the groundwater in Pasadena and the Rialto-Colton-Fontana region. Perchlorate is also a concern in Colorado River water, largely due to contamination from inactive ammonium perchlorate manufacturing facilities in Nevada. Perchlorate contamination of wells in the San Gabriel Valley, which resulted in the deactivation of many of these wells, has led to testing of ion exchange technologies for the removal of this constituent.

Naturally occurring arsenic, a known human carcinogen, is another contaminant of concern, present in the LAA supply as well as local aquifers. The City of Los Angeles currently manages arsenic concentrations in the LAA water through treatment. In Southern California, local water sources with high arsenic levels are found in Los Angeles, San Bernardino, and Riverside counties.

NDMA, a probable human carcinogen, is associated with the production of rocket fuel and the manufacture of explosives, paints, and other industrial goods. Contamination of surface water and groundwater by NDMA at missile and rocket fuel manufacturing and storage sites is a significant concern, particularly for groundwater supplies. NDMA can also be formed during the treatment of wastewater, which is a threat to aquifers that are recharged with reclaimed wastewater and later used for drinking water.

Groundwater contamination by hexavalent chromium, a suspect carcinogen better known as chromium 6, in the Los Angeles basin and elsewhere, has resulted from its use in various industries including aerospace and plating. In Los Angeles County, Los Angeles RWQCB staff is overseeing the ongoing assessment and cleanup of sites impacted by hexavalent chromium at defense-related businesses and manufacturing and other industrial sites.

MTBE and other oxygenates have been added to gasoline in areas with severe air pollution to help gasoline burn more cleanly and comply with federal law. Unfortunately, MTBE can also contaminate groundwater supplies when pipelines, fuel tanks, and other containers or equipment leak, when fuel is spilled, and when unburned fuel is discharged from watercraft. The high mobility and low biodegradability of MTBE present a significant risk to aquifer supplies. MTBE has been widely detected in South Coast groundwater, surface water, and imported water supplies. In particular, MTBE contamination forced the closure of more than half of Santa Monica's water supply wells and made the city more dependent upon imported water supplies and treatment systems. California has recently phased out MTBE from its gasoline supplies. As of January 1, 2004, California refineries no longer blend MTBE into gasoline. Ethanol is now used as the primary oxygenate in areas requiring oxygenate additives under federal law.

The 198-foot-high Matilija Dam in Ventura County has lost most of its water supply and flood control benefits due to sediment deposits. Originally built in 1947 to store up to 7,018 acre-feet of water, siltation has reduced its effective storage capacity to about 500 acre-feet. Moreover, the Matilija Dam has had adverse effects on the ecosystem of the Ventura River watershed, which supports several threatened and endangered species. The structure blocks riparian and wildlife corridors between the Ventura River and Matilija Creek. By trapping sediment that would otherwise be carried downstream, the dam also contributes to the long-term erosion of estuaries and beaches along the Ventura River.

The Matilija Dam Ecosystem Restoration Feasibility Study, a joint study by the Ventura County Watershed Protection District and the U.S. Army Corps of Engineers, is one of the largest dam removal studies ever undertaken in the United States. The study recommended the dam's removal in its July 2004 public draft report and environmental impact statement/environmental impact report. However, there are disputes over rights to the remaining water supply. The Casitas Municipal Water District, which leases the dam, pipeline, and rights to the dam's water from the Ventura County Watershed Protection District, is concerned with how this lost water supply to Casitas will be recovered once the Matilija Dam and reservoir are removed. Studies and discussions are continuing in order to develop solutions for the water supply impacts that could result from removal of this dam.

California's use of Colorado River water is being managed to ensure that the state reduces the use of this water from a high of 5.3 million acre-feet in previous years to its 4.4 million acre-feet annual apportionment. Until 2016, California may receive interim surplus water from the river depending on the storage level in Lake Mead. The Colorado River Board of California developed the basic plan, called California's Colorado River Water Use Plan or the "4.4 Plan," that outlines steps to reduce the state's use of Colorado River water. Those steps include a water transfer of conserved water from IID to SDCWA, the lining of the All-American and Coachella Canals, water storage and conjunctive use programs, water exchanges, improved reservoir management, salinity control, watershed protection, water reuse, and other measures. The signing of the Quantification Settlement Agreement (QSA) in 2003 enabled implementation of the 4.4 Plan (see Box 5-6).

Drought is a constant concern for water districts in the region. This has led to an emphasis on the development of local supplies and demand management strategies. Today, about 50 percent of Southern California's demand is being met through such local supplies as water conservation, recycling, and groundwater recovery. The uncertainty caused by scientific findings on climate change also has caused water agencies to question the reliability of imported sources.

Groundwater overdraft and lower groundwater levels are challenges to the region. Historically, agricultural, industrial, and urban development has led to increased groundwater pumping from many of the region's basins. In some basins over-extraction of groundwater has caused seawater intrusion, contributed to land subsidence, and resulted in legal disputes over pumping rights within specific basins.

Accomplishments

The region has developed a diverse water portfolio that is balanced between local and imported supplies. The primary objectives of the region's water agencies are to provide high quality, reliable, and affordable water. To achieve these objectives, local water districts have built additional facilities to increase surface storage and water transmission capacities. They have also implemented a variety of resource management strategies to increase the efficiencies of agricultural and urban water uses, utilize recycled water, groundwater conjunctive use, groundwater remediation, brackish water desalination, drinking water treatment, watershed management, groundwater banking, and water transfers from outside the region.

Box 5-6 Key Elements of California's Colorado River Quantification Settlement Agreement

The California Colorado River Quantification Settlement Agreement and related agreements will have the following effects:

- Permit the utilization of interim surplus water.
- Transfer as much as 30 million acre-feet of water from farms to cities in Southern California for up to the 75 year term of the agreement.
- Settle potential lawsuits between the Imperial Irrigation District and the U.S. Department of the Interior.
- Obligate California with the sole responsibility for restoration of the Salton Sea ecosystem.
- Provide for cooperation on the environmental review and mitigation for the Imperial Irrigation District/ San Diego County Water Authority Transfer Agreement, IID/ Coachella Valley Water District Acquisition Agreement, and Salton Sea habitat conservation plan/natural community conservation plan.
- Fund a $200 million project to line with concrete a portion of the earthen All-American Canal and a portion of the earthen Coachella Canal. Water conserved by reducing seepage will be transferred to San Diego and the San Luis Rey Indian Tribes, who will pay proportionally for operation and maintenance costs.
- Quantify, for the first time, the total Colorado River apportionments in California.

These diversified strategies guide the management of available resources in a manner that allows greater flexibility when adapting to water quality and supply challenges.

MWD built Diamond Valley Lake in the late 1990s to better manage water supplies between wet and dry years. Located near Hemet in southwestern Riverside County, the 800,000 acre-foot reservoir nearly doubles the region's existing surface storage capacity and provides increased terminal storage for SWP and Colorado River water. Diamond Valley Lake can also provide the MWD service area with a six-month emergency water supply after an earthquake or other disaster. It also provides water storage for drought protection and to meet peak summer demands.

The SDCWA finished construction of Olivenhain Reservoir in 2003 and completed filling its 24,000 acre-foot capacity with imported water in 2005. The reservoir, just southwest of Escondido in northern San Diego County, is designed to provide water to the San Diego region during natural or man-made emergencies. It is the first project completed in the SDCWA Emergency Storage Program.

The Inland Feeder is a conveyance facility for delivery of SWP water made available by the enlargement of the East Branch of the California Aqueduct (Figure 5-4). When it is completed, the Inland Feeder will deliver water by gravity to Diamond Valley Lake through 43.7 miles of tunnels and pipeline that start at Devil Canyon afterbay and tie into the CRA and Eastside Pipeline. The Inland Feeder will provide system reliability by linking the SWP and Colorado River systems and will improve water quality by allowing greater blending of SWP and Colorado River waters.

Figure 5-4 MWD inland feeder

The Inland Feeder will provide system reliability by linking the State Water Project and Colorado River systems and will improve water quality by allowing greater blending of SWP and Colorado River waters.

A recent agreement between MWD and SBVMWD allows MWD to purchase additional SWP water for blending with Colorado River water, and to store this water in the San Bernardino groundwater basin. This new groundwater supply also helps to resolve long-standing groundwater issues in the basin. The San Gorgonio Pass Water Agency recently extended the pipeline east from Mentone bringing SWP water to Beaumont.

On Oct. 10, 2003, representatives from MWD, SDCWA, IID, and Coachella Valley Water District (CVWD) signed the Quantification Settlement Agreement (QSA) and several other agreements that will execute several key components of the Colorado River Water Use Plan including establishing water budgets from IID and CVWD and making water transfers viable (see Box 5-5). The QSA includes a water transfer from IID to SDCWA, which began in 2003 and eventually will provide up to 200,000 acre-feet per year to San Diego County. The transfer will help increase water supply reliability for the South Coast Region.

In 2003, the SDCWA and IID consummated the largest water transfer agreement in the history of the United States. This transfer, which will eventually move 200,000 acre-feet of conserved water by farmers in the Imperial Valley annually to San Diego County, has helped reduce SDCWA's dependence on MWD and diversified its sources of imported water. The initial term of the agreement is for 45 years; a 30-year extension is possible with the mutual consent of both parties. In addition, SDCWA will gain an additional 77,000 acre-feet of water per year through projects it will undertake to line the All-American and Coachella canals to stop water loses that occur because of seepage. This program has a 110-year term.

State agencies, including DWR, SWRCB, and the California Bay-Delta Authority (CBDA), and the U.S. Bureau of Reclamation (USBR) are making major statewide investments in urban and agricultural water conservation programs, which regional and local agencies leverage with their own investments to reduce demands. As discussed in previous sections, additional demand reduction is achieved through passive conservation measures as a result of changes in manufacturing codes.

An example of this regional leveraging is MWD's water conservation program with its member agencies. Since 1992 Metropolitan has invested more than $191 million in conservation programs and related activities. In 2003 MWD implemented a new rate structure that includes a funding source dedicated to water conservation, recycling, groundwater recovery, and other local projects. The backbone of MWD's conservation program is the Conservation Credits Program, initiated in 1988, that contributes $154 per acre-foot of water conserved to assist member agencies in pursuing conservation opportunities. In tandem with these urban conservation efforts, MWD and IID entered into the 1988 IID/MWD Water Conservation Agreement and Approval Agreement. This agricultural water savings program began in 1990, and to date MWD has invested more than $200 million to construct, operate, and maintain projects with IID intended to conserve more than 100,000 acre-feet of water every year which can be transferred to MWD. In 2005 water savings from this program were calculated at 101,900 acre-feet.

Palo Verde Irrigation District and MWD have a 35-year agreement for a land management, crop rotation, and water supply program, under which Palo Verde farmers will stop irrigating between 7 to 29 percent of their land, on a rotating basis. This land fallowing program is estimated to produce between 24,500 acre-feet per year up to 110,000 acre-feet per year for use in Southern California. MWD will provide an estimated $6 million to local community improvement programs to counter potential negative economic impacts to communities in the Palo Verde region.

More than $440 million, primarily from State Propositions 13 and 50 and federal Title XVI grants, have been invested in water recycling programs in the region, resulting in over 500,000 acre-feet of water available per year, including Orange County Water District's (OCWD) current reuse of Santa Ana River water. The growth in recycled water is expected to be about 400,000 acre-feet over the next decade.

OCWD and Orange County Sanitation District's new Groundwater Replenishment System is designed to increase current water reuse by taking treated sewer water that is currently being released into the ocean and purifying it through microfiltration, reverse osmosis, and ultraviolet light with hydrogen peroxide advanced oxidation treatment. The purified water will then be injected into a seawater barrier and pumped to percolation ponds to seep into deep aquifers and blend with Orange County's other sources of groundwater. This Groundwater Replenishment System is projected to begin delivery of purified water in 2007, with potential for future expansion as needed.

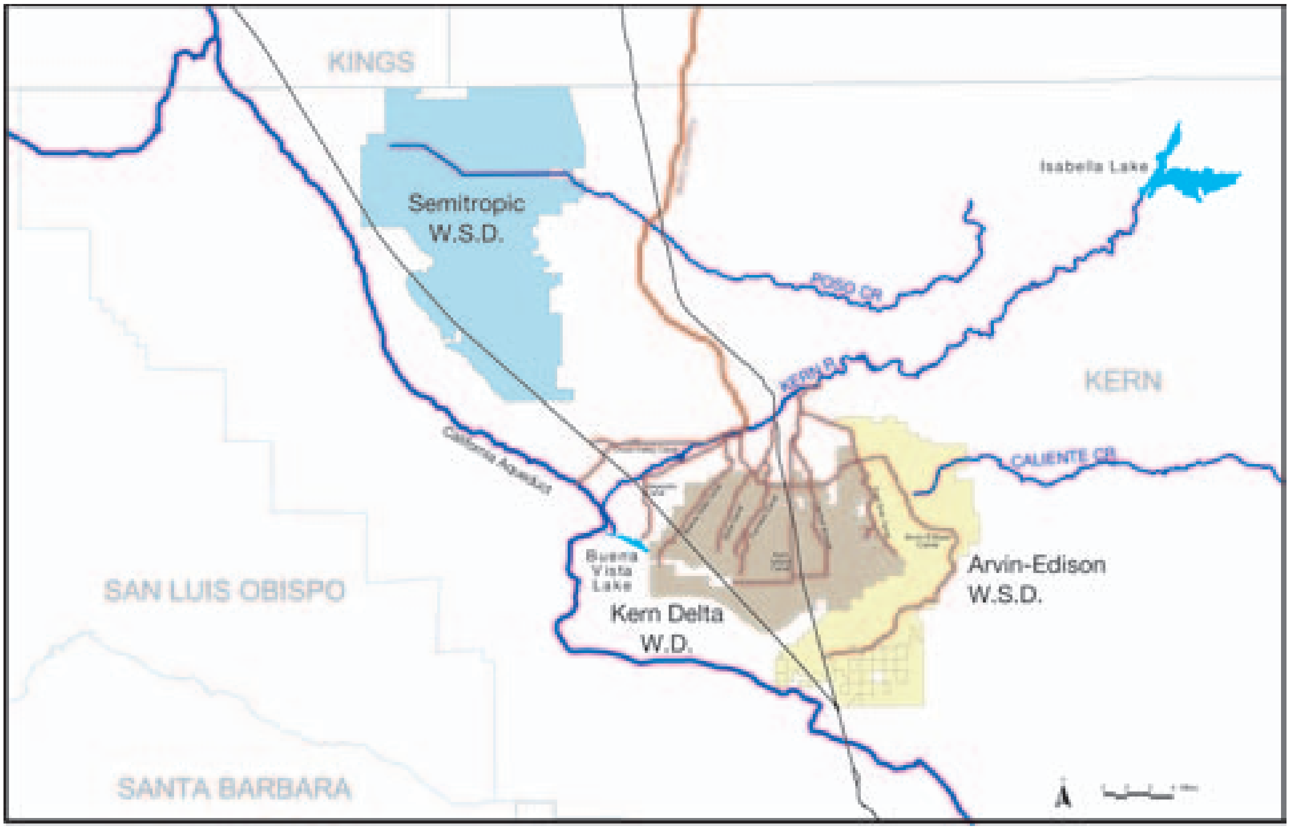
The development of groundwater storage and conjunctive use programs has improved the region's water supply reliability and overall water quality. A 2000 study by the Association of Groundwater Agencies indicates that existing conjunctive use programs in the region provide an estimated 2.5 million acre-feet of water per year, which is a fraction of the region's conjunctive use potential. It is estimated that more than 21.5 million acre-feet of additional water could be stored and used in Southern California groundwater basins with the resolution of institutional, water quality, and other issues. State agencies have supported the development of 34 groundwater management and storage projects throughout the region.

As a result of MWD's replenishment services pricing program, local agencies are implementing conjunctive use programs. They are storing imported water in groundwater basins and increasing their groundwater use during the summer and during drought years. It is estimated that an average of 100,000 acre-feet per year of groundwater supply is now produced as a result of MWD's discount pricing of water deliveries. MWD has identified the potential for 200,000 acre-feet of additional groundwater production during drought years. To accomplish this additional drought year production, about 600,000 acre-feet of dedicated storage capacity within the local basins may be required.

An example of this type of conjunctive use program is the Las Posas Basin Aquifer Storage and Recovery Project. The Calleguas Municipal Water District, in cooperation with MWD, has initiated a conjunctive use program in the Las Posas Groundwater Basin of Ventura County. The project is designed to store a maximum of 210,000 acre-feet of SWP water supplies that can be used during water supply shortages. The project will be phased into operation with full operation anticipated by 2010. To date, 18 wells have been constructed and about 50,000 acre-feet of water is in groundwater storage.

Recent groundwater storage agreements allow additional storage in wet years. Groundwater agreements to be implemented in the region have the potential to put more than 53-billion gallons of water into storage in Orange County, the west San Gabriel Valley, and the Inland Empire area. Groundwater storage can also be accumulated outside of the South Coast Hydrologic Region. MWD has recently developed water storage agreements with the Kern-Delta Water District, the Mojave Water Agency, and the North Kern Water Storage District, all located outside of the region. These groundwater storage programs are in addition to existing exchange agreements with the Semitropic Water Banking and Exchange Program

Figure 5-5 MWD storage agreements with San Joaquin Valley agencies



MWD recently developed water storage agreements with the Kern-Delta Water District, the Mojave Water Agency, and the North Kern Water Storage District, all located outside of the region. These groundwater storage programs are in addition to existing exchange agreements with the Semitropic Water Banking and Exchange Program in Kern County, the Arvin-Edison Water Storage Program in Kern County, and the Kern-Delta Storage Program

in Kern County, the Arvin-Edison Water Storage Program in Kern County, and the Kern-Delta Storage Program (see Figure 5-5). Castaic Lake Water Agency has also entered into a short-term groundwater banking arrangement with Kern County.

Groundwater quality issues are being identified and addressed at many locations throughout the region. In the San Gabriel Valley, the Main San Gabriel Basin Watermaster, San Gabriel Basin Water Quality Authority, Upper San Gabriel Valley Municipal Water District, and a number of water suppliers have actively pursued technical remedies for the groundwater quality problems. Several treatment facilities for removal of volatile organic compounds (VOCs) were first constructed in the 1990s. As of June 2002, 18 treatment facilities are operational. Groundwater supplies with high nitrate levels are either blended with other supplies or not used at all. Similar cleanup efforts are being pursued in the San Fernando Basin by the Los Angeles Department of Water and Power (LADWP) and the cities of Burbank and Glendale. Several groundwater desalting plants are currently operated by the Santa Ana Water Project Authority (SAWPA), Chino Basin Desalting Authority, city of Corona, Eastern Municipal Water District, Irvine Ranch Water District, the city of Oceanside, West Basin MWD, and the Sweetwater Authority. Brackish groundwater desalting currently delivers about 100,000 acre-feet of water per year, and will increase to about 250,000 acre-feet during the next decade. State Proposition 13 water bond funding is being utilized to expand desalting capacity in the region.

The SAWPA is a joint powers authority in the eastern portion of the region. It represents five agencies in the counties of Orange, Riverside, and San Bernardino and covers a watershed area of 2,650 square miles. It provides effective and focused watershed planning on a regional basis.

SAWPA operates a brine disposal line and the Arlington Desalter, which facilitates disposal of waste brine from regional desalting plants. SAWPA has been particularly successful in recent years in assisting its member agencies in implementing several new water resources projects that enhance groundwater recovery, groundwater storage, water quality improvement and water recycling through the use of Proposition 13 Water Bond funding. About 20 potential groundwater recovery projects have been evaluated with a potential net water yield of 95,000 acre-feet per year.

The Port Hueneme Water Agency was formed to develop and operate a brackish water desalting demonstration facility for its member agencies in western Ventura County. Its goals are to improve the quality and reliability of local groundwater supplies and decrease seawater intrusion in the Oxnard Plain. The facility will provide a full-scale demonstration of side-by-side operation of three brackish water desalting technologies: reverse osmosis, nanofiltration, and electrodialysis reversal.

Increasingly, the region's water wholesalers, such as Castaic Lake Water Agency, SBVMWD, Mojave Water Agency (MWA), MWD, and SDCWA are acquiring part of their future supplies from water marketing or exchange arrangements, using the CRA and California Aqueduct to convey the exchanged or purchased water.

An agreement in late 2003 between MWA and MWD calls for the exchange of 75,000 acre-feet of SWP flow from the California Aqueduct. Under this accord, MWA received about 23,000 acre-feet of MWD's State-authorized flow through the California Aqueduct at the end of year 2003. Additional water exchanges through this agreement will depend on the amount of rain or snowfall available to the SWP. Water will be stored in the high desert's underground aquifers to help replenish the water table, prevent well-deepening by residents, and meet future needs.

The South Coast region has placed an increased emphasis on improving watershed management and protection. Local, State, and federal agencies and nonprofit organizations have invested in several management efforts, including watershed education, monitoring, and wetlands management and protection. More than 40 entities are generating new partnerships and coalitions among various stakeholders in attempts to integrate elements of flood hazard mitigation, groundwater and storm water conservation, and management of the quality of storm water runoff, to better manage resources. Below are a few examples of the region's watershed programs:

- SAWPA, the largest watershed organization, was established to protect and enhance the quality and supply of the watershed and protect the environment by implementation of its watershed plan.
- Under the guidance of the Los Angeles County Department of Public Works, watershed management plans are being developed for five coastal watersheds within Los Angeles County. Eleven watershed and subwatershed plans have been completed with eight pending or proposed plans under way, making Los Angeles County the most productive county in the state in terms of watershed planning.
- The Hemet/San Jacinto Multipurpose Constructed Wetlands is a collaborative project between the USBR and Eastern Municipal Water District. The wetland is nearly 60 acres with five interconnected marshes. It provides nitrogen removal of secondarily treated recycled water and habitat for migratory waterfowl, shore birds, and raptors along the Pacific Flyway.
- The San Diego Creek Watershed is operated by the Irvine Ranch Water District. The watershed program helps sustain a restored marsh and treats contaminated urban runoff water from San Diego Creek before it enters into Newport Bay in Orange County.
- OCWD operates the Prado Basin Wetland in Riverside County. In cooperation with the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service, OCWD operates 465 acres of constructed freshwater wetlands to reduce the nitrogen concentration of river water.

Looking to the Future

The region's water agencies generally have solid plans for adapting to changing conditions and meeting future water needs. For example, the 2004 Report on MWD's water supplies states, "Metropolitan has a comprehensive supply plan to provide sufficient supplemental water supplies and to provide a prudent supply reserve over the next 20 years and beyond." SAWPA has begun a 10-year integrated program to help, among other things, drought-proof the watershed, so it can roll off imported water for up to three years during drought years. The Chino Basin is one area that has developed an integrated conjunctive management program with the potential to develop 500,000 acre-feet of new storage over the next 20 years, including new yield from storm water management, SWP and recycled water recharge, and the implementation of aggressive water use efficiency programs. Water districts in the Santa Clarita Valley of Los Angeles County are engaged in integrated urban water management planning, collaborative data collection, and a new groundwater plan. These and other ongoing planning programs are important to manage changing conditions facing the region. Water conservation programs, water recycling, and groundwater recovery, as well as water marketing and other water supply augmentation responses are being examined and implemented.

The signing of the Quantification Settlement Agreement and related agreements in October 2003 facilitated long-term water transfers from the IID and CVWP in the Colorado River Hydrologic Region to urban water users in the South Coast Hydrologic Region. They will help California reduce its use of Colorado River water to its basic allotment of 4.4 million acre-feet during years of normal supply. They will also make possible the transfer of additional water to be obtained through lining the All American and the Coachella canals. The water transfer between IID and SDCWA will help to stabilize MWD's and CVWD's water supplies, satisfy outstanding miscellaneous and Indian water rights, and provide funding that IID and farmers in the Imperial Valley will use to implement additional water conservation measures once the required fallowing is complete.

MWD will continue its replenishment services water pricing program to encourage local agencies to store imported water in groundwater basins for use during the summer and during drought years. In addition, local agencies in the region are now planning to use water transfers for part of their base supplies, a change from past years when marketing arrangements were viewed as primarily for drought year supplies.

In 2004 MWD updated its Integrated Water Resources Plan with the revised goal of achieving 1.1 million acre-feet of region-wide conservation by year 2025. The plan proposes to achieve this water conservation target utilizing several programs, including 500,000 acre-feet from compliance with new plumbing codes and other laws, 250,000 acre-feet from pre-1990 conservation, and 300,000 from active program-based conservation.

Ocean water desalination is sometimes described as the ultimate solution to Southern California's water supply shortfall. While it has become a more feasible source of supply due to technical advances, the development of desalination facilities still faces many challenges that include high energy requirements, environmental impacts of brine disposal, and plant-siting considerations. State agencies have provided funding for the Desalination Research and Innovation Partnership, which furthered the development of advance reverse osmosis membranes.

MWD and five of its member agencies have planned for the potential development of 126,000 acre-feet of desalinated ocean water. Those member agencies include LADWP, Long Beach Water Department, Municipal Water District of Orange County, WBMWD, and SDCWA. The SDCWA expects desalted ocean water to meet between 6 and 15 percent of the region's needs by 2020 and is conducting an environmental review for building an ocean water desalination facility on the Encina Power Plant property in Carlsbad. SDCWA also is carrying out feasibility studies of desalination facilities at Camp Pendleton and in the southern county. All three sites are on the coast.

Another future water supply option is management of the San Bernardino Basin as a groundwater storage facility. The basin has a capacity of about 5.5 million acre-feet. Pursuant to the January 1969 settlement for Western Municipal Water District et al. vs. East San Bernardino Valley Municipal Water District et al. Superior Court Riverside County Case number 78426, the Western-San Bernardino Watermaster determined that the safe yield of the San Bernardino Basin is about 232,000 acre-feet per year. SBVMWD has been working with the U.S. Geological Survey for many years to develop a groundwater computer model that will enable the agency to determine ways to enhance the safe yield of this basin.

The Groundwater Replenishment System, a high-technology water purification system, is a project under development by the OCWD and the Orange County Sanitation District. It will replace Water Factory 21, which was shut down in January 2004 in anticipation of construction of this new, larger system. The project will take highly treated wastewater and treat it beyond drinking water standards for groundwater recharge and injection into the seawater barriers along the coast. It will provide a second and reliable source of water to recharge the Orange County Basin; protect the basin from further water quality degradation brought on by seawater intrusion; and augment the existing recycled water supply for irrigation and industrial uses. In its first phase, the Groundwater Replenishment System will provide up to 72,000 acre-feet per year and allow for future expansion. It is expected to go online in 2007.

Flood control reservoirs are now being evaluated for their potential to provide some water supply benefits through the modification of their operations to enhance groundwater recharge and provide limited year-round storage. The SBVMWD, for example, has applied to the SWRCB for authorization to store storm water from the Santa Ana River in a reservoir that could be created behind Seven Oaks Dam. Los Angeles County Department of Public Works (LACDPW) is completing a study, in cooperation with the Army Corps of Engineers, to reauthorize four Corps flood control facilities in Los Angeles County for the purpose of capturing and safely storing storm water and then slowly releasing the water to downstream groundwater recharge facilities after storm events.

The Water Augmentation Study is a long-term research project, led by the Los Angeles and San Gabriel Rivers Watershed Council and supported financially by its partners, the USBR, MWD, LACDPW, Los Angeles RWQCB, Water Replenishment District of Southern California, LADWP, City of Los Angeles Watershed Protection Division, DWR, and the city of Santa Monica. The purpose of the study is to explore the potential for increasing local water supplies and reducing urban runoff pollution by increasing the upstream infiltration of storm water runoff. The project began in January 2000 to assess the impact of runoff-transported pollutants on rivers, coastal water, and beaches; the viability of adding these storm water resources to local water supplies, and the challenge of capturing storm water for infiltration, in terms of groundwater quality and quantity.

In 2000, DWR, in cooperation with the USBR and 10 Southern California water and wastewater agencies, undertook the Southern California Water Recycling Projects Initiative to continue the work previously started by the Southern California Comprehensive Water Reclamation and Reuse Study (SCCWRRS). The initiative is a multiyear planning study that evaluates the feasibility of a regional water-recycling plan and assists local water and wastewater agencies in final planning and environmental documentation leading to implementation of projects identified in the SCCWRRS. The initiative is funded on a 50-50 percent cost-sharing among the 12 agencies. The initiative identified short-term projects that could add about 378,000 acre-feet of recycled water for regional use. The 15 short-term projects were identified for the areas of Calleguas, East San Gabriel, West Basin, Central Basin, North Orange County, Central Orange County, Upper Oso, San Juan, Encina, San Pasqual Valley, North City, South Bay, Chino Basin, San Bernardino, and Eastern Basin.

As part of a regional strategy to improve water supply reliability, several agreements with water districts in the Central Valley are providing groundwater storage for the South Coast region:

- Semitropic Water Banking and Exchange Program. This program allows storage of up to 350,000 acre-feet in the groundwater basin underlying the Semitropic Water Storage District in Kern County.
- Arvin-Edison Water Storage Program. MWD and the Arvin-Edison Water Storage District have developed a program that allows Metropolitan to store water in the groundwater basin in the Water Storage District's service area in Kern County. Over the next 25 to 30 years, this groundwater storage program will provide average dry-year withdrawals of about 70,000 acre-feet annually.
- Kern-Delta Storage Program. This 25-year program will allow storage of up to 250,000 acre-feet of available State Water Project supplies.

Other potential management strategies includes interstate groundwater banking in Arizona, drought year land fallowing programs, lining parts of the All-American and Coachella canals, and agricultural water conservation beyond EWMP implementation. In addition, South Coast region water agencies are storing discount-priced imported water during winter months into groundwater basins and increasing their groundwater use during the summer and during droughts.

The Calleguas Municipal Water District operates a conjunctive use program in the Las Posas Groundwater Basin of Ventura County. Identified as the Las Posas Basin Aquifer Storage and Recovery Project, it is designed to store a maximum of 300,000 acre-feet of water supplies that can be used during short-term and long-term water supply shortages. The project calls for the construction of 30 dual-purpose groundwater wells that will be used for both injection and water production. Pipelines will be constructed to connect the wells with CMWD facilities as far away as the Cities of Simi Valley and Thousand Oaks. The source of water supplies would be the State Water Project. The project will be phased into operation with full operation anticipated by 2010. To date, 18 wells have been built and about 50,000 acre-feet of water is in storage.

To improve the reliability of its potable water supplies during droughts, the Western Municipal Water District is moving forward with plans to operate a conjunctive use program in groundwater basins in western San Bernardino and Riverside counties. The project, the Riverside-Corona Feeder, calls for the recharge of water supplies during above-average precipitation years into the groundwater basins in San Bernardino Valley and pumping those supplies during drought years. Sources of water for the recharging operations would be local surface runoff, including releases from the Seven Oaks Reservoir near the community of Mentone in San Bernardino County and the SWP. Recipients of the stored groundwater supplies are the cities of Corona and Riverside and the Elsinore Valley Water District. When completed, 20 wells and 28 miles of pipeline will have been constructed. About 40,000 acre-feet of groundwater supplies could be achieved through this project.

Most of the projects described above are designed to improve water quality as the way to obtain increased water supplies. These include watershed activities, such as the Water Augmentation Study, groundwater desalination, use of highly treated recycled water by the OCWD, reduction of sewage spills and storm water runoff through water conservation, and surface and groundwater storage projects that implement blending and treatment strategies to reduce contaminants in treated drinking water supplies.

In addition, MWD is committed to retrofitting all five of its water treatment plants to use ozone; adding fluoride to treated drinking water supplies; implementing a recreation policy for Diamond Valley Lake that protects drinking water quality; and supporting salinity reduction projects throughout the region. Outside the region MWD also supports efforts to preserve and enhance the Sacramento River watershed and the Delta, which are important to the operation of the SWP system.

Water Portfolios for Water Years 1998, 2000, and 2001

Hydrologic conditions for water years 1998, 2000, 2001 impacted the water supply and water use characteristics for the South Coast Hydrologic Region. These three years were selected because 1998 represents actual supplies and uses in a very wet year, 2000 presents water uses in a near-average water year (on a statewide basis), and 2001 presents the actual data for supplies and uses in a drier water year. In water year 1998, rainfall totals ranged from 170 percent of average in San Diego County to more than 250 percent of average in Ventura County with more than 50 percent of the annual precipitation in January and February. In comparison, during water year 2000 rainfall totals ranged from 60 percent of average in San Diego County to more than 100 percent of average in Ventura County. Precipitation amounts for the region for water year 2000 were average to moderately below average. Rainfall deficits increased from north to south. Water year 2001 was a dry year statewide, although closer to normal levels of precipitation (92 percent of average) occurred for the South Coast region.

Table 5-1 provides more detailed information about the total water supplies available to this region for these three specific years from precipitation, imports, and groundwater, and also summarizes all of the water uses in the region, including the large amount of evapotranspiration from vegetation and forests. The water portfolio table (Table 5-3) and companion water portfolio flow diagrams (Figures 5-6 and 5-7) provided more detailed information about how all available water supplies are distributed and used throughout this region.

Table 5-3 presents specific information about the developed or dedicated portion of the total available water for years 1998, 2000, and 2001, which summarizes all water that is used for urban, agricultural, and environmental purposes. The South Coast region's relatively high level of urban development is reflected in the data for urban water use patterns. In 1998, 78 percent of all applied water use in the region was urban. In 2000 and 2001, urban use accounted for about 81 percent of total water use in regional. By contrast, agriculture only accounted for 15 percent of all applied water in 1998; 17 percent in 2000; and 15 percent in 2001. Table 5-3 also provides detailed information about the sources of the developed water supplies, which are obtained from a mix of both surface water, groundwater supplies, and recycled water.

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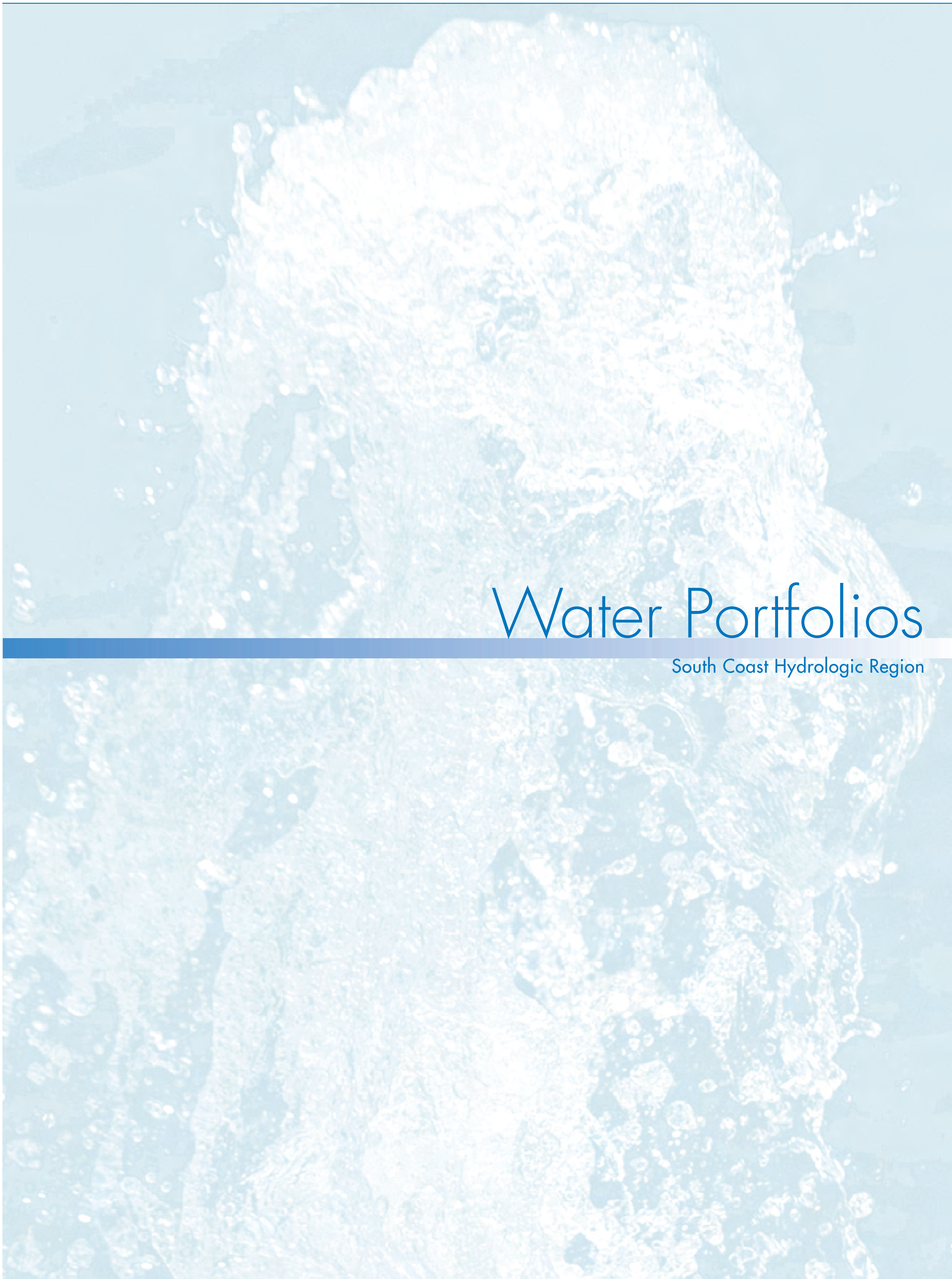


Water Portfolios

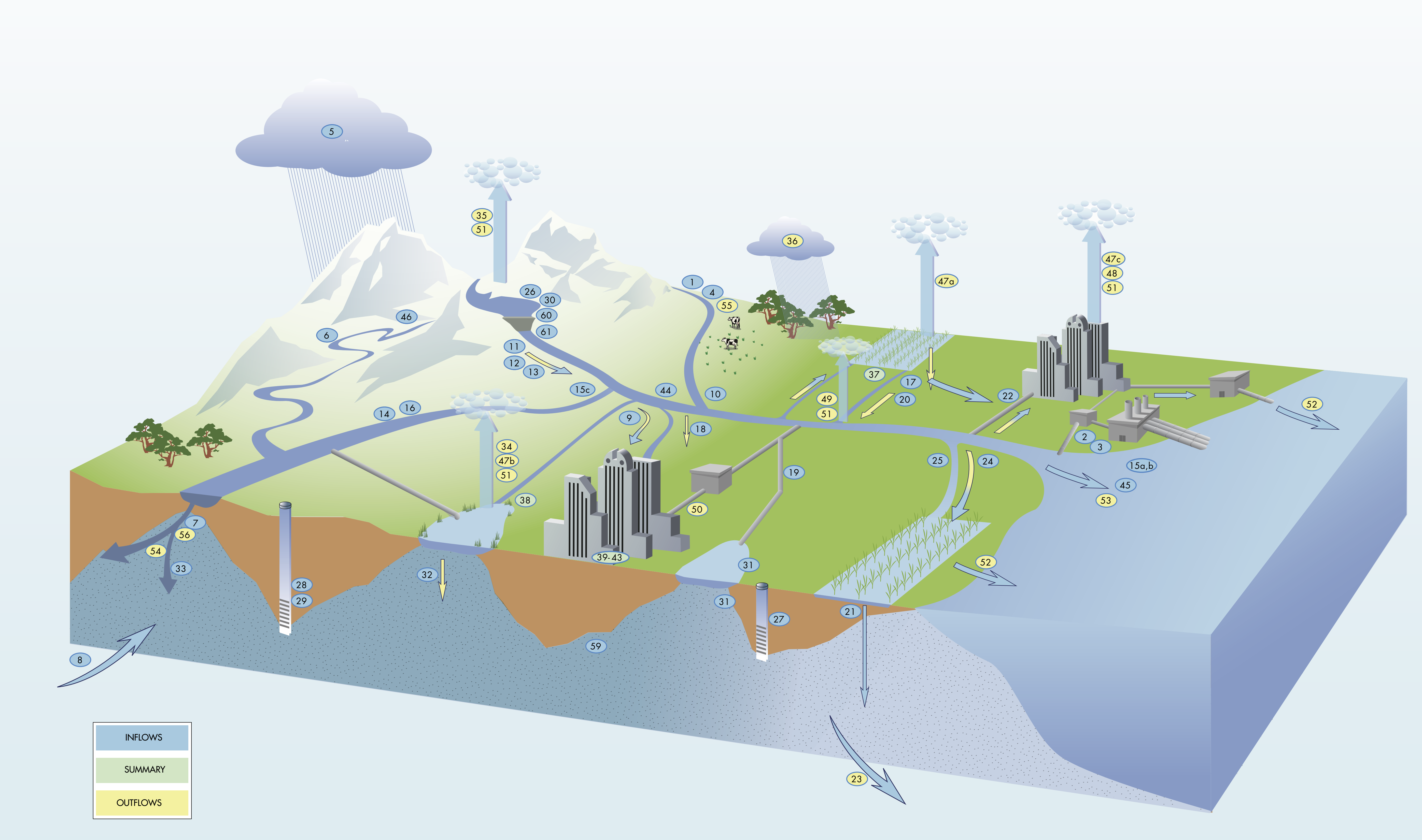
South Coast Hydrologic Region

Table 5-3 South Coast Region water portfolio (TAF)

ID Number:	Flow Diagram Component (see legend)	South Coast 1998	South Coast 2000	South Coast 2001
1	Colorado River Deliveries	1,081.3	1,296.0	1,250.5
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	20,873.0	7,522.1	9,327.0
6a	Runoff - Natural	N/A	N/A	N/A
b	Runoff - Incidental	N/A	N/A	N/A
7	Total Groundwater Natural Recharge	N/A	N/A	N/A
8	Groundwater Subsurface Inflow			N/A
9	Local Deliveries	292.1	211.4	217.1
10	Local Imports	442.0	294.0	272.0
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	-	-	-
12	Other Federal Deliveries	4.2	0.6	-
13	State Water Project Deliveries	687.7	1,300.1	958.7
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	3.5	3.5	3.5
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	-	-	-
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	-	-	-
b	Recycled Water - Urban	202.4	182.7	188.8
c	Recycled Water - Groundwater	2.1	37.1	36.2
20a	Return Flow to Developed Supply - Ag	-	-	-
b	Return Flow to Developed Supply - Wetlands	-	-	-
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	87.2	114.4	95.2
b	Deep Percolation of Applied Water - Wetlands	-	-	-
c	Deep Percolation of Applied Water - Urban	321.6	386.5	367.0
22a	Reuse of Return Flows within Region - Ag	-	-	-
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	287.7	37.8	111.7
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	-	-	-
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions			
26	Surface Water in Storage - Beg of Yr	1,380.6	1,515.5	1,643.3
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	786.0	865.0	841.3
29	Groundwater Extractions - Unadjudicated	846.3	1,008.4	1,020.9
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	1,752.5	1,643.3	1,975.6
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation			
b	Evaporation and Evapotranspiration from Unirrigated Ag			
35a	Evaporation from Lakes	18.5	18.5	17.9
b	Evaporation from Reservoirs	149.1	164.2	160.8
36	Ag Effective Precipitation on Irrigated Lands	256.8	150.2	166.1
37	Agricultural Water Use	691.9	908.4	758.4
38	Managed Wetlands Water Use	31.2	38.1	37.2
39a	Urban Residential Use - Single Family - Interior	990.7	1,252.8	1,144.3
b	Urban Residential Use - Single Family - Exterior	670.2	752.1	709.0
c	Urban Residential Use - Multi-family - Interior	603.2	543.1	510.0
d	Urban Residential Use - Multi-family - Exterior	105.9	139.7	151.0
40	Urban Commercial Use	699.5	914.1	885.5
41	Urban Industrial Use	186.0	209.8	209.8
42	Urban Large Landscape	165.7	242.8	187.5
43	Urban Energy Production	39.8	39.8	39.8
44	Instream Flow	-	-	-
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	-	-	-
47a	Evapotranspiration of Applied Water - Ag	494.8	645.8	542.9
b	Evapotranspiration of Applied Water - Managed Wetlands	31.2	38.1	37.2
c	Evapotranspiration of Applied Water - Urban	941.8	1134.6	1047.5
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	11.2	15	12.3
50	Urban Waste Water Produced	1824.8	2156.8	2015.9
51a	Conveyance Evaporation and Evapotranspiration - Urban	346.5	362.5	358.5
b	Conveyance Evaporation and Evapotranspiration - Ag	-	-	-
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	-	-	-
d	Conveyance Outflow to Mexico			
52a	Return Flows to Salt Sink - Ag	100.1	135.1	110.1
b	Return Flows to Salt Sink - Urban	2009.7	2363.3	2214.8
c	Return Flows to Salt Sink - Wetlands	-	-	-
53	Remaining Natural Runoff - Flows to Salt Sink	-	-	-
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	2,367.0	2,991.0	2,505.0
56	Regional Exports	0.0	0.0	0.0
59	Groundwater Net Change in Storage	-1,223.5	-1,372.5	-1,400.0
60	Surface Water Net Change in Storage	371.9	127.8	332.3
61	Surface Water Total Available Storage	2,112.7	3,058.8	3,058.8

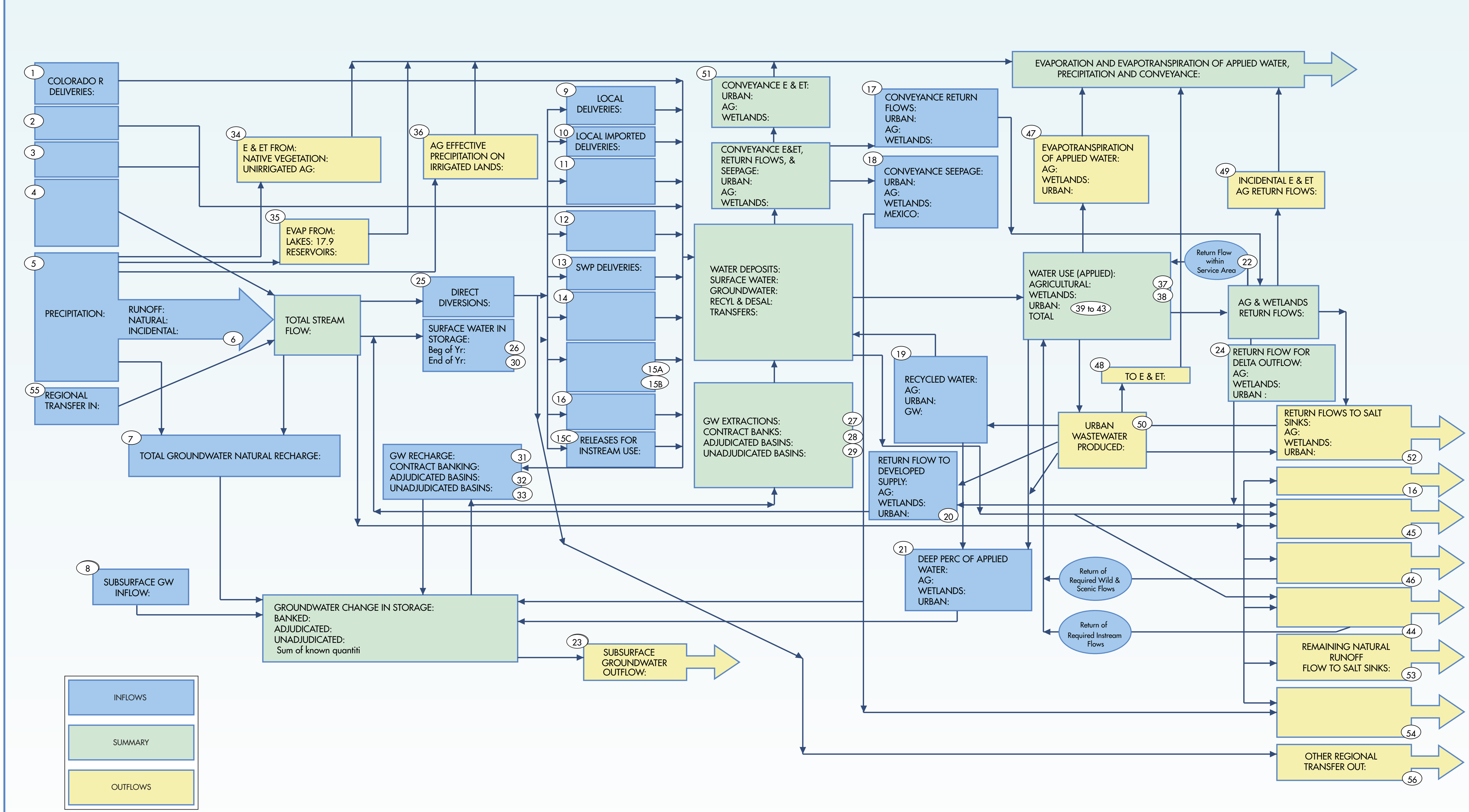
Legend: Inflows (blue) · Outflows (yellow) · Green number signifies included in summary boxes

Figure 5-6 South Coast region - illustrated water flow diagram



In this illustration of Table 5-3, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 5-7 South Coast region - schematic flow diagram



In schematic of Table 5-3, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.

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Chapter 6 Sacramento River Hydrologic Region

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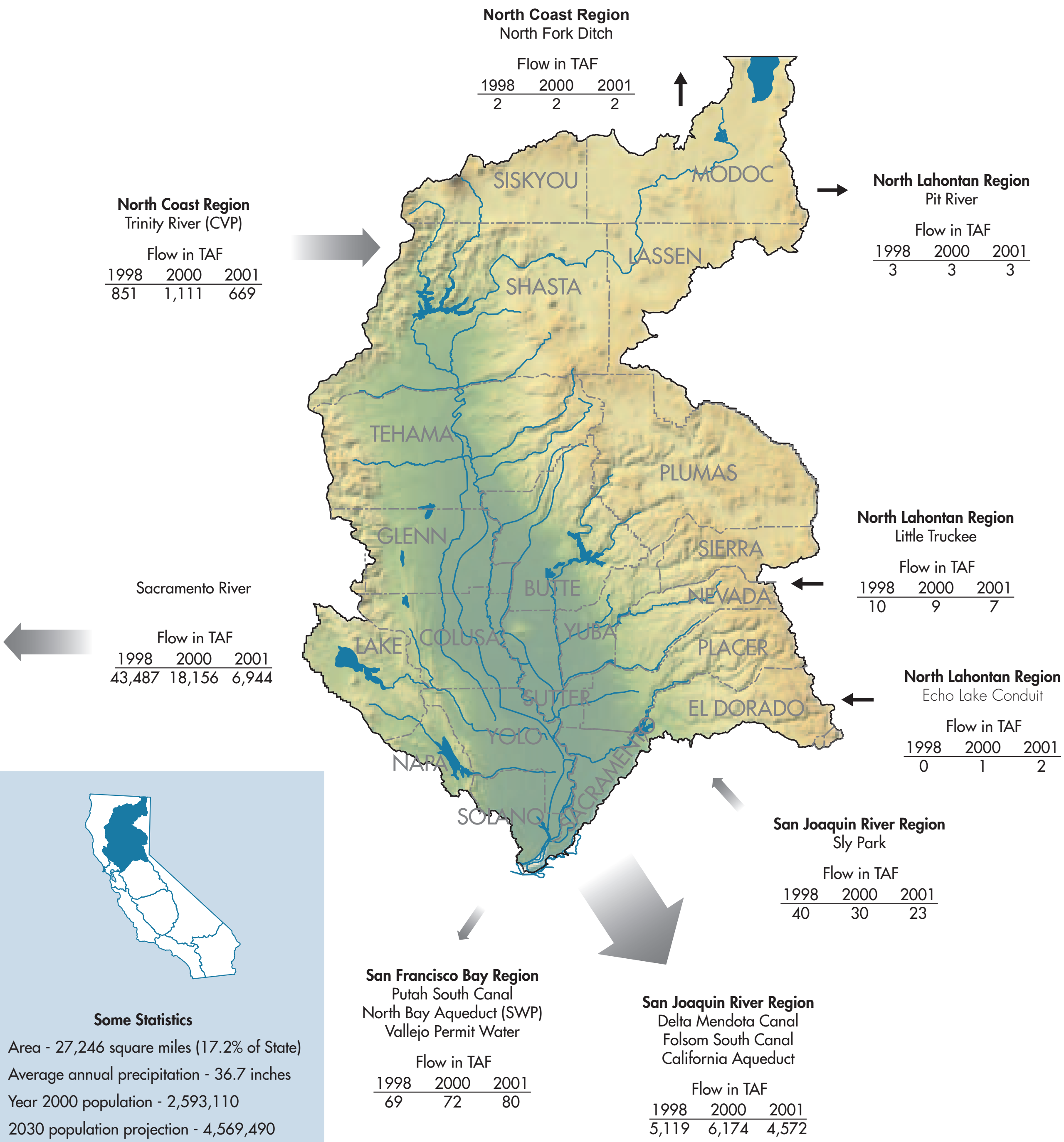
Figure 6-1 Sacramento River Hydrologic Region



Some Statistics

- Area - 27,246 square miles (17.2% of State)
- Average annual precipitation - 36.7 inches
- Year 2000 population - 2,593,110
- 2030 population projection - 4,569,490
- Total reservoir storage capacity - 16,146 TAF
- 2000 irrigated crop area - 2,038,900 acres

The Sacramento River Hydrologic Region includes the entire drainage area of California's largest river and its tributaries, extending from the Oregon border to Sacramento. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

Chapter 6 *Sacramento River Hydrologic Region*

Setting

The Sacramento River Hydrologic Region includes the entire drainage area of the state's largest river and its tributaries, extending from the Oregon border downstream to the Sacramento – San Joaquin Delta. The region covers 27,246 square miles including all or a portion of 20 predominately rural Northern California counties, and extends from the crest of the Sierra Nevada in the east to the summit of the Coast Range in the west (Figure 6-1). The northernmost area, mainly high desert plateau, is characterized by cold, snowy winters with only moderate rainfall, and hot, dry summers. The mountainous parts in the north and east typically have cold, wet winters with large amounts of snow providing runoff for summer water supplies. The Sacramento Valley floor has mild winters with less precipitation and hot dry summers. Overall annual precipitation in the region generally increases as you move from south to north and west to east. The heavy snow and rain that falls in this region contributes to the overall water supply for the entire state.

The many rivers and streams that are tributary to the Sacramento River provide important riparian habitat that is critical for many aquatic and terrestrial species including the spring-run Chinook salmon (Oncorhynchus tshawytscha), winter-run Chinook salmon (Oncorhynchus tshawytscha) and Central Valley steelhead (oncorhynchus mykiss). (For more information about increased concern over decline of endangered salmon, see Figure 6-2 and discussion under Ecosystem Restoration.) This region is the only known area for the winter-run Chinook. The valley floor region section adjoining the river, provide some of the most important wintering areas along the Pacific Flyway for many varieties of waterfowl. The region also has several wetland and waterfowl preserves that provide nesting and migration areas for threatened avian species including the bald eagle and Swainson's hawk and numerous species of neotropical birds. All of these valuable resources are vital components of the ecosystem and contribute to the ecological health of the entire state.

The Sacramento River Hydrologic Region also encompasses all or a portion of six of the state's 18 national forests. Lassen, Mendocino, Modoc, Plumas, Shasta-Trinity and Tahoe Basin national forests are contained or contiguous to the region and contribute to the dynamics of its vast landscape. These federal lands are each managed with specific goals for fish and wildlife such as the recovery of the spotted owl or the Chinook salmon, as well as for hydroelectric power and sustainable timber harvest. Such diverse goals often call for creative management strategies.

Agriculture is the region's largest industry, contributing a wide variety of crops including rice, grain, tomatoes, field crops, fruits and nuts. Crop statistics show that irrigated agricultural acreage in the region peaked during the 1980s and has since declined with a little more than 2 million acres irrigated in 2000. Excess applied irrigation water generally returns to the supply system through drainage canals, or recharges groundwater. Basin efficiency is usually very good because downstream users recycle return flows for their own use. In some places, return flows are the only water source for downstream agricultural users.

The southern portion of the Sacramento River Hydrologic Region is experiencing rapid population growth and urbanization. While California experienced a statewide population increase approaching 15 percent from 1990 to 2000, growth rates in the Sacramento metropolitan region have exceeded this trend. According to California Department of Finance projections, Sacramento County's population increased by 17.5 percent between 1990 and 2000, and is projected to grow by 26 percent between 2000 and 2010 to more than 1.5 million people. Similarly, the adjoining urban areas in Placer, El Dorado and Yolo counties are also experiencing the same levels of extensive growth and urban expansion. This ongoing rapid rate of urbanization is expected to generate significant land and water use challenges for the entire southern portion of the Sacramento River region, including adequate drought-period water supplies, growth in flood plains, conversion of productive farmland, and the preservation of sensitive environmental habitats.

The Sacramento River region includes the entire drainage area of the state's largest river and its tributaries, extending from the Oregon border downstream to the Sacramento–San Joaquin Delta. In this photo, the Sacramento River flows near downtown Sacramento. (DWR Photo)

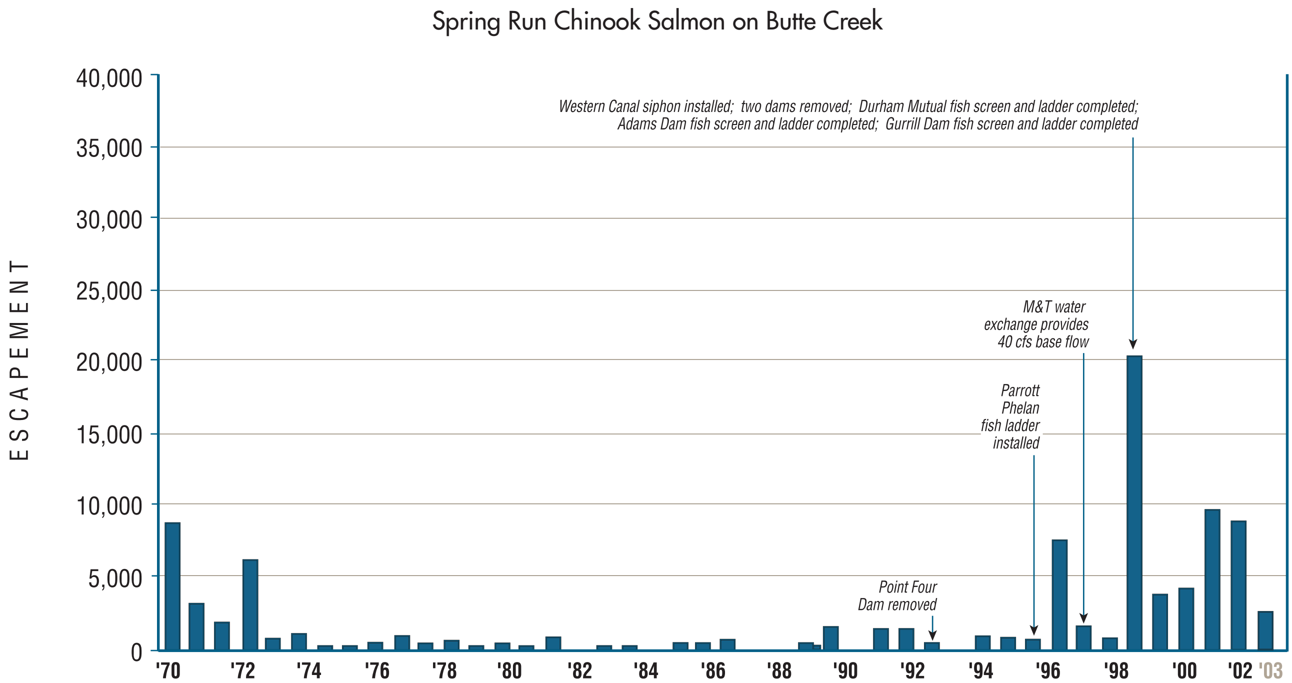
For the central and northern portions of the Sacramento River region, most urban development has occurred along the main highway corridors. Although a few of the larger cities in the region, such as Sacramento, divert most of their water from the larger rivers, the principal source of water for most of the urban and rural communities throughout this region is groundwater. The Sacramento Valley is recognized as one of the foremost groundwater basins in the state. In the rural mountain areas of this region, domestic supplies come almost entirely from groundwater.

Population

The population of the Sacramento River Hydrologic Region was 2,593,000 in 2000, which represents about 8 percent of California's total population. Table 6-1 provides an additional breakdown by county for populations, land areas, and the resulting population density. Geographically, Siskiyou County has the largest acreage in the region, 6,287 square miles, but with a 2000 population of only 44,750 the population density is about seven people per square mile. On the other hand, Sacramento County is the most populated county in the region, with a density of 1,274 people per square mile. When looking at the map of the region in Figure 6-1, it should be noted that both of these counties are only partially in the region. However, these statistics are useful in portraying the environment of the region, which, except for Sacramento, is predominately rural in nature with low population ratios per square mile.

Although 2000 population numbers indicate lower densities than other developed regions of the state, it is projected that the Sacramento River region's total population will increase to more than 4.5 million by the year 2030. Figure 6-3 provides a graphical depiction of the Sacramento River region's total population from 1960 through 2000, with current projections to 2030. This growth will have a significant impact on shaping the natural resources of the region. Population per square mile decreases as you move farther north into the region, which contains large areas of agriculture and forested lands, both private and public.

Figure 6-2 Butte Creek Progress



This performance measure reports the escapement (the number of adult salmon escaping mortality and successfully returning each year to spawn) of adult spring-run Chinook salmon, a threatened species under the state and federal Endangered Species acts, on Butte Creek. The Butte Creek population is one of the few remaining self-sustaining populations of spring-run Chinook salmon in the Central Valley. The spring-run in Butte Creek has been affected by significant impediments to upstream passage of adults stemming from dams, inoperative fish ladders, and reduced flows as a result of water diversions. Since 1995, restoration actions have included dam removal, installation and/or repair of fish ladders and fish screens, and improvements to base flow.

Increased concern over the decline in endangered salmon has stimulated several projects and programs. Figure shows number of returning adult spring-run Chinook salmon in Butte Creek from 1970 to 2003. Restoration projects and programs are listed by year of implementation.

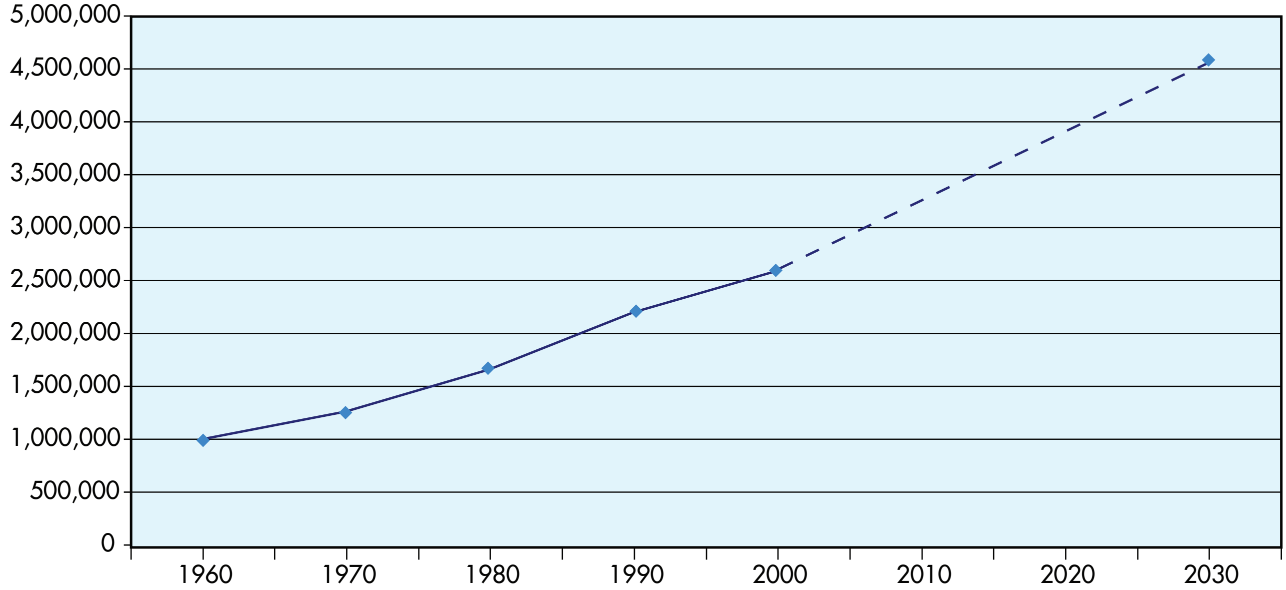
Future land use planning and decisions, at both the state and local level, will need to consider the changing complexion of the region, as well how to best use and preserve the vast open spaces and abundant natural resources in the region.

Water Supply and Usage

Because of the weather patterns that produce a high level of precipitation in the region, major water supplies from the region are provided through the development of reservoirs and from direct groundwater pumping, which historically has recharged through the winter months. Major reservoirs in the region provide water supply, recreation, power, environmental, and flood control benefits. The Central Valley Project (CVP) is the largest water project in the state, and includes Shasta Lake, Whiskeytown Lake, Keswick Reservoir and Folsom Lake in this region. A large portion of the water supplied by CVP is delivered for agriculture purposes, both in this region and as water exports to other regions. The U.S. Bureau of Reclamation's (USBR) Solano Project provides urban and agricultural water supply to parts of the Sacramento River Region and parts of the San Francisco Bay region. The major water supply facilities of the State Water Project (SWP) are along the Feather River basin in this region, consisting of Lake Oroville, Thermalito Afterbay, Lake Davis and Frenchman Reservoir. SWP water serves both urban and agricultural uses in this region and are exported south to other drier regions of the state. A large amount of water from both CVP and SWP reservoirs is released downstream to maintain environmental water quality standards in the Sacramento – San Joaquin Delta. Such storage releases are critical in the summer and fall, to prevent ocean salt water from penetrating east into the Delta during high tidal cycles.

There are several other, smaller reservoirs that add to the overall surface water supply. In total, the region has 43 reservoirs, with a combined capacity of almost 16 million acre-feet. Major reservoirs in the region provide not only water supply, but also are the source of recreation, power generation, and

Figure 6-3 Sacramento River Hydrologic Region population



Data from California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for the Sacramento River region.

other environmental and flood control benefits. In addition, the region has a network of creeks and rivers that convey water for use throughout the region and also provide nesting and rearing grounds for major fish and wildlife species. Figure 6-4 provides a graphical presentation of the categories of the water supply sources that are used to meet the developed water uses in this hydrologic region for 1998, 2000 and 2001.

Water use in the Sacramento River region is mostly for agricultural production with more than 2.0 million irrigated acres in 2000. Agricultural products include a variety of crops such as rice and other grains, tomatoes, field crops, fruits and nuts. A substantial number of acres of rangeland in this region are also used for livestock management. Much of the economy of the region relies on agricultural water supplies, which are diverted and distributed through extensive systems of diversion canals and drains. Basinwide water use efficiency is generally high, because many return flows from fields are captured by drainage systems and then re-supplied to other fields downstream. In some places, these return flows are the primary water source for other downstream uses, including agriculture and wildlife refuges. The water quality of these return flows is a concern for some downstream users, because agricultural runoff can contain elevated levels of pesticides and fertilizer salts. In addition, excess applied irrigation water can return to the supply system by percolating as groundwater recharge.

Table 6-1
Sacramento River Region Population Density by County

County	Population	Square Miles	Persons Per Square Mile
Butte	204,500	1639	125
Colusa	19,050	1151	17
El Dorado	159,700	1711	93
Glenn	26,750	1315	20
*Lake	58,800	1258	47
*Lassen	34,300	4557	8
*Modoc	9,375	3944	2
*Napa	125,400	754	166
Nevada	92,200	958	96
Placer	248,900	1404	177
Plumas	20,750	2554	8
Sacramento	1,230,600	966	1,274
Shasta	165,200	3785	44
*Sierra	3,610	953	4
*Siskiyou	44,750	6287	7
Sutter	79,400	603	132
Tehama	55,800	2951	19
*Trinity	13,000	3179	4
Yolo	169,400	1013	167
Yuba	60,700	631	96

* Represents counties only partially covered within the region
California Dept. of Finance (July, 2001 Estimated)

The larger urban areas in the region have developed near major rivers, so surface water diversions are a key component of municipal water supplies. However, the Sacramento Valley is also recognized as having one of the foremost groundwater basins in the state. The availability of abundant groundwater supplies under the valley floor has allowed urban areas to expand delivery capabilities by including the use of groundwater. In some areas, groundwater has become the principle source of water supply for urban as well as rural domestic uses.

In-stream flows, refuges and wildlife areas are the principal environmental use of water in the region. With the federal and state listing of the spring-run Chinook salmon, winter-run Chinook and Central Valley steelhead, much attention has been given to the recovery of these species and their related habitat. Tributaries to the Sacramento River, as well as the main stem itself, have been the focus of a number of ecosystem-related projects designed to increase the amount of environmental water use for habitat and species restoration.

In addition, the Sacramento Valley serves as a breeding and resting ground along the Pacific Flyway. Therefore, in more recent years, duck and other waterfowl habitat development in the valley section by duck clubs, non-profit groups and natural resource agencies have resulted in an increase in the use of environmental water in an attempt to increase the numbers of waterfowl species residing in or using the region. Certain agricultural practices are known to benefit many species of wildlife. The programs that provide the most benefits are the rice straw decomposition program and the use of agricultural return flow to refuges and duck clubs, which are designed to improve air and water quality in the valley. As a result of these programs, and other resource management activities, the Sacramento River region contains the largest and most extensive wetlands in the state. The Sacramento River region has a number of acres in both private and public ownership dedicated to managed wetlands. For example, in the northeastern mountain counties, associated with the Pit River system, such as the Big Valley and Alturas area, there are about 14,000 acres of managed wetlands. Farther south, in the Sacramento Valley, there are 16,987 acres in federal ownership; 11,987 acres of State lands; and 28,642 acres in private ownership managed as wetlands.

With the listing of the winter-run Chinook, spring-run Chinook salmon and Central Valley steelhead, much of the water diverted out of the Sacramento River waterways for agricultural use, environmental uses and refuge water supplies passes through state-of-the-art fish screens. These fish screens minimize take of the species when water is diverted from the river, and also increases system flexibility, allowing year-long diversion of water for agricultural purposes.

Current Situation

Table 6-2 presents a Water Supply Balance for this hydrologic region for 1998, a wet year; 2000, an average year; and 2001, a drier year. The total sources of all water supplies to the region are tabulated in the top portion of Table 6-2, the major uses of all water are shown in the middle section, and estimated interaction with groundwater storage is shown at the bottom of the table. Using 2000 as an example, a significant portion of the precipitation (57 million acre-feet) is used by native vegetation (forests), evaporation, unregulated runoff and percolation to groundwater, tabulated as 26.5 million acre-feet. Statutory Required outflows to maintain Delta water quality requirements (SWRCB Decision 1630) are the next largest component of water use, 12.3 million acre-feet, followed by consumptive use of applied water in the Sacramento River region, 5.56 million acre-feet, and water exports to other regions 6.2 million acre-feet. Table 6-3 provides more specific information about the developed or dedicated component of water supplies for agricultural, urban and environmental purposes, as assembled from actual data for 1998, 2000 and 2001. This table provides more specific information regarding the distribution of developed water, with large components used for environmental and agricultural purposes. Note that the environmental water use component of this table includes the amount required to maintain Delta outflow standards, which amounts to more than half of the tabulated environmental water usage. Figure 6-4 presents a bar chart that summarizes only the dedicated and developed urban, agricultural and environmental water uses in this hydrologic region.

State of the Region

Lands that are irrigated with groundwater generally enjoy a reliable supply as do those urban areas that depend on groundwater as all or part of their supply. However, in the foothills, groundwater development in fractured rock sources are highly variable in terms of water quantity and water quality and are an uncertain source for large-scale residential development. In the more rural portions of this region, small, widely dispersed populations translate into high per capita costs for municipal water system maintenance and improvements. Historic development pattern of small geographically dispersed population centers can constrain the ability to interconnect individual water systems or to develop centralized sources of good quality municipal water supplies because major capital improvement projects become more expensive.

Exports from the Sacramento Valley are a concern for some water interest groups in the region, because they are fearful of losing this resource which is a key component to future

Table 6-2 Sacramento River Hydrologic Region Water Balance Summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (168%)	2000 (105%)	2001 (67%)
Water Entering the Region			
Precipitation	89,500	57,106	35,895
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions***	901	1,150	700
Total	**90,401**	**58,256**	**36,595**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	4,119	5,532	5,456
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions***	5,194	6,251	4,657
Statutory Required Outflow to Salt Sink	11,039	8,879	5,663
Additional Outflow to Salt Sink	35,112	12,328	3,940
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	31,445	26,518	20,439
Total	**86,909**	**59,508**	**40,155**
Storage Changes in the Region			
[+] Water added to storage			
[-] Water removed from storage			
Change in Surface Reservoir Storage	2,752	-1,101	-2,412
Change in Groundwater Storage **	740	-151	-1,148
Total	**3,492**	**-1,252**	**-3,560**

Applied Water * (compare with Consumptive Use)	6,957	9,208	9,096

***Footnote for applied water**

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

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

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

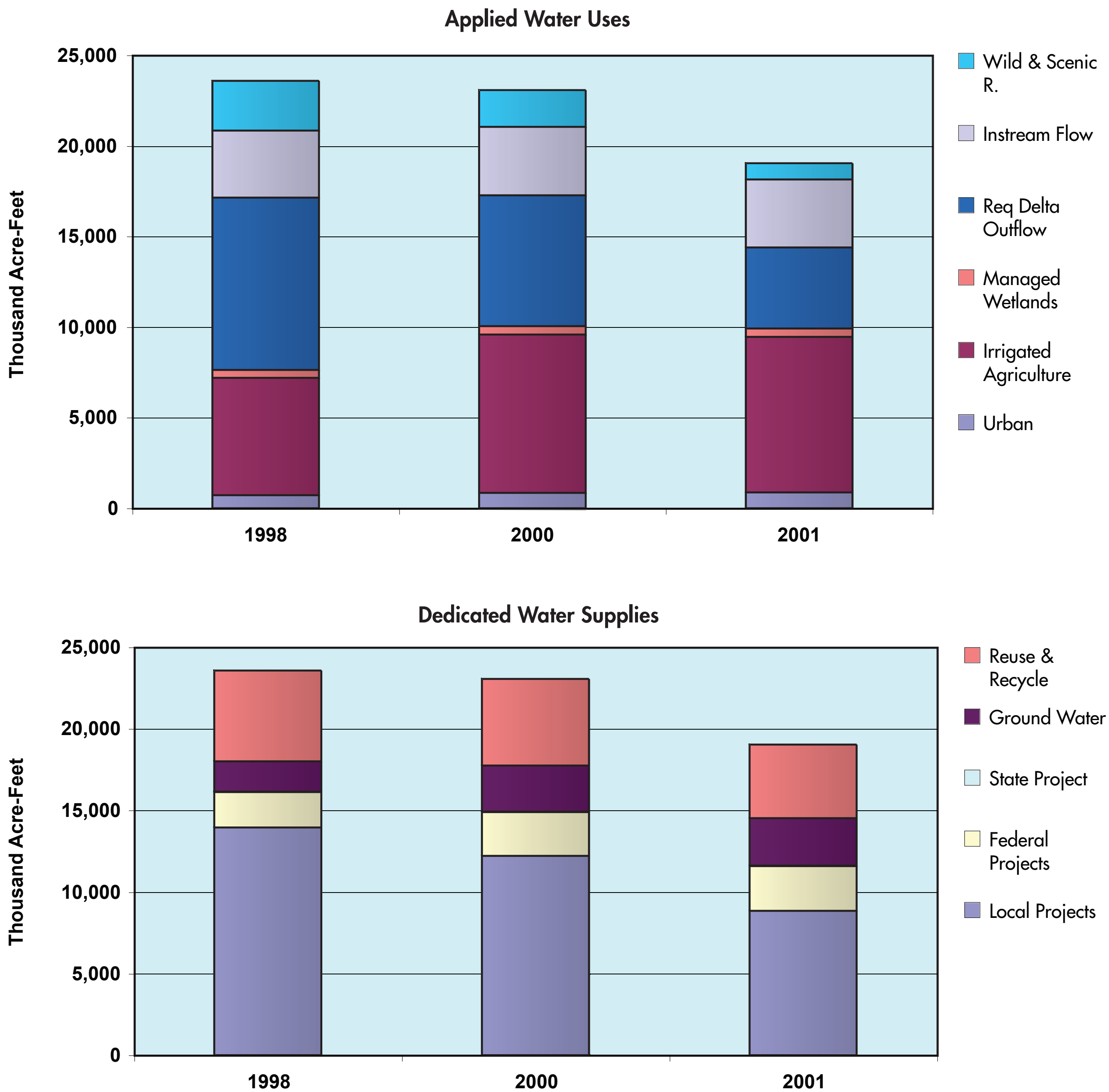
GW change in storage =
intentional recharge + deep percolation of applied water + conveyance deep percolation - withdrawals

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

Table 6-3 Sacramento River Region Water Use and Distribution of Dedicated Supplies (TAF)

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	91.8			111.2			120.1		
Commercial	113.1			140.4			137.5		
Industrial	77.3			84.2			84.5		
Energy Production	0.0			0.3			0.1		
Residential - Interior	191.5			223.3			229.2		
Residential - Exterior	243.8			291.7			297.3		
Evapotranspiration of Applied Water		313.2	313.2		378.8	378.8		384.4	384.4
E&ET and Deep Perc to Salt Sink		0.2	0.2		0.1	0.1		0.2	0.2
Outflow		312.0	309.4		368.8	366.2		379.6	377.0
Conveyance Applied Water	9.8			8.5			8.5		
Conveyance Evaporation & ETAW		4.9	4.9		4.3	4.3		4.3	4.3
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		4.9	4.9		4.2	4.2		4.2	4.2
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**727.3**	**635.2**	**632.6**	**859.6**	**756.2**	**753.6**	**877.2**	**772.7**	**770.1**
Agriculture									
On-Farm Applied Water	5,841.2			7,927.1			7,781.7		
Evapotranspiration of Applied Water		3,677.9	3,677.9		4,983.2	4,983.2		4,908.4	4,908.4
E&ET and Deep Perc to Salt Sink		122.0	122.0		173.4	173.4		174.2	174.2
Outflow		1,494.4	497.7		1,901.5	690.3		1,927.7	972.5
Conveyance Applied Water	617.0			786.8			785.4		
Conveyance Evaporation & ETAW		40.6	40.6		61.5	61.5		59.9	59.9
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		199.3	139.3		223.7	179.2		232.3	186.9
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**6,458.2**	**5,534.2**	**4,477.5**	**8,713.9**	**7,343.3**	**6,087.6**	**8,567.1**	**7,302.5**	**6,301.9**
Environmental									
Instream									
Applied Water	3,699.6			3,759.8			3,747.5		
Outflow		586.3	586.3		600.2	600.2		614.1	614.1
Wild & Scenic									
Applied Water	2,754.1			2,024.7			885.0		
Outflow		947.7	947.7		782.8	782.8		320.5	320.5
Required Delta Outflow									
Applied Water	9,505.0			7,231.6			4,486.2		
Outflow		9,505.0	9,505.0		7,231.6	7,231.6		4,486.2	4,486.2
Managed Wetlands									
Habitat Applied Water	398.3			429.5			445.7		
Evapotranspiration of Applied Water		127.5	127.5		169.7	169.7		162.9	162.9
E&ET and Deep Perc to Salt Sink		9.8	9.8		14.4	14.4		14.2	14.2
Outflow		208.2	204.2		193.3	189.1		201.4	197.0
Conveyance Applied Water	40.8			42.0			23.3		
Conveyance Evaporation & ETAW		1.9	1.9		1.9	1.9		1.3	1.3
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		5.2	5.2		5.2	5.2		2.7	2.7
Total Managed Wetlands Use	439.1	352.6	348.6	471.5	384.5	380.3	469.0	382.5	378.1
Total Environmental Use	**16,397.8**	**11,391.6**	**11,387.6**	**13,487.6**	**8,999.1**	**8,994.9**	**9,587.7**	**5,803.3**	**5,798.9**
TOTAL USE AND OUTFLOW	**23,583.3**	**17,561.0**	**16,497.7**	**23,061.1**	**17,098.6**	**15,836.1**	**19,032.0**	**13,878.5**	**12,870.9**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	13,939.5	13,939.5	13,021.9	12,204.8	12,204.8	11,172.4	8,843.0	8,843.0	8,075.4
Local Imported Deliveries	9.7	9.7	9.1	10.4	10.4	9.5	8.5	8.5	7.8
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	1,990.7	1,990.7	1,859.7	2,466.7	2,466.7	2,258.0	2,497.3	2,497.3	2,280.5
Other Federal Deliveries	198.0	198.0	185.0	228.3	228.3	209.0	239.5	239.5	218.7
SWP Deliveries	14.9	14.9	13.9	14.9	14.9	13.6	19.6	19.6	17.9
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	1,408.2	1,408.2	1,408.2	2,173.5	2,173.5	2,173.5	2,270.6	2,270.6	2,270.6
Deep Percolation of Surface and GW	446.5			641.7			656.3		
Reuse/Recycle									
Reuse Surface Water	5,575.8			5,320.8			4,497.2		
Recycled Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLIES	**23,583.3**	**17,561.0**	**16,497.7**	**23,061.1**	**17,098.6**	**15,836.1**	**19,032.0**	**13,878.5**	**12,870.9**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

Figure 6-4 Sacramento River region water balance for water years 1998, 2000, 2001



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

economic growth. Although there is an abundant water supply in this hydrologic region, limited infrastructure in the foothill communities and the historic water development for the needs of the downstream urban and agricultural users has resulted in some water supply shortages to outlying and foothill areas in dry years. The specific water problems of the foothills are described in more detail in Chapter 12 on the Mountain Counties region. Urban areas in the central part of this region generally have sufficient supplies to survive dry periods with periodic cutbacks. However, as future population growth increases in the region, the competition for high quality water for municipal water will also increase.

Many north valley water users are also concerned that in the future their surface water rights may be further curtailed, such that more groundwater will be needed for irrigation as well as for urban use. In this light, they are apprehensive about new proposals involving the export of surface and groundwater supplies to other locations, unless proper planning provides assurances for retaining the water necessary to meet future agricultural, urban and environmental needs at the local level.

Changes to surface water allocations in the region may occur as a result of negotiations for renewal of CVP contracts, increased environmental restoration needs, expanded conjunctive use of surface and ground water, and various plans and proposals for water transfers. Cumulatively, these changes could stimulate a substantial increase in groundwater use in the region. In addition groundwater development will most likely be targeted to meet a significant share of the moderately increasing water demands of the region. In response to this phenomenon, some local governments in the region are evaluating the use of groundwater regulations in relation to new development as a method to assure adequate water supply for future needs.

The potential for developing new supplies from groundwater is more favorable in the northern portion of the Sacramento Valley. The southern portion is already experiencing localized groundwater supply and quality problems, such as in the Sacramento area. Although substantial groundwater can potentially be identified in the Sacramento Valley, there is still a great deal of research that needs to be done to evaluate the quantity and quality of these supplies. If additional groundwater supplies are identified and documented for future use, some of the existing groundwater infrastructure might also have to be replaced or modified to use the resource to its fullest. Potential environmental impacts of increased groundwater extractions in the Sacramento Valley needs to be evaluated to determine if this would affect the amount of river surface flows and interaction with groundwater tables.

Competition for use of the groundwater resource is expected to continue as population increases, and the potential also exists for an increased number of water transfers in the future. Water transfers, especially those contracts with a groundwater substitution component, need to be evaluated for their cumulative effects, because the overall effect could contribute to greater use of the groundwater resources in the region that may negatively impact local water users.

In recent years, requirements for managing threatened and endangered species are influencing management of the region's water supplies. The salmon and steelhead fishery in the upper Sacramento River has declined greatly over past decades, resulting in many programs and projects for fishery restoration. Along the Sacramento River, factors that contribute to this problem include: unsuitably warm water temperatures, toxic heavy metals from acid mine drainage, pesticides and fertilizer runoff, degraded spawning gravels, obstructions to fish migration, and prior destruction of riparian habitat due to growth or noxious weed encroachment. It should be noted, however, that some riparian habitats are now being restored due to projects funded by federal and State agencies associated with CBDA (discussed later in this chapter).

In summary, the majority of the region does enjoy abundant groundwater and surface water supplies for all beneficial uses in the region. However, precautions should be taken with land use changes that may use a greater amount of the natural resources because the majority of the area is just beginning to understand its groundwater resources and how they, combined with surface water supplies, can be used most efficiently.

Challenges

Water Reallocation and Transfers

During extended periods of drought, water districts in the Sacramento River Region that rely on surface water supplies may be faced with insufficient water supplies, due to surface water allocation cutbacks imposed by their CVP and SWP water contracts. As shown in Table 6-4, CVP deliveries to this region in a normal year exceed 2.4 million acre-feet per year, while SWP deliveries in the Feather River service area average about 15,000 acre-feet per year. During extended droughts, reductions in deliveries could eventually force water users to choose between using groundwater to replace the reduced surface supplies, or taking valuable agricultural acreage out of production. The additional use of groundwater supplies by a greater number of water users during droughts may result in adverse impacts to the groundwater resource, which has the potential to negatively impact users that are totally dependent on groundwater supplies. Surface water transfer programs to other regions are of concern, because such programs have the potential to aggravate overuse of the groundwater resources. Before new out-of-basin water transfers are considered, local water interests would like to ensure that their existing surface water rights are protected, and that equitable use of groundwater supplies are established to sustain the local agricultural economy and natural resource needs.

With a growing demand for high quality water throughout the state, water transfers are being evaluated more closely as a means to move water out of the Sacramento River region to other parts of the state. In response, several counties in the region have passed laws that regulate or impede water transfers that would move water outside of their county, especially when a proposed transfer program has a groundwater component. In some counties, for instance, transferees are required to mitigate for third-party impacts associated with this type of water transfer and transfers require a permit approved by the Board of Supervisors or its designee. In other counties, transferring groundwater outside of the county is prohibited by local ordinances.

Water Quality

Surface water quality in the watershed is generally good, making the Sacramento River one of the most desirable water sources in the state. Nonetheless, turbidity, rice pesticides, and organophosphate pesticides such as diazinon affect fisheries and drinking water supplies. The decline of fisheries in the Sacramento River is in part related to water quality problems on the river's main stem: unsuitable water temperature, toxic heavy metals, such as mercury, copper, zinc, and cadmium from acid mine drainage, pesticides and fertilizer in agricultural runoff, and degraded spawning gravels. Holding of rice field drainage, allowing for degradation or rice herbicides, has effectively addressed this water quality concern among downstream water users, in particular, the city of Sacramento. In the Cache Creek watershed, Clear Lake suffers from large mercury, sediment, and nutrient loadings, the latter leading to nuisance algae blooms. Along with a few select other water bodies, the basin plan specifically prohibits direct discharges of wastes into Folsom Lake and the lower American River downstream to its confluence with the Sacramento; waste discharges from houseboats on Shasta, Clear Lake, and in the Delta are also banned. High density recreation use of Whiskeytown and Shasta lakes may be contributing to high bacteria levels in these two reservoirs.

In its triennial review, the Central Valley Regional Board identified mercury loads, a legacy of California's gold mining heritage, as one of the most significant water quality problems in the region. In particular, the Cache Creek watershed is the major source of mercury to the Delta; to a lesser extent, mercury is also a concern in Lake Berryessa and Marsh Creek Reservoir. An organic form of mercury, methylmercury, is a neurotoxin that is especially dangerous to fetuses and infants, attacking the central nervous system and causing an array of developmental and other problems. Because of methylmercury's bioaccumulative properties, several water bodies in the Sacramento River region have fish consumption advisories. Pesticide management and agricultural water discharge has recently come into the limelight with the Central Valley Regional Water Quality Control Board's decision to eliminate waivers associated with agricultural discharge. Coalitions in the region are forming partnerships to address this issue through a watershed approach as provided for by the Regional Board and affirmed by the State Water Resources Control Board in their review of the Irrigated Lands Conditional Waiver. Stakeholders in the region are working to find a solution that encompasses the protection of public health, meets current and future water quality regulations, and allows for a sustainable agricultural economy.

Groundwater quality in the Sacramento River Region is generally good, though there are local groundwater problems. Naturally occurring salinity impairs wells at the north end of the Sacramento Valley. Groundwater near the Sutter Buttes is impaired because of local volcanic geology, and hydrogen sulfide is a problem in wells in the geothermal areas in the western part of the region. Human-induced impairments, like nitrate, are generally associated with agriculture and septic tanks; the latter is especially an issue in Butte County, where 150,000 of its 200,000 residents rely upon individual septic systems. Septic tanks are often inappropriately sited in shallow, unconfined or fractured hard rock aquifers, where insufficient soil depth is available for necessary leaching. Heavy metals from historical burn dumps also contaminate groundwater locally. In the Sierra foothills there is potential for encountering uranium- and radon-bearing rock or sulfide mineral deposits containing heavy metals. Perchlorate, previously used as an oxidizer or booster for solid rocket fuel and now a human health concern in domestic water, has contaminated wells in Rancho Cordova, near Sacramento.

Accomplishments

The goals and objectives of the CBDA program play a prominent role in regional efforts to improve water supply reliability, water quality and ecosystem restoration. Current activities and accomplishments are summarized in the following sections.

Water Supply Reliability

Past concerns with potential groundwater exports have spurred numerous counties to enact groundwater ordinances to regulate groundwater extraction when groundwater is intended for export outside the county. In addition, some counties are also involved in extensive cataloging and inventory projects to determine the extent of their water resources and unmet needs of the region to ensure that current and future needs are met locally prior to water exports.

In addition, regional representatives are working in conjunction with CBDA to conduct an extensive reevaluation of additional off-stream surface storage reservoirs in this region designed to store excess water during high flow events and thereby, help alleviate pressure for water exports from the region. Water use efficiencies in the region could provide benefits to other regions of the state if the storage and conveyance capacity existed to hold and transport water when it is needed. This process, commonly known as the North of Delta Off-Stream Storage (NODOS) is evaluating previously identified sites for their suitability in this type of project. Specifically, the Department of Water Resources is conducting an environmental evaluation of the Antelope Valley on the west side of the Sacramento River, near Maxwell for the construction of off-stream storage currently known as Sites Reservoir.

Water Use Efficiency

Water use efficiency in the Sacramento Valley is included in a comprehensive and integrated program being pursued by the agricultural diverters in the region. Most water return flows in the region are "recoverable," which means that water returns to rivers and streams where it can be re-used by downstream diverters. Because of this, local incentives to improve water use efficiency are focused on the benefit of decreased operational costs. Water users have accomplished many water saving improvements, including laser-leveling of fields to decrease water consumption and the lining of canals to reduce subsurface seepage. DWR's Water Use Efficiency program uses grant funding to provide incentives to water users in the Sacramento Valley to develop system improvements that will make water available for uses that provide statewide benefits. These benefits include improving endangered species habitat and improving overall water quality throughout the system by improving source water quality.

The recent development of the Sacramento Valley Water Management Program (SVWMP) can provide a framework for improved regional coordination of water use efficiency in the Sacramento Valley. A regional approach to water use efficiency allows for the coordination and consolidation of individual efforts into a comprehensive plan that optimizes limited financial and water resources. The CALFED Bay-Delta Program, particularly the approach to the regional Quantifiable Objectives (QOs) articulates this regional approach to water use efficiency activities. Additionally, the AB 3616 Program, and the Central Valley Project Improvement Act (CVPIA) Water Conservation Standards could be incorporated to develop a unified regional approach to water use efficiency for the Sacramento Valley. In the SVWMP, the consolidated water use efficiency program would be able to coordinate with other program elements to better meet local needs (water user and environmental) and potentially provide water for other areas of the state.

Agencies involved in CALFED's Water Use Efficiency Program, including DWR, have accomplished the following results through Year 3 of the California Bay Delta Program:

- Partnerships forged for groundwater planning with local agencies in six areas.
- Work initiated on 22 groundwater management and groundwater storage projects.
- Progress made on studies for potential north-of-Delta off-stream storage and Shasta Dam enlargement. The proposed projects are among five surface storage options being studied to increase storage capacity and provide flexibility to the state's water system.
- $11 million in grants awarded for agricultural and urban water use efficiency programs.
- Key achievements made on streamlining water transfers and facilitating transfer agreements that protect local water users, economies and ecosystems.

Ecosystem Restoration

Prior to the Gold Rush of the late 1840s, the area known as the Sacramento Valley consisted of a warm and abundant natural environment, essentially a floodplain to the expansive Sacramento River, rich in natural habitats, such as oaks, sycamore and cottonwood. As the Gold Rush subsided, those it brought to California moved into the plains of the Sacramento Valley and began ranching and farming, clearing the land for these purposes. As the population bases increased in the valley, flood control projects and levees were created in an attempt to control the great river to the detriment of the natural processes of the river and the species that inhabited it. The CBDA Ecosystem Restoration Program attempts to return some of these natural functions to the creeks and rivers in the region to aid in the restoration and maintenance of the endangered species that once inhabited it.

Many ecosystem restoration programs and projects are under way in the Sacramento River region. Some of these projects are along the main stem of the Sacramento River and others involve work along or in the tributaries. CBDA Ecosystem Restoration and Watershed Programs in the Sacramento River region have focused on protecting and restoring habitat for threatened and endangered species, such as salmonids and other fish species and wildlife. Ecosystem protection and restoration on tributaries of the Sacramento River, as well as the main stem, will help to provide habitat for these species while also maintaining water quality in the source area streams that eventually flow into the Bay-Delta.

The Sacramento Valley with its alluvial soils, abundant water and moderate climate, is one of the richest agricultural regions on earth. These same physical attributes also make it an incredibly productive ecosystem that supports more than 250 species of fish and wildlife. For example, spring-run Chinook salmon swim in from the Pacific and climb 5,000 vertical feet, first through the Sacramento River and then Mill Creek, to spawn at the base of Lassen Peak. Canada geese fly from north of the Artic Circle to winter in the wetlands, and Swainson hawks migrate from as far south as Argentina to reach the biologically-rich Sacramento Valley.

During the past 130 years, more than 95 percent of the valley's historic riparian forests have been converted to other land uses. In 1988, federal and state agencies, along with interested stakeholders and regional and local nonprofit groups, began to stabilize this trend by protecting and restoring riparian habitat along the Sacramento River. To date, more than 20,000 acres have been protected in such areas as the Sacramento River National Wildlife Refuge, the Bureau of Land Management's lands north of Red Bluff, Sacramento River State Wildlife Area, other state parks in the region and various areas under private conservation ownership. In addition, about 4,000 acres of flood-prone agricultural land has been restored to riparian forest.

In 1986, the Legislature enacted Senate Bill 1086, which called for development of a riparian habitat inventory and created the Upper Sacramento River Fisheries and Riparian Habitat Management Plan. The purpose of this plan is to preserve remaining riparian habitat and reestablish a continuous riparian ecosystem along the Sacramento River. The final plan contained a conceptual Riparian Habitat Restoration Plan to guide riparian habitat restoration along the river and its major tributaries from Red Bluff to Verona. The management plan for this program also contained a more specific Fishery Restoration Plan, listing 20 actions to help restore the salmon and steelhead fisheries of the river and its tributaries. All of the proposed restoration is now under way, funded by a combination of federal, State, and local sources. The Central Valley Project Improvement Act of 1992 (CVPIA) includes many of the CVP related fishery restoration measures recommended by the SB 1086 plan.

One of the concerns expressed by regional stakeholders involves land acquisitions for restoration projects that may not allow for reimbursement of tax dollars to local governments for land conversion projects. Local governments fear that the loss of revenue from productive agricultural land taken off of the tax roles may affect their ability to provide health and safety in their jurisdictions. In response to this concern, since 2000, the CBDA has begun using conservation easements rather than direct purchases. This approach leaves the property on the tax roles, thus minimizing the negative impacts associated with land conversion.

Local governments would also like to see programs that provide for species recovery and protection which support reasonable recreational access for the public that would contribute to an increase in tourism dollars in the local economy. It is anticipated that increased recreation associated with a healthier river system will contribute to the local economy in the future.

The Sacramento River region is the focus of significant CBDA ecosystem restoration through several different sources, including local efforts, CVPIA and CBDA, and many more are planned for several decades including species recovery of fish. The CALFED Multi-species Conservation Strategy (MSCS) is a comprehensive regulatory plan for the CALFED Program developed in accordance with the federal Endangered Species Act (ESA), the California Endangered Species Act (CESA), and the Natural Communities Conservation Planning Act (NCCPA). The MSCS establishes the State and federal regulations for numerous species and habitat types throughout the focus area. By adhering to this plan, the program can comply with these regulating acts.

Increased concern over the decline in endangered salmon has stimulated several projects and programs in the region over the past several years designed to alleviate pressures on these fish. Significant work has been accomplished toward this end on Butte Creek, for example. Partnerships between landowners and agricultural water districts along the creek and State and federal agencies have resulted in the removal or reengineering of several small dams, the screening of diversions from this creek, and the construction of a canal siphon beneath Butte Creek to aid in fish passage for spawning and rearing. These partnerships resulted in the removal of the Western Canal, McPherrin, McGowan, and Point Four dams and screening modification or construction on five other diversions along this tributary. These efforts, which have been coordinated and partially funded through CBDA, have built strong partnerships in the valley between agencies and landowners. They have also contributed to an increase in the returning runs of spring-run Chinook salmon, with higher numbers in eight of the last nine years, compared to the previous two decades. These numbers are displayed in the following chart through 2003 (Figure 6-2).

Another major salmon recovery project in the Sacramento River region is on Battle Creek. The Battle Creek Restoration Program proposes to restore access for salmon and steelhead to about 42 miles of habitat in the north and south forks of Battle Creek while minimizing the reduction of clean and renewable energy provided by PG&E's Battle Creek Hydroelectric Project. This project includes removal of up to five diversion dams, construction of ladders and fish screens at three additional diversions and increasing flow releases from remaining diversion dams. Environmental documents for the project are under development and a proposal for additional funds is under review by the Ecosystem Restoration Program. PG&E is the majority landowner in the project area, and is working with the Bureau of Reclamation, USFWS, NOAA Fisheries, Department of Fish and Game under a memorandum of understanding signed in 1999. They are working closely with the Battle Creek Working Group that includes the Battle Creek Watershed Conservancy, other CALFED agencies and other interested parties.

A third example of restoration in the Sacramento River region lies on Clear Creek, which is also a tributary to the Sacramento River, near Redding in Shasta County. Restoring Clear Creek is identified in several significant documents or act of legislation, including CVPIA, Section 3406, (b)(12). Through increasing flows in the creek by releasing more water from Whiskeytown Dam; the removal of McCormick-Saeltzer Dam in 2000; supplementing the gravel supply, which was blocked by Whiskeytown Dam; implementing methods to control erosion having negative impacts to salmonid habitat; and restoring the stream channel the Clear Creek Restoration Program has contributed significantly to the five-fold increase in fall Chinook spawning escapements in Clear Creek from 1995 to 2002 over the baseline period of 1967 to 1991. Data also show trends of increases in steelhead and spring-run Chinook spawning and juvenile production.

Another major salmon recovery effort in the Sacramento River Region is the implementation of the CVPIA Anadromous Fish Screen Program. This program has partnered State and federal agencies with water diverters in the region to develop and implement fish screen projects for the large and significant diversions on the Sacramento and other rivers in the regions. As a result of this program, almost all of the water diverted from the Sacramento River is pumped through state-of-the-art fish screens. This program has increased the flexibility of diversions from the river, allowing diverters to increase deliveries to wildlife refuges, increase the acres of habitat for migratory waterfowl using the Pacific Flyway, and implement a valleywide rice straw decomposition program that replaces the traditional practice of burning rice straw. As a result of these efforts, the Sacramento Valley is seeing increases in anadromous fish populations without infringements on diversion rights.

In addition to the projects discussed above, another program under the ERP which is active in the region is the Environmental Water Program (EWP). The goal of this program is to identify and purchase 100,000 acre-feet of water annually to augment in-stream flows north of the Delta. Four of the five Tier 1 priority streams for the program lie in the region: Clear Creek, Mill Creek, Butte Creek and Deer Creek. The EWP is also working closely with Battle Creek, which has been identified as a Tier 2 priority stream in this program. Development of a regional implementation structure for the Ecosystem Restoration Program Plan that is consistent with and in collaboration with existing local restoration program integration efforts is vital.

There are currently numerous watershed groups in the region compiling valuable data and involved in restoration projects in their watersheds. However, these are only a piece of the larger fabric of the greater Sacramento River watershed. Efforts are continuing to provide a comprehensive view of the watershed based on information gathered from funded projects throughout the watershed. This will allow for more informed decision-making and better protection and use of the resources.

Through Year 3 of the CBDA Program, the Ecosystem Restoration Program (ERP) and CALFED Watershed program have provided funding to the Sacramento Valley region as follows:

- $172 million invested in 139 local ecosystem restoration projects. Funded projects, including more than 50 projects to improve fish passage, restore habitat, monitor and assess watersheds, and provide education and outreach.
- $11.4 million invested in 40 local watershed projects addressing areas such as spawning gravel, floodplain management and watershed education and outreach.
- $12 million provided for studies addressing mercury and other pollutants associated with abandoned mines.

Looking to the Future

Water agencies in the region continue to manage water in light of changing conditions in the region and the state. An example is the Sacramento Valley Water Management Program (SVWMP). This resource management program was established as an alternative to SWRCB Phase 8 litigation proceedings designed to determine the responsibility of meeting water quality standards in the Delta. This agreement allows the parties to collaborate in the development and implementation of a variety of water management projects that will increase the availability of Sacramento Valley water. The agreement provides that increased supplies will be used first to fully meet the in basin needs, but would also be made available to help meet the requirements of the 1995 Water Quality Control Plan, provide other environmental benefits, and potentially meet additional export needs.

The key to this program is to keep it focused on integrated regional planning. SVWMP hydrologists and engineers are involved in more than 50 projects into both short- and long-term work plans for the region. These projects are designed to protect Northern California surface water rights and groundwater basins through the implementation of groundwater planning and monitoring that provides for unmet demands in the Sacramento Valley before exporting water to other regions. They include system improvement and water-use efficiency measures, conjunctive management, and surface water reoperation projects that include groundwater protection elements. The SVWMP is based on local control. This program is undergoing an environmental review and will seek public funds, including Proposition 50, to help implement many of these projects.

In addition to the Sacramento Valley Water Management Program, several other entities are working to improve water supply reliability and quality in the region and throughout the state. For example, the Redding Area Water Council is considering local water transfers, conjunctive use of groundwater, groundwater management, and additional surface water developments to increase supplies.

The Regional Water Authority is a joint powers authority that represents the interests of nearly 20 water providers around Sacramento. The organization's mission is to help its members protect and enhance the reliability, availability, affordability and quality of water in this area of the region. RWA and its members have successfully implemented the American River Basin Conjunctive Use Program and a region-wide water efficiency program in furtherance of the goals and objectives of the historic Water Forum Agreement.

The Sacramento Water Forum has developed a Water Forum Agreement containing two, equal objectives: 1) provide reliable and safe water for the region's economic health and planned development through 2030; and 2) preserve the fishery, wildlife, recreational and aesthetic values of the lower American River. The proposed draft solution includes an integrated package of seven actions. Generally, foothill water interests would increase their diversions from the American River in average and wet years and decrease those diversions in drier and driest years. Placer County Water Agency would be providing excess water from non-American River sources to many of the participating water agencies during drier and driest years to help make up the decreased American River diversions in those years.

The Sacramento Valley Water Quality Coalition (SVWQC) was formed in 2002 to enhance and improve water quality in the Sacramento River watershed (Sacramento River Basin, Region 5a), while sustaining the economic viability of agriculture, functional values of managed wetlands and sources of safe drinking water. This group is comprised of more than 200 agricultural and wetlands interests that have joined with local governments throughout the region to improve water quality for Northern California farms, cities and the environment.

In response to the Central Valley Regional Water Quality Control Board's recent decisions to revise agricultural water discharge waivers, the SVWQC developed and submitted its Regional Plan for Action to both the SWRCB and the Regional Water Quality Control Board in June 2003. This plan was submitted as the SVWQC's General Report with its Notice of Intent (NOI) to meet the newly adopted water quality regulations. On Feb. 10, 2004, the Regional Board issued a Notice of Applicability (NOA) to the SVWQC verifying the NOI. As the next step to implement this SVWQC Plan and to meet the Regional Board's regulations, two documents were prepared and submitted on April 1, 2004, a Watershed Evaluation Report (WER) and a Monitoring and Reporting Program Plan (MRP). When approved by the RWQCB, these documents are intended to become the foundation for a rational, phased water quality management program.

Changes in Water Demands for 2030 Scenarios

To illustrate the general magnitude of future changes in urban, agricultural, and environmental water demands, DWR prepared preliminary estimates of average-year water demands for each of the three example 2030 scenarios. As described in Chapter 3 of Volume 1, these three future scenarios are identified as Current Trends, Less Resource Intensive, and More Resource Intensive. The Volume 4 Reference Guide includes a description of the methods and assumptions used to produce these estimates in "Analytical-based Scenario Water Demand Estimation."

Scenario demand estimates were made individually for the urban, agricultural, and environmental sectors for each of the 10 California hydrologic regions. DWR staff assigned a unique set of input values for each scenario to reflect the qualitative narrative descriptions and scenario factors in Table 4-1 of Volume 1.

As previously stated, these projections are preliminary estimates of plausible future demands, which were developed without consideration of water supplies and delivery capabilities. The complex modeling necessary to complete a full analysis of the three described scenarios will be undertaken in the next CWP process.

Regional Planning and Coordination

Regional coordination of water resource issues and planning in the Sacramento River region is just beginning and will initially focus on fostering regional cooperation and helping regional interests develop programs that are mutually beneficial to the various stakeholders. Efforts will be made to assist the stakeholders by increasing communication between groups in the region and between the region and CBDA programs.

CBDA staff and associated federal, State and local agencies will work closely with Sacramento Valley stakeholders, including those mentioned in preceding paragraphs as well as local elected officials, water district elected officials and staff, public agencies, watershed groups, environmental activists and other interested members of the public. The goal will be to assist regional efforts in the development of regional planning. This strategy will allow local stakeholders to have a voice in activities supported by CBDA through funding in the region. It will also outline how the region will coordinate these activities with other regions throughout the Bay-Delta solution area.

Several northern California counties have also sought and obtained grant funding through the AB 303 program, and formed working partnerships to help them develop regional groundwater monitoring. AB 303 provides up to $250,000 per project for groundwater monitoring activities, including the drilling of monitoring wells. Both Butte and Tehama County have completed an inventory/analysis of their water resources to assist them in future water planning. Lake County recently applied for funding under AB 303 to do the same. Butte, Glenn, Plumas, Sutter, Shasta, Tehama and Sacramento counties have all moved forward with the development of integrated groundwater management plans. Glenn, Tehama and Butte counties have obtained funding to increase their groundwater monitoring activities through AB 303 grant funding. Several other entities, such as Anderson-Cottonwood Irrigation District, Deer Creek Irrigation District, Glenn-Colusa Irrigation District, Western Canal Water District and Maxwell Irrigation District have all augmented their groundwater monitoring activities in the region as well. Other counties, some non-profit groups, and Resource Conservation Districts (RCDs) in the region have also received funding for major ecosystem restoration and conservation programs through the CBDA program.

Water Portfolios for Water Years 1998, 2000, and 2001

Tables 6-3 and 6-4 present actual information about the water supplies and uses for the Sacramento River Hydrologic Region. Water year 1998 was wet for this region, with annual precipitation at 168 percent of normal, while the statewide annual precipitation was 171 percent of average. 2000 represents nearly normal hydrologic conditions with annual precipitation at 105 percent of average for the Sacramento River region, and 2001 reflected dryer water year conditions with annual precipitation at 67 percent of average. For comparison, statewide average precipitation in 2001 was 72 percent of normal. Table 6-3 provides more detailed information about the total water supplies available to this region for these three specific years from precipitation, imports and groundwater, and also summarizes the uses of all of the water supplies. Water portfolio information is included in Table 6-4 and companion water portfolio flow diagram figures 6-5 and 6-6 provided more detailed information about how the available water supplies are distributed and used throughout this region.

A more detailed tabulation of the portion of the total available water that is dedicated to urban, agricultural and environmental purposes is presented in Table 6-4. Because much of the Sacramento River region is devoted to agricultural activities, a large component of the developed water is supplied to agricultural purposes. Dedicated environmental water use is also a large component of the developed water supply, primarily because the required Sacramento – San Joaquin Delta outflow is accounted for in this region. Table 6-4 also provides detailed information about the sources of the developed water supplies, which are primarily from surface water systems of the Sacramento River and its tributaries. The use of available groundwater supplies is also a significant resource to this region.

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Water Portfolios

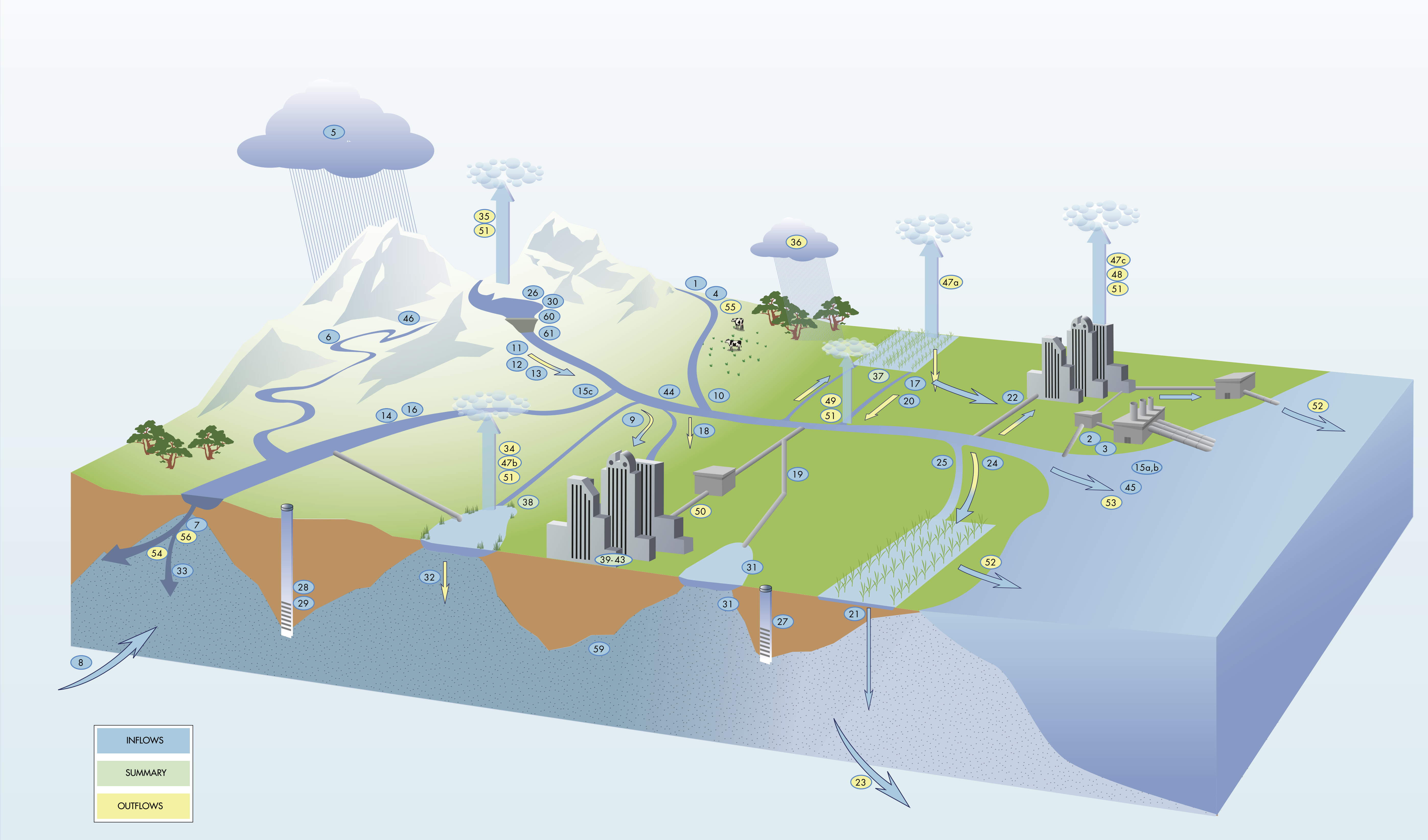
Sacramento River Hydrologic Region

Table 6-4 Sacramento River region water portfolio (TAF)

ID Number:	Flow Diagram Component (see legend)	Sacramento River 1998	Sacramento River 2000	Sacramento River 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	89,500.1	57,105.9	35,894.8
6a	Runoff - Natural			
b	Runoff - Incidental			
7	Total Groundwater Natural Recharge			
8	Groundwater Subsurface Inflow			N/A
9	Local Deliveries	13,939.5	12,204.8	8,843.0
10	Local Imports	9.7	10.4	8.5
11a	Central Valley Project :: Base Deliveries	1,572.3	1,912.9	2,002.0
b	Central Valley Project :: Project Deliveries	418.4	553.8	495.3
12	Other Federal Deliveries	198.0	228.3	239.5
13	State Water Project Deliveries	14.9	14.9	19.6
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	3,699.6	3,759.8	3,747.5
16	Environmental Water Account Releases	0	264	242
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	60.0	44.5	45.4
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	208.1	273.3	271.8
c	Conveyance Seepage - Managed Wetlands	23.8	24.5	13.4
19a	Recycled Water - Agriculture	-	-	-
b	Recycled Water - Urban	-	-	-
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	996.7	1,211.2	955.2
b	Return Flow to Developed Supply - Wetlands	4.0	4.2	4.4
c	Return Flow to Developed Supply - Urban	2.6	2.6	2.6
21a	Deep Percolation of Applied Water - Ag	179.3	299.8	320.3
b	Deep Percolation of Applied Water - Wetlands	8.3	11.6	12.3
c	Deep Percolation of Applied Water - Urban	80.0	91.6	91.4
22a	Reuse of Return Flows within Region - Ag	367.6	569.2	446.1
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	4,964.2	4,442.0	3,752.8
24a	Return Flow for Delta Outflow - Ag	-	-	227.9
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	1,564.2	1,413.2	965.0
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions			
26	Surface Water in Storage - Beg of Yr	9,727.2	11,603.3	10,502.6
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	1,854.7	2,815.2	2,926.9
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	12,479.2	10,502.6	8,090.8
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation			
b	Evaporation and Evapotranspiration from Unirrigated Ag			
35a	Evaporation from Lakes	320.7	331.5	326.1
b	Evaporation from Reservoirs	700.7	798.5	728.9
36	Ag Effective Precipitation on Irrigated Lands	1358	1057.5	1056.6
37	Agricultural Water Use	5,841.2	7,927.1	7,781.7
38	Managed Wetlands Water Use	398.3	429.5	445.7
39a	Urban Residential Use - Single Family - Interior	120.0	136.1	139.8
b	Urban Residential Use - Single Family - Exterior	224.3	267.9	273.0
c	Urban Residential Use - Multi-family - Interior	71.5	87.2	89.4
d	Urban Residential Use - Multi-family - Exterior	19.5	23.8	24.3
40	Urban Commercial Use	113.1	140.4	137.5
41	Urban Industrial Use	77.3	84.2	84.5
42	Urban Large Landscape	91.8	111.2	120.1
43	Urban Energy Production	-	0.3	0.1
44	Instream Flow	586.3	600.2	614.1
45	Required Delta Outflow	9505	7231.6	4486.2
46	Wild and Scenic Rivers	947.7	782.8	320.5
47a	Evapotranspiration of Applied Water - Ag	3677.9	4983.2	4908.4
b	Evapotranspiration of Applied Water - Managed Wetlands	127.5	169.7	162.9
c	Evapotranspiration of Applied Water - Urban	313.2	378.8	384.4
48	Evaporation and Evapotranspiration from Urban Wastewater	0.2	0.1	0.2
49	Return Flows Evaporation and Evapotranspiration - Ag	122	173.4	174.2
50	Urban Waste Water Produced	253	299.7	312.6
51a	Conveyance Evaporation and Evapotranspiration - Urban	4.9	4.3	4.3
b	Conveyance Evaporation and Evapotranspiration - Ag	40.6	61.5	59.9
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	11.7	16.3	15.5
d	Conveyance Outflow to Mexico			
52a	Return Flows to Salt Sink - Ag	637	869.5	931.5
b	Return Flows to Salt Sink - Urban	314.3	370.4	381.2
c	Return Flows to Salt Sink - Wetlands	179.24	164.1	169.3
53	Remaining Natural Runoff - Flows to Salt Sink	33,981.9	10,924.2	2,457.9
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	901.1	1,150.3	700.4
56	Regional Exports	5193.6	6250.8	4657.1
59	Groundwater Net Change in Storage	739.9	-150.8	-1,147.6
60	Surface Water Net Change in Storage	2,752.0	-1,100.7	-2,411.8
61	Surface Water Total Available Storage	16,145.6	16,145.6	16,145.6

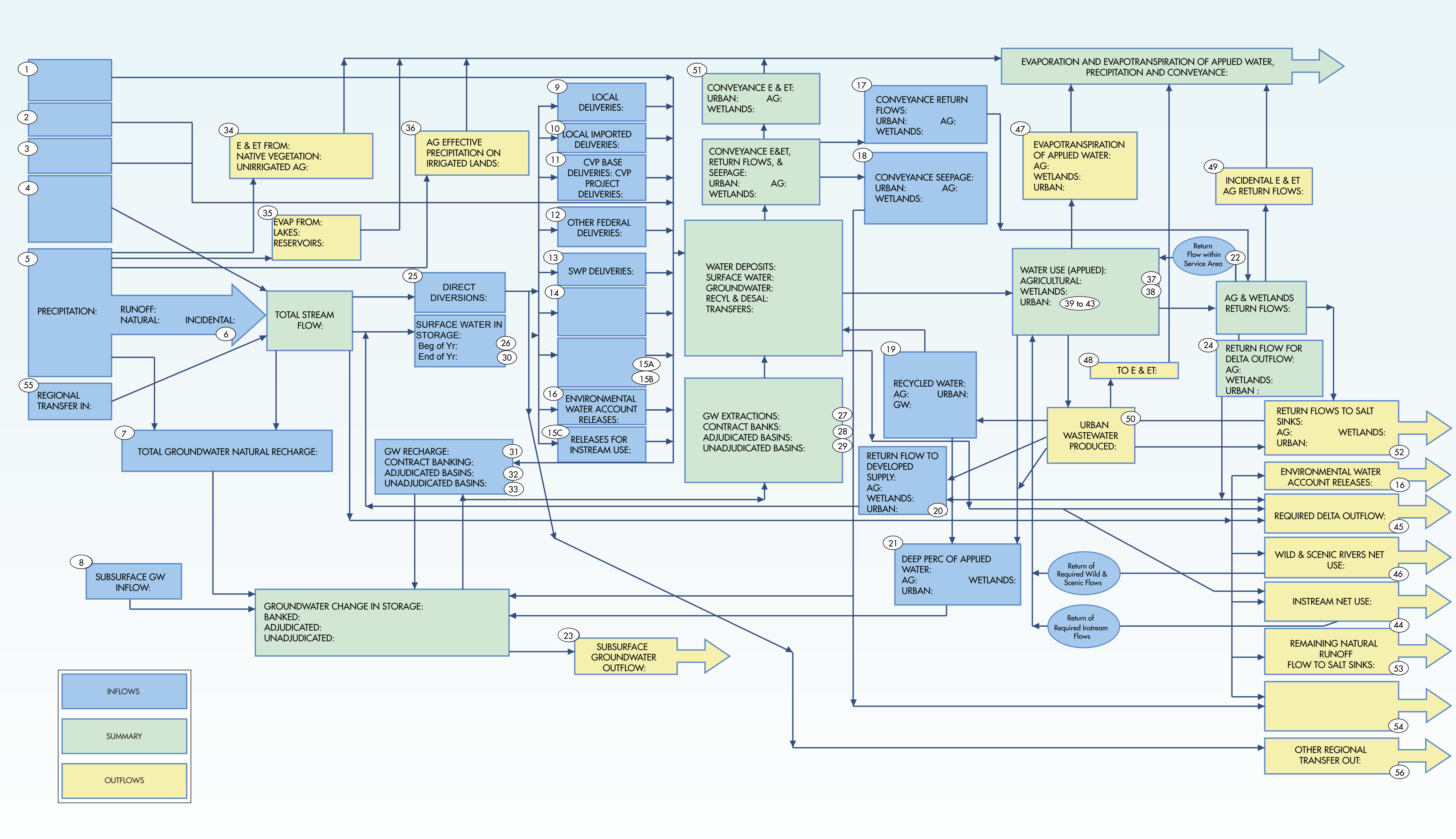
Inflows — Outflows — Green number signifies included in summary boxes

Figure 6-5 Sacramento River region - illustrated water flow diagram



In this illustration of Table 6-4, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 6-6 Sacramento River region - schematic flow diagram



In schematic of Table 6-4, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether the component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.

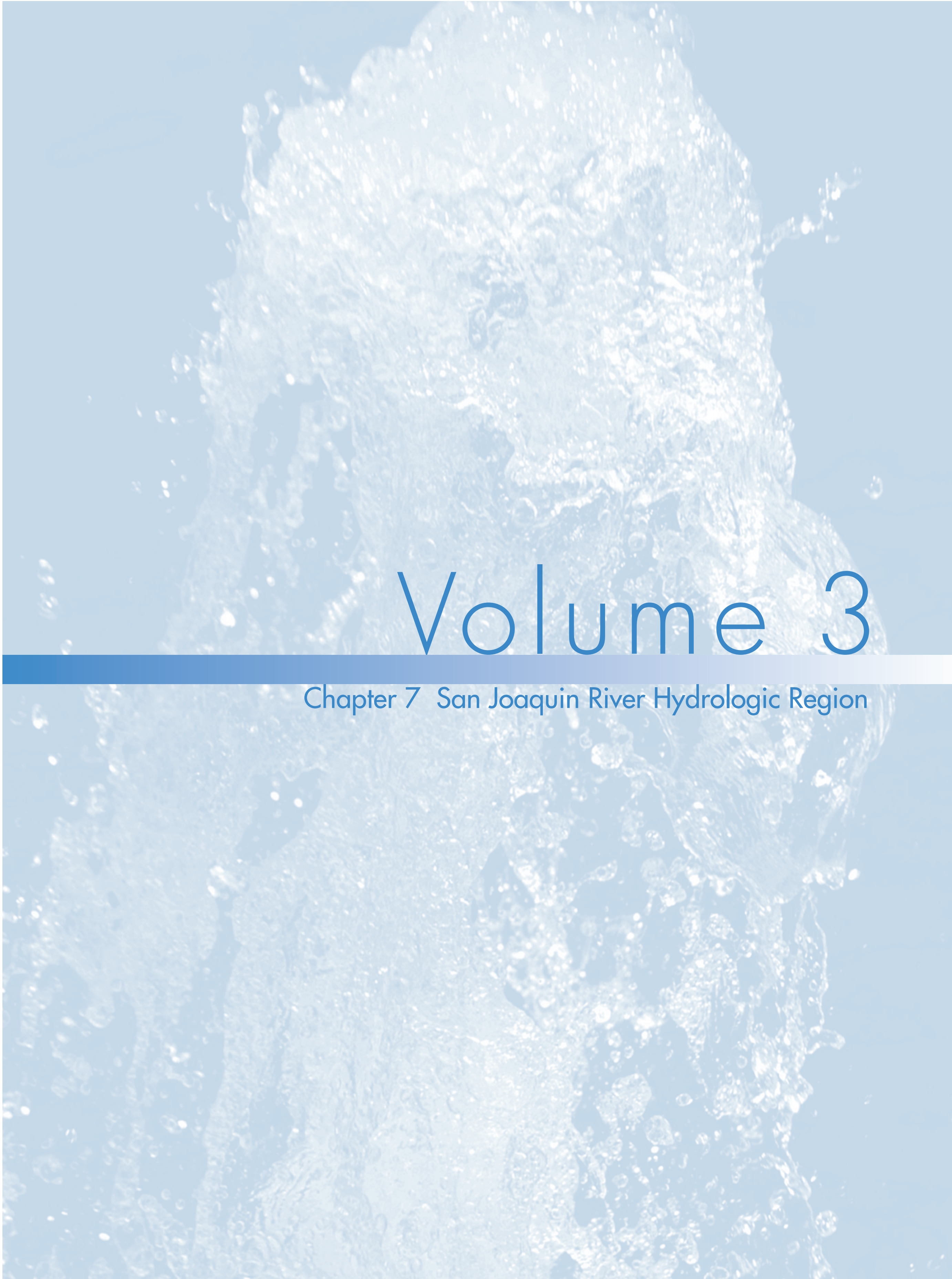


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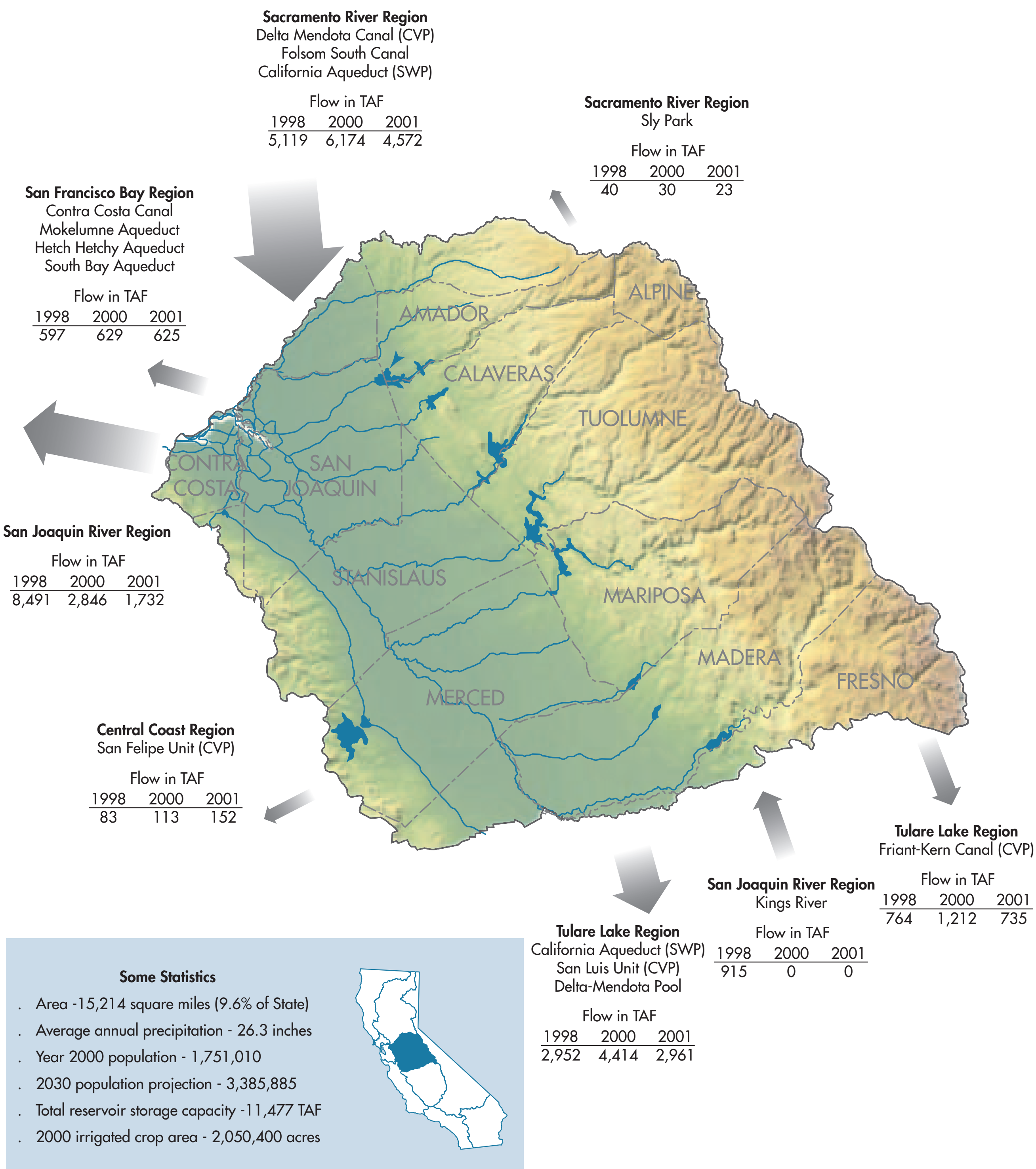
Figure 7-1 San Joaquin River Hydrologic Region



The San Joaquin River Hydrologic Region includes all of the San Joaquin River drainage area extending from Madera County in the south to the Delta in the north. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

Chapter 7 *San Joaquin River Hydrologic Region*

Setting

The San Joaquin River hydrologic region is in the heart of California and includes the northern portion of the San Joaquin Valley. It is bordered on the east by the Sierra Nevada and on the west by the coastal mountains of the Diablo Range. It extends from the southern boundaries of the Sacramento – San Joaquin Delta to include all of the San Joaquin River drainage area to the northern edge of the San Joaquin River in Madera. Roughly half of the Sacramento – San Joaquin Delta is within this hydrologic region, encompassing those portions of the Delta in Contra Costa, Alameda, and San Joaquin counties. The region extends south from just below the northeastern corner of Sacramento County and east to include the southern third of El Dorado County, almost all of Amador County, all of Calaveras, Mariposa, Madera, Merced, Stanislaus, and Tuolumne counties, and the western slope of Alpine County. The San Joaquin River Basin is hydrologically separated from the Tulare Lake Basin by a low, broad ridge that extends across the San Joaquin Valley between the San Joaquin and Kings rivers. A map and table of statistics describing the region are presented in Figure 7-1.

The San Joaquin River is roughly 300 miles long, which makes it one of the state's longest rivers. It has an average unimpaired runoff of about 1.8 million acre-feet per year, and its eight major tributaries drain about 32,000 square miles of watershed lands. The headwaters of the San Joaquin River begin near the 14,000 foot elevation of the crest of the Sierra Nevada. The river runs down the western slope of the Sierra, and then flows northwest to the Delta where it meets the Sacramento River. The two rivers converge in the 1,153-square-mile Sacramento-San Joaquin Delta—a maze of channels and islands—which also receives fresh-water inflow from the Cosumnes, Mokelumne and Calaveras rivers and other smaller streams. Historically, more than 40 percent of the state's annual run-off flowed to the Delta via the Sacramento, San Joaquin and Mokelumne rivers.

Climate

Because the San Joaquin Valley is isolated by mountains from the marine effects of coastal California, the maximum average daily temperature in the valley reaches a high of 101 degrees during late July. Daily temperatures during the warmest months usually range between 76 and 115 degrees. The northern part of this hydrologic region does benefit from Delta breezes during the hot summer periods, which are winds produced by the strong temperature difference between the hot valley regions and the cooler coastal climate of the San Francisco Bay area. Winter temperatures in the valley floor regions are usually mild, but during infrequent cold spells minimum readings occasionally drop below freezing. Heavy frost occurs in most fall and winter seasons, typically between the end of November and early March.

The San Joaquin River hydrologic region experiences a wide range of precipitation, which varies from low rainfall amounts on the valley floor to extensive amounts of snow in the higher elevations of the Sierra Nevada. The climate of much of the upland area on the west side of the valley floor resembles that of the Sierra Nevada foothills on the east side. The average annual precipitation of several Sierra Nevada stations is about 35 inches. Snowmelt runoff from the mountains is the major contributor to local water supplies for the eastern San Joaquin Valley. The climate of the valley is characterized by long, hot summers and mild winters. Average annual precipitation ranges from about 22 inches near the Stockton area in the north to about 11 inches in the southern portion of the region and further decreases to about 6.5 inches near the dry southwestern corner of the region.

Population

The population of the San Joaquin River region in year 2000 was about 1.7 million, which was about 5 percent of the state's total population. Although there are 15 counties partially or entirely in the San Joaquin River region, most of the popula-

The valley portion of the San Joaquin River region consists primarily of highly productive farmland and the rapidly growing urban areas of Stockton, Tracy, Modesto, Manteca, and Merced. The river runs down the western slope of the Sierra, and then flows northwest to the Delta. (DWR photo)

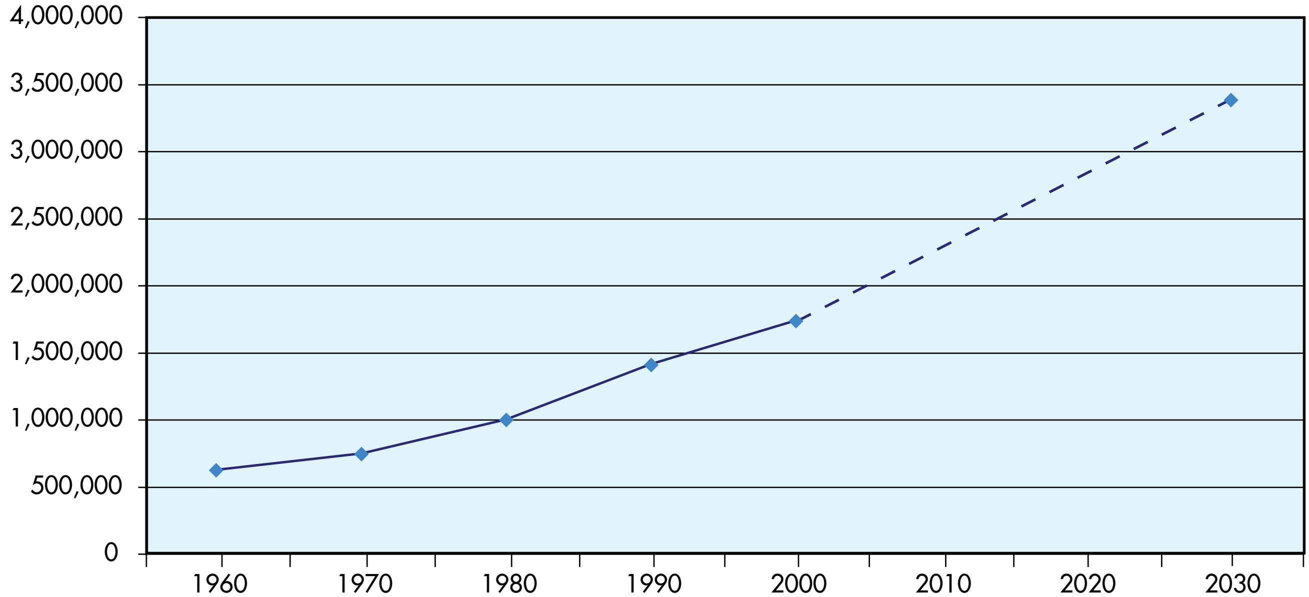
tion and agricultural land use occurs within five counties: San Joaquin, Stanislaus, Merced, Contra Costa, and Madera. Of these, the county with the largest year 2000 population was San Joaquin County with 567,600 people. Stockton, its largest city, had 243,771 people. Stanislaus County, population 567,600, was the second largest county in the region, and its largest city is Modesto with a population of 188,856. The county of Merced is the next largest with a population of 210,200; the city of Merced had a population of 63,800. For counties that are only partially within this hydrologic region, Contra Costa County had 145,775 residents, and Madera County had a year 2000 population of 127,400. Figure 7-2 provides a graphical depiction of the San Joaquin River region's total actual population from years 1960 through year 2000, with projections to year 2030.

California experienced a statewide population increase of almost 14 percent from 1990 to 2000, and the growth rates in San Joaquin valley cities and counties are projected to exceed that trend. According to California Department of Finance projections, growth rates for the above five counties will range between 18 and 32 percent over the next 10 years. The highest rate of urbanization will occur in the northern portion of the region. For San Joaquin County, the projected population will increase to 747,100 by 2010 and to 1,229,000 by 2030. Similarly, the projected population for Stanislaus County will increase to 559,100 by 2010, and to 744,600 by 2030. The rapid rates of growth and urbanization in these regions will generate significant land and water uses challenges for the entire San Joaquin Valley.

Land Use

The valley portion of the San Joaquin River region consists primarily of highly productive farmland and the rapidly growing urban areas of Stockton, Tracy, Modesto, Manteca, and Merced. Agriculture is the major economic and land use activity in the San Joaquin River region. The San Joaquin

Figure 7-2 San Joaquin River Hydrologic Region population



Data from California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for the San Joaquin River region.

Valley is recognized as one of the most important agricultural regions in California, with roughly 2 million acres of irrigated cropland and an annual agricultural output valued at more than $ 4.9 billion. The region has a high diversity of irrigated crops with about 34 percent as permanent orchard and vineyard crops and 29 percent as grains, hay, and pasture. Some of the other major crops include cotton, corn, tomatoes, and a variety of other field and truck crops. In addition to agriculture, other important industries in the region include food processing, chemical production, lumber and wood products, glass, textiles, paper, machinery, fabricated metal products, and various other commodities. About 1.95 million acres or 21 percent of the region's total land area were devoted to irrigated agriculture in year 2000.

While the valley floor areas of the San Joaquin River region are primarily privately owned agricultural land, much of the Sierra Nevada is national forest. The government-owned public lands include the El Dorado, Stanislaus, and Sierra national forests and Yosemite National Park. Public lands amount to about one-third of the San Joaquin River region's total land area. The national forest and park lands encompass more than 2.9 million acres; State parks and recreational areas and other State property account for about 80,000 acres; and U.S. Bureau of Land Management and military properties occupy over 200,000 and 5,100 acres, respectively. The valley portion of the region constitutes about 3.5 million acres, the eastern foothills and mountains total about 5.8 million acres, and the western coastal mountains comprise about 900,000 acres.

Restoration of Central Valley wetlands habitat is critical to the preservation of many species of fish and wildlife in the San Joaquin River ecosystem. Beginning in the 1990s, agencies began to make progress in efforts to set aside and restore acreage for wetland habitat. In 1990, the San Joaquin River Management Program was formed to restore the river system, which led to completion of the San Joaquin River Management Plan in 1995. This plan identified nearly 80 consensus-based actions intended to benefit the San Joaquin River system, which are organized into the categories of projects, feasibility studies, and riparian habitat acquisitions. Many federal and State agencies now have active roles in the funding and implementation of wetlands habitat restoration programs, including the U.S. Fish and Wild Service, the California Bay-Delta Authority and the California Department of Fish and Game. One of the larger projects along the San Joaquin River is the restoration of 775 acres of native riparian habitat on the

Table 7-1 San Joaquin River Hydrologic Region water balance summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (174%)	2000 (113%)	2001 (79%)
Water Entering the Region			
Precipitation	35,535	23,209	16,120
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions	6,034	6,174	4,572
Total	**41,569**	**29,383**	**20,692**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	3,705	4,762	4,983
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions***	4,436	6,398	4,496
Statutory Required Outflow to Salt Sink	0	0	0
Additional Outflow to Salt Sink	176	196	218
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	31,448	18,055	13,690
Total	**39,765**	**29,412**	**23,387**
Storage Changes in the Region [+] Water added to storage [-] Water removed from storage			
Change in Surface Reservoir Storage	2,248	67	-1,435
Change in Groundwater Storage **	-444	-96	-1,260
Total	**1,804**	**-29**	**-2,695**
Applied Water * (compare with Consumptive Use)	6,035	7,584	7,817

***Footnote for applied water**

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

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

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

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

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

West Unit of the San Joaquin River National Wildlife Refuge, west of Modesto. About 158,000 native trees, shrubs, and vines will be planted to accommodate the habitat needs of threatened and endangered species.

The San Joaquin Valley serves as a breeding and resting stop along the Pacific Flyway for many species of waterfowl. Public wildlife refuges in the San Joaquin River region include the San Luis National Wildlife Refuge, which encompasses 26,340 acres; the San Joaquin River National Wildlife Refuge with 2,875 acres; Merced National Wildlife Refuge with 8,280 acres; Los Banos Wildlife Area with 5,586 acres; Volta Wildlife Area with 2,891 acres; the North Grasslands Wildlife Area with 7,069 acres; the White Slough Wildlife Area with 969 acres; and the Isenberg Sandhill Crane Reserve at 361 acres. Toward the northern end of this region, the Cosumnes River Preserve is managed by the Nature Conservancy and has become the largest refuge area in the region at 36,300 acres. Additionally, there are many private duck clubs in the region that maintain wetland habitat.

Water Supply and Use

The primary sources of surface water in the San Joaquin River region are the rivers that drain the western slope of the Sierra Nevada. These include the San Joaquin River and its major tributaries, the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes rivers. Most of these rivers drain large areas of high-elevation watersheds that supply snowmelt runoff during the late spring and early summer. Other tributaries to the San Joaquin River include the Chowchilla and Fresno rivers, which originate in the Sierra Nevada foothills where most of the runoff results directly from rainfall.

The water balance table for the San Joaquin River hydrologic region (Table 7-1) summarizes all of the water supplies, uses, and outflows for years 1998, 2000, and 2001 and is supplemented by the detailed regional water accounting information in Table 7-2. As shown in Table 7-1, changes in groundwater storage are balanced with the available surface water each year to meet the regions needs. In wet years like 1998 excess surface water supply is added into groundwater storage, while in a drier year like 2001 the amount of groundwater pumped to meet water needs results in a net reduction of groundwater in storage. Table 7-3 (in large format at the end of this chapter) provides more specific information about the developed or dedicated component of water supplies for agricultural, urban and environmental purposes, as assembled from actual data for 1998, 2000 and 2001.

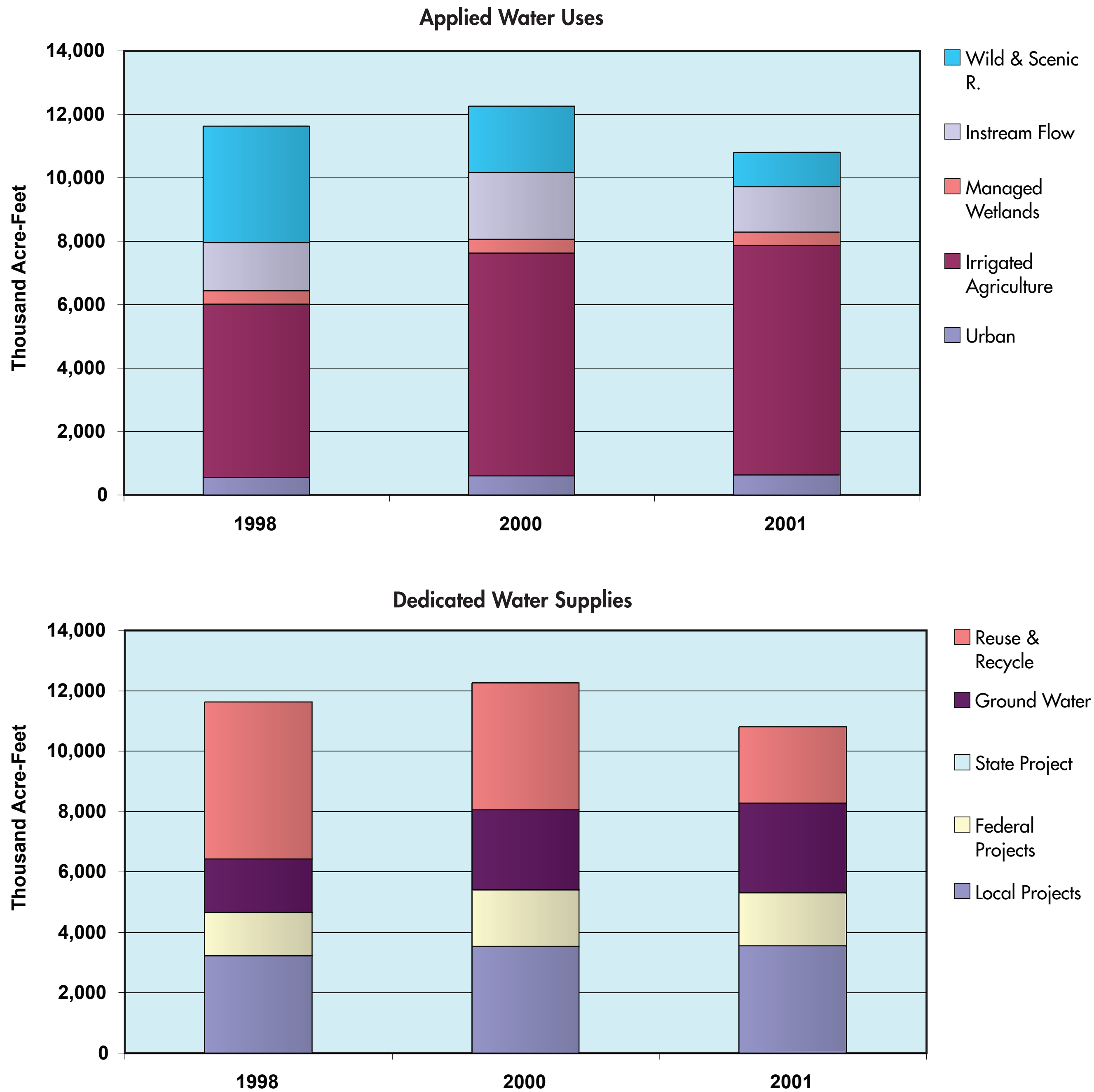
In 2000, an average water year, about 44 percent of the San Joaquin River region's developed water supply came from local surface sources, 23 percent was from imported surface supplies, and groundwater provided about 33 percent of the water supply. About 26 percent of the developed supply, excluding surface water and groundwater reuse, was used for dedicated natural flows to meet instream flow requirements. Figure 7-3 and Table 7-2 summarize all of the developed urban, agricultural and dedicated environmental water uses in this region for years 1998, 2000 and 2001.

Many surface water supply systems in the Sierra Nevada streams and rivers follow a similar pattern of use. Often a series of small reservoirs in the mountain valleys will gathers and store snowmelt runoff. This water is used to generate electricity as it is released downstream. Some diversions occur for consumptive use in local communities, but most flows are recaptured in larger reservoirs in the foothills and along the eastern edge of the valley. Most of these larger reservoirs were built primarily for flood control. However, many of them also store water for urban and agricultural purposes, and make downstream releases for fish and environmental needs. Irrigation canals and municipal pipelines divert much of the water from these reservoirs. Many of the small communities in the Sierra Nevada foothills receive most of their water from local surface supplies. The extensive network of canals and ditches constructed in the 1850s for hydraulic mining forms the basis of many of the conveyance systems. In addition to surface water, many of these foothill and mountain communities pump groundwater from hard rock wells and old mines to augment their supplies, especially during droughts. Groundwater supplies in the foothills are limited, but this is the primary source of water for individual residents who are not connected to municipal water systems.

On the valley floor, many agricultural and municipal users receive their water supply from large irrigation districts, such as the Modesto, Merced, Oakdale, South San Joaquin and Turlock Irrigation Districts. Most of this region's imported surface water supplies are delivered by the federal Central Valley Project, which average about 1.9 million acre-feet per year. In addition, Oak Flat Water District receives about 4,500 acre-feet per year from the State Water Project.

Most of the surface water in the upper San Joaquin River is stored and diverted at Friant Dam, and is then conveyed north through the Madera Canal and south through the Friant-Kern Canal. Average annual diversions from the San Joaquin River through the Friant-Kern and Madera Canals total about 1.5 million acre-feet per year. Releases from Friant Dam to the San Joaquin River are generally limited to those required to satisfy

Figure 7-3 San Joaquin River region water balance for water years 1998, 2000, 2001



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

Table 7-2 San Joaquin River Hydrologic Region water use and distribution of dedicated supplies (TAF)

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	30.2			32.9			35.5		
Commercial	34.5			37.6			39.6		
Industrial	86.3			89.4			90.1		
Energy Production	0.0			0.0			0.0		
Residential - Interior	176.2			191.5			199.7		
Residential - Exterior	214.0			231.3			243.7		
Evapotranspiration of Applied Water		191.0	191.0		206.6	206.6		218.4	218.4
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		142.3	142.3		150.0	150.0		160.8	160.8
Conveyance Applied Water	19.2			17.5			20.5		
Conveyance Evaporation & ETAW		12.6	12.6		12.0	12.0		13.6	13.6
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		6.6	6.6		5.5	5.5		6.9	6.9
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**560.4**	**352.5**	**352.5**	**600.2**	**374.1**	**374.1**	**629.1**	**399.7**	**399.7**
Agriculture									
On-Farm Applied Water	4,823.5			6,215.8			6,533.0		
Evapotranspiration of Applied Water		3,408.1	3,408.1		4,406.0	4,406.0		4,627.8	4,627.8
E&ET and Deep Perc to Salt Sink		74.4	74.4		11.6	11.6		14.3	14.3
Outflow		1,183.4	4.0		954.1	5.0		980.8	12.4
Conveyance Applied Water	379.0			461.5			449.1		
Conveyance Evaporation & ETAW		207.7	207.7		248.8	248.8		245.3	245.3
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		22.9	22.9		35.4	35.4		37.9	37.9
GW Recharge Applied Water	255.5			340.5			260.9		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**5,458.0**	**4,896.5**	**3,717.1**	**7,017.8**	**5,655.9**	**4,706.8**	**7,243.0**	**5,906.1**	**4,937.7**
Environmental									
Instream									
Applied Water	1,528.9			2,098.5			1,424.4		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Wild & Scenic									
Applied Water	3,661.1			2,093.8			1,091.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	414.5			444.8			414.7		
Evapotranspiration of Applied Water		105.9	105.9		149.7	149.7		136.6	136.6
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		134.2	1.6		128.3	1.6		135.7	1.5
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	414.5	240.1	107.5	444.8	278.0	151.3	414.7	272.3	138.1
Total Environmental Use	**5,604.5**	**240.1**	**107.5**	**4,637.1**	**278.0**	**151.3**	**2,930.1**	**272.3**	**138.1**
TOTAL USE AND OUTFLOW	**11,622.9**	**5,489.1**	**4,177.1**	**12,255.1**	**6,308.0**	**5,232.2**	**10,802.2**	**6,578.1**	**5,475.5**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	3,229.8	3,229.8	2,321.5	3,540.7	3,540.7	2,837.2	3,548.5	3,548.5	2,812.5
Local Imported Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	1,367.0	1,367.0	982.6	1,803.5	1,803.5	1,445.2	1,666.5	1,666.5	1,320.9
Other Federal Deliveries	64.3	64.3	46.2	65.8	65.8	52.7	97.6	97.6	77.4
SWP Deliveries	4.3	4.3	3.1	4.6	4.6	3.7	3.5	3.5	2.8
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	821.8	821.8	821.8	891.5	891.5	891.5	1,260.1	1,260.1	1,260.1
Deep Percolation of Surface and GW	943.8			1,754.8			1,708.5		
Reuse/Recycle									
Reuse Surface Water	5,190.0			4,192.3			2,515.6		
Recycled Water	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
TOTAL SUPPLIES	**11,622.9**	**5,489.1**	**4,177.1**	**12,255.1**	**6,308.0**	**5,232.2**	**10,802.2**	**6,578.1**	**5,475.5**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

downstream water rights, above Gravelly Ford, and for flood control. In the vicinity of Gravelly Ford, a high amount of subsurface percolation into the groundwater basin occurs because the river bed is primarily sand and gravel. As a result of the operation of Friant Dam, there are seldom any surface flows in the middle reaches of the San Joaquin River until it is joined by the Merced River and other major downstream tributaries Agricultural and municipal return flows into the river also contribute to the surface flow of the lower San Joaquin River.

The tributaries of the San Joaquin River provide the region with high-quality water that constitutes most of the surface water supplies for local uses. Much of this water is regulated by reservoirs and used on the east side of the San Joaquin Valley. Significant amounts of water are also diverted west across the valley to the San Francisco Bay Area via the Mokelumne Aqueduct, which supplies some for the urban water demands of East Bay Municipal Utility District, and the Hetch Hetchy Aqueduct, which supplies urban water to San Francisco and several other Bay Area cities. The average annual water diversions from the Mokelumne and Tuolumne rivers for export from the basin include 245,000 acre-feet through the Mokelumne Aqueduct and 267,000 acre-feet through the Hetch-Hetchy Aqueduct. Major dams on the tributary streams include Pardee and Camanche dams on the Mokelumne River, New Melones, Donnells, and Beardsley dams on the Stanislaus River, O'Shaunessy and New Don Pedro dams on the Tuolumne River, and Exchequer Dam on the Merced River.

In 2000, an average water year, agriculture accounted for about 57 percent of the San Joaquin River region's total developed water use, while urban water use was about 5 percent and environmental water use for dedicated purposes was 38 percent. Regional average urban per capita water use was about 304 gpcd. Imported water supplies to this region from the Central Valley Project, the State Water Project, and other federal deliveries, amounted to 1,874,000 acre feet. Environmental demands, including for refuges, instream requirements, and wild and scenic flows, totaled 4,637,100 acre feet (see Figure 7-3 and Table 7-2)

State of the Region

Challenges

Historically, the surface water originating from Sierra Nevada rivers has proven to be a dependable supply of high quality water, but it meets only half of the region's total water requirements. Imported surface water and groundwater-pumping make up the difference. Because the region relies on imported surface water from other regions, there is growing concern over the long-term availability of external supplies. Additionally, proposals to restore fisheries on the San Joaquin River through larger releases of water from Friant Dam have resulted in growing concerns over the long-term stability of the existing surface water supplies.

One of the major challenges facing the San Joaquin River hydrologic region is restoring the ecosystem along the San Joaquin River below Friant Dam while maintaining water supply reliability for other purposes. The river's historic salmon populations upstream of the Merced River were eradicated after the river water was diverted with the construction of Friant Dam in the 1940s. In August 2004, a federal judge ruled that the U.S. Bureau of Reclamation violated California State Fish and Game Code 5937 by not providing enough water downstream to sustain fish populations. Efforts to restore some surface flows to the San Joaquin River would help restore the ecosystem and improve the reliability and quality of water available to downstream farmers in the Delta. The litigation of these issues is not resolved, and the development of acceptable solutions will be challenging because of the potential to adversely impact water supplies to the Friant Water Users Authority.

Another major challenge is maintaining the integrity of the Sacramento – San Joaquin Delta levee system. More than 1,000 miles of levees protect Delta islands, and these lands are commonly 10 to 15 feet below sea level. The potential failure of a levee could occur as the result of major earthquakes or floods, or because of gradual deterioration and inadequate maintenance. Composed largely of peat soils, many islands are vulnerable to seepage and subsidence, which contributes to settlement and the risk of levee failure. Protection and restoration of the Delta levees is one of the key objectives of the CALFED Bay-Delta program as discussed in Chapter 12 of this volume.

Groundwater pumping is a major source of water supply for the San Joaquin River region, and it continues to increase in response to the growing urban and agricultural demands. Over the long-term, groundwater extraction cannot continue to meet all of the current and projected water demands without causing negative impacts on the groundwater basins. The primary impact is groundwater overdraft, a condition where the average long-term amount of water pumped out of the basin exceeds the amount of water recharged or naturally replenished into the groundwater basin. A serious consequence of long-term groundwater overdraft is land subsidence and compaction of the aquifer, with a resulting drop in the natural land surface. Land subsidence results in a reduction of aquifer storage space and may damage public facilities such as canals, utilities, pipelines, and roads. Pumping depressions from wells have caused poor quality water from the Delta to migrate underground toward eastern San Joaquin County. Several municipal wells in western Stockton have been abandoned because of the resulting decline in groundwater quality. Several existing and proposed measures can help counteract potentially serious overdraft conditions in some areas of the region, such as groundwater spreading basins and recharge programs. In some situations, the over-irrigation of crops with extra surface water in wet years and seepage from unlined canal systems can aid in groundwater recharge.

The major water quality problems of the San Joaquin River region are a result of many factors, including depleted freshwater flows, municipal and industrial wastewater discharges, salt loads from agricultural drainage and runoff, and other pollutants associated with long-term agricultural irrigation and production, including nutrients, selenium, boron, and organophosphate pesticides. The entire Central Valley, which includes the San Joaquin River, as well as the Sacramento River and Tulare Lake basins, has 40 water bodies that are impaired due to agriculture, including 800 miles of waterways, and 40,000 acres in the Delta. In its most recent triennial review of its basin plan, the Central Valley Regional Water Quality Control Board identified high priority problems as salinity and boron discharges to the San Joaquin River, low dissolved oxygen problems in the lower San Joaquin River, control of organophosphorous pesticides, and the need for stronger policies to protect Delta drinking water quality.

High salinity is a problem in the San Joaquin River basin because of the greatly altered flows of the river, most of which is diverted from its natural course at Friant Dam. In addition, imported irrigation water from State and federal projects annually transport more than a half million tons of salts into the west side of the San Joaquin River region. Water released from New Melones Reservoir on the Stanislaus River is used to help meet the salinity and dissolved oxygen requirements at Vernalis on the lower San Joaquin River. Agricultural drainage and discharges from managed wetlands are already regulated in the 370,000 acre Grasslands watershed, which contributes high levels of salts, selenium, boron, and nutrients to Mud and Salt Sloughs. These sloughs are some of the primary contributors of selenium to the San Joaquin River. Dairies, stockyards, and poultry ranches are also a concern in the region because they generate waste products including pathogens, nutrients, salts, and emerging contaminants that enter the waterways. Some dairies and other agricultural operations are already subject to regulatory review. Water releases from managed wetlands, part of State and federal wildlife refuge system, also can discharge salts and nutrients. The erosion of westside streams is the primary source of organochlorine pesticides in the San Joaquin River.

Migrating and spawning salmonids face high temperatures in the Stanislaus, Tuolumne, and Merced rivers downstream from dams during certain times of the year, depending on hydrologic and water supply conditions. Contamination of fish is also a concern in these three rivers as well as the main stem of the San Joaquin River. For example, the Central Valley Regional Water Quality Control Board cites one study of a 43-mile reach of the San Joaquin River (between the confluences with the Merced and the Stanislaus rivers) to be toxic to fish about half the time. In the lower San Joaquin River, low dissolved oxygen levels in the Stockton Deepwater Ship Channel are attributable to warm temperatures, low flows, nutrients, and channel configuration. This portion of the river with low dissolved oxygen is potentially a barrier to fall-run Chinook salmon migrating upstream to the Merced, Tuolumne, and Stanislaus rivers to spawn.

Groundwater quality throughout the region is generally adequate for most urban and agricultural uses. However there are roughly 1,000 square miles overlying groundwater along the western edge of the valley floor that is contaminated with high salinity from naturally occurring marine sediments of the Coast Range. The salinity of groundwater in the region can increase as a result of agricultural practices in which the evapotranspiration of crops and wetlands leaves behind the majority of salts contained in the imported water. In addition, high water-table conditions underlying marginal lands along the west side of the San Joaquin River region contribute to subsurface drainage problems. In order to maintain a salt balance in the root zone, much of this salt is leached into the groundwater. For aesthetic purposes, such as taste, Department of Health Services regulations recommend that drinking water contain less than 500 mg/L of salinity as measured by total dissolved solids. For agricultural uses, water with a salinity of less than 450 mg/L total dissolved solids is generally considered acceptable. While the above Department of Health Services recommendation is adopted by reference into the Regional Water Quality Control Board's basin plan to protect domestic use of groundwater, the basin plan contains no numerical salinity objectives for protection of agricultural beneficial uses.

Nitrates that are generated from the disposal of human and animal waste products or from the inefficient application of fertilizer and irrigation water have contaminated 200 square miles of groundwater in the region and do threaten some domestic water supplies. Pesticides have contaminated 500 square miles of groundwater basins, primarily in agricultural areas on the east side of the San Joaquin Valley, where soil permeability is higher and the depth to groundwater is more shallow. The entire Central Valley is home to about 500,000 single-family residential septic systems, each with leach fields that discharge to the groundwater. The most notable agricultural contaminant detected in groundwater samples from this region is dibromochloropropane, DBCP, which is a banned nematocide that has been found mostly along the State Route 99 highway corridor. There are also roughly 200 square miles of groundwater basins that are contaminated by naturally occurring selenium.

As of January 1, 2003, the passage of Senate Bill 390 ended the previously used conditional waivers for waste discharge requirements for 23 types of waste discharges, including irrigated agriculture and logging. A previously submitted petition from three environmental groups had requested that these waivers be rescinded because of concerns about pesticides in discharges. Unlike the federal Clean Water Act, which specifically exempts agricultural discharges from regulation, California's Porter-Cologne Water Quality Control Act allows a waiver from regulation only if it does not conflict with the public interest. The Central Valley Regional Water Quality Control Board granted such a waiver to irrigated lands in 1982, exempting the agricultural discharges using the waste discharge requirements process. That waiver did have conditions imposed, but because of a lack of staff resources, the regional board did not monitor or review compliance. Senate Bill 390 still allows the continuation of waivers, but only when specifically renewed by the regional board and when subject to a five-year review.

In relation to other regions of the State, water discharges from irrigated lands have their greatest impact to water quality in the Central Valley, which covers 40 percent of California's land area and contains 7-million irrigated acres and more than 25,000 individual agricultural dischargers. As an interim measure in July 2003, the Central Valley regional board adopted two types of conditional waivers for such discharges into surface water, one for "coalition groups" and the other for individuals. These waivers applied to surface runoff or tailwater, excess water diverted but not used, subsurface drainage to lower the water table for growing, and storm water runoff. Additional commodity-specific and low-threat waivers are also under consideration. The requirements contained in these new waivers include water quality monitoring and implementation of best management practices or management measures to control pollution. This new waiver program, which focuses on data collection, monitoring for toxicity, and drinking water constituents will expire on December 31, 2005. Subsequently, a 10-year implementation program is envisioned that would fully protect the state's waters from quality problems associated with discharges from irrigated lands in order to meet water quality objectives.

Although existing agricultural land use practices affect water quality now, the expanding urbanization of Central Valley cities will generate new and different water quality problems in the future. In anticipation of these problems, the Central Valley regional board has recently started requiring many municipal wastewater discharge systems to construct and operate more costly tertiary wastewater treatment facilities.

Accomplishments

The Reclamation Board of California and the U.S. Army Corps of Engineers in coordination with a broad array of stakeholders, have recently developed a new Comprehensive Plan for the flood management system of the Sacramento and San Joaquin River regions. Rather than a physical plan for flood facilities and systems, this Comprehensive Plan recommends an approach to design and implement projects in the future in ways that would reduce damage from flooding and restore the ecosystem.

The Millerton Area Watershed Coalition is conducting a comprehensive assessment of the San Joaquin River watershed and will evaluate activities that need to be changed to better protect and care for the watershed. The information and recommendations from this study will be developed into an outreach program to promote the protection and enhancement of the watershed, including the economic and environmental well-being of the communities within it. This comprehensive assessment is sponsored by the CALFED Watershed Program and coordinated through the U.S. Bureau of Reclamation.

The San Joaquin River Group Authority was formed in the 1990s in response to the development of the Sacramento – San Joaquin Bay Delta Water Quality Control Plan by the State Water Resources Control Board. The water quality control plan was adopted in 1995 and included significant water quality and flow standards for the lower San Joaquin River. The goals of the authority are to investigate fishery and water quality issues on the San Joaquin River and develop solutions that will protect the salmon fishery and improve water quality. To respond to water quality issues, the regional board is studying agricultural discharge quality controls, and may consider the use of agriculture waivers at a watershed level. Additional water quality monitoring will be necessary to address the various water quality problems on the Lower San Joaquin River. Landowners will have the choice of participating in water quality monitoring and improvement programs on a watershed level or on an individual basis. The watershed approach can be used to identify and address "hot spots" by working directly with individual landowners or encouraging individuals to work together to find solutions.

The San Joaquin River Group Authority also led the development of the Vernalis Adaptive Management Plan as a 10-year test program designed to study methods to improve salmon smolt survival in the lower San Joaquin River. Starting in the year 2000, the Vernalis plan has coordinated the release of water from upstream reservoirs each spring to generate a calculated pulse flow down the lower river to help salmon smolts migrate to San Francisco Bay and the ocean. The timing and duration of this pulse flow is coordinated with reduced State Water Project and Central Valley Project Delta export pumping in order to improve Delta flow patterns to guide the salmon smolts to the ocean. The plan's technical group coordinates extensively with several local and government agencies to oversee the successful test flow each year, which include real-time facility operations and monitoring, tracking of water flows and fish migration, and outreach and education. It is still too early in the 10-year test to determine how successful this program will be.

The Upper San Joaquin River Basin Storage Investigation evolved out of the CALFED Record of Decision of 2000. That decision states, "250 to 700 [thousand acre-feet] of additional storage in the upper San Joaquin watershed … would be designed to contribute to restoration of and improve water quality for the San Joaquin River, and facilitate conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities. Additional storage could come from enlargement of Millerton Lake at Friant Dam or a functionally equivalent storage program in the region." Surface storage options in the San Joaquin River region that may be considered as part of the CALFED program include of the investigation of (1) raising Friant Dam, (2) Fine Gold Creek Dam, and (3) Temperance Flat Dam, which includes three alternative sites. Additionally, Yokohl Valley Reservoir near Visalia in the Tulare Lake region could also be considered as part of these planning studies.

The Farmington Groundwater Recharge and Seasonal Habitat Program is a regional effort to recharge the underground aquifer in the Eastern San Joaquin County Basin. The basin aquifer is threatened by the eastward movement of saltwater from the Delta, which could eventually contaminate municipal wells in Stockton and limit the ability of farmers to grow crops, except for some salt-tolerant, low-value varieties. By periodically spreading an average of 35,000 acre feet of surplus water per year using the flooded-field method, the program is intended to reduce groundwater overdraft and establish a barrier to prevent saline water intrusion. The $33.5 million program is a partnership between Stockton East Water District and the U.S. Army Corps of Engineers. The program will initially seek to secure flooding rights on about 25 agricultural parcels totaling 1,200 acres. The initial 35,000 acre-foot per year objective was based on the Farming Groundwater Recharge and Seasonal Habitat Study, which was completed in 2001. Stockton East Water District was the lead local sponsor of the feasibility study with the U.S. Army Corps of Engineers. Other study participants included Central San Joaquin Water Conservation District, North San Joaquin Water Conservation District, City of Stockton, San Joaquin County, and California Water Service Company.

Through the South San Joaquin County Surface Water Supply Project, the cities of Tracy, Manteca, Lathrop, and Escalon have joined with the South San Joaquin Irrigation District to plan for a water treatment plant on the Stanislaus River. The project will use water that the irrigation district has conserved from improvements in irrigation practices and water efficiencies. Water will be taken from Woodward Reservoir, treated to drinking standards, and conveyed to the cities. A 40-mile long transmission pipeline would also be built from the treatment plant to deliver water to each of the participant cities. The $150 million project is expected to begin deliveries around May 2005. The project is scheduled to deliver 30,000 acre feet per year to the cities through 2010 and up to 44,000 acre-feet per year thereafter. The intent of the project is to reduce the reliance on groundwater and to satisfy future urban demand increases.

Relationship with Other Regions

The San Joaquin River region is dependent on receiving surface water from other regions of the State to meet a portion of its developed agricultural and urban water uses. For many years, the region has received imported Central Valley Project water from the Sacramento-San Joaquin Delta via the Delta Mendota Canal and from the project's Friant Dam on the upper San Joaquin River. This region also receives some State Water Project water from the California Aqueduct. The regional map in Figure 7-1 includes arrows that summarize these regional imports and exports for the years 1998, 2000, and 2001.

Some surface water supplies that originate in the San Joaquin region are also diverted across the valley to the San Francisco Bay region via the Mokelumne Aqueduct by the East Bay Municipal Utility District and through the Hetch Hetchy Aqueduct by the City of San Francisco. The average annual diversions by these two projects from the Mokelumne and Tuolumne rivers are about 245,000 acre-feet per year through the Mokelumne Aqueduct and 267,000 acre-feet per year through the Hetch-Hetchy Aqueduct.

In 1998, Contra Costa Water District completed Los Vaqueros Reservoir, which can hold 100,000 acre-feet in storage. This is an offstream reservoir in the northwest corner of the San Joaquin hydrologic region. The reservoir stores Contra Costa Water District water that has been diverted from the Delta in the late winter and spring when water quality is good. Water is typically withdrawn from Los Vaqueros Reservoir in the summer and fall to meet demands and improve the quality of water delivered to the water district's service areas. However, because a portion of the service area is in the San Francisco Bay Hydrologic Region, this water is considered to be an export from the San Joaquin region. Los Vaqueros Reservoir has only been operated for a few years, such that normal patterns of diversion and water use have not yet been established.

Looking to the Future

The water agencies within this region have many projects and programs planned to address water supply problems. These include studies to evaluate new local surface storage projects and investigations for water storage development in conjunction with the CALFED program. Local agencies are further implementing groundwater conjunctive use projects and increasing their efforts on water use efficiency and water recycling programs. As the urban areas in the valley continue to grow and expand, the current trend of agricultural land conversion to subdivisions is likely to continue. As an outcome of urban expansion, urban water usage is expected to increase in the future, while agricultural water use is projected to decline slightly. The effectiveness of urban and agricultural water conservation and water use efficiency measures will influence these water use trends.

Regional Planning

The San Joaquin Valley Water Coalition is a forum where water entities and interest groups can come together to discuss common issues related to water supply, quality, and distribution. The objective of this group is to ensure a water supply for the valley that is sustainable and capable of meeting the needs and concerns of all water users. The Westside Integrated Water Resources Plan was initiated in 2000 and is evaluating alternatives to increase water supplies and reduce demands in order to address current water supply deficits. The West Stanislaus Hydrologic Unit Area Project is a program sponsored by the U.S. Department of Agriculture and local growers to enhance water quality by reducing soil erosion into the San Joaquin River.

There are several other programs that are focusing on ecosystem restoration for the Merced, Stanislaus, Tuolumne, and San Joaquin rivers. The Grassland Bypass Project on the west side of the valley will consolidate the conveyance of subsurface drain flows on a regional basis. A portion of the federal San Luis Drain will be used to convey drainage flows around the Grassland habitat areas into Mud Slough before being discharged into the San Joaquin River above its confluence with the Merced River. The San Joaquin River Parkway and Conservation Trust has goals to preserve and restore San Joaquin River lands that have ecological, scenic, or historic significance. This group also works to educate the public on the need for river stewardship, research issues affecting the river, and promote educational, recreational and agricultural uses consistent with the protection of the river's resources.

Work is continuing on several programs at the watershed level in the region. For example, the San Joaquin River Management Program is seeking solutions to the common problems facing the region that affect the environment, water quality, agriculture, and flood control in the San Joaquin River watershed, without the limitations imposed by political boundaries. Also, several public and private partnerships on the east side of the valley are attempting to develop a Comprehensive Plan for the management, protection and restoration of the watersheds of the San Joaquin, Merced, Chowchilla, and Fresno rivers. The goal of this plan is to attain designations as Resource Conservation and Development Areas, so that watershed projects can be coordinated in Mariposa County and eastern Madera County.

Water Portfolios for Water Years 1998, 2000, and 2001

Water Year 1998

California experienced the affects of El Nino weather patterns from July 1997 to June 1998. The wet winter set new records for precipitation at many locations throughout the state. Annual precipitation for Fresno exceeded 180 percent of average; Stockton had almost 200 percent of average; and Los Banos recorded 248 percent of average rainfall. Watershed runoff was well above average as streamflow in the San Joaquin, Merced, Stanislaus and Tuolumne rivers reached about 165 percent of average. More detailed information about how these water supplies were stored and used on a region-wide basis is presented in water portfolio Table 7-3, and the companion Water Portfolio flow diagram Figures 7-4 and 7-5 (large-format graphics placed at the end of this chapter).

Total irrigated acreage in the San Joaquin River region was about 2,053,700 acres in 1998. Alfalfa acreage accounted for 11.5 percent of all irrigated crops in the region; almond and pistachio acreage accounted for 13.8 percent; and vineyard acreage was 10.9 percent of the total. Compared to year 1995, irrigated pasture acreage declined by about 15,400 acres. However, the acreage of corn rose by 36,800 acres, almonds and pistachios increased 8,600 acres, and vineyards increased by 29,600 acres compared to 1995 levels. These crop shifts indicate that growers are continuing the trend of converting field crops to almond and pistachio orchards and vineyards, in an effort to find commodities that generate better long-term profits.

The effects of the wet El Nino phenomenon on the San Joaquin River region were extensive, such that growers had little need to irrigate during the first four to five months of 1998. As shown in Table 7-3, the total 1998 agricultural on-farm applied water use was 4.8 million acre feet, and total agricultural water use was 5.5 million acre feet or 47 percent of all uses. These water use volumes are significantly lower than what is usually required in a normal year such as 2000. The regional average for agricultural on-farm applied water was 2.4 acre feet per acre. The total agricultural evapotranspiration of applied water, or ETAW, in 1998 amounted to 3.4 million acre feet.

Total urban applied water use, including residential, commercial, industrial, and landscape, in the region totaled 560,400 acre feet. The average per capita water use was about 301 gallons per day, and the urban ETAW was 191,000 acre feet. Urban water use accounted for only about 5 percent of the total water use in the region, and the population for the region was 1,669,890, or 4.9 percent more than 1995.

Total environmental water use for instream flows, wild and scenic rivers, and refuges was about 5.6 million acre-feet. This accounted for 48 percent of total uses. Environmental water includes water that is reserved for instream and wild and scenic river flow but can be used later as a supply by downstream users. Most of these requirements are for locations on the major rivers that drain from the Sierra Nevada to the valley floor. Refuge water supplies, which are diverted and applied directly onto wildlife refuges, totaled 414,500 acre feet, or 7 percent of total environmental uses.

Total water supplies needed to meet all of the above demands were 11.6 million acre feet, including local and imported Central Valley Project and State Water Project surface water, groundwater, and water reuse.

Water Year 2000

The weather for the 1999-2000 water year in the San Joaquin River region produced normal precipitation and streamflow. Rainfall amounts were slightly above average for most of the measuring stations in the region. Annual precipitation in both Madera and Modesto was 120 percent of average; Stockton rainfall was 99 percent of average; and Los Banos had 88 percent of normal precipitation. Ample moisture was received in the local watersheds, and runoff resulted in good surface water supplies. Watershed runoff was about average, with unimpaired runoff from the Tuolumne, Merced and San Joaquin rivers at about 103 percent of average. The unimpaired runoff from the Stanislaus, Mokelumne, and Cosumnes rivers was 99, 89, and 70 percent, respectively, indicating the regional variability of surface flows from one watershed to the next. Heavy rainfall occurred in January and February, delaying many agricultural activities such as pruning, planting, spraying, and field preparation.

Total irrigated acreage decreased only slightly from 1998, and was 2,050,400 acres for year 2000. Almond and pistachio acreage in 2000 was 292,500 acres, which was 9,300 acres higher than in 1998. The acreage of sugar beets dropped 26 percent to 18,500 acres, while the acreages of most other crops in the region remained about the same as in 1998.

In general, 2000 weather, water supplies, and evaporative demand were close to average in the San Joaquin River region. The total agricultural on-farm applied water was 6.2 million acre feet, and total agricultural water use was 7 million acre-feet or 57 percent of all uses, about 29 percent more than 1998. The regional average on-farm unit applied water use was 3 acre-feet per acre. The total agricultural ETAW was about 4.4 million acre feet, 29 percent higher than 1998. Since both 1998 and 2000 had similar total crop acreage, the significant increase in total agricultural applied water (29 percent higher) confirms that wet weather patterns result in significantly reductions in agricultural water needs.

Total urban water use for the region was 600,200 acre feet, which was about 7 percent higher than the total urban water use for 1998. Average per capita water use was around 304 gallons per day, and total urban ETAW for the year was about 206,600 acre-feet, 8 percent higher than 1998. Urban applied water accounted for about 5 percent of the total water use in the region.

Total environmental water use for instream flows, wild and scenic rivers, and refuges was about 4.6 million acre feet, 17 percent less than in 1998. Although water for required instream flows was higher than in 1998, the amount of water dedicated to wild and scenic rivers was much lower than those of 1998. In 2000, total environmental water use accounted for 38 percent of all developed water uses. Refuge supplies accounted for 444,800 acre feet or 10 percent of total environmental uses.

As shown in Table 7-2, total water supplies, including local and imported Central Valley Project and State Water Project surface water, groundwater, and reuse, amounted to 12.3 million acre-feet in year 2000, which was a 5 percent increase from 1998.

Water Year 2001

The 2000-2001 water year started out cooler than normal with cumulative rainfall below average through most of January. Rainfall amounts were slightly less than average for the water year, and annual totals were 88 and 83 percent of average for Madera and Stockton, respectively. As the accumulated precipitation lagged in January, large-scale weather patterns changed significantly as February approached and a series of Pacific storms moved into the state, helping to bring precipitation totals closer to average. This cool, wet period delayed many agricultural activities such as pruning, planting, spraying, and ground preparation. The weather became warmer by late April and the balance of the growing season offered good growing conditions.

Irrigated crop acreage totaled 2,042,700 acres in 2001, representing a 7,700 acre decline from water year 1998. Irrigated pasture acreage decreased to 158,800 acres, a 28,900 acres decrease or 15.4 percent decline from 1998; sugar beet acreage decreased to 7,600 acres, a 70 percent decline from 1998. However, miscellaneous truck crop acreage increased 10,800 acres or 16.7 percent higher than 1998, and vineyard acreage increased 18,800 acres or 8.4 percent. The acreage of almond and pistachio orchards increased by 13,000 acres compared to 1998 levels.

The total agricultural on-farm applied water in 2001 was 6.5 million acre feet, and total agricultural water use was 7.2 million acre feet or 67 percent of all water uses, 33 percent more than 1998 and 3 percent more than 2000. The regional average on-farm unit applied water was 3.2 acre feet per acre. Total agricultural ETAW was estimated at 4.6 million acre feet. This was about 36 percent higher than 1998 and 5 percent higher than 2000.

Total urban applied water use in this region was 629,100 acre feet, which was 12 percent higher than 1998 and 5 percent more than in year 2000. Average per capita water use was about 307 gallons per day, and total urban ETAW was about 218,400 acre feet, a 14 percent increase from 1998 and 6 percent increase from 2000. Total urban applied water use accounted for about 6 percent of the total water use in the region. Population for the region was 1,812,710, which is an 8.6 percent increase from 1998 levels.

Total environmental water use for instream flows, wild and scenic rivers, and refuges was about 2.9 million acre feet, 48 percent less than in 1998 and 37 percent less than in 2000. This decline in environmental water use occurs because instream flow requirements and wild and scenic river flows do change in response to the wetness or dryness of water year conditions. Total environmental water use was 27 percent of all uses in 2001, which is much less than the 48 percent share from year 1998. Refuge water supplies accounted for 414,700 acre feet or 14 percent of total environmental uses.

Total water supplies needed to meet the 2001 water uses, including local and imported from Central Valley Project and State Water Project surface water, groundwater, and reuse, amounted to 10.8 million acre feet, which was 7 percent less than 1998 and 12 percent less than 2000.

Selected References

2002 California 305(b) Report on Water Quality, State Water Resources Control Board

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Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001

The Modesto Bee newspaper

U.S. Bureau of Reclamation

Water Quality Control Plan, Regional Water Quality Control Board

Watershed Management Initiative Chapter, Regional Water Quality Control Board

Water Portfolios

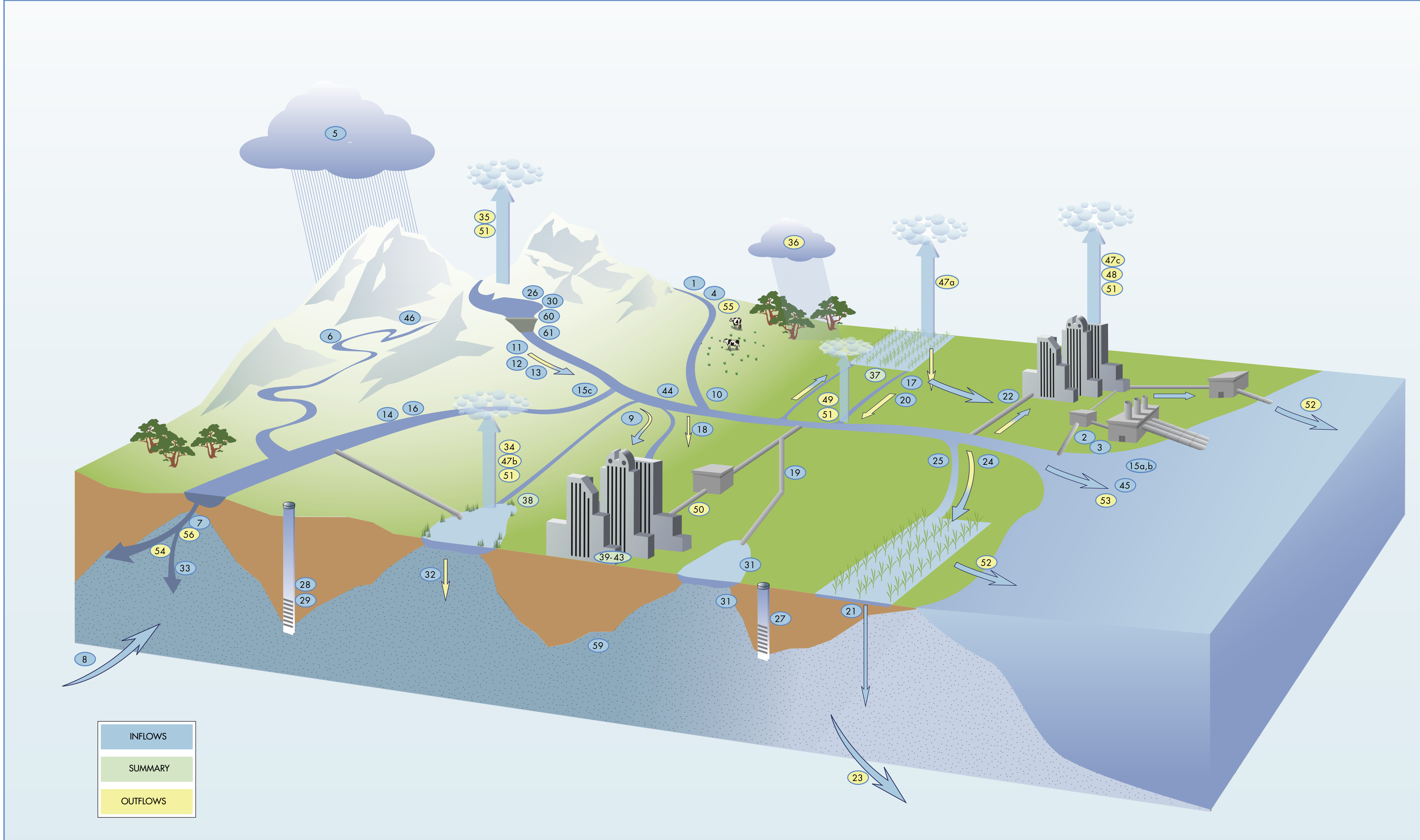
San Joaquin River Hydrologic Region

Table 7-3 San Joaquin River region water portfolio (TAF)

ID Number:	Flow Diagram Component (see legend)	San Joaquin River 1998	San Joaquin River 2000	San Joaquin River 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	35,534.7	23,208.5	16,120.2
6a	Runoff - Natural			
b	Runoff - Incidental			
7	Total Groundwater Natural Recharge			
8	Groundwater Subsurface Inflow			-
9	Local Deliveries	3,229.8	3,540.7	3,548.5
10	Local Imports	-	-	-
11a	Central Valley Project :: Base Deliveries	12.8	12.8	12.8
b	Central Valley Project :: Project Deliveries	1,354.2	1,790.7	1,653.7
12	Other Federal Deliveries	64.3	65.8	97.6
13	State Water Project Deliveries	4.3	4.6	3.5
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	1,528.9	2,098.5	1,424.4
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	-	-	0.2
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	1.2	1.2	1.2
b	Recycled Water - Urban	0.7	0.7	0.7
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	1,179.4	949.1	968.4
b	Return Flow to Developed Supply - Wetlands	132.6	126.7	134.2
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	157.7	844.2	910.1
b	Deep Percolation of Applied Water - Wetlands	174.3	166.5	142.3
c	Deep Percolation of Applied Water - Urban	207.9	226.3	229.5
22a	Reuse of Return Flows within Region - Ag	-	-	-
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	5,190.0	4,192.3	2,515.4
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	1.6	1.6	1.5
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions			
26	Surface Water in Storage - Beg of Yr	6,943.0	7,378.6	7,446.0
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	1,765.6	2,646.3	2,968.6
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	9,190.7	7,446.0	6,010.8
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation			
b	Evaporation and Evapotranspiration from Unirrigated Ag			
35a	Evaporation from Lakes	77.3	89.7	82
b	Evaporation from Reservoirs	419.9	477.1	449.3
36	Ag Effective Precipitation on Irrigated Lands	1514	870.3	820
37	Agricultural Water Use	5,079.0	6,556.3	6,793.9
38	Managed Wetlands Water Use	414.5	444.8	414.7
39a	Urban Residential Use - Single Family - Interior	93.5	101.4	106.1
b	Urban Residential Use - Single Family - Exterior	172.3	186.0	197.2
c	Urban Residential Use - Multi-family - Interior	82.7	90.1	93.6
d	Urban Residential Use - Multi-family - Exterior	41.7	45.3	46.5
40	Urban Commercial Use	34.5	37.6	39.6
41	Urban Industrial Use	86.3	89.4	90.1
42	Urban Large Landscape	30.2	32.9	35.5
43	Urban Energy Production	-	-	-
44	Instream Flow	-	-	-
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	-	-	-
47a	Evapotranspiration of Applied Water - Ag	3408.1	4406	4627.8
b	Evapotranspiration of Applied Water - Managed Wetlands	105.9	149.7	136.6
c	Evapotranspiration of Applied Water - Urban	191	206.6	218.4
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	74.4	11.6	14.3
50	Urban Waste Water Produced	117.8	123.4	131.8
51a	Conveyance Evaporation and Evapotranspiration - Urban	12.6	12	13.6
b	Conveyance Evaporation and Evapotranspiration - Ag	207.7	248.8	245.3
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	-	-	-
d	Conveyance Outflow to Mexico			
52a	Return Flows to Salt Sink - Ag	26.7	40.4	50.3
b	Return Flows to Salt Sink - Urban	148.9	155.5	167.7
c	Return Flows to Salt Sink - Wetlands	-	-	-
53	Remaining Natural Runoff - Flows to Salt Sink	0.2	-	-
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	6,034.4	6,173.5	4,571.8
56	Regional Exports	4435.8	6398.2	4496
59	Groundwater Net Change in Storage	-443.9	-96.1	-1,259.9
60	Surface Water Net Change in Storage	2,247.7	67.4	-1,435.2
61	Surface Water Total Available Storage	11,372.3	11,477.1	11,477.1

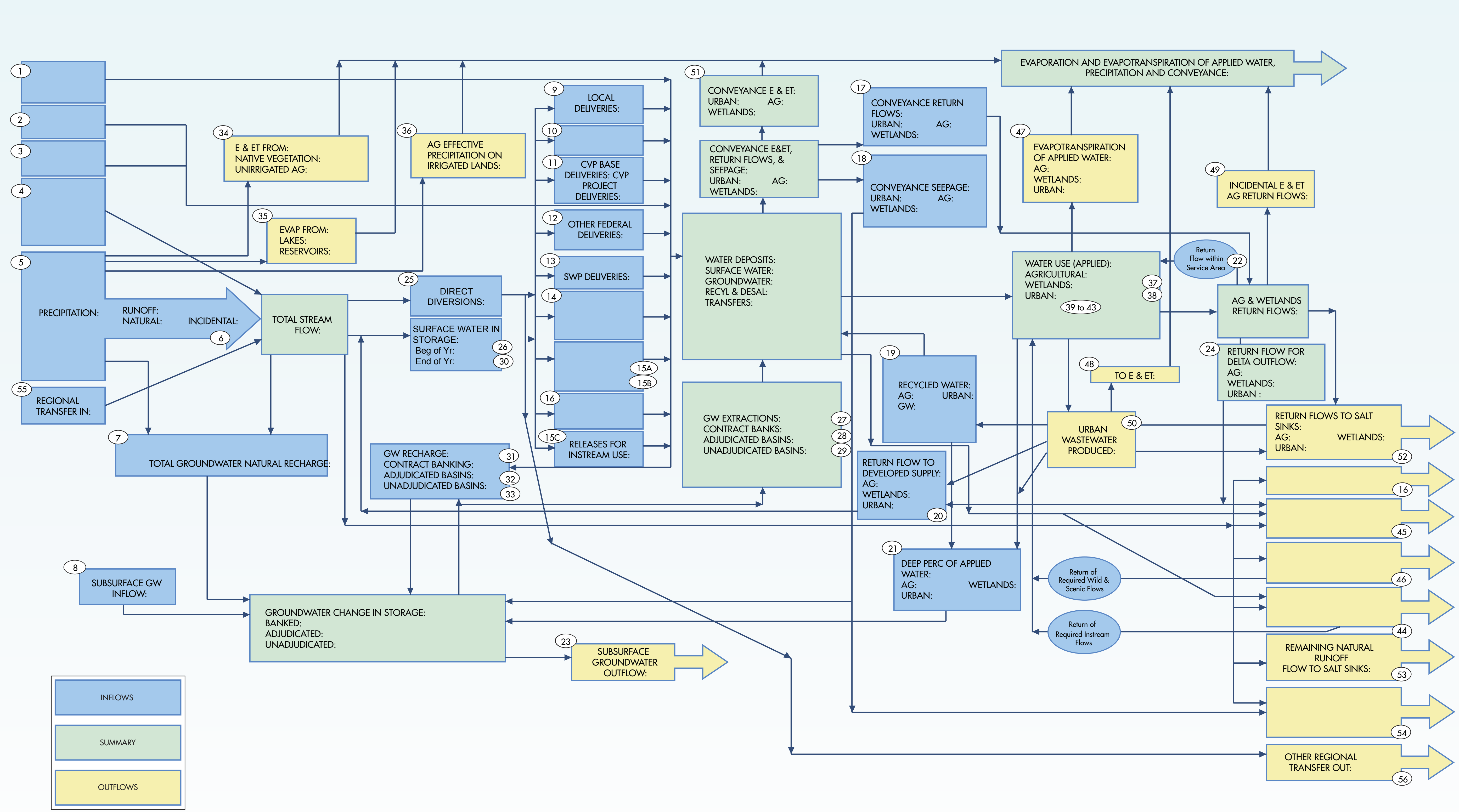
Inflows   Outflows   Green number signifies included in summary boxes

Figure 7-4 San Joaquin River region - illustrated water flow diagram



In this illustration of Table 7-3, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 7-5 San Joaquin River region - schematic flow diagram



In schematic of Table 7-3, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether the component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region

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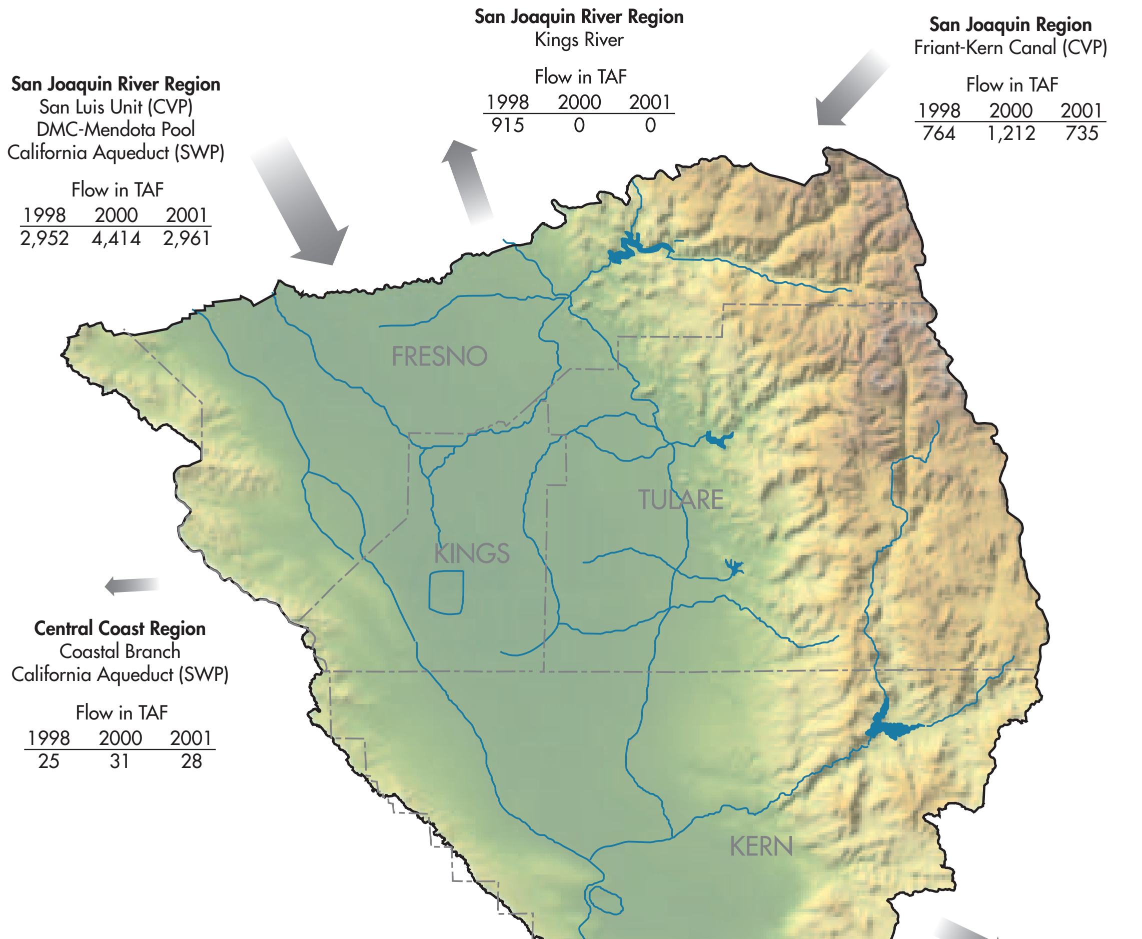
Figure 8-1 Tulare Lake Hydrologic Region



Some Statistics

- Area -17,033 square miles (10.7% of State)
- Average annual precipitation - 15.2 inches
- Year 2000 population - 1,884,675
- 2030 population projection - 3,121,625
- Total reservoir storage capacity -2,046 TAF
- 2000 irrigated crop area - 3,219,000 acres

The Tulare Lake Hydrologic Region is in the southern end of the Central Valley and is one of the nation's leading areas in agricultural production. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

Chapter 8 *Tulare Lake Hydrologic Region*

Setting

The Tulare Lake Hydrologic Region is in the southern end of the San Joaquin Valley. This region includes all of Tulare and Kings counties and large portions of Fresno and Kern counties. Major cities include Fresno, Bakersfield, and Visalia. The Tulare Lake region is one of the nation's leading areas in agricultural production with a wide variety of crops on about 3 million acres. Agricultural production has been a mainstay of the region since the late-1800s, and gross farm production receipts from the region account for 35 percent of the state's total agricultural economy. This region's population is also growing rapidly, and population growth rates began increasing above historical trends in the 1980s. As property values in the metropolitan coastal areas have become less affordable, many people began relocating to more affordable areas in the San Joaquin Valley. This trend has accelerated in recent years, and the California Department of Finance reported the Tulare Lake regional population at 2 million in 2001.

Native habitat in the region includes vernal pools, areas of valley sink scrub and saltbush, freshwater marsh, grasslands, arid plains, and oak savannah. The growth of agriculture in the Tulare Lake region has replaced much of the historic native grassland, woodland, and wetland.

A map of this region with a table of statistics are presented in Figure 8-1. The largest river is the Kings River, which flows west from the Sierra Nevada near the northern border of the region. The California Aqueduct extends the entire length of the west side of the region, delivering water to State Water Project (SWP) and Central Valley Project (CVP) contractors in the region and exporting water over the Tehachapi Mountains to Southern California. Significant rivers in the region include the Kings, Kaweah, Tule and Kern rivers, which drain into the valley floor of this hydrologically closed region. The Kings and Tule rivers historically terminated at the Tulare Lake, which was once the largest freshwater lake in the western United States. The Kern River historically terminated in two small lakes, Kern Lake and Buena Vista Lake. These lakes have been dry for many decades, and the waters that once fed them were long ago diverted for irrigation, such that the lake bottom lands are now heavily farmed. No significant rivers or creeks drain eastward from the Coast Ranges into the valley.

Climate

Land in the region is fertile and well suited for farming. The valley portion of the region is hot and dry in summer with long, sunny days and cooler nights. Winters are wet and often blanketed with dense fog. Nearly all of the annual rainfall occurs in the six months from November to April. The valley is broad and flat, and is surrounded by the Diablo and Coast Ranges to the west, the Sierra Nevada to the east, and the Tehachapi Mountains to the south. The surrounding mountains result in the comparative isolation of the region from marine effects. Because of this and the comparatively cloudless summers, average maximum temperatures approach a high of 101 degrees in late July. Winter temperatures on the valley floor are usually mild, but during infrequent cold spells readings occasionally drop below freezing. Heavy frost occurs during the winter of most years, and the geographic orientation of the valley generates prevailing winds from the northwest.

The mean annual precipitation in the valley portion of this region ranges from about 6 to 11 inches, with the lowest amounts near the south and eastern ends of the region. Sixty-seven percent of the precipitation occurs during the months of December through March, and 95 percent of all precipitation falls during the October through April period. The Tulare Lake region enjoys a high percentage of clear sunny days during most of the year, except during the winter months of November, December, January, and February. During periods of tule fog, which can last up to two weeks, sunshine is reduced to a minimum. This fog frequently extends to a few hundred feet above the surface of the valley and presents the appearance of a heavy, solid cloud layer. These prolonged periods of fog and low temperatures are important to orchard production for the deciduous fruit industry.

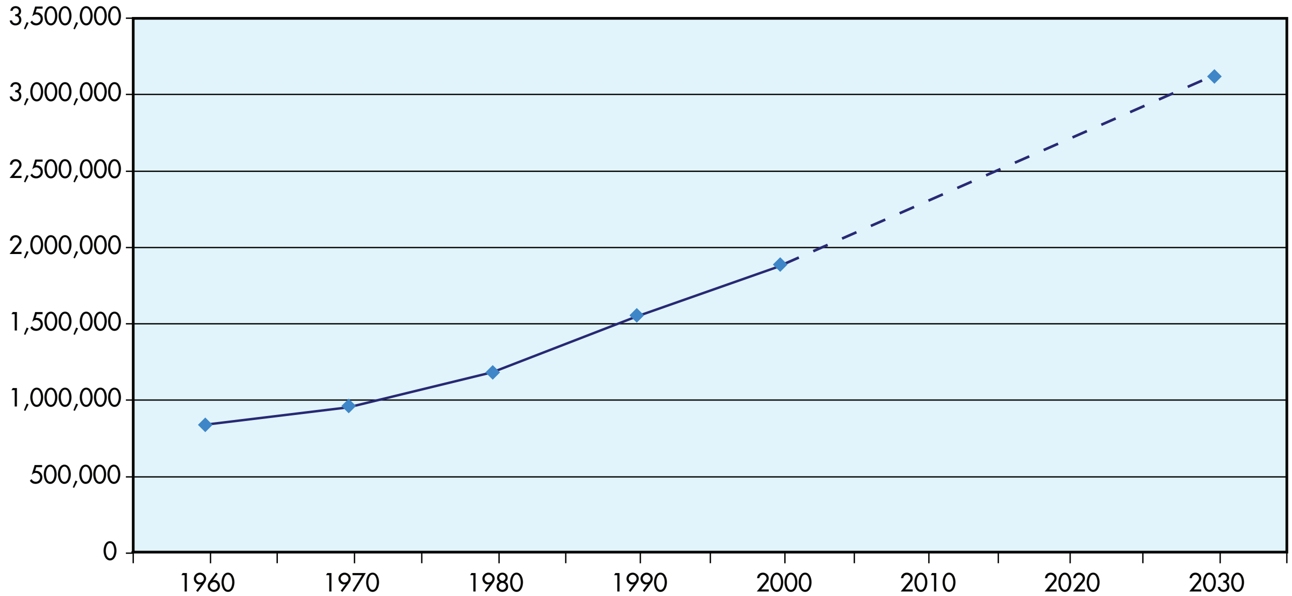
The Tulare Lake region is one of the nation's leading areas in agricultural production with a wide variety of crops on about 3 million acres. This is an unusual photo of Tulare Lake, which is normally dry. (DWR photo)

Population

The rate of population growth throughout the San Joaquin Valley is among the highest in the state, creating a strong demand for housing and urban infrastructure. The population in the Tulare Lake Region is now about 52 percent of the entire San Joaquin Valley population. While many communities in the region welcome the growth and income from a diversifying economy, the rapid urban growth is beginning to generate impacts on farming and the agricultural industry. In six years, between 1992 and 1998, nearly 37,000 acres of farmland were converted to urban uses according to Department of Conservation statistics. Even though there is a concern about accelerated urbanization and the subsequent conversion of farmland, relatively few private agricultural preservation efforts exist in the San Joaquin Valley. The largest regional population centers are the Fresno/Clovis metropolitan area and the cities of Bakersfield and Visalia. Other smaller population centers include the cities of Tulare, Hanford, Porterville, and Delano.

Household incomes and housing prices in the Tulare Lake region are lower on an average basis, compared to other regions of the state. New jobs in services, industries, construction, and agriculture are generally low-skilled and low-wage jobs, subject to seasonal fluctuation. As a result, unemployment consistently exceeds the state and national rates by as much as 10 percent. According to an April 2004 Public Policy Institute of California (PPIC) special survey, the most pressing San Joaquin Valley issues for residents of the South San Joaquin survey area were related to population growth and development. These issues included pollution, 32 percent; healthy economy, 13 percent; population growth, 11 percent; crime, 9 percent; and adequate water at 6 percent. The most notable trend of annual PPIC surveys is the increasing amount of concern about air pollution and all pollution in general. In 1999, pollution was cited by 9 percent of the survey respondents as the most important issue, 13 percent in 2001, 19 percent in 2002, 28 percent in 2003, and 32 percent in 2004.

Figure 8-2 Tulare Lake Hydrologic Region population



Data from California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for the Tulare Lake region.

Population density varies widely on a county-by-county basis, and large portions of some counties are virtually unpopulated. Much of the population lives in the more densely developed cities and towns. The population in the Tulare Lake region was about 1.55 million people in 1990 and reached 1.88 million by 2000. This is more than a 20 percent growth rate over that 10-year period. Statewide, California experienced a population increase approaching 14 percent from 1990 to 2000. Between 1998 and 2000, the population increased more than 3 percent, and California Department of Finance statistics project continued growth rates of 18 percent to 22 percent for the region's four counties over the next 10 years. Figure 8-2 shows the Tulare Lake region's population from 1960 through 2000, with projections to year 2030.

Land Use

The State and federal government agencies own about 30 percent of the land in the region, including about 1.7 million acres of national forest, 0.8 million acres of national parks and recreation areas, and 1 million acres of land managed by the U.S. Bureau of Land Management. The region's foothills border Kings Canyon and Sequoia National Parks and the Sierra National Forest. Privately owned land totals about 7.4 million acres. Irrigated agriculture accounts for more than 3 million acres of the private land, while urban areas take up over 350,000 acres. Other agricultural lands and areas with native vegetation represent an additional 1.4 million acres in the region.

The climate and soils of the Tulare Lake region contribute significantly to the tremendous agricultural production of the farm lands and to the diversity of crops grown. Counties in the Tulare Lake region represent three of the top five agricultural counties in the state, as measured by total value of production. More than 250 varieties of crops and farm commodities are produced in the region. While cotton was the number one crop in many past years, grapes have recently outpaced cotton in terms of gross production receipts. More than 10 percent of the irrigated acreage in California and about 12 percent of the 3 million irrigated acres in the region is planted in alfalfa. Alfalfa acreage in the region has been rising in recent years in response to the needs of the expanding dairy industry. Tulare County, in the heart of the region, is currently the nation's richest dairy county. Deciduous and citrus trees are the main agricultural crops in the lower foothills, and livestock grazing and timber harvesting occur in the higher elevation areas.

The Central Valley constitutes less than 1 percent of the United States farmland but produces 8 percent of the total agricultural output. Further, while more than 12 percent of the national gross receipts for farming came from California's agriculture, more than 4 percent of these came from the Tulare Lake region alone. According to the California Department of Agriculture, total statewide agricultural production and gross cash income in 1998 declined 6 percent from 1997, and statewide gross income in 2001 increased 1 percent from 2000. By comparison, agricultural production and cash income in the Tulare Lake region declined to $9.1 billion from 1997 to 1998, which was only a 3.7 percent decrease. Between 2000 and 2001, the Tulare Lake regions agricultural production increased by 3.4 percent to $9.9 billion.

Some of the crops and farm commodities that are produced in the Tulare Lake region experienced dramatic increases in export value in 2001. Table grapes, milk and cream, and walnuts all showed double-digit percentage increases in export value from 1998. However, most farm commodities experienced declines in export values between 1998 and 2001. Seven of the top 10 exported crops or commodities declined in value. These included almonds, $760 million to $686 million; cotton, $734 million to $605 million; and wine, $506 million to $491 million. These increases and decreases within the agricultural industry dominate the economy of these four counties and the region as a whole.

Water Supply and Use

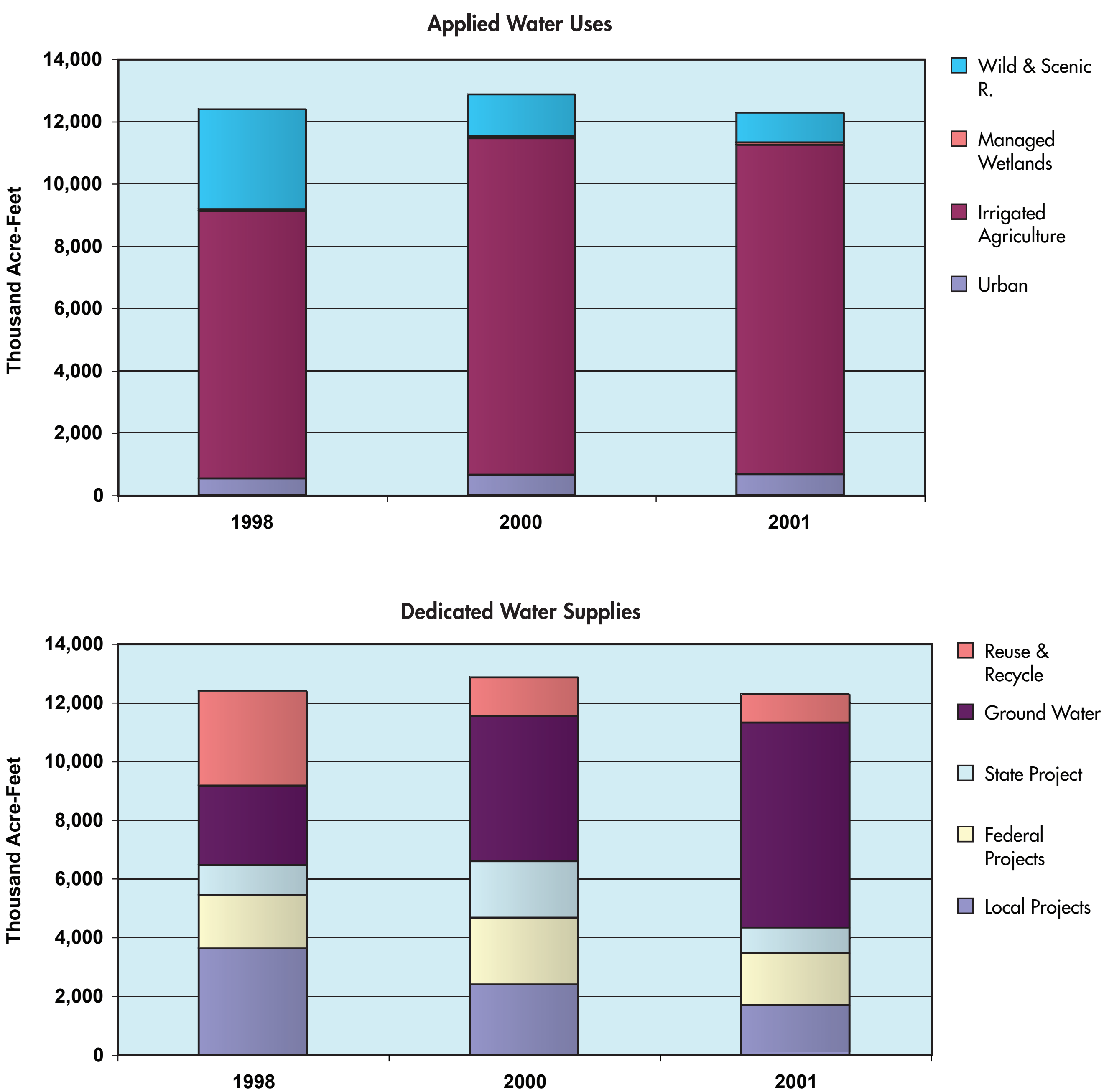
The region receives most of its surface water runoff from four main rivers that flow out of the Sierra Nevada, which are the Kings, Kaweah, Tule, and Kern rivers. The development and use of water from these rivers has played a major role in the history and economic development of the region. Major water conveyance facilities in the region include the California Aqueduct, the Friant-Kern Canal, and the Cross Valley Canal. Water diversions from the San Joaquin River at Friant Dam are also a significant supply source for all uses in the Tulare Lake region. The water districts in the region have developed an extensive network of canals, channels, and pipelines to deliver water supplies to customers. Water storage facilities and conveyance systems control and retain most of the surface water runoff from the watersheds in the region, except in extremely wet years when floodwaters may flow out of the region to the San Joaquin River. During flood years, excess water flows down the north fork of the Kings River toward Mendota Pool and on to the San Joaquin River. In the wettest years, Kings River floodwaters reach the normally dry Tulare Lake via the south fork of the river. Excess runoff from the Kaweah and Tule rivers might also flow into Tulare lakebed, flooding low-lying agricultural fields. This excess surface water is managed to the maximum extent for use in artificial groundwater recharge. In the rare event water leaves the basin, it is because the absorptive capacity of the groundwater systems in the region has been exceeded. Floodwater can also occasionally be diverted from the Kern River intertie into the California Aqueduct for use in other SWP service areas. Figure 8-3 graphically summarizes the water supplies and the developed water uses in the region for 1998, 2000, and 2001.

Water stored in many Sierra Nevada reservoirs is also used to generate electricity as it is released downstream. Some diversions occur for consumptive use in local communities, but most flows are recaptured in larger reservoirs in the foothills and along the eastern edge of the valley. These larger reservoirs were built primarily for flood control, but many of them were also designed with additional storage capacity for agricultural, urban, and fishery purposes. Smaller communities in the Sierra foothills receive their water from smaller local surface supplies and groundwater. These mountain communities sometimes pump groundwater from hard rock wells and old mines to augment their supplies, especially during droughts. Groundwater is the only source available for many foothill and mountain residents who are not connected to a municipal water system.

Major statewide water projects in the Tulare Lake region include the SWP's California Aqueduct, which includes a State/federal joint use segment known as the San Luis Canal. The aqueduct is along the western side of the valley, and it also pumps water over the Tehachapi Mountains for uses in Southern California. Water from the Sacramento-San Joaquin Delta is imported into the region through the California Aqueduct for both agricultural and urban purposes. Federal CVP water is also exported from the Delta through the San Luis Canal to agencies with federal water contracts on the west side of the valley, such as Westlands Water District. On the eastern side of the valley, the CVP's Friant-Kern Canal runs south along the foothills and transports San Joaquin River water to agencies along the valley's eastern side and extends into Kern County.

The SWP provides an average of 1.2 million acre-feet of surface water annually to the region for both agricultural and urban purposes. The U.S. Bureau of Reclamation supplies an average of 2.7 million acre-feet from the CVP through the Mendota Pool, the San Luis Canal, and the Friant-Kern Canal, primarily for agricultural uses. Actual deliveries to contrac-

Figure 8-3 Tulare Lake region water balance for water years 1998, 2000, 2001



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

tors vary from year to year based upon a number of factors, including water supply conditions and reservoir storage in Northern California. Other factors that may influence imported surface water deliveries include pumping equipment malfunction, natural disasters, temporary closures for infrastructure development, and environmental challenges.

Groundwater has historically been important for both urban and agricultural uses in the Tulare Lake region. Groundwater pumped from the basin's aquifers account for about 33 percent of the region's total annual water supply, and also account for 35 percent of all groundwater use in the state. Additionally, the region's groundwater supply represents about 10 percent of the state's overall developed water supply for agricultural and urban uses. Most towns and cities along the east side of the valley, including Fresno, Visalia and Bakersfield, rely primarily on groundwater. Bakersfield occasionally obtains supplemental water from local surface water and some imported SWP water. Fresno, Visalia, Bakersfield, and other cities also have groundwater recharge programs to help ensure that groundwater will continue to be a viable water supply in the future. On the valley's western side, smaller cities like Avenal, Huron, and Coalinga rely on imported surface water from the San Luis Canal to meet municipal demands. This surface water is of better quality than the local groundwater supplies on the western side, which often have poor water quality.

In addition to the recharge programs employed by some valley cities, extensive groundwater recharge programs (known as water banks) are also operated by water districts and agencies, which have stored significant amounts of surplus water underground for future use and exchanges through water banking programs. For more than 100 years, water users throughout the region have used conjunctive use to maximize the water supply and maintain the groundwater basins.

Table 8-1 presents a water balance summary of all water supplies and uses for the Tulare Lake region. Table 8-3 presents actual data for the dedicated and developed urban, agricultural and environmental water uses in the region for 1998, 2000, and 2001. A comparison of regional urban, agricultural and environmental water uses indicates that urban water use is about 5 percent of total uses, agricultural water use averages 84 percent and environmental water use is normally about 11 percent of the developed water supplies.

As surface water was developed and imported water became available, water districts were organized to fund water conveyance and delivery infrastructure to serve the area's developing agriculture. Many different crops are grown throughout the region. Most of the agricultural land in the region lies in organized water districts. Many water districts in recent years have actively been changing water management practices and physical structures to improve the efficiency of water delivery and use.

Urban water use accounts for about 5 percent of the total applied water in the Tulare Lake region. Until recently, many of the communities in the region have not used water meters, and customers are charged a flat rate for water use. However, urban communities are gradually working toward the installation of water meters as funding allows. State legislation, AB 514 (Kehoe), signed into law in October 2003, requires all California cities that receive water from the CVP to install and use water meters by year 2013. Some of the larger cities that are affected include Sacramento, Folsom and Fresno. In Fresno, the new law is being viewed as a solution to a long-standing problem. It is believed that AB 514 will remove the requirement for Fresno to obtain voter approval to amend its charter to permit metering of water. The U.S. Bureau of Reclamation and the federal Department of Interior have made the installation of water meters a requirement if Fresno plans to renew its CVP contract for 60,000 acre-feet of surface water from the Friant Division.

The variability of industrial water use is a function of economic, climate, and technological factors. Agriculture harvest schedules have a large effect because significant amounts of water are used for processing harvested crops. Local water agencies supply water to most of the smaller industrial facilities in the cities. However, larger industrial and institutional water users both inside and outside urban areas generally develop their own groundwater supplies or divert from local surface water sources. Higher per capita water use in areas like Fresno and Bakersfield are generally due to their higher concentration of these industries. In the case of Bakersfield, the food processing and oil industries have historically been a large segment of the total industrial water use activity.

Water Recycling

In the Tulare Lake region, discharge of recycled water is regulated through the Central Valley Regional Water Resources Control Board, as described in the Board's Tulare Lake Basin Plan. The significant increase in population in the Tulare Lake region has resulted in a rising volume of recyclable water. This has forced municipalities to reassess collection, transmission, and treatment capacities of their wastewater plants to handle

Table 8-1 Tulare Lake Hydrologic Region Water Balance Summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (207%)	2000 (93%)	2001 (85%)
Water Entering the Region			
Precipitation	27,306	12,693	11,564
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions	3,716	5,627	3,696
Total	**31,022**	**18,320**	**15,260**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	5,401	7,427	7,591
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	1,857	1,540	1,093
Statutory Required Outflow to Salt Sink	0	0	0
Additional Outflow to Salt Sink	457	457	458
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	22,606	10,578	10,374
Total	**30,321**	**20,002**	**19,516**
Storage Changes in the Region [+] Water added to storage [-] Water removed from storage			
Change in Surface Reservoir Storage	438	-57	-141
Change in Groundwater Storage **	263	-1,625	-4,115
Total	**701**	**-1,682**	**-4,256**
Applied Water * (compare with Consumptive Use)	8,429	10,717	10,717

***Footnote for applied water**

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

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

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

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

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

increasing volumes. Most of the recycled water in the region is used for irrigation and groundwater recharge. The rest is evaporated. There are several cities, such as Bakersfield, that built recycled water delivery systems for agricultural irrigation use. When effluent is discharged, a discharge permit must be obtained as part of the EPA National Pollutant Discharge Elimination System (NPDES) Permitting Program. Water reuse in the Tulare Lake region was estimated to be over 150,000 acre-feet in 2000. Groundwater recharge programs account for more than half of all recycled water use.

State of the Region

Challenges

Whenever a region looks outside of its borders for more water, statewide water management and integrated resource planning become important considerations. Depending on the package of options chosen, one region's actions can affect another region's supplies. Statewide planning involves assessing trends in each region's water demand and quantifying the cumulative effects of each region's demand and use patterns on statewide supplies. It basically parallels planning at the local and regional levels. By working through a statewide planning process, the magnitude of both intra- and inter-regional effects can be analyzed. However, in a number of circumstances, measures that would be taken to manage demand, to increase supplies, or to improve water service reliability are local decisions. These decisions must assess and compare the cost of increased water reliability against the economic, environmental, and social costs of potential shortages.

In the short term, those areas of California that rely on the Sacramento-San Joaquin Delta for all or a portion of their surface water face an unreliable supply due to the evolving protections for aquatic species and water quality. At the same time, California's water supply infrastructure is severely limited in its capacity to transfer marketed water through the Delta due to those same operating constraints. Until solutions to complex Delta problems are identified and put in place and demand management and supply augmentation options are implemented, some water-dependent regions will experience imported water shortfalls. Such limitations of surface water deliveries will continue to exacerbate groundwater overdraft in the Tulare Lake region because groundwater is used to replace much of the shortfall in surface water. In addition, water transfers within these areas have and will become more common as farmers seek to minimize water supply effects on their operations. In urban areas, water conservation and water recycling will be accelerated to help offset short-term water needs. Proposition 50, also known as "Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002," provides a mechanism for funding projects to augment systems and supplies, optimize delivery systems, use recycled water, and increase water management efficiency.

Distinct environmental water needs exist for each of the four major watersheds in the Tulare Lake Hydrologic Region that encompass the river systems of the Kings, Kaweah, Tule and Kern. There has been significant activity on both the Kings and Kern Rivers to restore flows for habitat as well as recreation. Modification to outlet structures and timing of releases on the Kings River provide cooler water temperatures to protect the resident trout populations. Gravel augmentation is also carried out to provide spawning habitat. The Kern County Water Agency has implemented a successful and innovative program of delivering water supplies down the river through the City of Bakersfield, thus providing water for instream uses which can later be extracted farther downstream through the use of wells. Environmental water supplies on the Kaweah and Tule rivers are being modified due to the mitigation requirements tied to reservoir enlargement projects on both systems.

Groundwater pumping, a major source of supply in the Tulare Lake region, continues to increase in response to growing urban and agricultural demands. If groundwater extraction continues to be used to offset anticipated but unmet surface water imports, it will have negative consequences. One such effect of long-term groundwater overdraft is land subsidence, which also results in a reduction of aquifer storage space. This has already caused some damage to canals, utilities, pipelines, and roads in the region. In an effort to slow this condition, many water agencies have adopted groundwater replenishment programs by taking advantage of excess water supplies available in wet years, incidental deep percolation, and seepage from unlined canals.

On the region's west side, salinity, sulfate, boron, chloride, and selenium limit the uses of groundwater. Salinity is the primary water quality factor affecting use of groundwater for irrigation and native habitat. Where groundwater quality is marginal to unusable for agriculture, farmers use good quality surface water to irrigate crops or blend higher quality surface water with poor quality groundwater to create a larger supply. The inefficiency of some crop irrigation systems can increase percolation of irrigation water into the shallow unconfined aquifers, causing drainage problems and degrading groundwater quality. This marginal to poor quality groundwater has mounded up to reach crop root zones in this area and is threatening the viability of agriculture there.

Agricultural runoff and drainage are also the main sources of nitrate, pesticides, and selenium that endanger groundwater and surface water beneficial uses. The basin also has a relatively large concentration of dairies that contribute microbes, salinity, and nutrients to both surface water and groundwater. Nitrate has contaminated more than 400 square miles of groundwater in the Tulare Lake Basin. In addition, oilfield waste has impacted water quality. According to the Regional Water Quality Control Board's basin plan, there are more than 800 oilfield waste dischargers, of which 250 are regulated under waste discharge requirements.

Naturally occurring arsenic as well as pesticides and industrial chemicals have contaminated some groundwater supplies that are used for domestic water in the region. For example, the lone well that provides water for city of Alpaugh's 760 residents (40 percent of whom are defined as living at poverty levels) contains unsafe levels of naturally occurring arsenic. By 2006, new federal and State rules will force more than 50 central San Joaquin Valley communities, including Hanford, Pixley, and Tranquility, to cut arsenic levels to one-fifth the current allowable levels. The contamination of 40 wells in Fresno due to high levels of dibromochloropropane (DBCP), trichloroethylene (TCE), and other organic compounds resulted in the installation of activated charcoal filtration systems to remove these contaminants.

The quality of local surface water from the Kings River and the San Joaquin River (diverted south through the Friant-Kern Canal) is generally considered excellent for irrigation, municipal, and industrial uses. However the Central Valley Regional Water Quality Control Board has specifically identified salinity in the lower Kings River as a water quality priority in its 2002 Triennial Review. On the west side of the region, the California Department of Water Resouces (DWR) has sought solutions to the flooding on the Arroyo Pasajero, which threatens the California Aqueduct. The aqueduct, which forms a barrier to arroyo floodwaters and sediment flow, is at risk of failure during major rainstorms in the watershed. Also, the naturally occurring asbestos in the arroyo sediments that enter the aqueduct during floods has raised questions of possible health risks. Both Panoche and Silver creeks contribute large sediment loads to the valley floor, and Panoche Creek also contains elevated levels of selenium.

For many years, portions of the Tulare Lake region have experienced significant drainage problems. The need for proper drainage of agricultural return flows has long been recognized by federal and State agencies. Planning for drainage facilities to serve the San Joaquin Valley began in the mid-1950s. The poorly drained area is concentrated along the western side of the San Joaquin Valley from Kern County north into the San Joaquin River Hydrologic Region. Although the San Joaquin Valley has some of the most productive agricultural lands in the world, much of the west side of the valley is plagued by poor subsurface drainage that adversely effects crop productivity. Between 1977 and 1991, the area affected by saline shallow groundwater on the west side doubled to about 750,000 acres. At present, a substantial portion of the valley, about 2.5 million acres, is threatened by saline shallow groundwater resulting from the lack of proper drainage.

In addition, drainage water is sometimes contaminated with naturally occurring, but elevated, levels of selenium, boron, and other toxic trace elements that threaten the water quality, environment, and fish and wildlife. Water planners had originally envisioned a master surface water drain to remove this poor quality water, but that proposal was never implemented. The U.S. Bureau of Reclamation has an obligation to provide agricultural drainage service to farm lands served by the CVP on the west side of the valley. To convey this sometimes contaminated drainwater more directly to the San Joaquin River and away from the sensitive San Luis National Wildlife Refuge Complex, a portion of the San Luis Drain was reopened in September 1996 as part of the Grassland Bypass Project. The San Luis Drain was modified to allow drainage through six miles of Mud Slough, a natural waterway that passes through the San Luis National Wildlife Refuge Complex and a section of the North Grassland Wildlife Area.

Monitoring the quality of San Joaquin Valley agricultural drainage water began in 1959 as a cooperative agreement between the DWR and the University of California. In 1984, the San Joaquin Valley Drainage Program was established as a joint federal and State effort to investigate drainage and drainage-related problems and identify possible solutions. In September 1990 the San Joaquin Valley Drainage Program summarized its findings and presented a plan to manage drainage problems in a report titled "A Management Plan For Agricultural Subsurface Drainage and Related Problems in the Westside San Joaquin Valley." In December 1991 several federal and State agencies signed a memorandum of understanding and released an implementation strategy titled "The San Joaquin Valley Drainage Implementation Program." The purpose of the 1991 MOU and its strategy document was to coordinate various programs in implementing the 1990 recommendations.

In 1997 member agencies of the San Joaquin Valley Drainage

Implementation Program and the University of California initiated a plan to review and evaluate the 1990 Plan and update its recommendations. Eventually, the San Joaquin Valley Drainage Authority, which includes districts in the Grassland, Westlands, and Tulare subareas, was formed to develop a long-term solution for drainage problems in the valley, which could include out-of-valley disposal. Studies continue in pursuit of cost-effective ways to dispose of the drainage water.

In 2002 the U.S. Bureau of Reclamation released a new San Luis report, which declared that an "in-Valley" solution to the drainage problem on the valley's west side should be implemented. The proposed alternative contains features that include a drainwater collection system, regional drainwater reuse facilities, selenium treatment, reverse osmosis treatment for the Northerly Area, and evaporation ponds for disposal of accumulated salts.

Also in 2002 the Westlands Water District and the United States reached a settlement agreement regarding the drainage of lands that the federal government was legally obligated to provide to west side farmers. Under this agreement the federal government would buy the poorest drained agricultural lands from farmers and then remove those lands from agricultural production. As a result of this agreement, the number of acres requiring drainage service in the San Luis Unit will initially be reduced by retiring about 33,000 acres, part of a long-term plan that may eventually retire up to 200,000 acres.

Accomplishments

Many water districts in recent years have actively been working to improve agricultural water delivery and use efficiencies. About 14 individual water districts encompassing more than 1.3 million acres have become signatories to the Agricultural Water Management Council and have prepared Agricultural Water Management Plans. In addition, many water districts are working with individual growers to improve on-farm irrigation water management systems and efficiency. These activities include providing irrigation scheduling information, assistance in obtaining low interest loans, water trading to improve delivery efficiency, delivery augmentation and irrigation system evaluations.

On the western side of the San Joaquin Valley, particularly in Fresno and Kings counties, farmers are using more sprinkler irrigation and less flood, basin, or furrow irrigation as a means to reduce excess runoff. This change in water use methods also reduces incidental deep percolation to groundwater, which is beneficial for areas that have problems with high water tables. In addition, improved management of the remaining farm lands that use furrow and basin irrigation is resulting in the reduction of applied water. By 1998, less than half of the agricultural land in this region still used the flood irrigation method.

Many farmers use sprinklers and drip irrigation, especially on truck crops where small applications of water early in the growing season are very beneficial. The amount of water applied during the pre-irrigation of cotton and other crops has been significantly lowered via increased use of sprinklers. Buried drip irrigation systems have been increasing in acreage, as the proper equipment and designs are proven successful. Currently, almost all new plantings and replanting of orchards and vineyards are installing drip or micro-sprinkler irrigation systems and many older plantings are being converted from furrow or basin systems, where conditions are favorable for success. As trees and vines age, their yields decrease to a point where returns are no longer profitable, and orchards are then replanted. Eventually nearly all trees and vines in the region are likely to be irrigated with micro-irrigation systems, as long as conditions are favorable to this conversion.

DWR conducted a survey of irrigation methods being used to irrigate crops in Kern County in conjunction with its summer land use surveys performed in 1984 and 1998, as shown in Table 8-2. The results indicate that the adoption of micro-irrigation systems has increased dramatically in all plantings of truck and permanent crops over this period. This transition to the more efficient drip and micro-sprinkler systems has greatly improved agricultural water use efficiency and thus reduced the amount of applied water that is needed.

In general, management of all irrigation systems, including non-pressurized irrigation systems, such as furrow and basin, has been improving. Economic factors, such as the need to keep overall production costs down, are a primary reason for increasing farm water use efficiency. These agricultural economic considerations include higher production costs, higher utility rates, and low market prices for crops sold. Inconsistent year to year contract deliveries from the CVP and SWP have also motivated farmers to improve efficiency. Farmers are using a wider availability of crop irrigation scheduling information and soil moisture monitoring programs to respond to these cost concerns. On-going and expanded public outreach and training efforts by the UC Cooperative Extension, irrigation districts, and other agencies has made helped make these improvements possible.

Table 8-2 Percentage of acreage of each crop category by irrigation method used – Kern County

	1984	1998	1984	1998	1984	1998
	SURFACE		SPRINKLER		MIRCRO	
GRAIN	52.1	46.1	47.9	53.9	0.0	0.0
FIELD CROPS	63.9	77.2	36.1	22.8	0.0	0.0
ALFALFA	77.2	88.3	22.8	11.7	0.0	0.0
PASTURE	76.9	81.7	23.1	18.3	0.0	0.0
TRUCK CROPS	17.4	24.9	82.6	70.5	0.0	4.6
DECIDUOUS ORCHARD	41.9	29.9	27.2	6.1	30.9	64.0
SUBTROPICAL	13.8	2.8	23.4	0.6	62.8	96.6
VINEYARD	59.2	36.1	15.7	1.8	25.2	62.1

Efforts to improve water use efficiency in the urban sector began earnestly during the last six-year drought, which extended from 1987 through 1992. The California Urban Water Conservation Council was created in 1991 with the development and signing of the "Memorandum of Understanding Regarding Urban Water Conservation in California." The CUWCC is composed of urban water agencies, public interest organizations, government agencies, and private entities. Together these organizations work to promote efficient urban water use statewide. Many water and utility companies throughout the state offer financial and technical assistance programs that specifically help residential customers with limited finances to implement water and energy efficiency programs in their homes.

Throughout the State, Urban Water Management Plans are now required under the provisions of the California Urban Water Management Planning Act. These plans must be adopted and submitted to the State every five years by all water suppliers that provide water for municipal purposes to more than 3,000 customers. In general, these plans must describe an agency's current sources of water supply and the municipal demands being served, provide estimates of future urban demands, and describe the proposed management methods and water supply sources that will be developed to meet the future needs. Water agencies and municipalities in the Tulare Lake region that have submitted urban water management plans include West Kern Water District, North of the River Municipal Water District, East Niles Community Services District, City of Clovis, City of Dinuba, McAllister Ranch, Tejon-Castaic Water District, City of Wasco, Oildale Mutual Water Company, Vaughn Water Company, City of Bakersfield, City of Corcoran, City of Lemoore, City of Reedley, City of Hanford, Kern County Water Agency, and the City of Sanger. Nine of the above agencies now have completed urban water management plans.

Regarding groundwater, the Groundwater Management Act of 1992, AB 3030 (California Water Code Section 10750 et seq.) allows certain defined existing local agencies to develop groundwater management plans. Groundwater basins are explained and defined in "California's Groundwater" (DWR Bulletin 118, Update 2003). Before the passage of AB 3030, the California Water Code had been amended by AB 255 in 1991 which allowed local agencies overlying critically overdrafted groundwater basins to develop groundwater management plans. Six water agencies in the Tulare Lake region prepared groundwater management plans under AB 255 laws. Following AB 3030 legislation, 26 additional groundwater management plans have been adopted in this region. In 2002, SB 1938 amended existing law related to groundwater management by local agencies. This law now requires any public agency that applies for State funds for the construction of groundwater projects or groundwater quality projects to prepare and implement a groundwater management plan that contains more specific procedures and plan components.

Cities and counties in the region are continually introducing new water system technology to solve problems, reduce costs, and improve system operations as part of efforts to maintain, expand, and update their municipal water systems. After years of violating state drinking water standards for taste and smell, the city of Mendota, in western Fresno County, is in the process of implementing major water system improvements. Three new wells east of the city have been constructed, each with the capacity to pump up to 1,500 gallons per minute. This new groundwater supply is transported to the city's treatment facility via a 20-inch pipeline, where a new filtering tank has been added to improve the water purification system.

The California Revolving Fund program disburses low interest loans to address water quality problems associated with discharges from wastewater and water reclamation facilities, as well as from nonpoint source discharges and for estuary enhancement. This policy was written to implement the 1987 Amendments to the Federal Clean Water Act, which created the State Revolving Fund (SRF) Loan Program. In the Tulare Lake Region recent program participants include (1) the town of Alpaugh with a treatment and collection system, (2) the City of Fresno's treatment plant expansion, (3) the County of Kern's Rexland Acres community sewer collection and transmission system, and (4) the Fresno Metropolitan Flood Control District's storm water quality management program.

The City of Clovis received AB 303 funding for a proposed project that will include (1) compiling groundwater recharge basin site characteristics to increase recharge capabilities, (2) constructing groundwater monitoring wells at recharge facilities to better monitor percolation and movement, and (3) creating a Ground Water Information System (data management system) to provide a comprehensive and organized data base for improved groundwater data accessibility and maintenance.

In Kern County, the Kern Water Bank groundwater program will receive Proposition 13 funding to increase the recovery capacity of the Kern Water Bank. The Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program administered by the Kern County Water Agency will receive Proposition 13 funding to provide additional opportunities for Kern County facilities to capture and transport high-flow water supplies and may provide water for ecosystem restoration and the Environmental Water Account.

Another project receiving Proposition 13 funding is the Kern Water Bank River Area Recharge and Recovery Project that would allow the Kern Water Bank Authority to provide as much as 50,000 acre-feet per year of additional water recovery capability. In years when recovery needs are less than recovery capacity, water could be recovered for the Environmental Water Account or other ecosystem restoration needs.

The North Kern Groundwater Storage Project will take advantage of wet-year high flows and store them in the groundwater aquifer. This may reduce demands on water supplies from the Delta in dry years.

The Westlands Water District received AB 303 funding to find more water, including potential conjunctive use opportunities. The investigation included three deep soil-boring and monitoring wells installed by DWR to evaluate the storage, water quality, and extraction potential of the groundwater aquifer. AB 303 also paid for the installation of 35 shallow borings to evaluate the percolation potential of the uppermost soil sediments. The study was completed in 2002 and recommended the area where Arroyo Pasajero intersects with Interstate 5 as a site for conjunctive use groundwater application.

Within the past several years, Broadview Water District announced that landowners had decided to sell the district due to the increasing costs of water production and the additional water system costs associated with the district's drainage and salinity problems. In 2003 the Pajaro Valley Water Management Agency and Broadview Water District began negotiating the sale. Pajaro Valley WMA had prepared the necessary paperwork and completed the required studies, but negotiations never culminated in an agreement that was acceptable to both parties. At about this time, Westlands Water District, which shares part of its northern district boundary with Broadview, began negotiations with the Broadview Water District. Westlands recently announced that negotiations had been completed to purchase the Broadview Water District and that the acquisition would encompass all the Broadview lands and include the Broadview Water District's 27,000 acre-foot CVP water service contract. This sales/purchase agreement is being circulated among Broadview landowners for their approval, and the transaction is expected to be completed in 2005. District staff has also met with Fresno County Local Agency Formation Commission to discuss annexing the Broadview lands into Westlands.

For several years Westlands WD has been attempting to "augment" its water supplies by selling agricultural lands that have severe drainage problems and then using the water entitlements retained from those lands to firm up the water entitlements to the remaining irrigated lands within the district. The impending purchase of Broadview Water District with its CVP water entitlement is another example of this ongoing process.

Among other regional programs, the U.S. Natural Resources Conservation Service has been promoting agricultural programs in western Fresno County that:

(1) reduce the amount of salts leached to ground water and improve shallow, saline water table conditions with improved irrigation water management.
(2) improve the distribution and management of livestock to reduce erosion using prescribed grazing, fencing, and improved watering facilities for livestock.
(3) reduce soil salinity in the crop root zone to improve cropland productivity with improved irrigation water management and soil salinity management.
(4) reduce the amount of airborne particulates with adjusted

timing of agricultural operations, vegetating turn areas, and avoiding tracking soil onto the county roads.

(5) reduce sheet and rill erosion on rangeland through improved livestock distribution and production of forage.

The Lake Kaweah Enlargement Project proposes to raise the Lake Kaweah spillway by 21 feet and increase the lake's water storage capacity by 43,000 acre-feet to 183,000 acre-feet, or 28 percent. Still a small lake in comparison to others in California, the enlargement project will increase flood protection to downstream communities on the Kaweah Delta river system, especially near Visalia. The dam's spillway crest, a U-shaped cut, is being raised with the installation of "fuse gates." These gates are like large concrete teeth that pop out like fuses if the lake should become so full. Once completed, farmers are expected to see immediate benefits because a larger lake will allow longer irrigation periods during the summer months. Additionally, the Tulare Lake bottom lands are less likely to be inundated with flood flows that occasionally interrupt farming operations. Recreational use will also be enhanced because even in winter, when lake levels are low, it will be large enough for boating. The federal government is funding more than half the cost of the $33 million project, the State Reclamation Board is providing $10.1 million, and the local agencies are providing the remaining $5.4 million.

The Coordinated Resource Management and Planning (CRMP) groups in the Tulare Lake region include the Panoche/Silver Creek CRMP, the Stewards of the Arroyo Pasajero Watershed CRMP, and the Cantua/Salt Creek Watersheds CRMP. The general purpose of these groups is to promote watershed health throughout the western Fresno County foothills. The primary concerns in these watersheds are flooding, erosion, sediment transport, and the quality of water entering into the San Joaquin River and the California Aqueduct. Some of the water management strategies that have been developed to address these problems include streamflow and water quality monitoring programs, revegetation of embankments, and implementation of watershed best management practices.

As part of the Kern County Water Agency's Kern River Restoration and Water Supply Improvement Program, the Kern River Parkway will include a new 40-acre multipurpose recharge lake and recreation area with a permanent 10-acre recharge lake and adjoining playing field that will be surrounded by grassy slopes and tree-shaded seating areas. During extremely wet water years, these open 25-acre fields will be flooded and used for groundwater recharge in the spring. There will also be a new access route to the existing Kern River north bank equestrian trail from the future Jewetta Avenue extension.

Relationship with Other Regions

The Tulare Lake region receives CVP water from the San Joaquin River region via the Friant-Kern Canal and imported water from the Sacramento-San Joaquin Delta via the SWP California Aqueduct and the CVP San Luis and Delta-Mendota canals. The regional map in Figure 8-1 identifies the amounts of water imports and exports for recent years 1998, 2000, and 2001. The economic health of the region heavily depends on the availability of imported surface water to meet current and future needs. Several water districts within the Tulare Lake region have developed groundwater storage and recovery programs that benefit water districts outside of the region. Groundwater overdraft has created sufficient dewatered storage space to store water for local uses and for extraction and exchange or delivery to other agencies. Revenues generated by these storage and recovery programs have helped finance additional conveyance infrastructure to move surface water to areas that were previously served with groundwater. This type of conjunctive use activity ultimately helps relieve overdraft, while providing additional water supplies to agencies outside of the region.

Looking to the Future

Major water agencies and counties within the Tulare Lake region have been proactive for many years in all facets of water use and supply planning (see Box 8-1 Ongoing Planning Activities). The efficiency of water diversions from local rivers and streams is continually being optimized to meet agricultural and urban purposes. In addition, when it became apparent that the groundwater supply was not sustainable for meeting all future water demands, water agencies worked with the CVP and SWP to find ways to improve delivery capabilities.

The predominantly agricultural economy is now adapting to share water resources with the rapidly growing urban economy. New projects have been identified as necessary to better manage the local water supplies, as well as to adhere to more stringent water quality standards and environmental regulations.

Regional Planning

An important component of California's ability to meet future water needs involves the voluntary transfer of water from one user to another. In recent years, programs and proposals that involve water transfers have become very active in the Tulare Lake region and adjacent areas. Water districts have also made significant progress in the development and expansion of groundwater banking agreements and conjunctive use programs, which facilitate the storage and movement of water to where it is needed.

The San Joaquin Valley Water Coalition is one example of several regional groups that facilitate the discussion of common issues related to water supply, water quality, and water management to ensure the reliable distribution of water. Some of the factors that are commonly considered in these regional planning efforts include:

- Population growth, impacts, and resulting water needs
- Groundwater overdraft and associated problems
- Preservation of prime agricultural lands
- Reliability of water supplies in foothill and mountain communities
- Reliability of water supplies for fish, refuges, and the environment
- Potential water transfers and exchanges and their effects
- Groundwater banking programs
- Groundwater quality issues, particularly for drinking and municipal use

Several examples of recent projects that have evolved through the use of regional planning approaches are mentioned below.

Pond-Poso Improvement District Project Enhancements. The Pond-Poso Improvement District is working to improve the groundwater resource in north-central Kern County. The district recently qualified for Proposition 204 funds. A primary goal is to encourage local groundwater users to begin using surface water whenever available instead of groundwater, which will help to stabilize the groundwater basin. The project is being completed by the Semitropic Water Storage District.

Pioneer Groundwater Recharge and Recovery Project. Funding obtained from Proposition 204 will be used to enhance the Kern County Water Agency's Pioneer Project. This project will develop methods to maximize recovery of recharged groundwater, to increase the water supply available to the program participants. The project has the potential to reduce dry-year demands for surface water from the Sacramento-San Joaquin

Pond - Shafter - Wasco Irrigation and Water Use Efficiency. This effort is targeting agricultural irrigation in Kern County. The project's goals are to (1) implement a Total Farm Management Program for the San Joaquin Valley portion of Kern County; (2) reduce PM-10 levels on 50 percent of the permanent crops harvested in the valley; (3) reduce agricultural water use by 15 percent over the next five years through changes to irrigation systems and irrigation management; (4) increase wildlife habitat by 30 percent over the next five years; and 5) educate local growers about new or proven techniques in water, air, nutrient, and pesticide management. The Pond-Shafter-Wasco Resource Conservation District and the Natural Resources Conservation Service are leading this project.

Kern County Groundwater Storage and Water Conveyance Infrastructure Improvement Program. Proposition 13 funding will be used to provide additional opportunities for Kern County to develop water supplies for local uses, increase opportunities for ecosystem restoration, and increase sales to the Environmental Water Account. Kern County Water Agency has received the funding to develop this program.

White Wolf Basin Groundwater Banking Project. The White Wolf Basin is a small, somewhat isolated, groundwater basin in the southeastern corner of Kern County. The Wheeler Ridge-Maricopa Water Storage District is studying groundwater banking using this aquifer. Surface water from the California Aqueduct would be imported for use in groundwater storage. Recovered water could then be conveyed back to the aqueduct, or introduced into the district's distribution system and exchanged for SWP water. Pilot wells are being drilled in order to better understand the geology of the groundwater basin.

South Valley Water Management Program. The southern

Box 8-1 Ongoing Planning Activities

- Kern County Water Agency Conjunctive Management Program
- Water Agency Exchanges and Transfers
- Kern County Water Agency EWA Sales
- Optimization of Water Conveyance Systems
- Inter-regional Water Storage, Drought Supply Agreements

end of the San Joaquin Valley has water conveyance facilities that are interconnected, especially in Kern County. During wet years water can become available for short durations from any of a number of sources, including the San Joaquin River, Kings River, and Kern River. The Kern County Water Agency and several south valley water districts are evaluating possible ways to coordinate supplies and deliveries in order to take full advantage of these wet year supplies.

Rosedale-Rio Bravo Water Storage District Banking Program. The Rosedale-Rio Bravo Water Storage District (RRB) is developing a groundwater banking project with a maximum storage of 500,000 acre-feet. Recharge basins and recovery wells are being constructed. Generally, RRB will store water for other entities in wet years by offering a 2-for-1 exchange proposal. In drier years this water would be returned, either by exchange delivery of RRB's SWP or Kern River water, or by pumping from wells if there is insufficient exchange capacity.

Kern Delta Water District/Metropolitan Water District Joint Banking Project. Kern Delta Water District is developing a groundwater banking partnership with the Metropolitan Water District of Southern California. MWD will store water in the groundwater basin underlying the Kern Delta Water District in wet years and recover the water during drier years. The project is similar in concept to a separate joint Arvin-Edison/MWD Program. The program contemplates storing a maximum of 250,000 acre-feet of water for MWD.

Other long-term programs and activities that may be considered for the Tulare Lake region include:

- Methods to increase agricultural water use efficiency
- Methods to increase urban water use efficiency
- Water conservation activities
- Agricultural land retirement
- Temporary fallowing of crop lands
- SWP water supply augmentation concepts
- CVP water supply augmentation proposals
- Mid-Valley Canal as a new surface water facility
- Demand reduction strategies
- Short-term water transfers
- Use of "gray water" for approved purposes
- Water recycling proposals
- Local conjunctive use
- Groundwater reclamation efforts
- Treatment and reuse of brackish agricultural drainage water

Water Portfolios for Water Years 1998, 2000, and 2001

Detailed information about actual water supplies and water uses (called "water portfolios") for water years 1998, 2000, and 2001 is presented in tables 8-3 and 8-4 and figures 8-4 and 8-5.

Water Year 1998

California weather and precipitation were significantly affected by an El Nino weather event during the winter of 1997-98. The last prior El Nino period occurred in 1991-92. Wet El Nino storms did not begin earnestly until January 1998, after which storm impacts resulted in damage to a number of crops. Of California's 58 counties, 42 were declared major disaster areas during that year.

The wet weather damaged some winter and spring crops and delayed the planting and development of some summer season crops. Consumers felt the impacts from the resulting higher supermarket prices for California vegetables. Producers had difficulty getting into their soggy fields in the spring, delaying normal farming practices, such as spraying, pruning, and tying vines. The wet weather also reduced both the quality and volume of many crops harvested during this year. However for late-developing crops such as cotton, raisins, and table grapes, the fall weather produced clear skies and good temperatures, which allowed the majority of these late-season crops to be harvested without weather problems.

Watershed runoff was well above normal, as unimpaired runoff from both the San Joaquin and Kings rivers was about 170 percent of average, the Kaweah River was 196 percent of normal, and the Kern River runoff was 224 percent of average.

The total amount of acreage irrigated in this region varies in direct relation to the amount of surface water available from local and imported sources in any particular year. The 1998 total irrigated acreage was 3.2 million acres, based on abundant water supplies. The trends in crop acreage pointed towards increased acreage of higher value commodities such as fruits, tree nuts and vegetables; while the acreage of field crops was declining. Acreage planted in wine grapes was rapidly increasing, and the acreage planted in almond trees also continued to increase at a steady rate.

The dairy industry continued its growth in 1998, particularly in Tulare County, which is now the top milk-producing county in the nation. Alfalfa acreage in the Tulare Lake region exceeded 360,000 acres in 1998, up from 279,600 acres reported in

Table 8-3 Tulare Lake Hydrologic Region Water Use and Distribution of Dedicated supplies (TAF)

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	16.1			19.2			19.8		
Commercial	37.5			44.6			46.4		
Industrial	53.5			63.8			66.4		
Energy Production	0.0			0.0			0.0		
Residential - Interior	208.6			248.8			259.0		
Residential - Exterior	219.4			261.4			272.5		
Evapotranspiration of Applied Water		187.1	187.1		223.3	223.3		232.5	232.5
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	10.6			12.8			13.3		
Conveyance Evaporation & ETAW		10.6	10.6		12.8	12.8		13.3	13.3
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.7			2.9			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**546.4**	**197.7**	**197.7**	**653.5**	**236.1**	**236.1**	**677.4**	**245.8**	**245.8**
Agriculture									
On-Farm Applied Water	7,006.6			9,677.3			9,933.6		
Evapotranspiration of Applied Water		5,181.0	5,181.0		7,162.0	7,162.0		7,320.4	7,320.4
E&ET and Deep Perc to Salt Sink		457.3	457.3		457.3	457.3		457.8	457.8
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	735.4			797.0			590.5		
Conveyance Evaporation & ETAW		415.3	415.3		472.5	472.5		380.0	380.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	824.8			328.3			42.6		
GW Recharge Evap + Evapotranspiration		18.0	18.0		13.0	13.0		1.4	1.4
Total Agricultural Use	**8,566.8**	**6,071.6**	**6,071.6**	**10,802.6**	**8,104.8**	**8,104.8**	**10,566.7**	**8,159.6**	**8,159.6**
Environmental									
Instream									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Wild & Scenic									
Applied Water	3,205.0			1,331.1			964.1		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	62.9			73.7			76.3		
Evapotranspiration of Applied Water		32.7	32.7		41.4	41.4		38.3	38.3
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		3.1	0.0		2.5	0.0		2.5	0.5
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	62.9	35.8	32.7	73.7	43.9	41.4	76.3	40.8	38.8
Total Environmental Use	**3,267.9**	**35.8**	**32.7**	**1,404.8**	**43.9**	**41.4**	**1,040.4**	**40.8**	**38.8**
TOTAL USE AND OUTFLOW	**12,381.1**	**6,305.1**	**6,302.0**	**12,860.9**	**8,384.8**	**8,382.3**	**12,284.5**	**8,446.2**	**8,444.2**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	3,621.8	3,621.8	3,620.1	2,397.0	2,397.0	2,396.1	1,698.0	1,698.0	1,697.2
Local Imported Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	1,811.3	1,811.3	1,810.4	2,280.2	2,280.2	2,279.3	1,787.9	1,787.9	1,787.1
Other Federal Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWP Deliveries	1,035.0	1,035.0	1,034.5	1,915.2	1,915.2	1,914.5	849.3	849.3	848.9
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	-163.0	-163.0	-163.0	1,792.4	1,792.4	1,792.4	4,111.0	4,111.0	4,111.0
Deep Percolation of Surface and GW	2,871.0			3,145.0			2,874.2		
Reuse/Recycle									
Reuse Surface Water	3,205.0			1,331.1			964.1		
Recycled Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLIES	**12,381.1**	**6,305.1**	**6,302.0**	**12,860.9**	**8,384.8**	**8,382.3**	**12,284.5**	**8,446.2**	**8,444.2**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

1995. Corn acreage rose even faster than alfalfa, exceeding 257,000 acres in the region in 1998, which was driven by the increasing demand for cattle feed by the dairy industry.

Cotton acreage was substantially lower due primarily to the El Nino weather, decreasing to 655,400 acres (35 percent less than year 1995). Growers continued the trend of converting field crop land to almond/pistachio orchards in an effort to generate better long-term profits. The combined almond/pistachio acreage of 245,700 acres was 32 percent higher than the acreage reported in 1995.

The El Nino storms provided a significant amount of rainfall on agricultural fields, filling soil profiles, and reducing the early season evapotranspiration of applied water (ETAW). Consequently, less applied water was needed for irrigation compared to most normal years. Estimated total agricultural on-farm applied water was 7 million acre-feet for the Tulare Lake region; total agricultural water use was 8.6 million acre-feet (or 69 percent of all uses). The total agricultural ETAW in 1998 in the region was 5.2 million acre-feet. The regional average unit ETAW was 1.6 acre-feet per acre. Individual crop ETAW amounts vary due to differences in rainfall, growing season, soil texture, and rooting depths.

Total urban applied water use, including residential, commercial, industrial, and landscape, in the region was 546,400 acre-feet. Urban water use accounted for only about 5 percent of the total applied water in this hydrologic region. The total population of the region in 1998 was 1,816,440. Total urban ETAW for the year was about 187,100 acre-feet, and the regional average per capita water use was about 268 gallons per day.

Total environmental demand for instream flows, wild and scenic rivers, and waterfowl refuges was about 3.3 million acre-feet. This accounted for 26 percent of total uses. This includes water that is reserved for instream and wild and scenic river flows but can later be diverted as a supply by other downstream users. Refuge water uses, which are supplies applied directly onto wildlife refuges, accounted for 62,900 acre-feet.

Total supplies, including local and imported CVP and SWP surface water, groundwater, and reuse, amounted to 12.4 million acre-feet, as detailed in Table 8-3.

Water Year 2000

The weather for water year 1999-2000 in the Tulare Lake Region was very close to the long-term average. Rainfall was slightly below normal in the southern areas of the region, where Bakersfield received 81 percent of average. Precipitation was somewhat higher than normal in the northern areas of this region, where Fresno received 120 percent of average. Watershed runoff was about 101 percent of average from both the San Joaquin and Kings rivers, 87 percent of average from the Kaweah River and about 70 percent of average from the Kern River.

Total irrigated crop acreage within the region was 3.2 million acres, which was virtually unchanged from 1998. However, the acreage of some individual crops did change significantly from 1998. The largest change in crop acreage was for cotton, which increased 10.7 percent to 725,300 acres in 2000. The combined almond and pistachio acreage of 257,000 was 11,200 acres, or 4.6 percent higher than in 1998. Corn acreage, primarily for silage, declined 10 percent during this year.

The total agricultural on-farm applied water in 2000 for the Tulare Lake region was 9.7 million acre-feet, a significant 38 percent increase over 1998. This large difference illustrates the degree to which wet and cool conditions can alter the irrigation water demand and crop acreage grown. 1998 was a very wet and cool year (low evaporative demand), which reduced irrigation demand dramatically. In contrast the total agricultural water use for 2000 was 10.8 million acre-feet (84 percent of all uses) and 26 percent more than 1998. The regional average agricultural on-farm unit applied water was about 3.4 acre-feet per acre.

The total agricultural ETAW in the region was about 7.2 million acre-feet, or 38 percent higher than that of 1998. The regional average unit ETAW was 2.2 acre-feet per acre.

The dairy industry continued its strong growth in year 2000. New records were set for the number of milk cows and milk production. In 2000, California led the nation in total milk production with a record 32.2 billion pounds, representing a 6 percent increase from the previous year. The Tulare Lake region was responsible for a large part of this increase in the number of dairies and cows.

In 2000, total urban applied water for the region was 653,500 acre-feet, which was about 20 percent higher than the total applied water in 1998. Urban water use accounted for more than 5 percent of the total applied water in the region. Total population in 2000 in the Tulare Lake region climbed to 1,884,650, an increase of 3.8 percent over the 1998 population. Average per capita water use was also much higher than 1998, at 310 gallons per day. Total urban ETAW for the year was about 223,300 acre-feet, an increase of 19 percent from 1998.

Environmental demand for instream flows, wild and scenic rivers, and refuges for the region was about 1.4 million acre-feet in year 2000, which is 57 percent less than 1998. This category accounted for 11 percent of total uses. Because the components of environmental water use are directly tied to streamflows, this category of use will always decline during normal to drier water years. Refuge supplies, which are supplies applied directly onto wildlife refuges, accounted for 73,700 acre-feet in 2000.

Total developed water supplies, including local and imported from the CVP and SWP surface water, groundwater, and reuse, amounted to about 12.9 million acre-feet, which is 4 percent more than in 1998.

Water Year 2001

The 2001 water year started out cooler than normal with cumulative rainfall below average through most of January. However, large-scale weather patterns changed significantly as February approached and a series of Pacific storms moved into the state, bringing regional precipitation totals closer to normal. Rainfall amounts were slightly less that average for the water year in the region with totals in both Fresno and Bakersfield about 93 percent of average.

Except for a thunderstorm in April that produced significant high wind, hail, and rainfall, crop development was generally normal throughout the remainder of the growing season. Less than normal precipitation in local watersheds resulted in below normal river runoff and below normal surface water supplies. Runoff from the San Joaquin, Kings, and Kaweah rivers was about 71 percent of average for each, while runoff from the Kern River was 54 percent of average.

Total irrigated agricultural acreage was 3.1 million acres, a decline of 9.6 percent (or 126,000 acres) from year 2000. The price for milk and cream commodities rose 14 percent in 2001 and pushed Tulare County to the top agricultural producing position in the nation, surpassing Fresno County, which had held the number-one position for many years. Cotton acreage was 639,400 acres, which was 85,900 fewer acres than in 2000, due primarily to the drop in price of the upland variety. Sugar beet acreage continued its multiyear downward spiral to 15,100 acres, 47 percent less acreage than in 2000. The transition into wine grapes over the past several years leveled out as the market reached a point of saturation, and prices began to weaken. The acreage of raisin grapes dropped almost 20 percent in 2001 responding to the dramatic drop in price over the past two years. Raisin growers had received more than $1,000 per ton in 1999 compared to about $525 per ton in 2001. The almond/pistachio acreage continued the upward trend of previous years, increasing more than 10 percent in 2001.

The total agricultural on-farm applied water in 2001 for the Tulare Lake region was 9.9 million acre-feet, and total agricultural water use was 10.6 million acre-feet or 86 percent of all water uses. This amount is 23 percent more than 1998, but 2 percent less than year 2000. This resulted in an average unit rate of 3.4 acre-feet per acre. The total agricultural ETAW in the region was 7.3 million acre-feet, about 41 percent higher than 1998 and 2 percent higher than 2000.

The total urban applied water in 2001 for the region was 677,400 acre-feet, which was 24 percent higher than 1998 and 4 percent higher than 2000. Urban water use accounted for about 5.5 percent of the total applied water in the region. Total population in the region for 2001, was 1,921,915, an increase of 2 percent over the 2000 population and 5.7 percent higher than 1998. Average per capita water use was about 315 gallons per day, possibly due partly to the drier water supply conditions. Total urban ETAW for the year was about 232,500 acre-feet, an increase of 24 percent from 1998 and 4 percent from 2000.

Total environmental demand for instream flows, wild and scenic rivers, and refuges for the region was about 1.04 million acre-feet, 68 percent less than 1998 and 26 percent less than 2000. This accounted for about 8.5 percent of total uses. This includes water that is reserved for instream and wild and scenic river flow, which is generally much lower in below normal water years. Refuge supplies, which are applied directly onto wildlife refuges, accounted for 76,300 acre-feet.

Total water supplies, including local and imported CVP and SWP surface water, groundwater, and reuse, amounted to 12.3 million acre-feet, 1 percent less than 1998 and 4 percent less than 2000.

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Water Portfolios

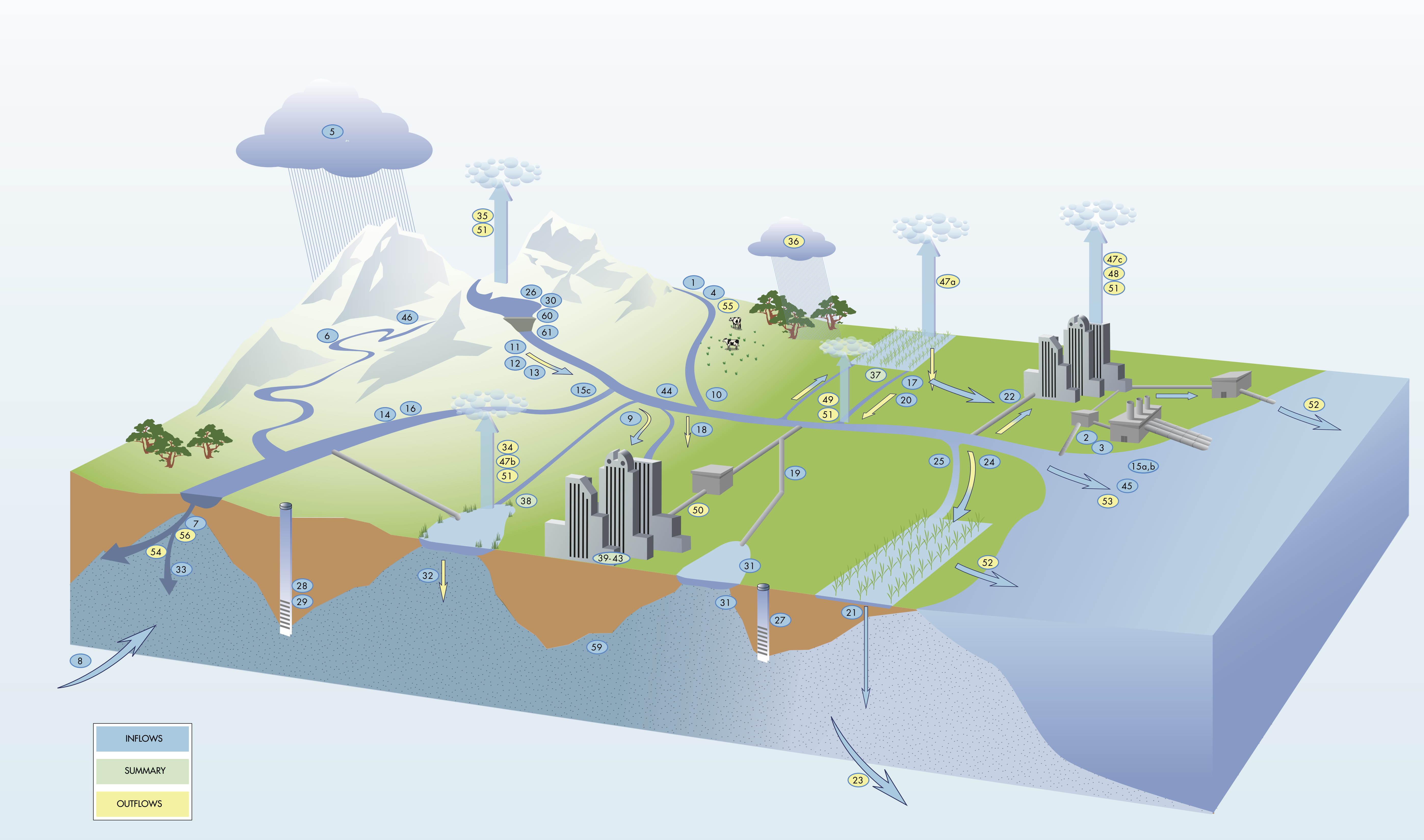
Tulare Lake Hydrologic Region

Table 8-4 Tulare Lake region water portfolio (TAF)

ID Number:	Flow Diagram Component (see legend)	Tulare Lake 1998	Tulare Lake 2000	Tulare Lake 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	27,305.9	12,692.9	11,563.6
6a	Runoff - Natural	N/A	N/A	N/A
b	Runoff - Incidental	N/A	N/A	N/A
7	Total Groundwater Natural Recharge	N/A	N/A	N/A
8	Groundwater Subsurface Inflow			N/A
9	Local Deliveries	3,621.8	2,397.0	1,698.0
10	Local Imports	-	-	-
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	1,811.3	2,280.2	1,787.9
12	Other Federal Deliveries	-	-	-
13	State Water Project Deliveries	1,035.0	1,915.2	849.3
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	-	-	-
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	-	-	-
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	-	-	-
b	Recycled Water - Urban	-	-	-
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	-	-	-
b	Return Flow to Developed Supply - Wetlands	3.1	2.5	2.0
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	1,368.1	2,058.2	2,155.2
b	Deep Percolation of Applied Water - Wetlands	27.1	29.7	34.5
c	Deep Percolation of Applied Water - Urban	348.2	414.5	431.7
22a	Reuse of Return Flows within Region - Ag	-	-	-
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	3,205.0	1,331.1	964.1
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	-	-	-
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions			
26	Surface Water in Storage - Beg of Yr	865.3	708.7	652.2
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	2,708.0	4,937.4	6,985.2
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	1,303.6	652.2	511.4
31	Groundwater Recharge-Contract Banking	99.8	167.4	-3.9
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation			
b	Evaporation and Evapotranspiration from Unirrigated Ag			
35a	Evaporation from Lakes	39.3	38.5	34.2
b	Evaporation from Reservoirs	232.9	233.8	190.6
36	Ag Effective Precipitation on Irrigated Lands	2320.5	1121.7	729.6
37	Agricultural Water Use	7,831.4	10,005.6	9,976.2
38	Managed Wetlands Water Use	62.9	73.7	76.3
39a	Urban Residential Use - Single Family - Interior	101.6	121.1	126.2
b	Urban Residential Use - Single Family - Exterior	155.1	184.9	192.7
c	Urban Residential Use - Multi-family - Interior	107.0	127.7	132.8
d	Urban Residential Use - Multi-family - Exterior	64.3	76.5	79.8
40	Urban Commercial Use	37.5	44.6	46.4
41	Urban Industrial Use	53.5	63.8	66.4
42	Urban Large Landscape	16.1	19.2	19.8
43	Urban Energy Production	-	-	-
44	Instream Flow	-	-	-
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	-	-	-
47a	Evapotranspiration of Applied Water - Ag	5181	7162	7320.4
b	Evapotranspiration of Applied Water - Managed Wetlands	32.7	41.4	38.3
c	Evapotranspiration of Applied Water - Urban	187.1	223.3	232.5
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	-	-	-
50	Urban Waste Water Produced	-	-	-
51a	Conveyance Evaporation and Evapotranspiration - Urban	10.6	12.8	13.3
b	Conveyance Evaporation and Evapotranspiration - Ag	433.3	485.5	381.4
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	-	-	-
d	Conveyance Outflow to Mexico			
52a	Return Flows to Salt Sink - Ag	457.3	457.3	457.8
b	Return Flows to Salt Sink - Urban	-	-	-
c	Return Flows to Salt Sink - Wetlands	-	-	0.5
53	Remaining Natural Runoff - Flows to Salt Sink	-	-	-
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	3,715.7	5,626.6	3,695.8
56	Regional Exports	1856.7	1539.9	1093
59	Groundwater Net Change in Storage	262.8	-1,625.0	-4,114.9
60	Surface Water Net Change in Storage	438.3	-56.5	-140.8
61	Surface Water Total Available Storage	2,046.1	2,046.1	2,046.1

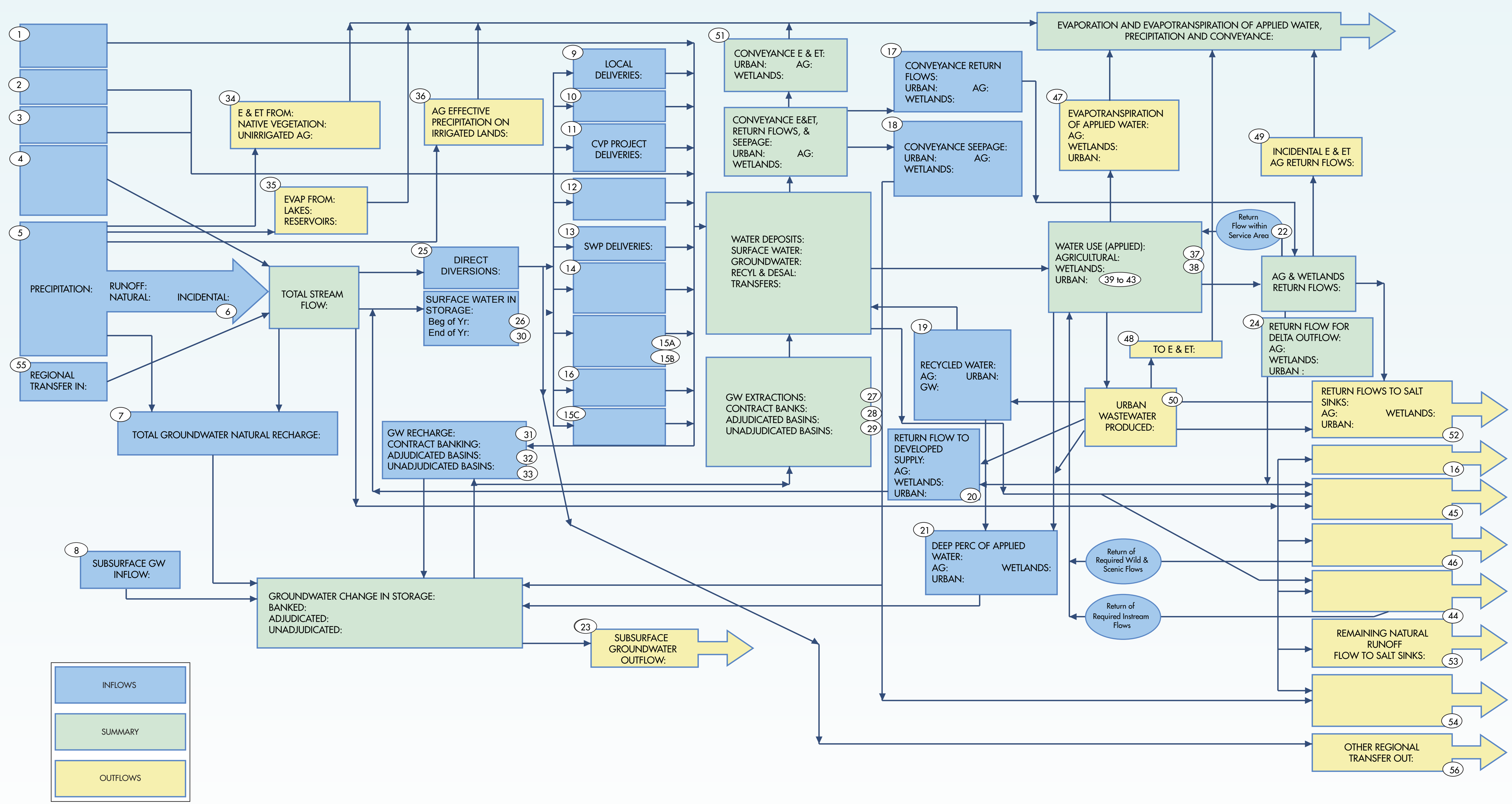
Inflows   Outflows   Green number signifies included in summary boxes

Figure 8-4 Tulare Lake region - illustrated water flow diagram



In this illustration of Table 8-4, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 8-5 Tulare Lake region - schematic flow diagram



In schematic of Table 8-4, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether the component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.

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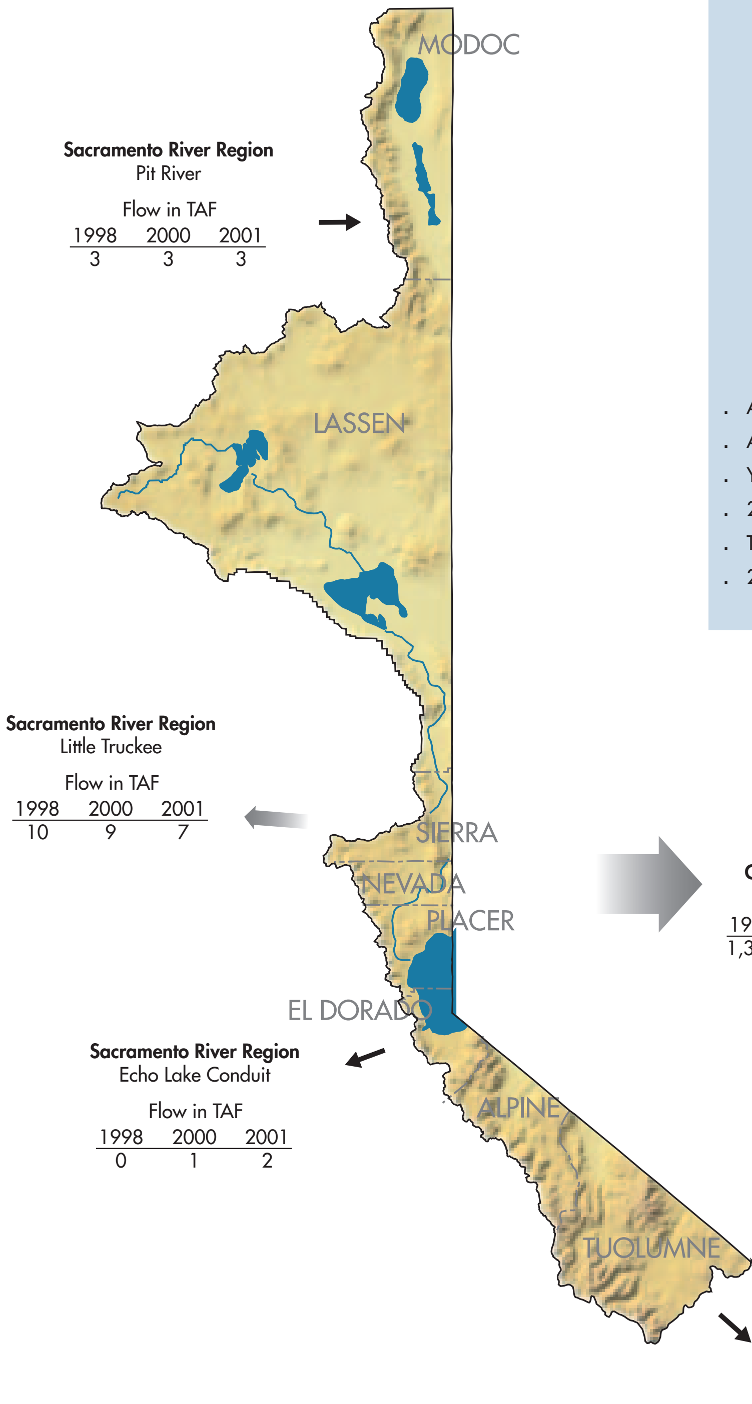
Tables

Figure 9-1 North Lahontan Hydrologic Region



Some Statistics

- Area - 6,122 square miles (3.9% of State)
- Average annual precipitation - 23.1 inches
- Year 2000 population - 99,035
- 2030 population projection -130,800
- Total reservoir storage capacity - 1,181 TAF
- 2000 irrigated crop area - 125,200 acres

The North Lahontan Hydrologic Region is in the northeast corner of California, and its surface waters drain eastward toward Nevada. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

Chapter 9 *North Lahontan Hydrologic Region*

Setting

The North Lahontan Hydrologic Region forms part of the western edge of the Great Basin, a large landlocked area that includes most of Nevada and northern Utah. The crest of the Sierra Nevada forms much of the western boundary of this region. All surface water in the region 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 9-1). The region covers 6,122 square miles, about 4 percent of California's total area. The region includes portions of Modoc, Lassen, Sierra, Nevada, Placer, El Dorado, Alpine, Tuolumne, and Mono counties. The northern part of this region is primarily arid high desert with relatively flat valleys at elevations of 4,000 to 5,000 feet, bordered on the west by mountain peaks that reach between 7,000 and 9,000 feet. The central and southern portions of this region are comprised of the eastern slopes of the Sierra Nevada and include the California portion of the Lake Tahoe Basin. The major rivers of the region are the Truckee, Carson and Walker, which carry the mountain snowmelt into Nevada. The mountain crests up to 11,000 feet form the western boundary of the region.

Climate

The region's climate is characterized by dry summers with the exception of occasional scattered thundershowers. Winter precipitation ranges from less than 5 inches in the valleys of Eastern Modoc and Lassen counties to about 30 inches in the Walker Mountains to 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 much of northern Nevada

Population

By 2000, about 99,000 people, a quarter of 1 percent of California's population, lived in the North Lahontan Region. The largest population center is the city of Susanville, the county seat of Lassen County. The cities of Truckee and South Lake Tahoe have large permanent populations, and large transient tourist populations during the summer and winter holidays.

It is estimated that the region's population will grow to 130,800 by 2030. Most of this growth is expected to occur around the existing urban communities of Susanville, Lake Tahoe, Truckee, and the adjacent Martis Valley area. Figure 9-2 provides a graphical depiction of the North Lahontan region's total population from 1960 through 2000, with current projections to 2030.

Land Use

Much of the region is either national forest or lands under the jurisdiction of the Bureau of Land Management. Cattle-ranching is the principal agricultural activity with pasture and alfalfa being the dominant irrigated crops. Commercial crop production is very limited because of the short growing season. Although growing seasons vary considerably each year, the mountain valleys where most crops are grown are usually frost free from late May to mid-September or about 120 days.

Tourism and recreation are the principal economic activities in the Truckee-Tahoe area and the surrounding mountains. On a typical summer day, the number of visitors in the Tahoe basin often exceeds the number of full-time residents. In the Lake Tahoe Basin, urban growth is tightly controlled by the Tahoe Regional Planning Agency, which is responsible for protecting the sensitive environment and water quality of the basin. To the north, the town of Truckee and the adjacent Martis Valley region are experiencing more rapid urban development. For environmental purposes, the principal consumptive use of water is for the State wildlife areas around Honey Lake,

The central and southern portions of the North Lahontan region include the eastern slopes of the Sierra Nevada and the California portion of the Lake Tahoe Basin. (DWR Photo)

which provide important habitat for waterfowl and several threatened or endangered species, including the bald eagle, sand hill crane, bank swallow, and peregrine falcon.

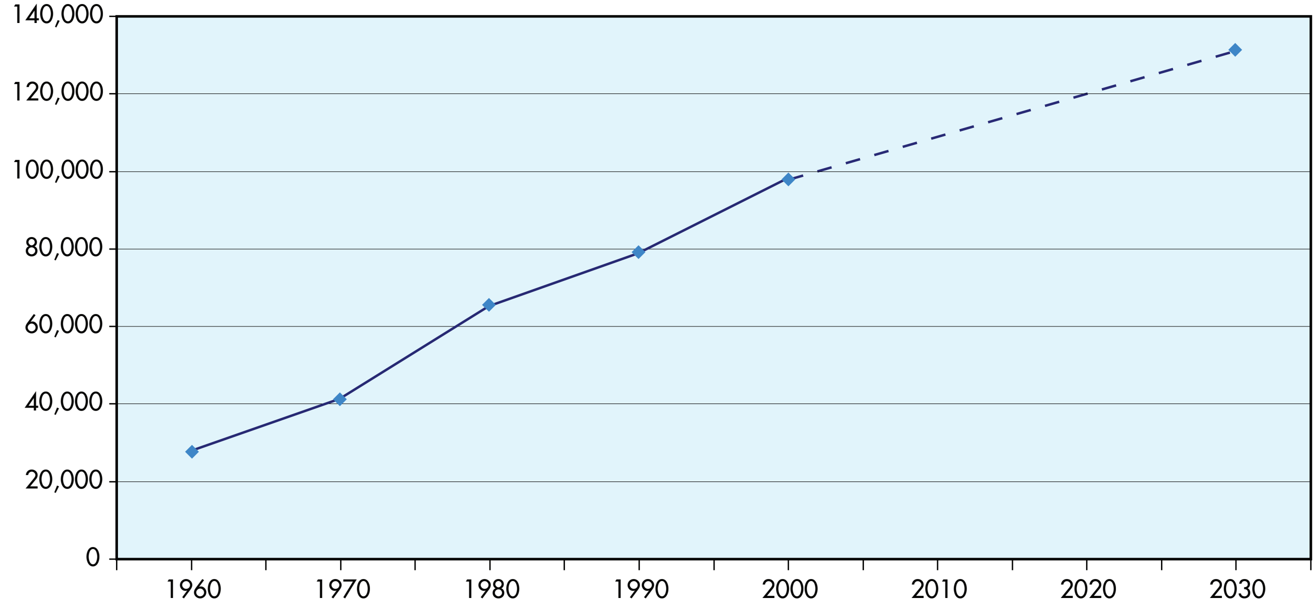
Water Supply and Use

Unimpaired runoff of the streams and rivers averages 1.6 million acre-feet per year, of which only about one-quarter is 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; the Carson River, 335,000 acre-feet; and the Walker River, 300,000 acre-feet. The Susan River is the only major river in the northern half of the region and its annual discharge at Susanville averages 60,000 acre-feet.

The Truckee, Carson, and Walker rivers are governed in large part by existing federal court water rights decrees administered by court-appointed watermasters. The interstate nature of these rivers, combined with the long history of disputes over water rights, has created a complex system of river management criteria. On the Carson River for example, more than 55 years of federal court litigation has been necessary to resolve water rights disputes, resulting in approval of the Alpine Decree, which governs operation of the river today.

Much of the supply from the Truckee, Carson, and Walker rivers has been reserved for use by Nevada interests under various historical water rights settlements, agreements, and SWRCB surface water rights permits. On the California side of these interstate basins, most locally developed water supplies are from groundwater or small surface water diversions, with storage provided by outlet dams constructed on natural lakes. Figure 9-3 provides a graphical presentation of all of the water supply sources that are used to meet the developed water uses in this hydrologic region for 1998, 2000 and 2001. A second chart in this figure summarizes all of the dedicated and developed

Figure 9-2 North Lahontan Hydrologic Region population



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

urban, agricultural and environmental water uses within this region for the three years.

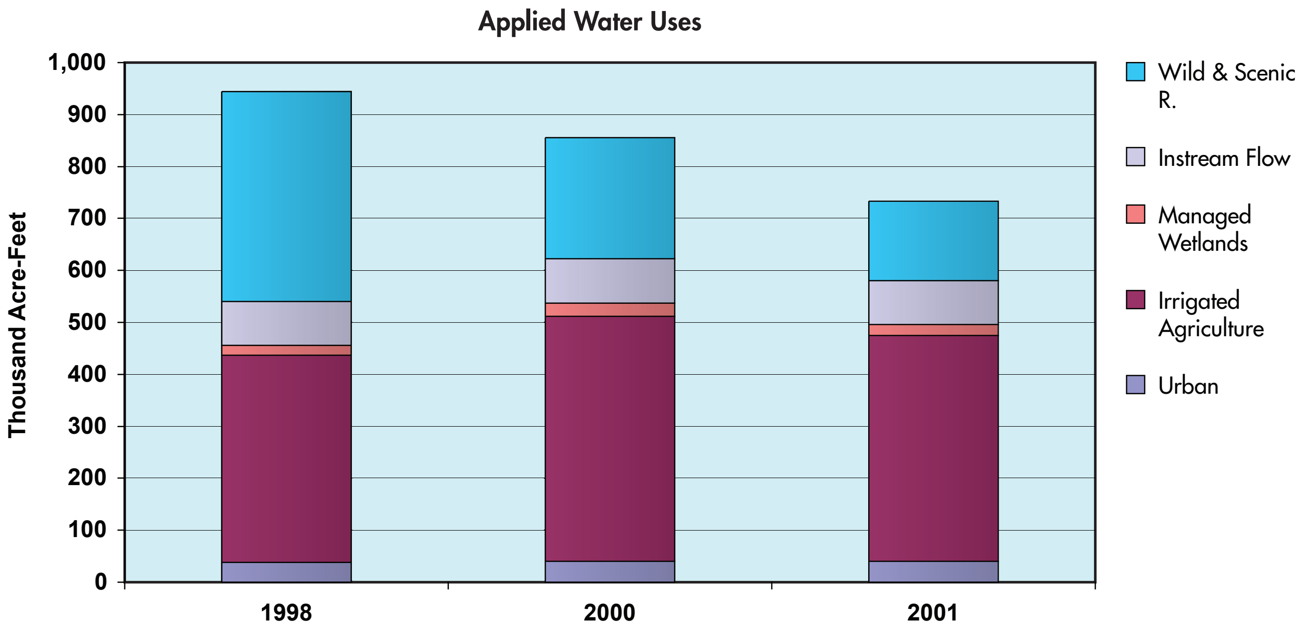
Lake Tahoe is the largest reservoir in the region, with the top 6 feet of storage operated by the U.S. Bureau of Reclamation in conjunction with the federal watermaster to meet downstream water rights in Nevada. Other federal water storage facilities in the Truckee River basin include Stampede Reservoir, Boca Reservoir, and Prosser Creek Reservoir, constructed primarily to provide water supply for urban and agricultural water use in Nevada, downstream flood protection, protection of threatened and endangered species and recreation. Independence and Donner lakes are now operated by Truckee Meadows Water Authority to supply water to the Reno – Sparks region. The U.S. Army Corps of Engineers also completed the Martis Creek Dam in 1971 as additional Truckee River flood protection for the Reno-Sparks area.

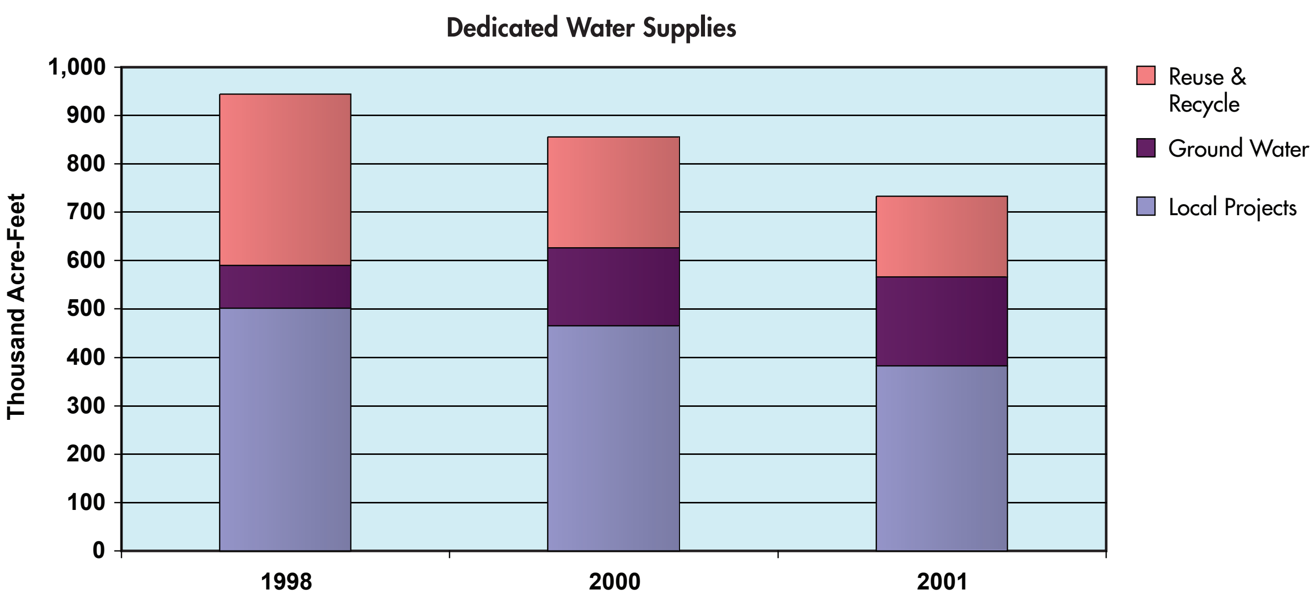
Farther south on the Walker River, both Bridgeport Reservoir and Topaz Lake are large reservoirs that capture the spring snowmelt from the Sierra Nevada, and are operated by the Walker River Irrigation District to provide summer irrigation water to Nevada farmers in that watershed.

Most urban water uses in the North Lahontan region are supplied from groundwater wells. There are 24 groundwater basins and two subbasins recognized in the region. Thirteen of these basins are shared with Nevada and one with Oregon. These basins cover about 1,033,240 acres (1,610 square miles) or about 26 percent of the entire region. Information about groundwater storage capacities is available for only six of the 26 basins, and the combined storage for these underground basins is estimated at approximately 24 million acre-feet. Although the groundwater basins were delineated based on mapped alluvial fill, much of the groundwater produced actually comes from underlying fractured rock aquifers. This is particularly true in the volcanic areas of Modoc and Lassen counties where volcanic flows are interstratified with lake sediments and alluvium. Wells constructed in these volcanic formations commonly produce large amounts of groundwater, whereas wells constructed in fine-grained lake deposits produce less. Because the thickness and lateral extent of the fractured hard rocks outside of the defined basin are generally not known, actual groundwater in storage in these areas is also unknown.

About 5,000 acre-feet of reclaimed municipal wastewater are exported out of the Lake Tahoe Basin each year by the South Tahoe Public Utility District for recharge and agri-

Figure 9-3 North Lahontan region water balance for water years 1998, 2000, 2001





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

cultural use in the Carson River watershed. Truckee Tahoe Sanitation Agency also treats wastewater from the north end of the Lake Tahoe Basin and returns about 4,000 acre-feet to the Martis Valley groundwater basin each year. Farther to the north, the Susanville Sanitary District reclaims more than 3,000 acre-feet of wastewater each year for use on nearby irrigated pasturelands.

The principal consumptive uses of water for environmental uses in the region are those of State wildlife areas around Honey Lake. The Honey Lake Wildlife Area 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, sand hill crane, bank swallow, and peregrine falcon. 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 gallons per minute. 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 Game 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 sand hill crane also inhabit this area. In addition to the Honey Lake and Willow Creek Wildlife Areas, DFG 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.

River flows that have been designated as wild and scenic constitute a large part of the environmental water use within the North Lahontan region. The east fork of the Carson River and the west fork of the Walker River are listed as State-designated wild and scenic, for the California portions of these two interstate rivers.

State of the Region

Challenges

Much of the northern portion of North Lahontan region is chronically short of water. In the Modoc and Lassen County areas drought is a way of life for agriculture, and seasonal irrigation takes place only as long as water is available. During dry years areas with little or no surface storage may only have irrigation water available for a short period early in the season, resulting in irrigation of limited acreage unless growers are able to supplement their surface water supply by pumping groundwater. However in the Modoc and Lassen County regions groundwater is also limited and some well-pumping capacities are known to diminish very rapidly during the first year of droughts.

While the Truckee River Operating Agreement has the potential to settle 50 years of disputes over Truckee and Carson River waters, the execution and implementation of this agreement will require considerable effort in the coming years. A final environmental impact statement /environmental impact report (EIS/EIR) is being prepared by the U.S. Department of Interior and the California Department of Water Resources to evaluate the potential benefits and impacts of TROA, as well as alternatives to TROA. After the EIS/EIR is completed and certified, TROA will be signed, approved by the courts and implemented. The TROA contains 14 chapters with more than 200 pages of operating criteria and conditions pertaining to water priorities, deliveries and operation of the water facilities in the system.

In the Walker River basin, California and Nevada have been discussing interstate water allocation issues that could potentially affect future uses of the river in both states. The primary issue of concern is the long-term decline in the water level and associated water quality of Walker Lake, which is the river's terminus in central Nevada. The water level at Walker Lake is estimated to have declined by about 140 feet from an historical high elevation of about 4,080 feet in 1882 to 3,941 feet in 2003. Starting in the early 1900s much of the water in the Walker River was developed to provide water to agricultural lands in Nevada. Bridgeport Reservoir and Topaz Lake were built upstream to meet those needs. As the uses increased, the flows to Walker Lake diminished, and the lake has become increasing more saline, such that the lakes historic Lahontan cutthroat trout population is severely threatened. As the lake has declined, the level of salinity as measured by total dissolved solids (TDS) has increased to measured values of 13,000 ppm TDS. Significant increases in the amount of fresh water entering Walker Lake will be needed in order to maintain or restore the fishery, which would likely affect the water uses and supplies of all upstream parties in both states. Other issues that could also affect existing water users in this basin are the potential water rights claims of the Walker River Indian Reservation, which is just upstream of Walker Lake.

Water quality in the North Lahontan region is generally very good, but many communities face specific water quality problems. These include groundwater contamination from septic tank discharges in urban subdivisions near Susanville and Eagle Lake, and MTBE contamination in South Lake Tahoe. Drinking water quality has also become a greater issue for many surface water systems around Lake Tahoe, forcing many of the smaller private systems to consolidate or change ownership because they are unable to afford the new monitoring and treatment regulatory requirements. South Tahoe Public Utility District, the largest water purveyor in the Tahoe basin, is also experiencing some difficulty in meeting these water quality requirements. The abandoned Leviathan Mine, a Superfund site in the upper reaches of the Carson River watershed, impacts local creeks with acid mine drainage water. The top water quality issues emerging from the Lahontan Regional Water Quality Control Board's (RWQCB's) 2003 Triennial Review included proposals to revise the waste discharge prohibition for piers in Lake Tahoe, and sodium standards for the Carson and Walker Rivers and their tributaries.

Lake Tahoe is the subject of its own chapter in the region's basin plan, and receives many specific and extraordinary water quality protections. The Porter-Cologne Water Quality Control Act bans the discharge of domestic wastewater from California in the Lake Tahoe Basin; the same ban is in effect in Nevada by executive order, resulting in the export of all domestic wastewater from the basin. Discharges of industrial wastewater, wastes from boats and marinas, food wastes, and solid waste are also prohibited in the Tahoe basin. Lake Tahoe's clarity has declined as development has increased around the shoreline, increasing the sediment load and nutrients reaching the lake and its tributaries. In the late 1960s, the clarity of the lake – as measured by the depth to which a Secchi disk (a small white disk of specific size) is visible – was about 100 feet; but in recent years, the average Secchi disk visibility has been closer to 70 feet. Nutrients, such as nitrogen and phosphorous used in landscaping fertilizers, can enter the lake via storm water runoff, promoting growth of algae and thereby reducing clarity. Nitrogen pollution in the basin is primarily due to vehicles, while phosphorous is mostly derived from erosion and dust (phosphate-based detergents are banned).

Roads and road maintenance, including snow removal and de-icing, are the focus of new restrictions that are intended to reduce erosion and other water quality impacts into the streams that enter Lake Tahoe. The traditional use of salt for road de-icing had resulted in adverse impacts to the trees and plants which help prevent erosion and sediment from flowing into the lake. Forest fires, grazing, and logging also present a threat to the lake's water clarity due to related and subsequent erosion into the stream systems. The use of agricultural pesticides in the Lake Tahoe Basin is prohibited, and the Tahoe Regional Planning Agency has more recently banned the use of two-stroke engines in all boats on Lake Tahoe, to prevent contamination from gasoline components such as benzene and MTBE. Other restrictions on land development and soil disturbances are used in the continuing efforts to maintain or improve the lake's water quality, and programs that purchase and preserve sensitive lands are being implemented. Lake Tahoe is now extensively monitored by many federal and State agencies, and researchers such as the University of California, Davis, Tahoe Research Group, and the University of Nevada Desert Research Institute.

Local California interests in the northern part of the Lahontan Region have been apprehensive for several years about plans and proposals from northern Nevada interests in the Reno area that have envisioned the development of additional water supplies from the northeastern California watersheds. In the late 1980s, the Silver State Plan triggered concerns about water exports to Nevada from as far north as Modoc County, more than 150 miles north of Reno. The plan proposed building a pipeline north nearly to the Oregon border to tap groundwater basins, some of which extend across the California-Nevada line. More recently, the proposed Truckee Meadows Project has generated concern about potential depletion of California groundwater supplies in the Honey Lake and Long Valley Creek areas. To date, none of these proposals have been finalized or implemented.

Accomplishments

Years of disputes over the waters of the Truckee and Carson rivers led to the enactment of the Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Public Law 101-618) in 1990. Provisions of the Settlement Act, including interstate water allocation, will not take effect until several conditions are completed, which include the negotiation and approval of a new Truckee River Operation Agreement (TROA). The act specifies an interstate allocation of the waters between California and Nevada, provides for the settlement of Native American water rights claims at Pyramid Lake, and provides water supplies for specified environmental purposes in Nevada. When it is implemented the act will allocate to California 23,000 acre-feet of surface water annually in the Lake Tahoe Basin, and 32,000 acre-feet of surface water annually in the Truckee River Basin below Lake Tahoe. In the Carson River Basin California will receive water allocations that correspond to existing water uses, and the remainder of the water supplies from both watersheds will be allocated to uses in Nevada.

Negotiation of a proposed Truckee River Operating Agreement began in 1991, involving California and Nevada, the U.S. Department of Interior, the Pyramid Lake Paiute Indian Tribe, Sierra Pacific Power Company, and local water users in both California and Nevada. The language for this 220-page draft operating agreement was finalized in October 2003, and the draft EIR/EIS for implementation of the TROA was released in mid-2004. After the final EIS/EIR is completed and certified, the negotiating parties will sign TROA. When executed, the TROA would establish new daily river operations procedures to meet water rights on the Truckee River and to enhance spawning flows in the lower Truckee River for the threatened fishery species of cui-ui and Lahontan cutthroat trout. TROA would provide for management of water in the Truckee basin in California, including instream flow requirements and reservoir storage for fishery and recreation uses, and would include procedures for coordinating releases and exchanges of water among the watershed's reservoirs. TROA would become the exclusive federal regulations governing water stored in Lake Tahoe, Martis Creek, Prosser Creek, Stampede, and Boca reservoirs. The agreement would also provide an accounting procedure for surface and groundwater diversions in California's part of the Truckee Basin and would enhance streamflows for recreational purposes.

Programs to manage and restore the water quality and clarity of Lake Tahoe are making progress by regulating development within the basin and by working to reduce surface water pollutants from entering the lake. The Tahoe Regional Planning Agency is a bistate agency created by Congress with authority to set regional environmental standards, issue land use permits, including conditions to protect water quality, and take enforcement actions throughout the basin. TRPA's regional plan includes specific goals and timetables for accomplishing environmental objectives, and this bi-state agency also implements capital improvement programs to repair environmental damage and restore water quality. TRPA has identified nearly $500 million in capital improvements that are needed to achieve the regional plan's environmental targets. Federal, state, and local governments have invested nearly $90 million in erosion control, storm water drainage, stream zone restoration, public transit, and other capital projects. The USFS's Lake Tahoe Basin Management Unit controls more than 70 percent of the land in the Lake Tahoe Basin. The LTBMU has begun a watershed restoration program and a land acquisition program to prevent development of sensitive private lands. Within the California side of this basin, the Lahontan Regional Water Quality Control Board has a major role in protecting Lake Tahoe, by actively monitoring and enforcing surface water quality for all uses and discharges. In recent years, federal and state agencies have increased funding to protect the environment of Lake Tahoe. Nevada approved a $20 million bond measure to perform erosion control and other measures on the east side of the lake. In California, Proposition 204 recently provided $10 million in bond funds for land acquisition and programs to control soil erosion, restore watersheds, and preserve environmentally sensitive lands.

On the Carson and Walker rivers, the California Department of Fish and Game is also concerned about maintaining instream flows and reservoir pools to restore and preserve the fishery. In conjunction with American Land Conservancy, a private land trust organization, DFG has been acquiring lands and water rights at Heenan Lake in the upper watershed of the East Fork of the Carson River. This small reservoir was originally built to supply irrigation water for Nevada, but it is now being used by DFG to raise Lahontan cutthroat trout to stock in other locations throughout the Sierra Nevada. Selected sections of the upper Carson River tributaries are managed by DFG as wild trout waters, where stocking of hatchery fish is not allowed. The goal of these efforts is to maintain and preserve the trout fishery in both the upper Carson and Walker rivers, which are recognized as some of the best trout fishing in the state.

Relationship with Other Regions

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. Most of the surplus flows from these three rivers also flow into Nevada, where it is used for a variety of purposes. There are two small historic exports of surface water out of the North Lahontan hydrologic region to the Sacramento River region. At Echo Lakes in the upper Lake Tahoe Basin, an average of about 2,000 acre-feet per year is exported through a tunnel into the south fork of the American River in conjunction with a hydroelectric power development that began in 1876. Another water export of about 6,000 acre-feet per year 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 region). Near the southern end of the North Lahontan region another small water diversion exists, providing surface water from the upper tributaries of the Walker River to the Mono Lake Basin for summer irrigation purposes.

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

Looking to the Future

The northern part of this hydrologic region contains portions of Modoc, Lassen and Sierra counties, in which no major changes in water use are anticipated in the near future. A small amount of agricultural expansion may be possible in areas that can support additional groundwater development. Likewise, the modest need for additional municipal and irrigation supplies can be met by some expansion of present surface systems or by increased use of groundwater.

Concern for protecting the limited groundwater resources of the region has led to establishment of formal groundwater management programs in the Honey Lake and Long Valley basins. In Modoc County, similar groundwater proposals are being considered for the Surprise Valley region. At present, neither the Honey Lake nor Long Valley groundwater management districts are active, but can be activated when needed. In the Lake Tahoe and Truckee River basins, the proposed Truckee River Operating Agreement (TROA) interstate allocation would also establish limits on groundwater procedures and withdrawal limits from these areas.

The interstate surface waters of the Truckee, Carson and Walker rivers are controlled by federal watermasters according to existing federal court decrees. Each of these legal decrees may be revised to some degree within the next decade, as a result of TROA implementation on the Truckee River and through mediation regarding the Walker River water uses. Since further water development in these basins may be limited, especially in Nevada, water transfers are expected to play an increasing role to meet changing and higher-priority needs. In Nevada, such water transfers have already occurred through the acquisition of agricultural lands and water rights which are then transferred to meet municipal needs in Reno/Sparks region.

Within the Placer and Nevada county portions of the North Lahontan region, several large residential and commercial developments are being proposed for the Truckee and Martis Valley regions. If these developments are completed, it is likely that significant new demands will be placed on the groundwater supplies and sewage disposal capabilities of this region.

Water Portfolios for Water Years 1998, 2000, and 2001

Water year 1998 was a wet year for this region, with annual precipitation at 142 percent of normal, while the statewide annual precipitation was 171 percent of average. Year 2000 represents approximately normal hydrologic conditions with annual precipitation at 89 percent of average for the North Lahontan region. 2001 reflected dry-water-year conditions with annual precipitation at 49 percent of average. For comparison, statewide average precipitation in year 2001 was 72 percent of normal. Table 9-1 provides more detailed information about the total water supplies available to this region for these three specific years from precipitation, imports and groundwater, and also summarizes the uses of all of the water supplies. The data in Table 9-1 shows that more water from these three interstate rivers flows into Nevada than is consumptively used in the North Lahontan region.

A more detailed tabulation of the dedicated portion of the total available water used for urban, agricultural and environmental purposes is presented in Table 9-2. Because most of the North Lahontan region is largely undeveloped, dedicated environmental water uses are a larger component of the total developed water uses in this region. Table 9-2 also provides detailed information about the sources of the developed water supplies, which are obtained from a mix of both surface water and groundwater supplies. The water portfolio tables at the end of this chapter summarize the detailed regional water accounting for all agricultural, urban and dedicated environmental water uses of the region. Graphical representations of the regions water supplies and uses are also presented in the water portfolio diagrams in Figures 9-4 and 9-5.

Selected References

2002 California 305(b) Report on Water Quality, State Water Resources Control Board

California's Groundwater Bulletin 118-03, Update 2003, California Department of Water Resources

Nonpoint Source Program Strategy and Implementation Plan, 1998-2013, State Water Resources Control Board, California Coastal Commission, January 2000

Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001

Truckee River Operation Agreement, Draft October 2003

Water Quality Control Plan, Regional Water Quality Control Board

Watershed Management Initiative Chapter, Regional Water Quality Control Board

Table 9-1 North Lahontan Hydrologic Region Water Balance Summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (142%)	2000 (89%)	2001 (49%)
Water Entering the Region			
Precipitation	10,655	6,708	3,756
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions	3	3	3
Total	**10,658**	**6,711**	**3,759**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	263	327	307
Outflow to Nevada	1,391	754	552
Exports to Other Regions	12	12	9
Statutory Required Outflow to Salt Sink	180	141	113
Additional Outflow to Salt Sink	83	92	92
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	8,572	5,493	3,223
Total	**10,501**	**6,819**	**4,296**
Storage Changes in the Region [+] Water added to storage [-] Water removed from storage			
Change in Surface Reservoir Storage	147	-66	-430
Change in Groundwater Storage **	10	-42	-107
Total	**157**	**-108**	**-537**
Applied Water * (compare with Consumptive Use)	432	524	490

***Footnote for applied water**

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

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

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

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

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

Table 9-2 North Lahontan Hydrologic Region Water Use and Distribution of Dedicated Supplies (TAF)

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	2.3			2.6			2.6		
Commercial	9.0			9.7			9.3		
Industrial	12.5			12.5			12.5		
Energy Production	0.0			0.0			0.0		
Residential - Interior	7.9			9.0			8.7		
Residential - Exterior	6.2			6.3			7.2		
Evapotranspiration of Applied Water		8.8	8.8		8.7	8.7		9.4	9.4
Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		14.9	14.9		16.1	16.1		16.5	16.5
Conveyance Losses - Applied Water	0.0			0.0			0.0		
Conveyance Losses - Evaporation		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**37.9**	**23.7**	**23.7**	**40.1**	**24.8**	**24.8**	**40.3**	**25.9**	**25.9**
Agriculture									
On-Farm Applied Water	375.1			462.4			428.4		
Evapotranspiration of Applied Water		241.1	241.1		301.3	301.3		281.1	281.1
Irrecoverable Losses		19.5	19.5		20.2	20.2		12.5	12.5
Outflow		66.8	66.8		75.8	75.8		74.7	74.7
Conveyance Losses - Applied Water	23.5			13.4			6.2		
Conveyance Losses - Evaporation		2.3	2.3		1.7	1.7		1.0	1.0
Conveyance Losses - Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Outflow		1.5	1.5		1.1	1.1		0.0	0.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**398.6**	**331.2**	**331.2**	**475.8**	**400.1**	**400.1**	**434.6**	**369.3**	**369.3**
Environmental									
Instream									
Applied Water	84.6			85.0			84.5		
Outflow		84.6	84.6		85.0	85.0		84.5	84.5
Wild & Scenic									
Applied Water	404.1			233.3			152.5		
Outflow		95.6	95.6		56.2	56.2		28.7	28.7
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	18.7			25.9			20.5		
Evapotranspiration of Applied Water		13.2	13.2		19.8	19.8		16.9	16.9
Irrecoverable Losses		0.2	0.2		0.3	0.3		0.2	0.2
Outflow		0.0	0.0		0.6	0.6		0.0	0.0
Conveyance Losses - Applied Water	0.0			0.0			0.0		
Conveyance Losses - Evaporation		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Irrecoverable Losses		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Losses - Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	18.7	13.4	13.4	25.9	20.7	20.7	20.5	17.1	17.1
Total Environmental Use	**507.4**	**193.6**	**193.6**	**344.2**	**161.9**	**161.9**	**257.5**	**130.3**	**130.3**
TOTAL USE AND LOSSES	**943.9**	**548.5**	**548.5**	**860.1**	**586.8**	**586.8**	**732.4**	**525.5**	**525.5**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	501.4	501.4	501.4	469.5	469.5	469.5	311.8	311.8	311.8
Local Imported Deliveries	0.3	0.3	0.3	0.3	0.3	0.3	3.3	3.3	3.3
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Federal Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWP Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	41.8	41.8	41.8	112.0	112.0	112.0	189.6	189.6	189.6
Artificial Recharge	0.0			0.0			0.0		
Deep Percolation	46.7			49.6			45.3		
Reuse/Recycle									
Reuse Surface Water	348.7			223.7			161.6		
Recycled Water	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
TOTAL SUPPLIES	**943.9**	**548.5**	**548.5**	**860.1**	**586.8**	**586.8**	**716.6**	**509.7**	**509.7**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***-15.8***	***-15.8***	***-15.8***

Water Portfolios

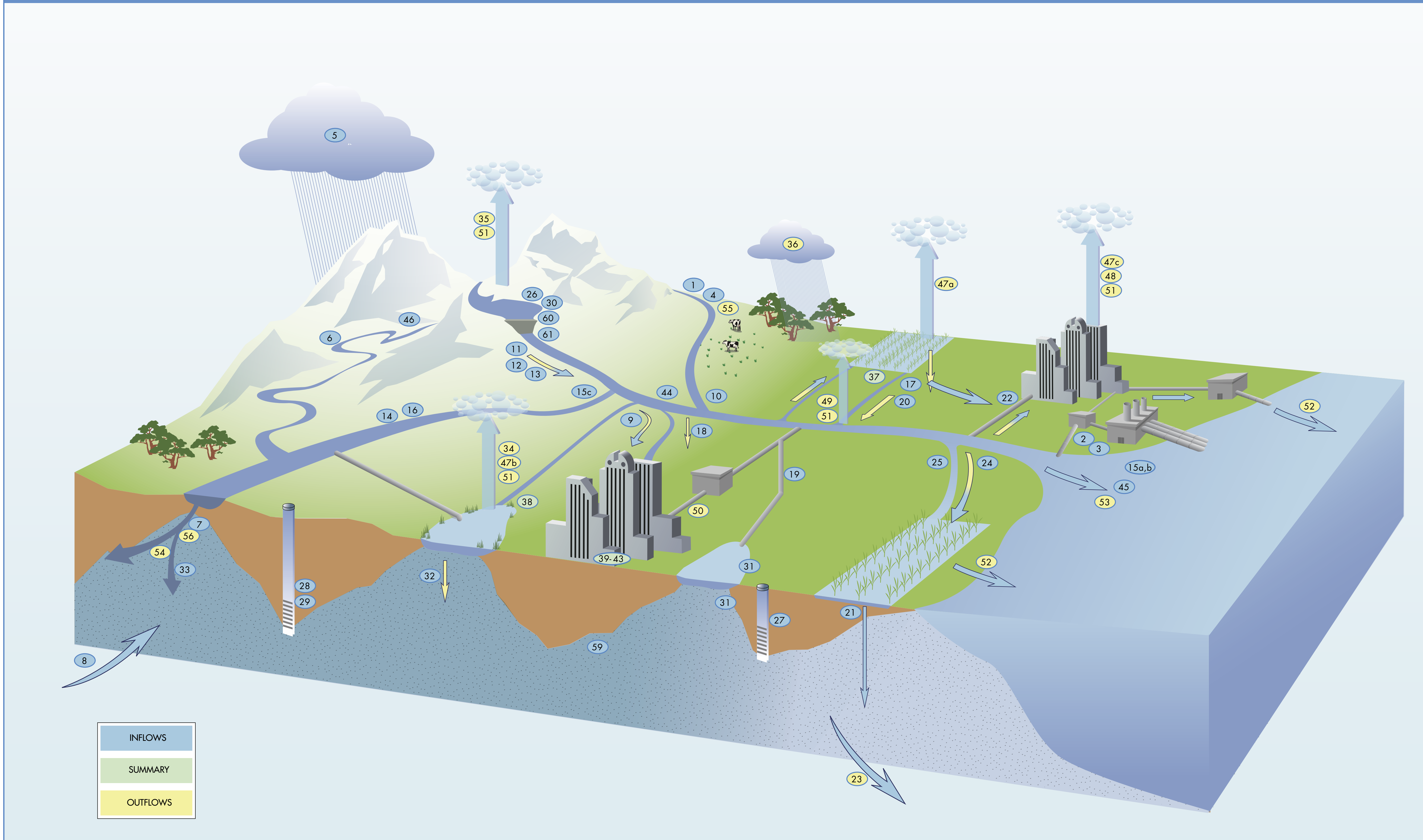
North Lahontan Hydrologic Region

Table 9-3 North Lahontan region water portfolio (TAF)

ID Number:	Flow Diagram Component (see legend)	North Lahontan 1998	North Lahontan 2000	North Lahontan 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	10,654.6	6,708.3	3,755.9
6a	Runoff - Natural	N/A	N/A	N/A
b	Runoff - Incidental	N/A	N/A	N/A
7	Total Groundwater Natural Recharge	N/A	N/A	N/A
8	Groundwater Subsurface Inflow			N/A
9	Local Deliveries	501.1	464.6	381.9
10	Local Imports	0.3	0.3	0.3
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	-	-	-
12	Other Federal Deliveries	-	-	-
13	State Water Project Deliveries	-	-	-
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	84.6	85.0	84.5
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	5.8	3.6	2.1
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	5.0	5.0	5.0
b	Recycled Water - Urban	-	-	-
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	-	-	-
b	Return Flow to Developed Supply - Wetlands	-	-	-
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	19.8	28.9	29.3
b	Deep Percolation of Applied Water - Wetlands	0.3	0.4	0.3
c	Deep Percolation of Applied Water - Urban	12.8	13.3	12.6
22a	Reuse of Return Flows within Region - Ag	27.9	36.2	30.8
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	313.5	181.9	126.9
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	-	-	-
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions		N/A	N/A
26	Surface Water in Storage - Beg of Yr	853.2	903.5	837.6
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	88.8	162.0	183.8
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	1,000.0	837.6	407.8
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation	N/A	N/A	N/A
b	Evaporation and Evapotranspiration from Unirrigated Ag	N/A	N/A	N/A
35a	Evaporation from Lakes	294.6	313.6	317.6
b	Evaporation from Reservoirs	175.5	213.7	267.6
36	Ag Effective Precipitation on Irrigated Lands	62.6	32.5	12.2
37	Agricultural Water Use	374.8	457.6	428.4
38	Managed Wetlands Water Use	18.7	25.9	20.5
39a	Urban Residential Use - Single Family - Interior	3.2	4.3	3.6
b	Urban Residential Use - Single Family - Exterior	5.2	5.0	5.8
c	Urban Residential Use - Multi-family - Interior	4.0	4.3	4.6
d	Urban Residential Use - Multi-family - Exterior	1.0	1.1	1.2
40	Urban Commercial Use	8.3	9.0	8.5
41	Urban Industrial Use	14.3	14.3	14.4
42	Urban Large Landscape	2.2	2.4	2.5
43	Urban Energy Production	-	-	-
44	Instream Flow	84.6	85	84.5
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	95.6	56.2	28.7
47a	Evapotranspiration of Applied Water - Ag	241.1	298.2	281.1
b	Evapotranspiration of Applied Water - Managed Wetlands	13.2	19.8	16.9
c	Evapotranspiration of Applied Water - Urban	8.6	8.5	9.2
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	19.5	20.2	12.5
50	Urban Waste Water Produced	25.1	27	27.1
51a	Conveyance Evaporation and Evapotranspiration - Urban	-	-	-
b	Conveyance Evaporation and Evapotranspiration - Ag	2.3	1.7	1
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	0.2	0.3	0.2
d	Conveyance Outflow to Mexico	N/A		
52a	Return Flows to Salt Sink - Ag	68	75.2	74.7
b	Return Flows to Salt Sink - Urban	15.3	16.6	16.9
c	Return Flows to Salt Sink - Wetlands	-	0.6	-
53	Remaining Natural Runoff - Flows to Salt Sink	180.2	141.2	113.2
54a	Outflow to Nevada	1390.6	753.9	551.9
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	3.0	3.3	3.3
56	Regional Exports	11.9	11.8	10
59	Groundwater Net Change in Storage	9.8	-41.5	-107.2
60	Surface Water Net Change in Storage	146.8	-65.9	-429.8
61	Surface Water Total Available Storage	1,181.2	1,181.2	1,181.2

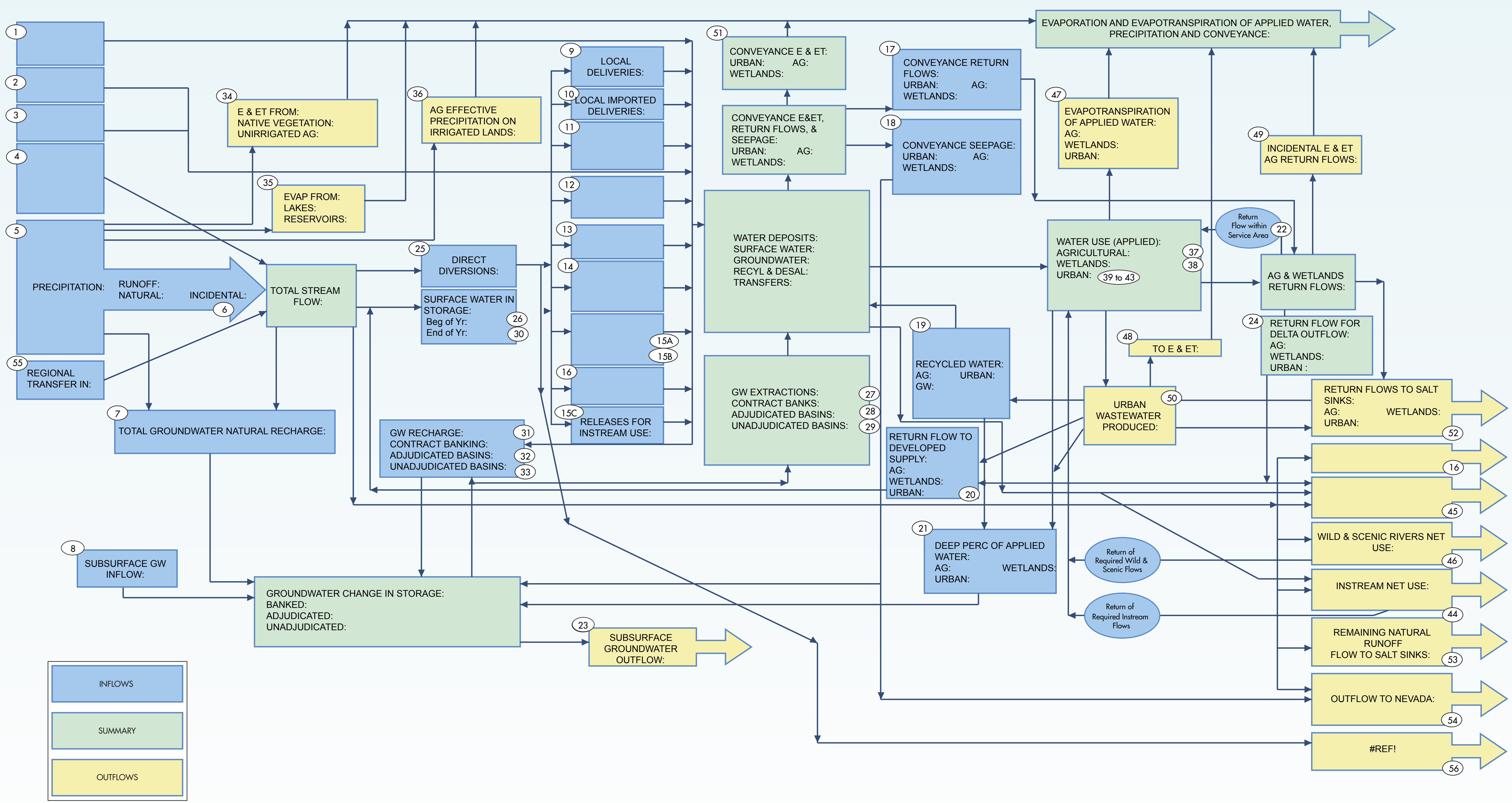
Legend: Inflows (blue) · Outflows (yellow) · Green number signifies included in summary boxes

Figure 9-4 North Lahontan region - illustrated water flow diagram

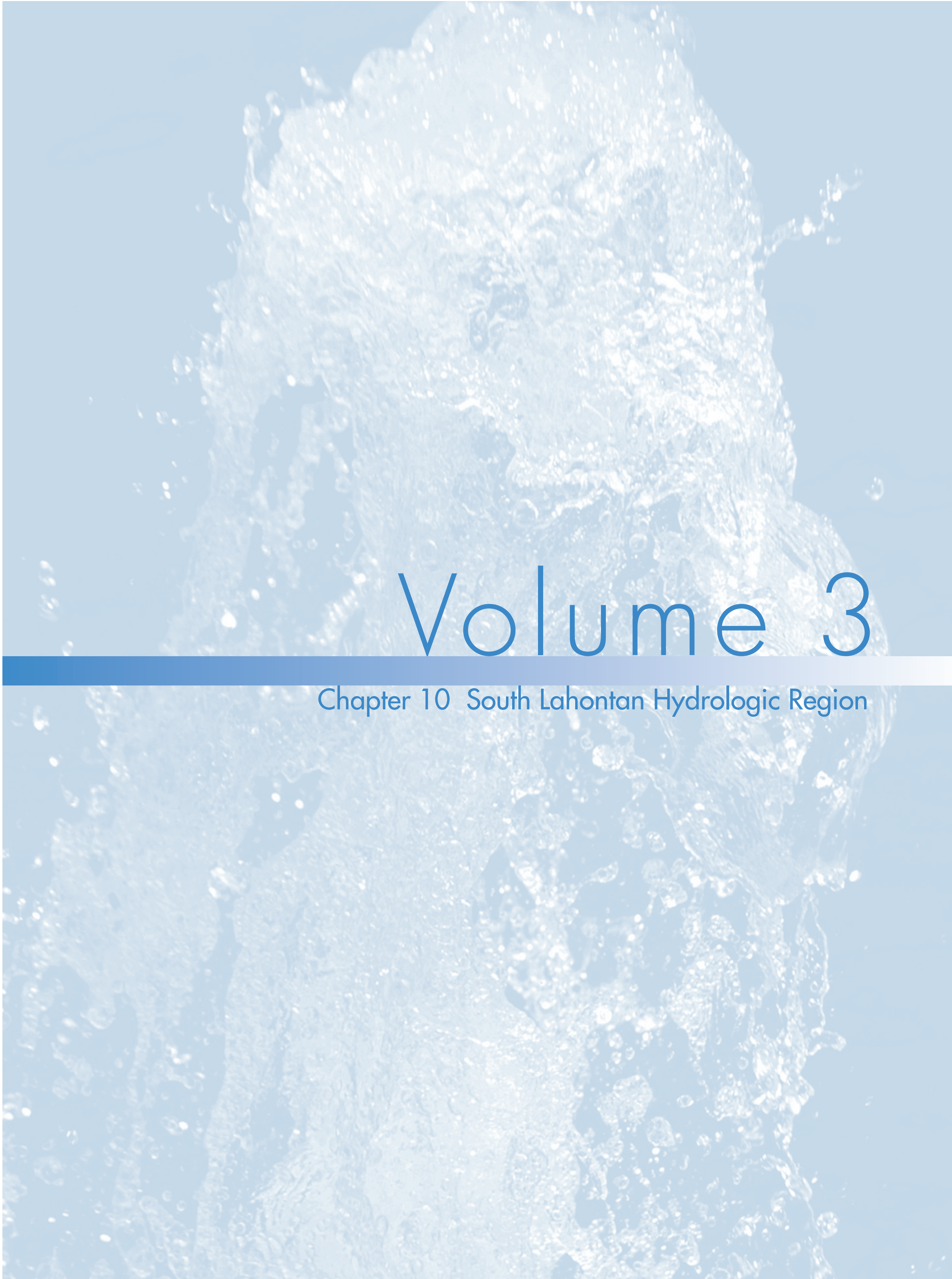


In this illustration of Table 9-3, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 9-5 North Lahontan region - schematic flow diagram



In schematic of Table 9-3, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether the component is water input, output or summary. Blank boxes are flow diagram components not relevant to the region.



Volume 3

Chapter 10 South Lahontan Hydrologic Region

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Figure10-1 South Lahontan Hydrologic Region

Some Statistics

- Area -26,732 square miles (16.9% of State)
- Average annual precipitation - 7.8 inches
- Year 2000 population - 721,490
- 2030 population projection - 1,266,375
- Total reservoir storage capacity - 459 TAF
- 2000 irrigated crop area - 65,080 acres

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

Chapter 10 *South Lahontan Hydrologic Region*

Setting

Although the South Lahontan hydrologic region brings to mind images of desert with Joshua trees, sand dunes, and dry lakes, it also contains the glacier-carved topography of the eastern slopes of the Sierra Nevada and the eastern slopes of the San Gabriel and San Bernardino mountains. The northern half of the region includes Mono Lake, Owens Valley, Panamint Valley, Death Valley, and the Amargosa River Valley. The Mojave Desert occupies the southern half of the region, and is characterized by many small mountain ranges and valleys with playas, or dry lakes. The region has the highest and lowest elevation points in the continental United States: Mount Whitney with an elevation of 14,495 feet and Death Valley at 282 feet below sea level. The region includes all of Inyo County and parts of Mono, San Bernardino, Kern, and Los Angeles counties (Figure 10-1).`

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

Climate

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

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

Box 10-1 Death Valley Temperatures

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

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

Population

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

Land Use

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

Water Supply and Use

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

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

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

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

***Footnote for applied water**

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

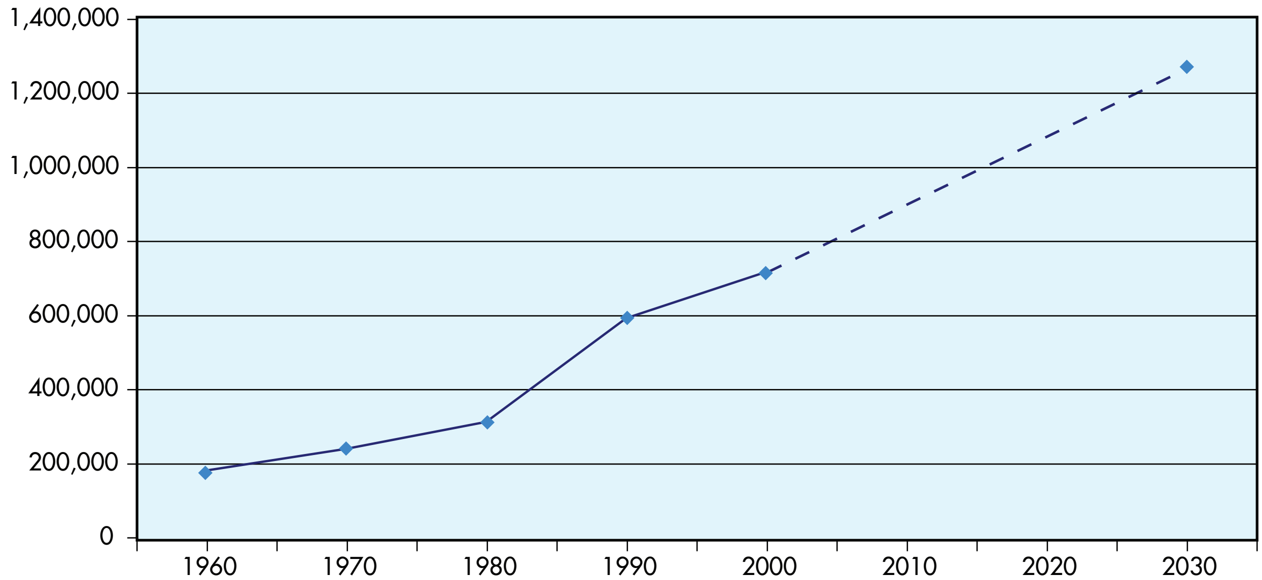
****Footnote for change in Groundwater Storage**

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

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

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

Figure 10-2 South Lahontan Hydrologic Region population



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

north into the Mono Basin in 1940 and additional water was diverted. A second, 137-mile-long pipeline was completed in 1970. More recently, exports have been modified and reduced as a result of litigation to preserve Mono Lake and to mitigate the dust problems that resulted from the diversion of water from Owens Lake.

There are eight small reservoirs in the Los Angeles Aqueduct system with a combined storage capacity of about 323,000 acre-feet. These reservoirs were built to store and regulate flows in the aqueduct. The northernmost reservoir is Grant Lake in Mono County. Six of the eight reservoirs are in the South Lahontan region. Bouquet and Los Angeles Reservoirs are in the South Coast region. Water from the aqueduct system passes through 12 hydropower plants on its way to Los Angeles. The annual energy generated is more than 1 billion kilowatt-hours, enough to supply the needs of 220,000 homes.

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

Groundwater provides about 41 percent of the average annual water supply in the region. Groundwater is used conjunctively with surface water in the more heavily pumped basins. Seventy-six groundwater basins underlie about 55 percent of this hydrologic region. The total estimated demand met by groundwater in the region is about 239,000 acre-feet, according to the 2003 update of DWR Bulletin 118 California's Groundwater. Most of the groundwater production is concentrated, along with the population, in basins in the southern and western parts of this hydrologic region. Many other areas of this hydrologic region are designated as public land and have low population density. As such, many of the groundwater basins have not been significantly used, and there is thus little data available about groundwater volume and quality.

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

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

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

The 2,700 acre-feet capacity Littlerock Reservoir provides water to Littlerock Creek Irrigation District and to Palmdale Water District (PWD). PWD recently funded most of a seismic rehabilitation of the original dam (constructed in 1924) in exchange for control of the water supply for the next 50 years. Water from Littlerock Reservoir is released into a canal that conveys flows to PWD's Lake Palmdale, a 42,000 acre-foot storage reservoir.

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

In the northern part of the South Lahontan region, the town of Mammoth Lakes provides water from surface and groundwater sources to a permanent population of about 5,000, an average daily population of about 13,000, and a peak weekend and holiday period population of up to 30,000 people per day. In communities that are popular tourist destinations, this pattern of peak population and water use that is several times the permanent base level is a common water supply and distribution problem.

Most of the quantified environmental water demands (listed in Table 10-3) are in the northern part of this hydrologic region, and involve the restoration of the water surface elevation for Mono Lake. The required inflows are the result of several years of court litigation, and have resulted in improving water surface elevations in recent years. Another identified environmental water demand involves current and proposed, releases into the Owens River to restore flows that were previously intercepted for use in Los Angeles after 1913, and for use in restoring surface water to Owens Lake.

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

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

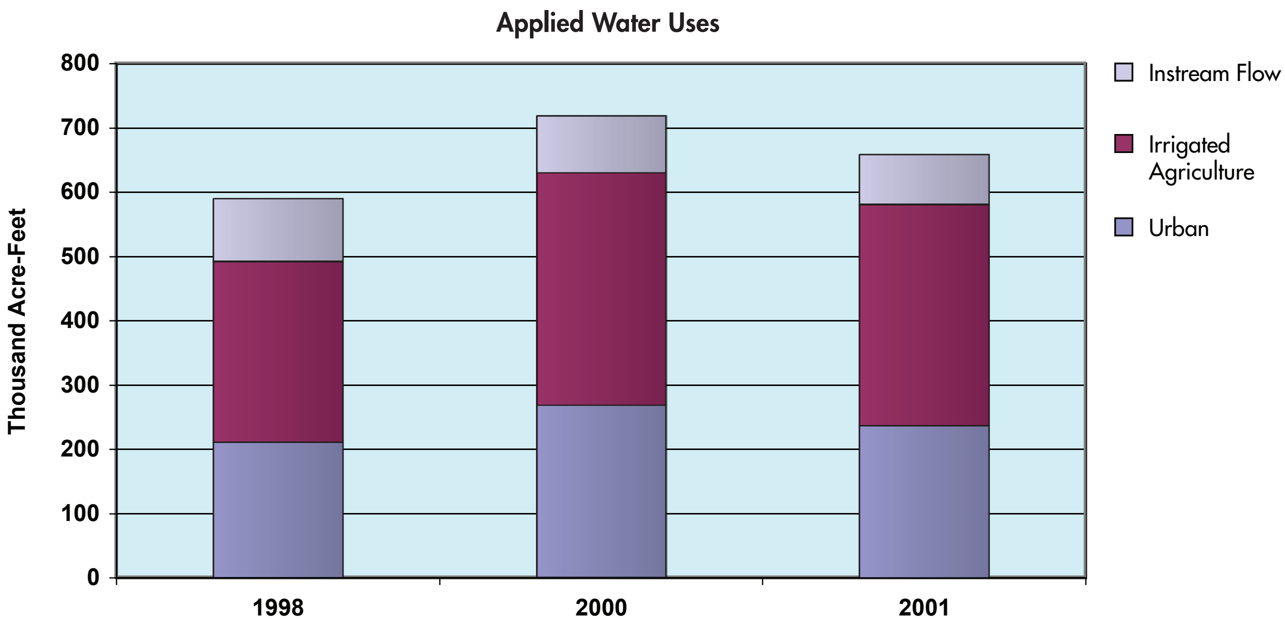
State of the Region

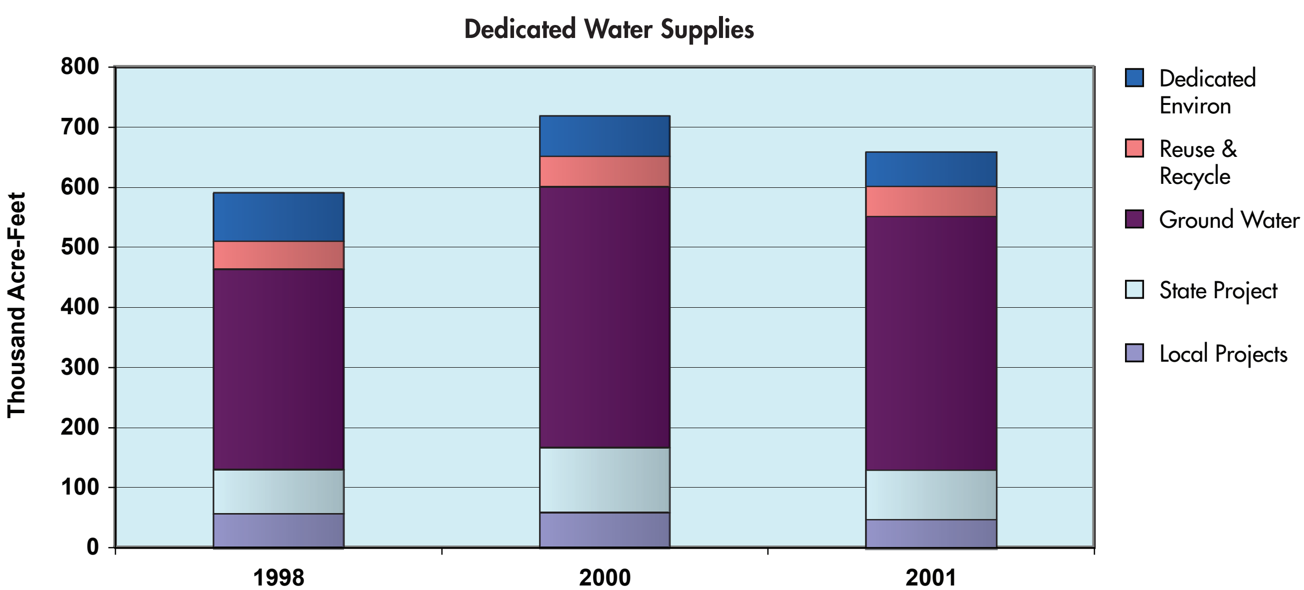
Challenges

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

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

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





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

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

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

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

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

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

Accomplishments

The region has developed solutions to two major water issues during the past 10 years, which are the overuse of the Mojave River Valley groundwater basin and changes to water diversions from the Owens River/Mono Basin by the city of Los Angeles. The Mojave River groundwater basin was in overdraft since the early 1950s, which led to court adjudication in 1996 and the appointment of the Mojave Water Agency as the basin watermaster (see Box 3-2). The Los Angeles Department of Water and Power is involved with many restoration projects for the Owens River and Mono Basin. In 1993, LADWP began final flow releases to restore Mono Lake to a water surface elevation of 6,392 feet. By 2003, Mono Lake elevation had reached 6,382, a level where LADWP can export 16,000 acre-feet per year. LADWP has developed plans to help ranchers manage grazing practices in the Crowley Lake tributary area. The Owens Gorge Rewatering Project and the Lower Owens River Project are two other significant restoration programs being implemented by LADWP to restore the river after 50 years of dewatering.

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

Mojave Water Agency has entered into a creative multiyear groundwater banking and exchange agreement with the Solano County Water Agency in northern California. During any wet year, SCWA can bank up to 10,000 acre-feet of its annual SWP water in MWA's groundwater basin, not to exceed a total balance of 20,000 acre-feet. During droughts, SCWA can take part of MWA's SWP water by exchange, using the North Bay Aqueduct to divert the water from the Sacramento-San Joaquin Delta. MWA has developed the ability to store more imported supplies in the Mojave River Basin at MWA's Rock Springs groundwater recharge facility and is considering more recharge facilities in other areas. Several other districts are also studying potential groundwater recharge and exchange projects. Funds from loan and grant programs, especially for drought relief, will play an important role in the continued development of water projects for this region.

Relationship with Other Regions

While most of Mojave Water Agency's service area is in the South Lahontan region, a portion of its service area does extend into the Colorado River Hydrologic Region (Lucerne and Johnson valleys and the Morongo Basin). This includes the community of Yucca Valley, which has an allocation for up to 7,200 acre-feet of MWA's surface water from the SWP.

As described in previous sections, imported State Water Project water is used to recharge groundwater supplies in the Mojave River Valley basins. Some of these surface water and groundwater supplies are also exported from the Owens and Mono portions of South Lahontan Hydrologic Region to the South Coast Hydrologic Region by the Los Angeles Department of Water and Power, using the Los Angeles Aqueduct. Recent exports through these facilities to the South Coast region were 442,000 acre-feet in 1998, 294,000 acre-feet in year 2000, and 272,000 acre-feet in 2001.

Looking to the Future

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

Regional Planning

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

Box 10-2 Mojave River Adjudication

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

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

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

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

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

The Antelope Valley Water Group (AVWG) was formed in 1991 to provide coordination among valley water agencies and other planning groups. AVWG members include the cities of Palmdale and Lancaster, Edwards Air Force Base, AVEK, Antelope Valley United Water Purveyors Association, Los Angeles County Waterworks Districts, PWD, Rosamond Community Services District, and Los Angeles County. AVWG then completed the Antelope Valley Water Resource Study in 1995 to address regional water management issues. That study evaluated the valley's existing and future water supplies from groundwater, the SWP, Littlerock Reservoir, and recycling, and then compared those supplies with projected water demands. The study concluded that there is a low level of water supply reliability in the study area, and concluded that full 1998 water demands could only be met half of the time without overdrafting groundwater resources. The report recommended water conservation, recycling, and conjunctive use as strategies to reduce expected water shortages, and identified three potential sites (two on Amargosa Creek and one on Littlerock Creek) with high potential as groundwater recharge spreading ponds. The study also identified several potential groundwater injection sites within existing Los Angeles County Waterworks and PWD municipal well fields, and treated SWP water was identified as a potential recharge source. AVWG agencies are now developing individual programs and projects based on the recommendations from that 1995 water resource study.

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

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

In 2002, the Quartz Hill Water District constructed six wells in order to develop the capability to participate in future conjunctive use projects. Only four of these wells were equipped with groundwater pumps because the water yield from the other two wells was too small. Quartz Hill WD is also planning to add groundwater injection equipment to some of it's wells, so that recharge of the groundwater basin can occur whenever surplus SWP water supplies are available.

Water Portfolios for Water Years 1998, 2000, and 2001

Water Year 1998

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

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

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

In 1998 about 442,000 acre-feet of surface water was exported from this region to the South Coast through the Los Angeles Aqueduct, as a result of the wet winter and abundant water supplies. SWP water deliveries into the South Lahontan region were 73,000 acre-feet from the California Aqueduct. An additional 844,000 acre-feet of SWP surface water flowed through this region in the California Aqueduct, passing from the Tulare Lake region for deliveries to the South Coast region. These regional imports and exports are summarizedon the regional map in Figure 10-1.

Water Year 2000

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

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

Water Year 2001

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

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

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

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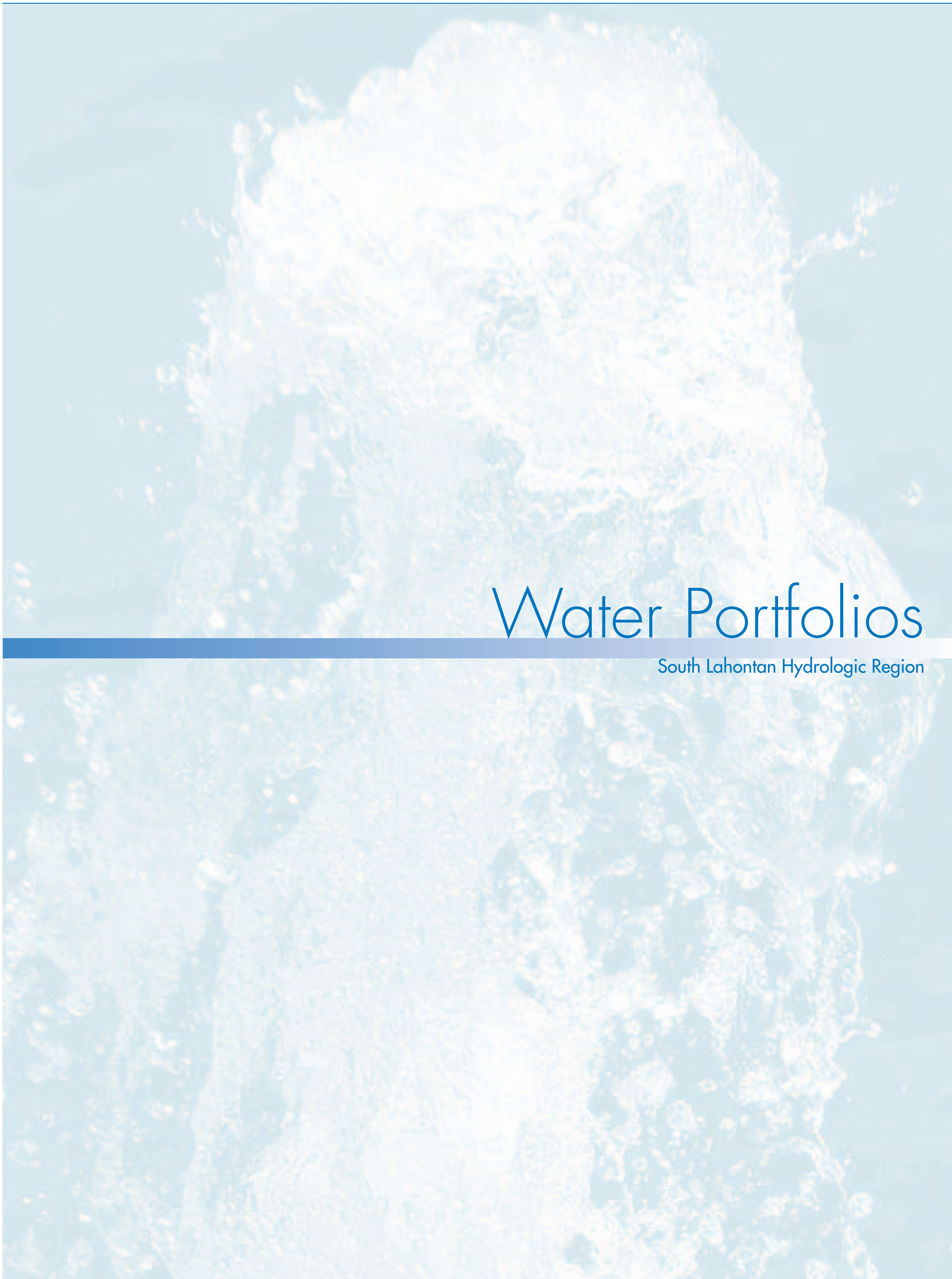


Water Portfolios

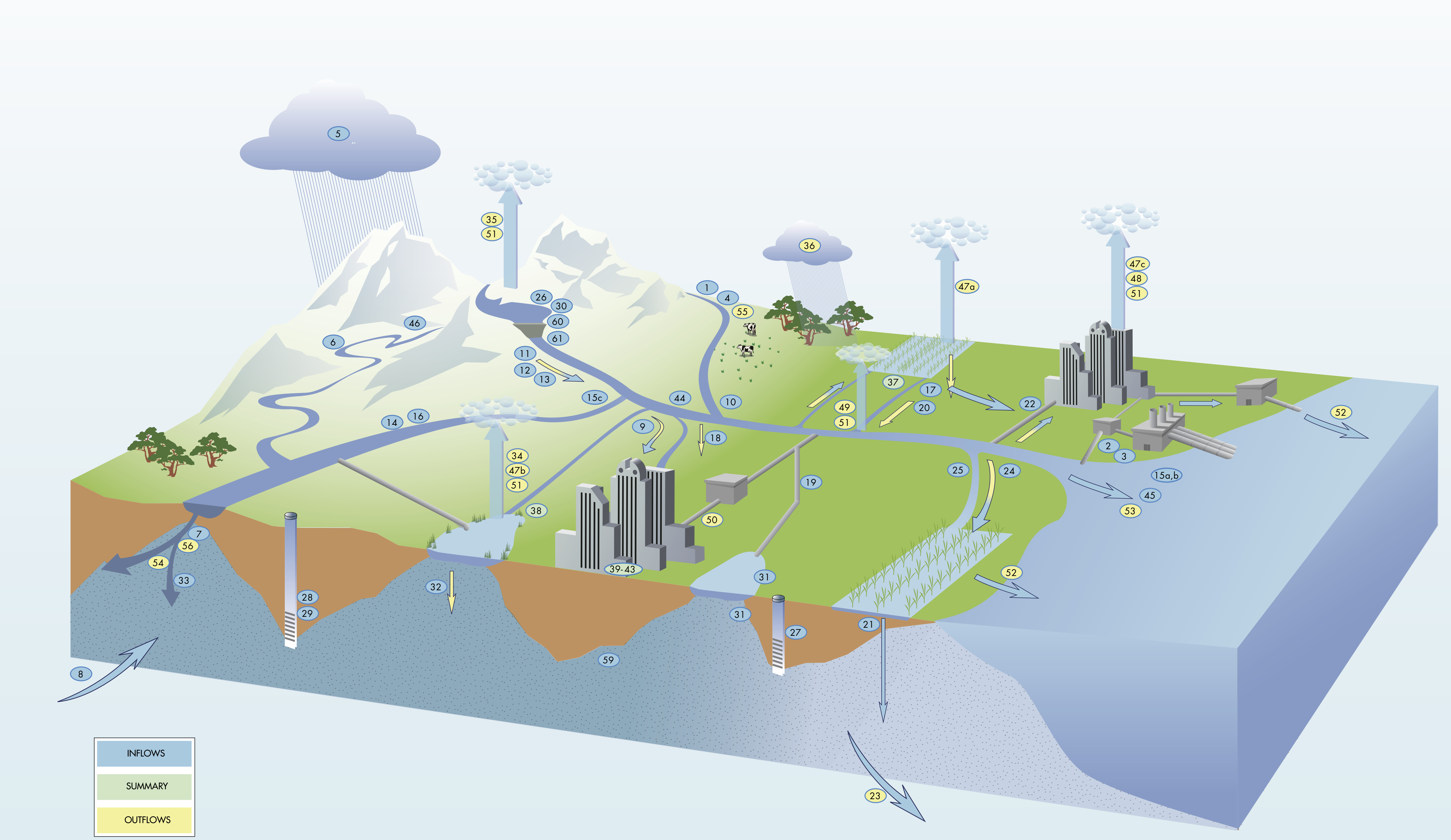
South Lahontan Hydrologic Region

Table 10-3 South Lahontan region water portfolio (TAF)

ID Number:	Flow Diagram Component (see legend)	South Lahontan 1998	South Lahontan 2000	South Lahontan 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	20,409.3	7,476.1	9,740.9
6a	Runoff - Natural			
b	Runoff - Incidental			
7	Total Groundwater Natural Recharge			
8	Groundwater Subsurface Inflow			N/A
9	Local Deliveries	56.6	58.1	46.8
10	Local Imports	-	-	-
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	-	-	-
12	Other Federal Deliveries	-	-	-
13	State Water Project Deliveries	73.1	108.0	81.9
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	98.4	88.8	78.4
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	-	-	-
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	-	-	-
b	Recycled Water - Urban	28.0	29.0	29.5
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	-	-	-
b	Return Flow to Developed Supply - Wetlands	-	-	-
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	35.4	44.2	42.1
b	Deep Percolation of Applied Water - Wetlands	-	-	-
c	Deep Percolation of Applied Water - Urban	66.1	83.5	75.6
22a	Reuse of Return Flows within Region - Ag	-	-	-
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	18.6	21.4	20.6
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	-	-	-
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions			
26	Surface Water in Storage - Beg of Yr	329.4	326.2	317.8
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	61.8	61.8	61.8
29	Groundwater Extractions - Unadjudicated	272.3	372.9	360.5
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	401.5	317.8	316.5
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation			
b	Evaporation and Evapotranspiration from Unirrigated Ag			
35a	Evaporation from Lakes	162.4	163.7	163.4
b	Evaporation from Reservoirs	45.1	45.1	42.1
36	Ag Effective Precipitation on Irrigated Lands	33.5	9.9	7.2
37	Agricultural Water Use	280.6	361.0	344.0
38	Managed Wetlands Water Use	-	-	-
39a	Urban Residential Use - Single Family - Interior	74.5	109.0	100.8
b	Urban Residential Use - Single Family - Exterior	55.8	68.6	68.4
c	Urban Residential Use - Multi-family - Interior	11.9	28.0	12.7
d	Urban Residential Use - Multi-family - Exterior	7.1	8.6	6.9
40	Urban Commercial Use	27.8	19.0	20.1
41	Urban Industrial Use	8.1	4.7	5.6
42	Urban Large Landscape	8.4	6.6	5.3
43	Urban Energy Production	6.3	6.3	6.3
44	Instream Flow	79.8	67.4	57.8
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	-	-	-
47a	Evapotranspiration of Applied Water - Ag	187.8	237.7	235
b	Evapotranspiration of Applied Water - Managed Wetlands	-	-	-
c	Evapotranspiration of Applied Water - Urban	71.282	83.791	80.591
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	5.7	7.3	6.7
50	Urban Waste Water Produced	29.34	36.14	33.34
51a	Conveyance Evaporation and Evapotranspiration - Urban	8.51	10.6	8.81
b	Conveyance Evaporation and Evapotranspiration - Ag	-	-	-
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	-	-	-
d	Conveyance Outflow to Mexico			
52a	Return Flows to Salt Sink - Ag	51.7	65.4	60
b	Return Flows to Salt Sink - Urban	58.89	84.41	66.1
c	Return Flows to Salt Sink - Wetlands	-	-	-
53	Remaining Natural Runoff - Flows to Salt Sink	79.8	67.4	57.8
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	917.7	1,509.7	1,065.7
56	Regional Exports	1286	1695.0	1255
59	Groundwater Net Change in Storage	-226.2	-294.1	-299.0
60	Surface Water Net Change in Storage	72.1	-8.4	-1.3
61	Surface Water Total Available Storage	458.9	458.9	458.9

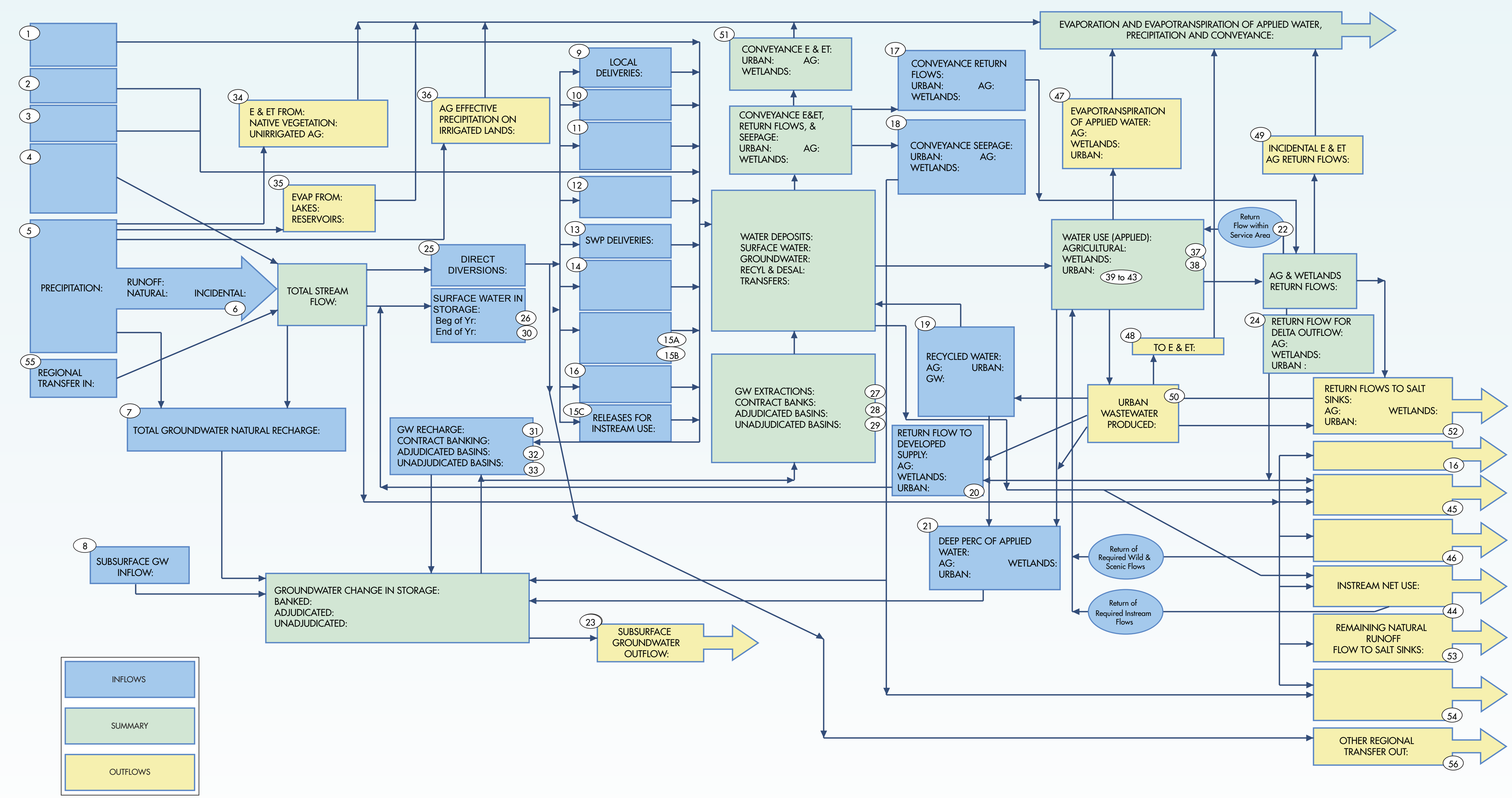
Legend: Inflows (blue) | Outflows (yellow) | Green number signifies included in summary boxes

Figure 10-4 South Lahontan region - illustrated water flow diagram

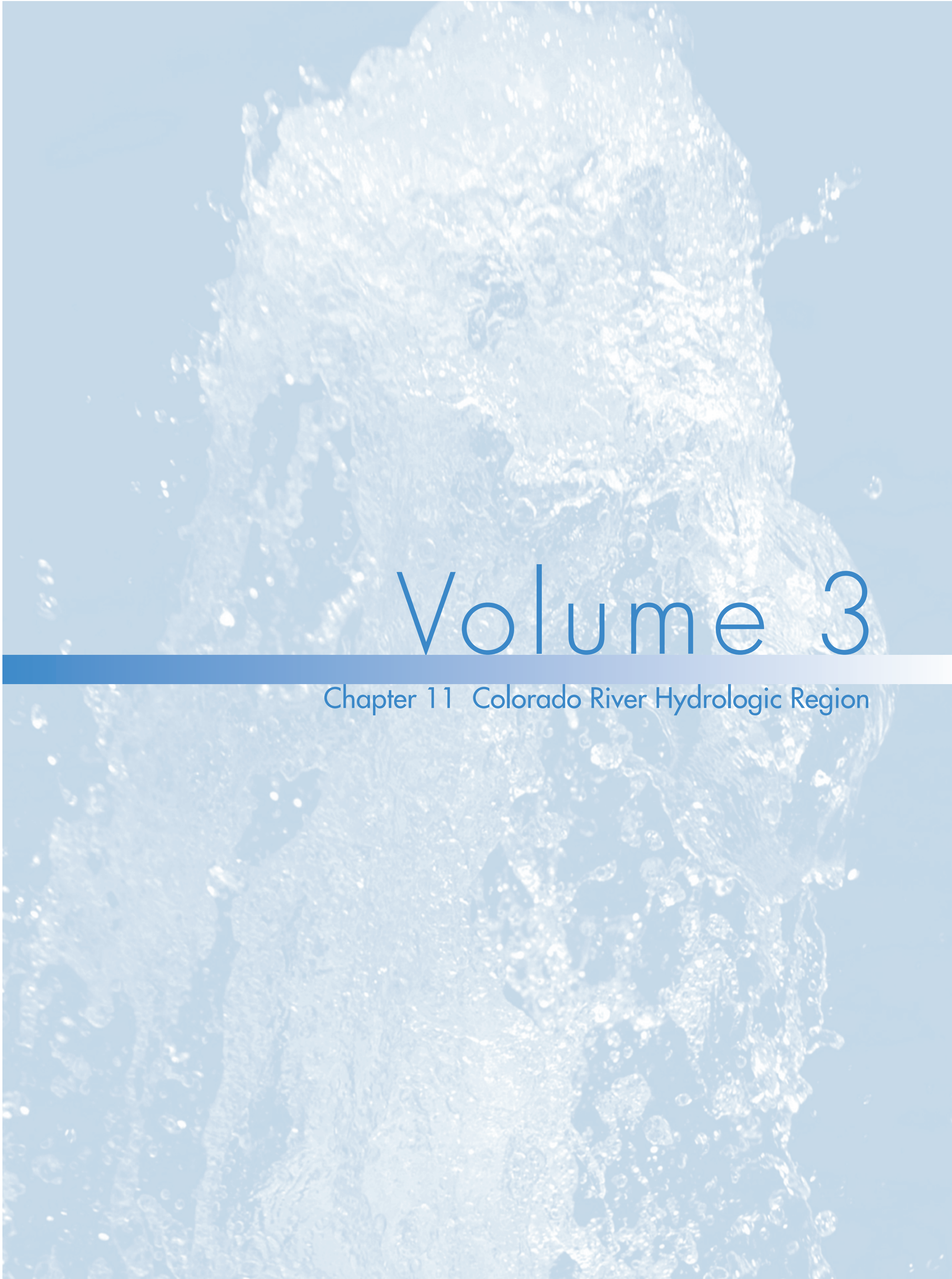


In this illustration of Table 10-3, key components of the flow diagram are illustrated as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 10-5 South Lahontan region - schematic flow diagram



In schematic of Table 10-3, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether the component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.



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Chapter 11 Colorado River Hydrologic Region

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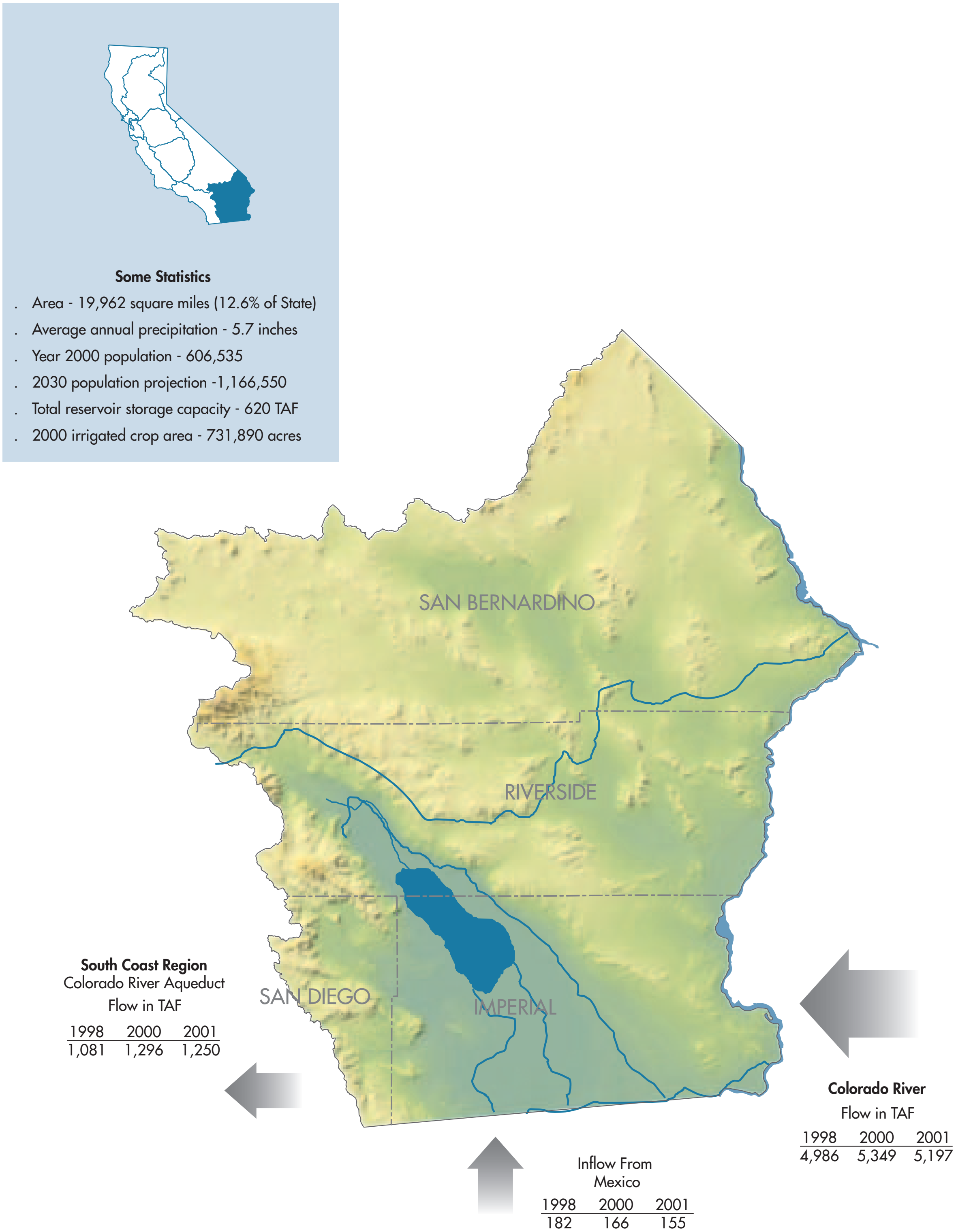
Figure 11-1 Colorado River Hydrologic Region



The Colorado River Hydrologic Region is in the southeastern corner of California and includes the Imperial and Coachella valleys, known for year-round agricultural production. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

Chapter 11 *Colorado River Hydrologic Region*

Setting

The Colorado River hydrologic region covers the southeast portion of California and contains 12 percent of the state's land area. The Colorado River forms most of the region's eastern boundary and the international boundary with Mexico forms its southern boundary (Figure 11-1 is a map and table of statistics that describe this region). The region includes all of Imperial County, about the eastern one-fourth of San Diego County, the eastern two-thirds of Riverside County, and the southeastern one-third of San Bernardino County. It has a variety of arid desert terrain that includes many bowl-shaped valleys, broad alluvial fans, sandy washes, and hills and mountains.

The Colorado River region includes a large portion of the Mojave Desert, primarily in that part of the region in San Bernardino County and eastern Riverside County. The area to the east and south of the Mojave Desert is a portion of the Sonoran Desert. Elevations in the region generally range from 1,000 to 3,000 feet in the Mojave Desert, to less than 1,000 feet along the Colorado River. The lowest areas in this region are more than 200 feet below mean sea level in the Coachella and Imperial Valleys. Mountain peaks attain elevations of 6,000 to 7,000 feet. Many of these arid valleys contain playas (dry lake beds), some of which are quite large. Bristol Dry Lake, near the Mojave National Preserve, is a playa that covers more than 50 square miles.

Climate

Nearly all of the Colorado River region has a subtropical desert climate with hot summers and generally mild winters. Average annual rainfall is very low and precipitation ranges between 3 to 6 inches per year, most of which occurs in the winter months. However, summer storms do occur and can generate significant rainfall in some years. Clear and sunny conditions typically prevail, and the region receives from 85 to 90 percent of the maximum possible sunshine each year, the highest value in the United States. Winter maximum temperatures are mild, but summer conditions are generally very hot, with more than 100 days with temperatures of over 100 degrees Fahrenheit each year in the Imperial Valley.

Population

In 2000, the population for the region was about 606,000, which represented an increase of 31 percent from the 1990 population. More than half of the region's population resides in the Coachella Valley, where significant urbanization has occurred. Most of the remaining population is in the Imperial Valley and in the corridor between the cities of Yucca Valley and Twenty-nine Palms along Highway 62. From 2000 to 2030, the California Department of Finance projects that the regional population will almost double to 1,166,550 people. Figure 11-2 provides a graphical depiction of the Colorado River region's total population from 1960 through 2000, with projections to 2030.

Land Use

The region is a land of unequalled agricultural bounty with a growing urban sector, and large expanses of open, wild terrain. The U.S. Bureau of Land Management (BLM) administers a large portion of the region's land, but many other entities also oversee significant areas. (See Box 11-1 for acronyms used in this chapter.)

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

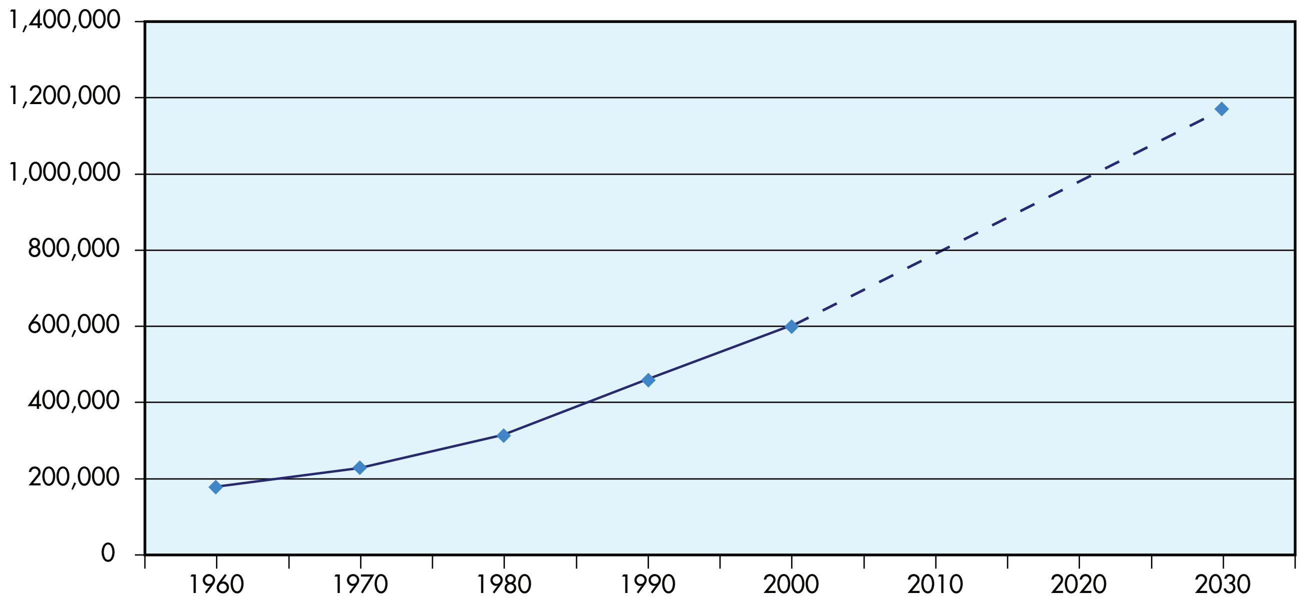
Despite its arid conditions, the region produces more than $1.5 billion of agricultural commodities annually. The largest water body in the Colorado River region is the Salton Sea (in photo background), a saline body of water about 50 feet deep. (DWR photo)

Despite the arid conditions, significant areas of agricultural and urban land use exist in the region. Agriculture is the most prominent land use, with more than $1.5 billion of agricultural commodities produced in the region each year. Over 600,000 acres of land are farmed each year. The largest agricultural area occurs in the Imperial Valley where over 450,000 acres of land are farmed annually. More than 93,000 acres are farmed in the Palo Verde Valley, followed by 60,000 acres in the Coachella Valley. Smaller, but equally important agricultural operations also exist in the Bard and Mojave valleys.

Box 11-1 Acronyms Used in the Colorado River Regional Report

BWD	Bard Water District
CVWD	Coachella Valley Water District
DFG	California Department of Fish and Game
DWA	Desert Water Agency
DWR	California Department of Water Resources
IID	Imperial Irrigation District
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
maf	million acre-feet
MWD	Metropolitan Water District of Southern California
PVID	Palo Verde Irrigation District
QSA	Quantification Settlement Agreement of 2003
SGPWA	San Gorgonio Pass Water Agency
SDCWA	San Diego County Water Authority
SSAM	Salton Sea Accounting Model
SWP	State Water Project
USBR	US Bureau of Reclamation
USFS	US Fish and Wildlife Service

Figure 11-2 Colorado River Hydrologic Region population



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

A wide variety of crops are planted and harvested in the region, some of which are grown only during specific times of the year. In terms of acres, alfalfa is the leading crop produced in the Colorado River region. Almost 250,000 acres were grown in 2000, of which 180,000 acres were in the Imperial Valley. Although constrained by summer climate, winter and spring vegetables, which include carrots, broccoli, lettuce, onions, and melons, rank second in overall acres. Of the 150,000 acres harvested, almost 100,000 acres of the vegetables harvested in 2000 came from the Imperial Valley.

The Coachella and Bard valleys are noteworthy for citrus and subtropical fruit production, especially dates. The table grape industry is also well established in the Coachella Valley.

The cattle industry in the Imperial Valley is extremely important to the region's $1 billion per year agricultural production. In 2001, the cattle industry, with a value of $243 million, ranked as the third highest-value commodity produced in the Imperial Valley. Vegetable and melon crops were ranked first with a value of $403 million, while field crops were the second-ranked commodity worth $285 million.

Other important crops grown in the Colorado River region include wheat, sugar beets, and Sudan grass. Although less cotton is grown now than at its peak in the early 1980s, some cotton is still grown, mostly in the Palo Verde Valley.

Multiple-cropping is the prevalent agricultural practice in the Imperial, Palo Verde, Coachella, and Bard valleys. During 2000, it was estimated that over 100,000 acres were double-cropped in the region.

Urban land uses and acreage are expanding, and co-exist with agriculture in the region. In the northern Coachella Valley, urbanization continues to expand between the Cities of Palm Springs and Indio. Other growing cities in the Coachella Valley include Palm Desert, Rancho Mirage, and La Quinta. This corridor is characterized by the presence of numerous extensively landscaped residential developments, expansion of local business and consumer service centers, construction of luxury hotels and resort properties, and the operation of over 100 private and public golf courses. Upscale commercial and residential expansion, which has been under way for several decades, is continuing at a robust pace. This expansion supports the region's recreation and tourism industry and its growing number of wealthy retirees and part-time residents.

Although smaller in scale, the region's urban areas in the corridor between the cities of El Centro and Imperial and around the city of Calexico have also been expanding. Business and consumer services there support the population of the Imperial Valley and the neighboring Mexicali Valley. In 2001 a third port of entry across the border with Mexico opened, which generates increased traffic resulting from NAFTA-related business activity.

In the Imperial and Palo Verde valleys and the southern one-half of the Coachella Valley, small to moderately sized cities and communities provide support for the surrounding agricultural and non-agricultural activities. There are also numerous single-family residential dwellings scattered throughout the region. Many of the business and industrial sectors in the cities of Blythe, Brawley and Indio provide services that also support this type of lifestyle.

Water Supply and Use

About 85 percent of the region's urban and agricultural water supply comes from surface water deliveries from the Colorado River. Water from the river is delivered into the region through the All-American and Coachella canals, local diversions, and the Colorado River Aqueduct by means of an exchange for State Water Project (SWP) water. The Colorado River is an interstate and international river whose use is apportioned among the seven Colorado River Basin states and Mexico by a complex body of statutes, decrees, and court decisions known collectively as the "Law of the River" (Table 11-1). Local surface water, groundwater, and the SWP provide the remainder of water to the region. In addition, many of the alluvial valleys in the region are underlain by groundwater aquifers that are the sole source of water for local communities. There are other alluvial valleys that have poor quality water that is not suitable for potable use. Figure 11-3 presents two bar charts that summarize all of the dedicated and developed urban, agricultural and environmental water uses and the sources of supply within this hydrologic region for years 1998, 2000 and 2001.

In California, the Seven Party Agreement of 1931 established local agencies' apportionments of Colorado River water, which were further defined in the Quantification Settlement Agreement of 2003 (Tables 11-2, 11-3, 11-4, and Table 11-5). The Secretary of the Interior apportions water to California water users according to the Seven Party and the Quantification Settlement Agreement (QSA). Water use that occurs within a state is charged to that state's Colorado River apportionment. Thus, federal water uses, including uses associated with federal reserved rights (for example, tribal water rights), must also be accommodated within California's basic apportionment of 4.4 million acre-feet per year plus one-half of any available surplus water.

Neither Coachella Valley Water District (CVWD) nor Desert Water Agency (DWA) has facilities to take direct delivery of SWP water. Instead, both agencies have entered into exchange agreements with the Metropolitan Water District of Southern California (MWD), whereby MWD releases water from its Colorado River Aqueduct into the Whitewater River for storage in the upper Coachella Valley groundwater basin. In exchange, MWD takes delivery of an equal amount of the agencies' SWP water. San Gorgonio Pass Water Agency (SGPWA), which serves the Banning-Beaumont area, also lacks the facilities to take delivery of SWP water into the portion of its service area that is within the Colorado River region. However, SGPWA is currently delivering SWP water into the Santa Ana planning area of the South Coast Hydrologic Region. When Phase 2 of the East Branch Extension is eventually completed, SWP water will be delivered into the Colorado River Hydrologic Region. However, the California Department of Water Resources (DWR) is still developing plans for this Phase 2 extension project. (See Table 11-6 for SWP contractors in the Colorado River region.)

Groundwater provides about 7.5 percent of the region's applied water supply in normal years and about 7.7 percent in drought years (DWR 1998). Groundwater storage capacity has been estimated for 40 of the region's 57 groundwater basins and totals more than 175 million acre-feet. The largest water-using area in the region, the agricultural area of the Imperial Valley, is located mostly over a saline basin and therefore lacks usable groundwater.

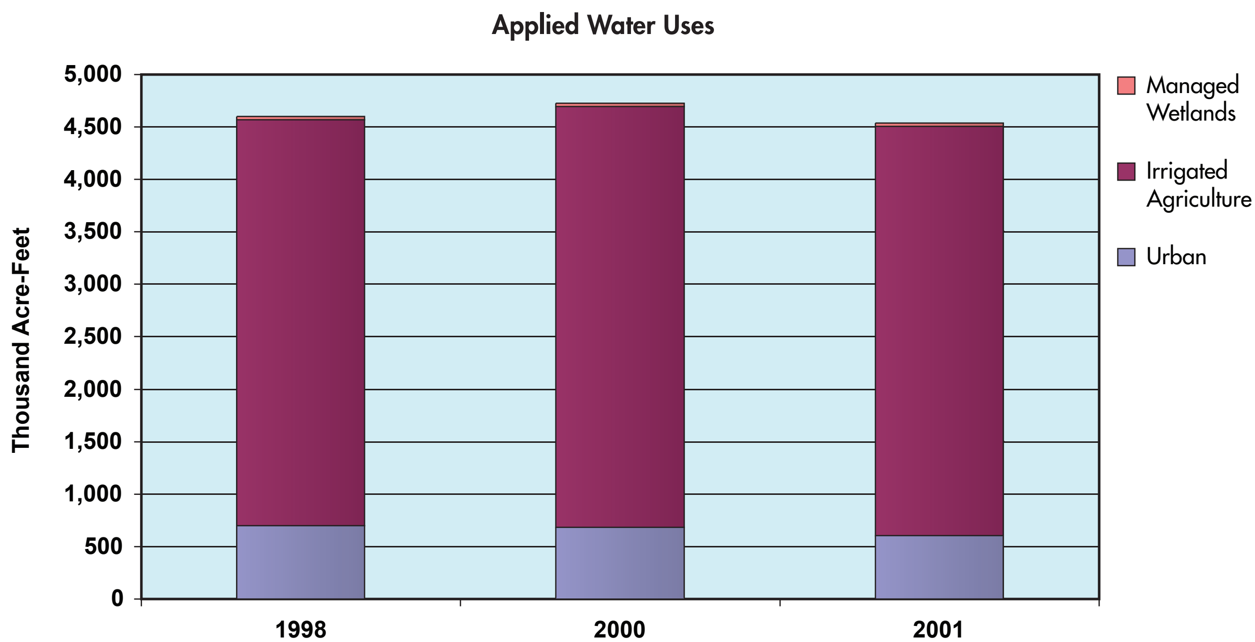
In the Coachella Valley, groundwater levels began declining in the late 1920s due to extensive pumping. Since 1948, imported water supplies have been brought into this area from the Colorado River via the Coachella Canal. These surface water deliveries have enabled decreased pumping of groundwater in the southeastern portion of the valley and have thus helped recharge the basin. As a result, groundwater levels rose in this part of the valley until the 1980s. Since then the groundwater levels have again declined because of urban development and increased groundwater pumping.

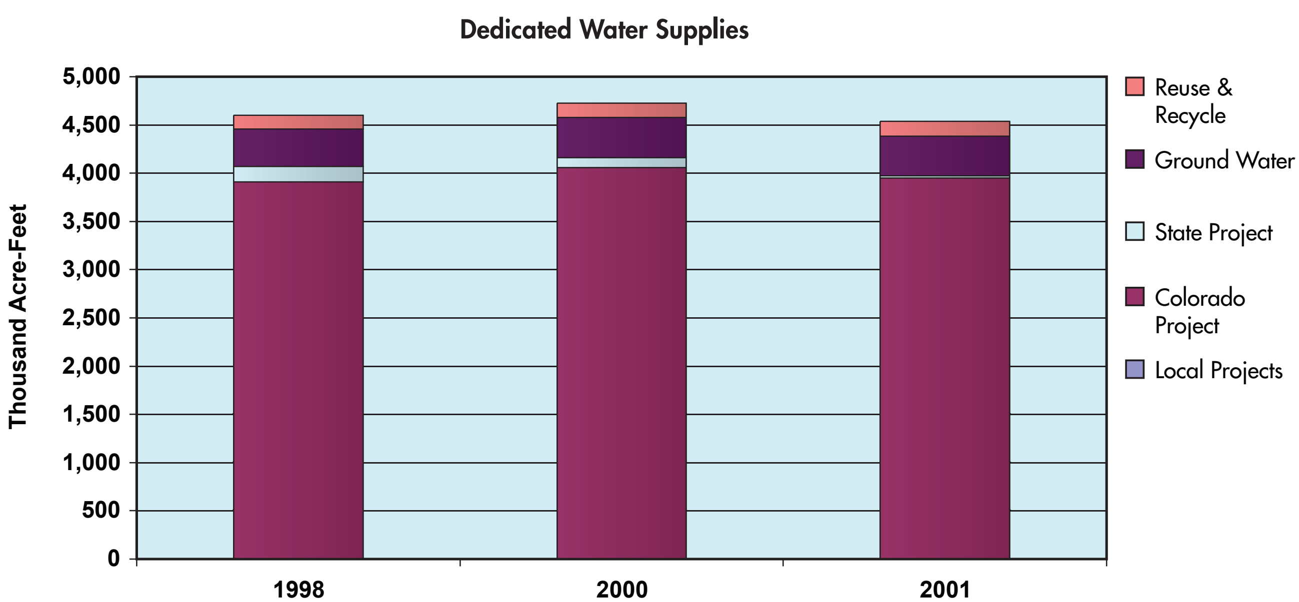
Local water districts in the Coachella Valley have been working to address the decline in groundwater levels. The agreement between CVWD and DWA to bring SWP supplies into the

Table 11-1 Key Elements of the Law of the River

Document	Date	Main Purpose
Colorado River Compact	1922	The Upper Colorado River Basin and the Lower Colorado River Basin are each provided a basic apportionment of 7.5 maf annually of consumptive use. The Lower Basin is given the right to increase its consumptive use an additional 1 maf annually.
Boulder Canyon Project Act	1928	Authorized USBR to construct Boulder (Hoover) Dam and the All-American Canal (including the Coachella Canal), and gave congressional consent to the Colorado River Compact. Provided that all users of Colorado River water stored in Lake Mead must enter into a contract with USBR for use of the water.
California Limitation Act	1929	Limited California's share of the 7.5 maf annually apportioned to the Lower Basin to 4.4 maf annually, plus no more than half of any surplus waters.
Seven Party Agreement	1931	An agreement among seven California water agencies/ districts to recommend to the Secretary of the Interior how to divide use of California's apportionment among the California water users.
U.S. - Mexican Treaty	1944	Apportions Mexico a supply of 1.5 maf annually of Colorado River water except under surplus or extraordinary drought conditions.
U.S. Supreme Court Decree in Arizona v. California, et al.	1964	Apportions water from the mainstream of the Colorado River among the Lower Division states. When the Secretary determines that 7.5 maf of mainstream water is available, it is apportioned 2.8 maf to Arizona, 4.4 maf to California, and 0.3 maf to Nevada. Quantifies tribal water rights for specified tribes, including 131,400 af for diversion in California.
Colorado River Basin Project Act	1968	Authorized construction of the Central Arizona Project (CAP). Requires Secretary of the Interior to prepare long-range operating criteria for major Colorado River reservoirs.
U.S. Supreme Court Decree in Arizona v. California, et al. supplemental decrees	1979, 1984, 2000	Quantifies Colorado River mainstream present perfected rights in the Lower Basin states.
Quantification Settlement Agreement and Related Agreements	2003	Complex package of agreements that, among other things, further quantifies priorities established in the 1931 Seven-Party Agreements and enables specified water transfers in California.

Figure 11-3 Colorado River region water balance for water years 1998, 2000, 2001





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

Table 11-2 Annual apportionment of use of Colorado River water
(amounts represent consumptive use)

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

a. Plus 200 taf of surplus water, when available as determined by the United States. Water delivered to Mexico must meet specified salinity requirements. During an extraordinary drought or other cause resulting in reduced uses in the United States, deliveries to Mexico would be reduced proportionally with uses in the United States.
b. The total volume is (7.5 + 7.5 + 1.0 + 1.5) = 17.5 maf/yr. Note that this total refers to all waters of the Colorado River System, which is defined as that portion of the Colorado River and its tributaries in the United States.

Table 11-3 Annual Apportionment of Water from the Colorado River Mainstream to the Lower Basin
(amounts represent consumptive use)

Arizona	2.8 maf
Nevada	0.3 maf
California	4.4 maf
Total	7.5 maf

Table 11-4 Annual Intrastate Apportionment of Water from the Colorado River Mainstream within California under the Seven Party Agreement [c]
(amounts represent consumptive use)

Priority 1	Palo Verde Irrigation District for beneficial use on 104,500 acres of lands within the Palo Verde Valley.
Priority 2	USBR's Yuma Project in California for beneficial use on up to 25,000 acres of lands within said Project
Priority 3	Imperial Irrigation District and lands served from the All American Canal in Imperial and Coachella Valleys, and Palo Verde Irrigation District for use on 16,000 acres in the Lower Palo Verde Mesa.
Priorities 1 through 3 collectively are not to exceed 3.85 maf/yr. The Seven Party Agreement did not quantify the division of this volume among the three priorities. Priorities 1-3 were further defined in the 2003 Quantification Settlement Agreement.	
Priority 4	Metropolitan Water District of Southern California (MWD) for coastal plain of Southern California – 550 taf/yr.
Priority 5	An additional 550 taf/yr to MWD, and 112 taf/yr for the City and County of San Diego [d].
Priority 6[e]	Imperial Irrigation District and lands served from the All-American Canal in Imperial and Coachella Valleys and Palo Verde Irrigation District for use on 16,000 acres in the Lower Palo Verde Mesa, for a total not to exceed 300 taf/yr.
Total of Priorities 1 through 6 is 5.362 maf/yr.	
Priority 7 [e]	All remaining water available for use in California, for agricultural use in California's Colorado River Basin.

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

d. Subsequent to execution of the Seven Party Agreement, MWD, SDCWA, and the city of San Diego executed a separate agreement transferring its apportionment to MWD.

e. Under the 2003 Quantification Settlement Agreement, MWD (& SDCWA) gained access to water that may be available under Priority 6 and 7,

Table 11-5 Quantification Settlement Agreement for Priorities 1- 3 Annual Use of Colorado River Water by California Agencies
(amounts represent consumptive use)

	Priority 3 Quantification	Approved Net Consumptive Use in 2003 [a]	Approved Net Consumptive Use in 2003 [a]
Priority 1,2, and 3b – Based on historical average use; deliveries above this amount in a given year will be deducted from MWD's diversion (order) for the next year; as agreed by MWD, IID, CVWD, and Secretary of the Interior (PVID & Yuma Project are not signatories to the QSA and are unaffected by it)	420 taf	420.0 taf	420.0 taf
Imperial Irrigation District	3,100 taf	2972.2 taf	2607.8 taf
Coachella Valley Water District	330.0 taf	347.0 taf	424.0 taf
Total Priority 1-3 Use	3,850 taf	3745.0 taf	3466.3 taf
Remainder of 3.85 for use by MWD (& SDCWA) through priority rights and transfer agreements	0 taf	105.0 taf [b]	383.7 taf [b]

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

b. Includes miscellaneous present perfected rights, federal rights reserved, and decreed rights.

Table 11-6 SWP contractors in the Colorado River region

Agency	Maximum Annual Deliveries (taf)	SWP Deliveries in 2000 (taf)
Coachella Valley Water District	23.1	42.3
Desert Water Agency	38.1	58.2
Mojave Water Agency (a)	75.8	11.2
San Gorgonio Pass Water Agency	17.3	0
Total SWP Delivery	153.3	111.7

a Maximum Annual Amounts include amounts for both the South Lahontan and Colorado River Regions; 7.3 taf of this amount is allocated to Colorado River Region.

valley was an important first step. In 1984, another agreement was reached among CVWD, DWA, and MWD which allowed for the advanced deliveries of Colorado River water into the Coachella Valley during periods of high flows on the river. These supplies helped speed the pace of groundwater replenishment of the basin and provided water for future uses. However, groundwater levels still continue to decline in much of the basin.

Under the 1984 agreement, MWD was also permitted to bank up to 600,000 acre-feet of surface water in the groundwater basin. When withdrawals are needed, MWD will use its Colorado River surface water along with CVWD's SWP allocations, and CVWD will then use the banked groundwater until the volume stored under this agreement is gone.

In 2000, the estimated applied water demands for urban, agriculture, and the environment for the Colorado River region totaled 4,727,000 acre-feet. The estimated applied water demand for agriculture was 4,013,000 acre-feet, or about 85 percent of the total. In accordance with the terms of the October 2003 QSA and related agreements, actual agricultural water use is expected to be reduced in future years.

Almost all of the agricultural demands in the region occur in the three major agricultural areas previously described, the Imperial, Palo Verde, and Coachella valleys. The Imperial Valley, with more than 500,000 acres of crops harvested each year (including double cropping), accounts for almost 70 percent of the total applied water demands for the region. In the Imperial and Palo Verde valleys, all agricultural demands are met with water from the Colorado River. In the Coachella Valley, agricultural demands are supplied by a combination of Colorado River surface water and groundwater.

Urban applied water demands account for about 15 percent of the overall totals for the Colorado River region. In 2000, total urban applied water was estimated to be 683,000 acre-feet. Most of these urban demands occur in the Coachella Valley, amounting to 527,000 acre-feet in year 2000 which is almost 80 percent of the total urban applied water for the region. Established housing and commercial uses have been augmented by large housing tracts with intensive landscaping, hotels, shopping centers, country clubs, golf courses, and polo fields. Landscape irrigation demands in the Coachella Valley are large because of the expanse of turf grass and landscaping that have occurred in the past two decades.

Despite the availability of a reliable and inexpensive water supply, water districts and users are well aware of the importance of water conservation programs to efficiently use and manage water. The agricultural growers in all of the districts do precision land forming for specific crops and use plastic and other mulches to reduce evapotranspiration and improve productivity.

For the past 50 years, the Imperial Irrigation District (IID), the region's largest irrigation district, has implemented programs and completed projects designed to improve the efficiency of its water conveyance system. Under the 1988 IID/MWD Water Conservation Agreement and the Approval Agreement in 1989, 15 new projects were completed. These included the construction of three lateral interceptors serving more than 83,400 acres, the building of two regulatory reservoirs and four interceptor reservoirs, concrete-lining of nearly 200 miles of lateral canals, installation of new hardware and software to upgrade the existing telemetry control on the IID conveyance system, and completion of a new, state-of-the-art Water Control Center. These infrastructure upgrades complemented existing IID programs including farmer-initiated measures, canal lining, canal seepage recovery, and regulatory reservoirs.

In addition to the improvements to its water conveyance system, IID also implemented 13-Point and 21-Point Water Conservation Programs. IID also provides training and technical assistance to its agricultural customers through its Irrigation Management and Monitoring program. Its most valued service has been the dissemination of information to farmers and irrigation personnel about methods to improve their irrigation operations. These programs actively promote the use of technical methods and instruments to improve irrigation efficiencies; including level basin drip systems, level basin laser-leveling, irrigation scheduling, portable pump-back and tailwater return systems, salinity assessment, and soil moisture sensors. IID also has a training program that it uses to provide growers with flow records, based on metering of the water delivered and tailwater runoff, for any particular irrigation site.

In addition to the water supply savings in the IID/MWD agreement, improvements to IID's water distribution system and other water conservation activities conserve more than 525,000 acre-feet of water annually. Of this amount, the IID estimates that 385,000 acre-feet of the savings are attributable to the efforts by its agricultural customers.

CVWD has also made important improvements to its water conveyance system. Water is delivered to its agricultural customers through metered, underground pipelines. The conveyance system is computerized, which adds to the system's efficiency. In addition to the infrastructure improvements, CVWD provides technical services in efficient irrigation management to its agricultural and residential customers.

The districts have also examined their water operation policies and procedures. This review has resulted in modifications in the delivery procedures that have improved efficiencies and assisted farmers in their irrigation scheduling.

Palo Verde Irrigation District (PVID) has installed telemetry controls for more than 132 key control structures, which has improved the management of water in its canals. Most of the fields in the PVID and other district service areas have been laser-leveled. Flattened fields help improve the uniform distribution of water. All deliveries to the PVID's retail agricultural customers are measured, as are IID's and CVWD's.

PVID, IID, and CVWD, in cooperation with the University of California Cooperative Extension and DWR, have installed California Irrigation Management Information System (CIMIS) stations to collect the climatological data that agricultural water users need to estimate crop evapotranspiration of applied water (ETAW) and to develop irrigation schedules. Water users are made aware of improvements in irrigation management and crop growing procedures through local water conservation boards and farm advisory boards.

To assist CVWD, PVID entered into an emergency six-month fallowing program in 2003. More than 16,417 acres of farmland were idled and the unused water, 41,000 acre-feet, was made available to CVWD.

IID, PVID, and CVWD signed a Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California. By signing the MOU, the districts demonstrated their intention to adopt and use agricultural water management plans that would improve agricultural water management and have beneficial environmental impacts within their service areas. IID's 2002 Agricultural Water Management Plan has been endorsed by the Agricultural Water Management Council that oversees the MOU.

Growers in the major agricultural areas use the latest irrigation hardware and management techniques to increase both the efficiencies of their operations and crop yields. In the Imperial Valley, it is common to see drip, micro-sprinklers, and drip tape systems being used along with the traditional systems of furrow, basin, and hand-move sprinklers. Drip tape is most commonly used for high-market value crops such as vegetables. Drip and micro-sprinkler systems are commonly used to irrigate the citrus and subtropical fruit orchards. Currently, less than 1 percent of the total orchard acreage, mainly date palms, is flood irrigated.

In the Coachella Valley most irrigation operations with vegetables and truck crops use drip tape and hand-move sprinklers. Some furrow irrigation is still used. Citrus and subtropical fruit orchard irrigation is done with drip and micro-sprinklers; although flood or basin irrigation is still used for mature date palms. Almost all the vineyards are being irrigated by some type of drip system; only a very small portion still rely on furrow irrigation. The use of overhead sprinkler systems is a common sight in vineyards throughout the valley, where they are used for frost protection and the inducement of vine dormancy for earlier fruit-sets.

Although most of the water conservation has been directed to agriculture, water districts in the Coachella Valley provide technical assistance to the managers of large landscaped areas, such as golf courses, to evaluate and offer suggestions about irrigation hardware and operations. CVWD also provides loans to its retail customers for irrigation upgrades. Desert Water Agency offers classes in English and Spanish to homeowners, property managers, and government and school personnel on irrigation efficiency strategies and tools.

The largest water body in the region is the Salton Sea, a saline body of water about 50 feet deep. (See Box 11-2 Salton Sea Description.) Today's surface water elevation is about 229 feet below sea level. The Salton Sea has a concentration of total dissolved solids of about 46,000 mg/L, which is about 33 percent greater than that of ocean water. Most of the environmental water demands in the region are for the Sonny Bono Salton Sea National Wildlife Refuge, DFG Imperial Wildlife Area, wetland areas on the shore of the Salton Sea, and to maintain the viability of the sea under the QSA through 2017. To meet conditions for the IID/SDCWA transfer approved under the 2003 Colorado River QSA, from 2003 through 2017, IID will fallow enough ground to provide 800,000 acre-feet to the Salton Sea as mitigation for transferring water to San Diego. The Salton Sea ecosystem is considered a critical link on the international Pacific Flyway, providing wintering habitat for migratory birds, including some species whose diets are based exclusively on fish. The expected average annual inflows to the Salton Sea during the 25-year time frame of the California Water Plan Update 2005 are expected to be about 962,000 acre-feet per year, based on estimates using the Salton Sea Accounting Model (SSAM). This estimate has a standard deviation sensitivity range of about +/- 100,000 acre-feet per year.

State of the Region

Challenges

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

In 1993, the UFSWS published a draft recovery implementation plan for endangered fish in the upper Colorado River Basin. The draft plan included protecting instream flows, restoring habitat, reducing impacts of introduced fish and sportsfish management, conserving genetic integrity, monitoring habitat and populations, and increasing public awareness of the role and importance of native fish.

Box 11-2 Salton Sea Description

The present day Salton Sea was formed in 1905, when Colorado River water flowed through a break in an irrigation diversion structure that had been constructed along the U.S./Mexican border to divert the river's flow to agricultural lands in the Imperial Valley. Until that break was repaired in 1907, the uncontrolled diversions of river water drained into the Salton Sink, a closed interior basin whose lowest point is about 278 feet below sea level.

Historically, the Colorado River's course has changed several times. At times, the river discharged to the Gulf of California as it does today. At other times it flowed into the Salton Sink. Lake Cahuilla, the name used for any of the several prehistoric lakes to have occupied the Salton Sink, dried up some 300 years ago. In the past 2000 years, archaeological records indicate that the Colorado River actually headed northwest into the Salton Sink or Trough more often than it headed south into the Gulf of California.

Problems facing native fish in the mainstem Colorado River and its tributaries will not be easily resolved. For example, two fish species most in danger of extinction, the bonytail chub and razorback sucker, are not expected to survive in the wild. In recent years, most stream and reservoir fisheries in the basin have been managed for non-native fish. These management practices have harmed residual populations of native fish. However the native fish species are readily propagated in hatcheries, such that recovery plans include captive broodstock programs to maintain the species.

Reestablishing wild populations from hatchery stocks will have to be managed in unison with programs that manage river habitat. For example, although 15 million juvenile razorback suckers were planted in Arizona streams from 1981through 1990, the majority of these planted fish were likely eaten by introduced predators. In 1994, the states of Colorado, Wyoming, and Utah reached an agreement with USFWS on protocols for stocking non-native fish in the Upper Basin. Stocking protocols are consistent with native fish recovery efforts. In a program which began in 1989, USBR and other federal and state agencies have cooperated to capture, rear, and successfully reintroduce about 15,000 razorback sucker larvae in Lake Mojave.

Instream flows in the mainstem and key tributaries are being evaluated as components of native fish recovery efforts. State and federal agencies are conducting studies to estimate base flow and flushing flow needs for listed and sensitive species in various river reaches.

In the Lower Colorado River Basin, representatives of the three states, federal agencies, several Native American tribes, and Colorado River water and power users have completed and signed the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The LCR MSCP is intended to provide long-term compliance with the federal and California Endangered Species Acts, as well as the fully protected species statutes in California.

The LCR MSCP is a 50-year program that is designed to provide more than 8,100 acres of high quality aquatic, wetland, and native broadleaf riparian habitat along the Lower Colorado River from Lake Mead to Mexico. The restored and maintained habitats are expected to provide ecological benefits and mitigate potential impacts to 26 covered species being addressed within the LCR MSCP. Some of the proposed habitat restoration may involve the conversion of existing agricultural lands to native riparian habitats, as well as removal of non-native salt cedar (tamarisk) and replacement with native broadleaf riparian habitat – cottonwood, willow, and mesquite, for example.

Box 11-3 Salton Sea Ecosystem

The Salton Sea, a saline lake with a total dissolved solids of approximately 46,000 ppm (mg/L) - 33 percent greater than that of ocean water is California's largest (surface area) lake and has been famous for its sport fishing and other recreational uses. It is also a federally designated repository to receive and store agricultural, surface, and subsurface drainage waters from the Imperial and Coachella valleys. The Salton Sea has a water surface elevation of about 229 feet below mean sea level.

Wildlife and aquatic species, which are dependent upon habitat created by the discharge of agricultural return flows, are threatened by the increasing salinity of the sea, as salts in the water are concentrated through evaporation. The sea's importance to wildlife has grown because about 95 percent of California's wetlands in other areas have disappeared through changes in land use.

The Salton Sea ecosystem, including the Sonny Bono Salton Sea National Wildlife Refuge and adjacent agricultural lands, is considered a critical link on the International Pacific Flyway for migratory birds. The amount of freshwater inflow available to the Sea will be affected by water transfers to the South Çoast region as well as by water conservation in Mexico. As specified by the State Water Resources Control Board, IID is required to provide a defined freshwater inflow for mitigation from 2003 through 2017.

By the end of 2006, the California Resources Agency is required to complete a Salton Sea ecosystem restoration study and an environmental document to idenntify a preferred alternatiive for Salton Sea Restoration.

Additionally, the LCR MSCP participants plan to rear and reintroduce more than 660,000 razorback suckers and 620,000 bonytail to the mainstream of the Colorado River during the 50-year LCR MSCP. More than 360 acres of backwater habitats are to be created along the Lower Colorado River to provide nursery habitat for juvenile native fish and additional wetland habitat for marsh species and migratory waterfowl.

Several California water and power agencies that use Colorado River water were participants in the LCR MSCP planning process and are signatories to the plan. The LCR MSCP is expected to begin implementation in early 2005. The USBR, in conjunction with representatives of the three states and the U.S. Fish and Wildlife Service, will be the agency primarily responsible for implementing the LCR MSCP.

The Salton Sea, with its increasing salinity, selenium contamination, and eutrophication, is the primary focus of water quality issues within this hydrologic region. The largest sources of surface water inflow to the sea are the New and Alamo rivers and the Imperial Valley agriculture drains, all of which contribute pesticides, nutrients, selenium, and silt. The New River has been described as the most polluted river in the United States. Originating in Mexicali, Mexico, the New River flows across the border, through the city of Calexico, and then north, and empties into the Salton Sea. It conveys urban runoff, untreated and partially treated municipal and industrial wastes from the Mexicali Valley, and agricultural runoff from the Mexicali and Imperial valleys. These pollution sources contribute pesticides, pathogens, silt, nutrients, trash, and volatile organic compounds (the latter, primarily from Mexican industry) to the sea. The Alamo River, which originates just two miles south of the border and also flows north to the Salton Sea, consists mainly of agricultural drainage from the Imperial Valley. The Coachella Valley Stormwater Channel, which also drains to the sea, at its north end is heavily contaminated with pathogens from municipal wastewater plants in the Coachella Valley and agricultural drainage.

A multiagency group, The Citizen's Congressional Task Force on the New River, was created in 1997. Its mission is to improve agricultural drain water quality that flows into the New River and, ultimately, to the Salton Sea. Participating agencies include IID, Desert Wildlife Unlimited, County of Imperial, USBR, U.S. Geological Survey, USFS, DFG, California Regional Water Quality Control Board, USEPA, Ducks Unlimited, and U.C. Riverside. In 2000, the Task Force constructed two pilot wetland projects, a seven-acre site near Brawley and a 68-acre site near Imperial, to test the effectiveness of constructed wetlands in lowering non-point source pollutants. Due to the success of the pilot sites, up to 30 additional wetland sites are proposed on both the New and Alamo rivers. Additional information on this program can be found on the Task Force web site at www.newriverwetlands.com.

Contamination in the Salton Sea presents threats to migrating birds on the Pacific Flyway. At certain times of the year, nutrient loading to the sea supports large algal blooms that contribute to odors, as well as low dissolved oxygen levels which adversely affect fisheries. Selenium is a more recent constituent of concern,and has the potential to adversely affect fish and wildlife.

The relatively saline Colorado River provides irrigation and domestic water to much of Southern California. Of recent concern to human health is the presence of low levels of perchlorate in the Colorado River from a Kerr-McGee chemical facility in the Las Vegas Wash, the nation's largest perchlorate contamination site. In addition high levels of hexavalent chromium occur in groundwater wells near the town of Needles, resulting from a PG&E natural gas compressing station. Septic systems at recreational areas along the river are also a concern for domestic and recreational water uses. Other important water quality issues in this region include increasing levels of salinity, nitrates and other substances in groundwater associated with animal feeding and dairy operations and septic tank systems, especially in the Desert Hot Springs area and in the Cathedral City Cove area. In the Coachella Valley, high levels of nitrates restrict the use of several domestic water supply wells.

To address the issue of declining groundwater levels, CVWD prepared a water management plan for the lower Coachella Valley. The plan considered alternatives that include basin adjudication, water conservation, water recycling and direct or in lieu recharge with water imported from the Colorado River or from the SWP. This plan was completed and approved in 2002.

As a result of a 1964 U.S. Supreme Court decree in Arizona v. California, California's basic apportionment of Colorado River water was quantified and five lower Colorado River Indian tribes were awarded 905,000 acre-feet of annual diversions, 131,400 acre-feet of which were allocated for diversion in and chargeable to California pursuant to a later supplemental decree. In 1978, the tribes asked the court to grant them additional water rights, alleging that the U.S. failed to claim a sufficient amount of irrigable acreage, called omitted lands, in the earlier litigation. The tribes also raised claims called boundary land claims for more water based on allegedly larger reservation boundaries than had been assumed by the court in its initial award. In 1982, a Special Master appointed by the Supreme Court to hear these claims recommended that additional water rights be granted to the tribes. In 1983, however, the U.S. Supreme Court rejected the claims for omitted lands from further consideration and ruled that the claims for boundary lands could not be resolved until disputed boundaries were finally determined.

Three of the five tribes – the Fort Mojave Indian Tribe, the Fort Yuma-Quechan Indian Tribe, and the Colorado River Indian Tribe – are pursuing additional water rights related to the boundary lands claims. A settlement has been reached on the claims of the Fort Mojave Indian Tribe and the Colorado River Indian Tribe. The settlements as approved by the U.S. Supreme Court provide 5,122 acre-feet of additional diversions to these two tribes. An agreement has also been reached to settle the claim of the Fort Yuma - Quechan Indian Tribe, which is currently before the U.S. Supreme Court.

In 2003 legislation was enacted to enable the QSA's local agency signatories to reach agreement on how to reduce their use of Colorado River water to California's basic interstate apportionment of 4.4 million acre-feet annually. As a result of this legislation the State accepted significant responsibilities and liabilities for mitigation of QSA environmental impacts and for restoration of the Salton Sea ecosystem, The QSA implementation legislation is contained in three approved bills, SB 277 (Ducheny), SB 317 (Kuehl), and SB 654 (Machado), which were chaptered in 2003. Among other things, the legislation establishes State policy with respect to Salton Sea, stating the intent of the Legislature that the State would undertake the restoration of Salton Sea ecosystem and permanent protection of its fish and wildlife. It provides that no further funding obligations or in-kind contributions for Salton Sea restoration would be required of IID, CVWD, MWD, or SDCWA. Any future actions to restore Salton Sea would be the sole responsibility of the State. Additionally, IID is held harmless from Salton Sea impacts resulting from transfers of conserved water.

With respect to QSA implementation, the legislation authorizes DFG to issue incidental take permits for California's fully protected species, and provides that DFG chair a joint powers authority whose other members are SDCWA, IID, and CVWD. The three local agencies are to contribute $133 million to the joint powers authority for QSA environmental mitigation, with the State being responsible for mitigation in excess of that amount. The three local agencies are also to contribute $30 million to the Salton Sea Restoration Fund managed by DFG. The legislation provides for a conditional transfer of conserved water from IID to MWD of up to 1.6 million acre-feet of Colorado River water, under specified terms. Proceeds from sale of the water – estimated at up to $300 million – are to go to the Salton Sea Restoration Fund. The Secretary for Resources is directed to prepare a Salton Sea ecosystem restoration study and environmental documentation, and identify a preferred alternative by the end of 2006. The study, to be conducted in consultation with a legislatively mandated advisory committee and with the Salton Sea Authority, is to include a proposed funding plan for implementing the preferred alternative.

Accomplishments

Over the past 20 years, several large-scale water conservation actions involving Colorado River water users have been completed, as shown in Table 11-7. Since 1993, development and implementation of these programs and projects have included consideration of environmental issues and environmental justice values.

Relationship with Other Regions

After eight years of negotiations, the signing of the Quantification Settlement Agreement on October 10, 2003, facilitated a second long-term water transfer from the Imperial Irrigation District in the Colorado River Hydrologic Region to urban water users in the South Coast Hydrologic Region. It will also make possible the transfer of additional water to be obtained through lining of the All American and the Coachella canals. The water transfer from IID will help stabilize MWD's, SDCWA's and CVWD's water supplies, satisfy outstanding miscellaneous and Indian water rights, and provide funding that IID and farmers in the Imperial Valley will use for additional water conservation measures once the required interim fallowing period is completed.

Although the facilities to deliver SWP water supplies to the region have yet to be built, CVWD and DWA receive their annual allocations of SWP water through an exchange agreement with the South Coast region's largest water wholesale agency, MWD. These districts are also participants in another agreement that delivers and stores water from the Colorado River into the Coachella Valley's largest groundwater basin during periods of high flows.

Water districts in both regions are also cooperating in water conservation and land fallowing programs. The 1988 IID/MWD Water Conservation Agreement resulted in conservation

Table 11-7 Existing Colorado River Region Water Conservation Actions / Agreements Since 1980				
Year	Action	Participants	Comments/Status	Estimated Savings
1980	Line 49 miles of Coachella Canal	USBR, CVWD,	Project completed.	132 taf/yr
1990	IID distribution system improvement and on-farm water management projects designed to conserve 100 taf/yr.	IID, MWD	Project completed. Under QSA agreement extends through 2037 (2047, if not terminated by SDCWA; 2077, if renewed by mutual consent of IID / SDCWA) Conservation projects - canal lining, regulatory reservoirs, lateral spill interceptor canals, tailwater return systems, non-leak gates, 12-hour water delivery, drip irrigation, and system automation. MWD funded $96.5 million (1988$) for program costs; pays O&M for duration of agreement.	Conservation verification in 1998 - 107 taf
1992	Groundwater banking in Arizona	MWD, Central Arizona WCD, So. Nevada WA	Test program to bank up to 300 taf.	MWD and SNWA have stored 139 taf in Arizona groundwater basins.
1992	PVID land fallowing	PVID, MWD	Project completed. Two-year land fallowing test program. Covered 20,215 acres in PVID.MWD paid $25 million to farmers over a two-year period.	186 taf were made available, but the water was subsequently spilled from Lake Mead when flood control releases were made from the reservoir.
1995	Partnership agreement	USBR, CVWD	Provides, among other things, for studies to optimize reasonable beneficial use of water in the district.	N/A
2003	Water transfer agreement	IID, SDCWA, CVWD	Initial term of 35 years; 45 years if not terminated by SDCWA; 75 years if renewed by mutual consent of IID / SDCWA. SDCWA pays for water transferred & to Sea.	In 2003, SDCWA receives 10 taf and the Salton Sea receives 5 taf. By 2017, SDCWA amount increases to100 taf and the Salton Sea amount increases to 150 taf. From 2018 through the remainder of agreement (2077, if extended), SDCWA would receive 200 taf (from 2001 on) and the Salton Sea would receive 0 acre-feet. For CVWD, it receives 4 taf in 2008 and 103 taf by 2024. This decreases to 100 taf in 2039, if agreement is extended.
2003	Land lease agreement	PVID, CVWD	PVID conserved and transferred water supplies to CVWD.	40.6 taf in 2003.
2003	Canal Lining	IID, CVWD, San Luis Rey River Indian Water Authority, other Indian tribes	Portions of the All American Canal and the Coachella Canal will be lined. SDCWA pays for construction and O&M. 16 taf will be provided for the San Luis Rey Indian water rights settlement.	67.7 taf/yr - All American Canal 26 taf/yr - Coachella Canal

of water supplies from the construction of new facilities, water system automation, and the implementation of technical assistance programs for farmers within the IID water service area. The conserved water is delivered to MWD and CVWD.

As part of an on-going agreement, MWD will provide technical and financial assistance to the PVID for the construction of facilities and implementation of programs to conserve water supplies within the PVID service area. MWD will be permitted to divert conserved water supplies resulting from these projects and programs.

Looking to the Future

On October 10, 2003, MWD, IID, CVWD, SDCWA, and the Secretary of the Interior signed the Colorado River Water Delivery Agreement: Federal Quantification Settlement Agreement (QSA) for the purpose of Section 5(B) of the Interim Surplus Guidelines. This agreement specifies, how, over time, California will reduce its use of Colorado River water to its basic apportionment of 4.4 million acre-feet per year in all years, except for those years in which the Secretary of the Interior declares a surplus of water on the Colorado River.

The QSA will remain in effect for 35 years, or 45 years if not terminated by SDCWA, or 75 years if renewed by mutual consent of IID and SDCWA. The QSA is expected to achieve the objective sought by the other Colorado River Basin states and the federal government of reducing California's use of Colorado River water to its annual basic apportionment of 4.4 million acre-feet. This reduction will be achieved through, among other practices, transfer of water use from IID to SDCWA and to CVWD. While it is the intent of IID to transfer water saved through conservation, from 2003 through 2012 all of the water transferred to SDCWA will come from land fallowing. Fallowing for this transfer will decrease from a high of 90,000 acre-feet per year in 2012, until by 2017 all water transferred to SDCWA will come from efficiency conservation measures. At the same time, additional land fallowing will occur to meet flow requirements (5,000 acre-feet per year in 2003, growing to 150,000 acre-feet in 2017 unless reduced or eliminated as a result of "Salton Sea Restoration") for environmental mitigation as a result of the reduced agricultural drainage to the Salton Sea.

At its peak, land fallowing in the IID service area is anticipated to be up to 40,000 acres, as needed to provide up to 150,000 acre-feet of mitigation water to the Salton Sea in 2017. After 15 years, it is expected that improvements in water use efficiency will be sufficient to meet the terms of the QSA, and land fallowing would no longer be needed for environmental mitigation. One of the long-term assumptions in MWD's Integrated Resources Plan is that MWD's Colorado River supply will be maximized through water transfers from agricultural water users in the Colorado River hydrologic region (IID and PVID) to urban water users in the South Coast hydrologic region (SDCWA and MWD).

Box 11-4 Key Elements of California's Colorado River Quantification Settlement Agreement

The California Colorado River Quantification Settlement Agreement and related agreements will have the following effects:

- Permit the utilization of interim surplus water.
- Transfer as much as 30 million acre-feet of water from farms to cities in Southern California for up to the 75 year term of the agreement.
- Settle potential lawsuits between the Imperial Irrigation District and the U.S. Department of the Interior.
- Obligate California with the sole responsibility for restoration of the Salton Sea ecosystem.
- Provide for cooperation on the environmental review and mitigation for the Imperial Irrigation District/ San Diego County Water Authority Transfer Agreement, IID/ Coachella Valley Water District Acquisition Agreement, and Salton Sea habitat conservation plan/natural community conservation plan.
- Fund a $200 million project to line with concrete a portion of the earthen All-American Canal and a portion of the earthen Coachella Canal. Water conserved by reducing seepage will be transferred to San Diego and the San Luis Rey Indian Tribes, who will pay proportionally for operation and maintenance costs.
- Quantify, for the first time, the total Colorado River apportionments in California.

The agricultural water purveyors in the region (IID, PVID, CVWD, and Bard Water District) will continue to implement Efficient Water Management Practices. Water districts in the Coachella Valley will continue with their efforts to provide technical assistance to the managers of large landscape areas to help improve the efficiencies of irrigation.

CVWD and DWA will continue to work together to address declining water levels in the Coachella Valley's largest groundwater basin, the Indio sub-basin. CVWD is operating an active groundwater recharge program for the upper end of the Coachella Valley, generally, the urbanized part of the valley. CVWD recharges groundwater with imported Colorado River water and with Whitewater River flows using percolation ponds. CVWD and DWA levy extraction fees on larger groundwater users in the upper Coachella Valley.

With support from the Quechan Indian Reservation and from the Southern Low Desert Resource Conservation and Development Council, Bard Water District (BWD) is undertaking an $8 million project for capital improvements on the Reservation Division of the USBR's Yuma Project. This improvement project is mostly funded by a $4 million matching grant from the North American Development Bank. The Quechan Indian Reservation contributed $2 million of the matching funds and $2 million was raised by BWD customers. BWD is rehabilitating about 10 miles of earthen canals with concrete lining and pipeline in 2004 and an additional 10 miles are to be rehabilitated in 2005. BWD will also be replacing more than 100 irrigation gates and structures. These improvements will greatly increase the effectiveness of its system by reducing canal seepage and evaporation.

Over the years, the USBR and others have considered potential solutions to stabilize the Salton Sea's salinity and elevation. Most recently, the Salton Sea Authority has been performing appraisal level evaluations of some of the frequently suggested alternatives, such as large scale pump-in, pump-out pipelines to the Pacific Ocean. The authority is investigating integrated strategies where a smaller, lower salinity lake with a stable water surface would be coupled with treatment/desalination of some brackish inflows. The treated water could then be sold or could be part of a water transfer that would help fund the project.

Under direction contained in the QSA implementing legislation, the Secretary of the California Resources Agency is undertaking a study of alternatives for restoration of the Salton Sea. A deadline of December 31, 2006 was established for the completion of the study and submittal to the legislature.

The Colorado River Quantification Settlement Agreement (QSA), finalized and signed in October 2003, outlines key elements for California to operate within its basic annual allotment of 4.4 million acre-feet from the Colorado River, as summarized in Box 11-4.

Water Portfolios for Water Years 1998, 2000, and 2001

Above average rainfall occurred during water year 1998 in Blythe, with near average rainfall elsewhere in the region. For water years 2000 and 2001, rainfall totals were below average; and 2000 could also be considered as a dry year. In water year 1998, rainfall totals were 176 percent above average for the National Weather Service station in Blythe, 104 percent of average for the El Centro 2 SSW station and 108 percent of average for Palm Springs.

Water year 2000 was very dry. Rainfall totals measured by the Blythe station for the year were only 17 percent of average; for El Centro, 10 percent of normal; and for Palm Springs, 35 percent of normal. Conditions improved slightly for water year 2001. The Blythe station measured rainfall that was 120 percent of normal. For El Centro, it was 78 percent of normal. For Palm Springs, it was 74 percent.

Tables 11-8 through 11-10 present actual information about the water supplies and uses for the Colorado River hydrologic region for these three years. About 85 percent of the region's water comes from surface deliveries from the Colorado River. The high level of agricultural activity in the region is reflected by the large agricultural water demand relative to other water uses. In 2000, agricultural water demand was 85 percent of all developed applied water uses in the region. By contrast, urban water use only accounted for 14 percent of total demand. The Water Portfolio Flow Diagrams (Figures 11- 4 and 11-5) provide a graphical presentation of how water supplies are distributed and used throughout this region.

Despite the climatological conditions, demands for water supplies by the region's urban and agricultural users and the environment did not exhibit any large fluctuations during the years between 1998 and 2001. The total applied water demand for 1998 was 4,602,000 acre-feet. For 2000, the demand increased slightly to 4,726,900 acre-feet. In 2001, it decreased to 4,536,800 acre-feet.

Table 11-8 Colorado River Hydrologic Region Water Balance Summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (154%)	2000 (50%)	2001 (80%)
Water Entering the Region			
Precipitation	9,455	3,034	4,770
Inflow from Mexico	182	166	155
Inflow from Colorado River	4,986	5,349	5,197
Imports from Other Regions	0	0	0
Total	**14,623**	**8,549**	**10,122**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	2,814	2,865	2,775
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	1,081	1,296	1,250
Statutory Required Outflow to Salt Sink	0	0	0
Additional Outflow to Salt Sink	1,185	1,252	1,228
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	9,646	3,320	5,049
Total	**14,726**	**8,733**	**10,302**
Storage Changes in the Region [+] Water added to storage [-] Water removed from storage			
Change in Surface Reservoir Storage	-15	-19	1
Change in Groundwater Storage **	-88	-165	-181
Total	**-103**	**-184**	**-180**
Applied Water * (compare with Consumptive Use)	4,107	4,288	4,174

***Footnote for applied water**

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

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

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

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

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

Table 11-9 Colorado River Region Water Use and Distribution of Dedicated Supplies (TAF)

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	156.9			148.8			122.4		
Commercial	71.4			123.5			145.0		
Industrial	3.3			4.6			4.6		
Energy Production	76.7			76.7			76.7		
Residential - Interior	170.0			170.3			159.1		
Residential - Exterior	65.2			59.1			75.1		
Evapotranspiration of Applied Water		222.1	222.1		207.9	207.9		196.5	196.5
E&ET and Deep Perc to Salt Sink		76.6	76.6		82.8	82.8		84.6	84.6
Outflow		124.7	124.7		129.9	129.9		131.0	131.0
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
GW Recharge Applied Water	156.4			100.6			24.1		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**700.0**	**423.4**	**423.4**	**683.5**	**420.6**	**420.6**	**606.9**	**412.1**	**412.1**
Agriculture									
On-Farm Applied Water	3,531.8			3,674.6			3,561.7		
Evapotranspiration of Applied Water		2,560.4	2,560.4		2,627.3	2,627.3		2,548.5	2,548.5
E&ET and Deep Perc to Salt Sink		80.3	80.3		86.8	86.8		83.5	83.5
Outflow		723.3	723.3		778.9	778.9		752.1	752.1
Conveyance Applied Water	338.6			338.6			338.6		
Conveyance Evaporation & ETAW		64.0	64.0		64.0	64.0		64.0	64.0
Conveyance Deep Perc to Salt Sink		167.6	167.6		167.6	167.6		167.6	167.6
Conveyance Outflow		107.0	107.0		107.0	107.0		107.0	107.0
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**3,870.4**	**3,702.6**	**3,702.6**	**4,013.2**	**3,831.6**	**3,831.6**	**3,900.3**	**3,722.7**	**3,722.7**
Environmental									
Instream									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Wild & Scenic									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	31.6			30.2			29.6		
Evapotranspiration of Applied Water		31.6	31.6		30.2	30.2		29.6	29.6
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	31.6	31.6	31.6	30.2	30.2	30.2	29.6	29.6	29.6
Total Environmental Use	**31.6**	**31.6**	**31.6**	**30.2**	**30.2**	**30.2**	**29.6**	**29.6**	**29.6**
TOTAL USE AND OUTFLOW	**4,602.0**	**4,157.6**	**4,157.6**	**4,726.9**	**4,282.4**	**4,282.4**	**4,536.8**	**4,164.3**	**4,164.3**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	6.6	6.6	6.6	6.3	6.3	6.3	4.0	4.0	4.0
Local Imported Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorado River Deliveries	3,905.1	3,905.1	3,905.1	4,053.0	4,053.0	4,053.0	3,946.6	3,946.6	3,946.6
CVP Base and Project Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Federal Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SWP Deliveries	156.4	156.4	156.4	100.6	100.6	100.6	24.1	24.1	24.1
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	73.4	73.4	73.4	105.3	105.3	105.3	171.7	171.7	171.7
Deep Percolation of Surface and GW	313.6			311.0			237.1		
Reuse/Recycle									
Reuse Surface Water	130.8			133.5			135.3		
Recycled Water	16.1	16.1	16.1	17.2	17.2	17.2	17.9	17.9	17.9
TOTAL SUPPLIES	**4,602.0**	**4,157.6**	**4,157.6**	**4,726.9**	**4,282.4**	**4,282.4**	**4,536.7**	**4,164.3**	**4,164.3**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

Minor reductions in the irrigated crop acres occurred from 1998 to 2000, followed by a slight increase for 2001. Total crop acreage for the region (including double-cropping) was 761,760 acres in 1998, 731,890 acres for 2000, and 739,830 for 2001. Noticeable declines were observed for irrigated grains and other field crop categories. A steady increase in production acreage has been observed for the vegetables crops classified in the "other truck" category.

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Water Portfolios

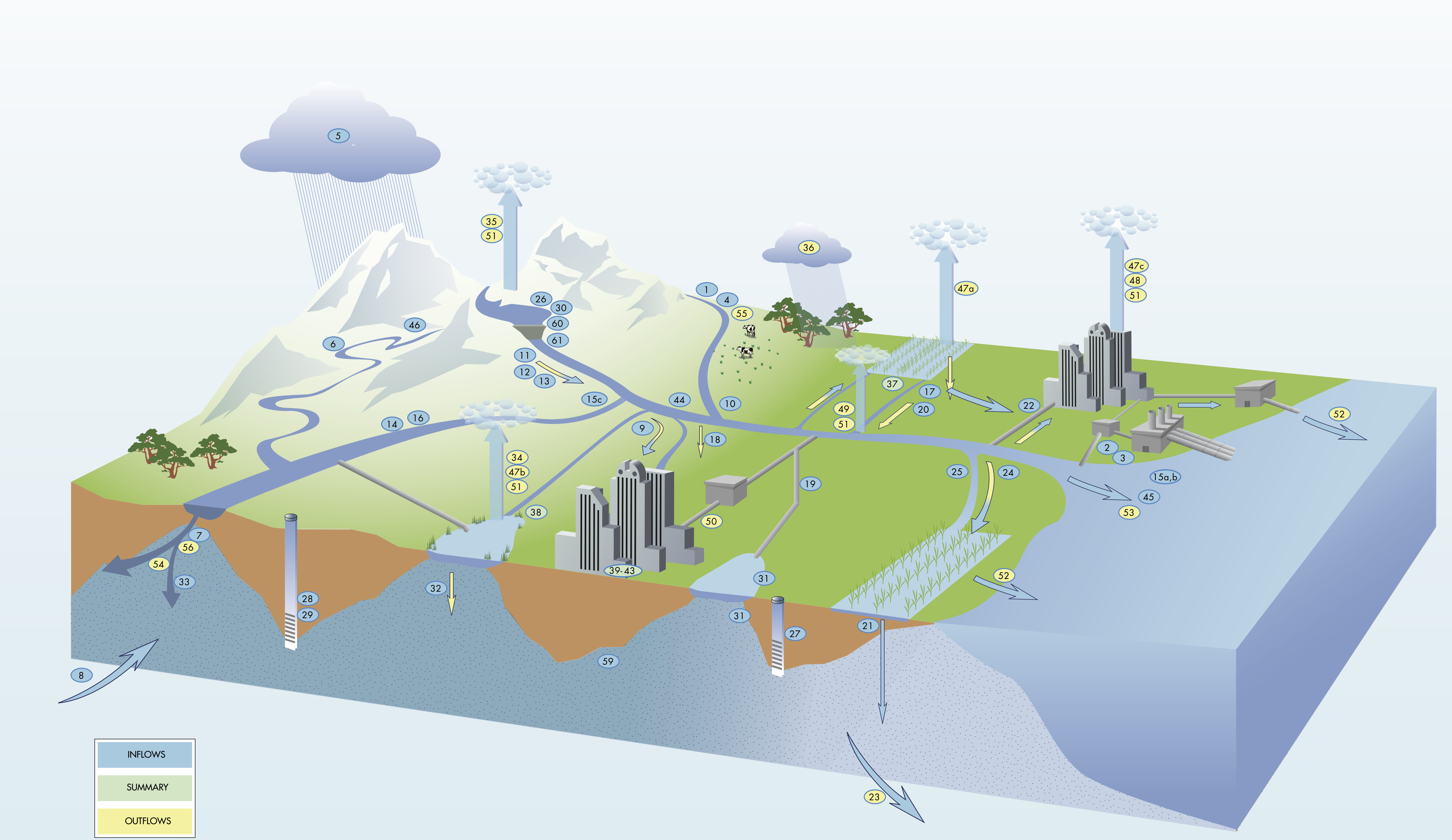
Colorado River Hydrologic Region

Table 11-10 Colorado River region water portfolio (TAF)

ID Number:	Flow Diagram Component (see legend)	Colorado River 1998	Colorado River 2000	Colorado River 2001
1	Colorado River Deliveries	3,905.1	4,053.0	3,946.6
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	182.4	165.6	154.7
5	Precipitation	9,454.8	3,033.9	4,769.9
6a	Runoff - Natural	N/A	N/A	N/A
b	Runoff - Incidental	N/A	N/A	N/A
7	Total Groundwater Natural Recharge	N/A	N/A	N/A
8	Groundwater Subsurface Inflow			N/A
9	Local Deliveries	6.6	6.3	4.0
10	Local Imports	-	-	-
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	-	-	-
12	Other Federal Deliveries	-	-	-
13	State Water Project Deliveries	156.4	100.6	24.1
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	-	-	-
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	-	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	-	-	-
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	-	-	-
b	Recycled Water - Urban	16.1	17.2	17.9
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	-	-	-
b	Return Flow to Developed Supply - Wetlands	-	-	-
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	47.8	48.8	44.6
b	Deep Percolation of Applied Water - Wetlands	-	-	-
c	Deep Percolation of Applied Water - Urban	109.4	161.6	168.4
22a	Reuse of Return Flows within Region - Ag	130.8	133.5	135.3
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	-	-	-
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	-	-	-
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions	N/A	N/A	
26	Surface Water in Storage - Beg of Yr	580.8	585.4	566.9
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	387.0	416.3	408.8
23	Groundwater Subsurface Outflow	N/A	N/A	N/A
30	Surface Water Storage - End of Yr	566.3	566.9	568.3
31	Groundwater Recharge-Contract Banking	-14.7	-59.2	-8.9
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation	N/A		N/A
b	Evaporation and Evapotranspiration from Unirrigated Ag	N/A		N/A
35a	Evaporation from Lakes	1555.5	1552.5	1552.4
b	Evaporation from Reservoirs	120	121.5	120.6
36	Ag Effective Precipitation on Irrigated Lands	146.6	14.1	76.2
37	Agricultural Water Use	3,531.8	3,674.6	3,561.7
38	Managed Wetlands Water Use	31.6	30.2	29.6
39a	Urban Residential Use - Single Family - Interior	144.2	154.6	123.1
b	Urban Residential Use - Single Family - Exterior	57.1	55.8	67.4
c	Urban Residential Use - Multi-family - Interior	25.9	15.7	36.0
d	Urban Residential Use - Multi-family - Exterior	8.1	3.3	7.7
40	Urban Commercial Use	71.4	123.5	145.0
41	Urban Industrial Use	3.3	4.6	4.6
42	Urban Large Landscape	156.9	148.8	122.4
43	Urban Energy Production	76.7	76.7	76.7
44	Instream Flow	-	-	-
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	-	-	-
47a	Evapotranspiration of Applied Water - Ag	2560.4	2627.3	2548.45
b	Evapotranspiration of Applied Water - Managed Wetlands	31.6	30.2	29.6
c	Evapotranspiration of Applied Water - Urban	222.102	207.9	196.48
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	80.3	86.8	83.5
50	Urban Waste Water Produced	61.9	67.6	69.2
51a	Conveyance Evaporation and Evapotranspiration - Urban	13.91	14.42	14.6
b	Conveyance Evaporation and Evapotranspiration - Ag	64	64	64
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	-	-	-
d	Conveyance Outflow to Mexico	N/A	N/A	
52a	Return Flows to Salt Sink - Ag	997.9	1053.5	1026.7
b	Return Flows to Salt Sink - Urban	187.39	198.28	201
c	Return Flows to Salt Sink - Wetlands	-	-	-
53	Remaining Natural Runoff - Flows to Salt Sink	-	-	-
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	4,986.0	5,349.0	5,197.0
56	Regional Exports	1081	1296	1250
59	Groundwater Net Change in Storage	-88.1	-164.5	-180.6
60	Surface Water Net Change in Storage	-14.5	-18.5	1.4
61	Surface Water Total Available Storage	620.4	620.4	620.4

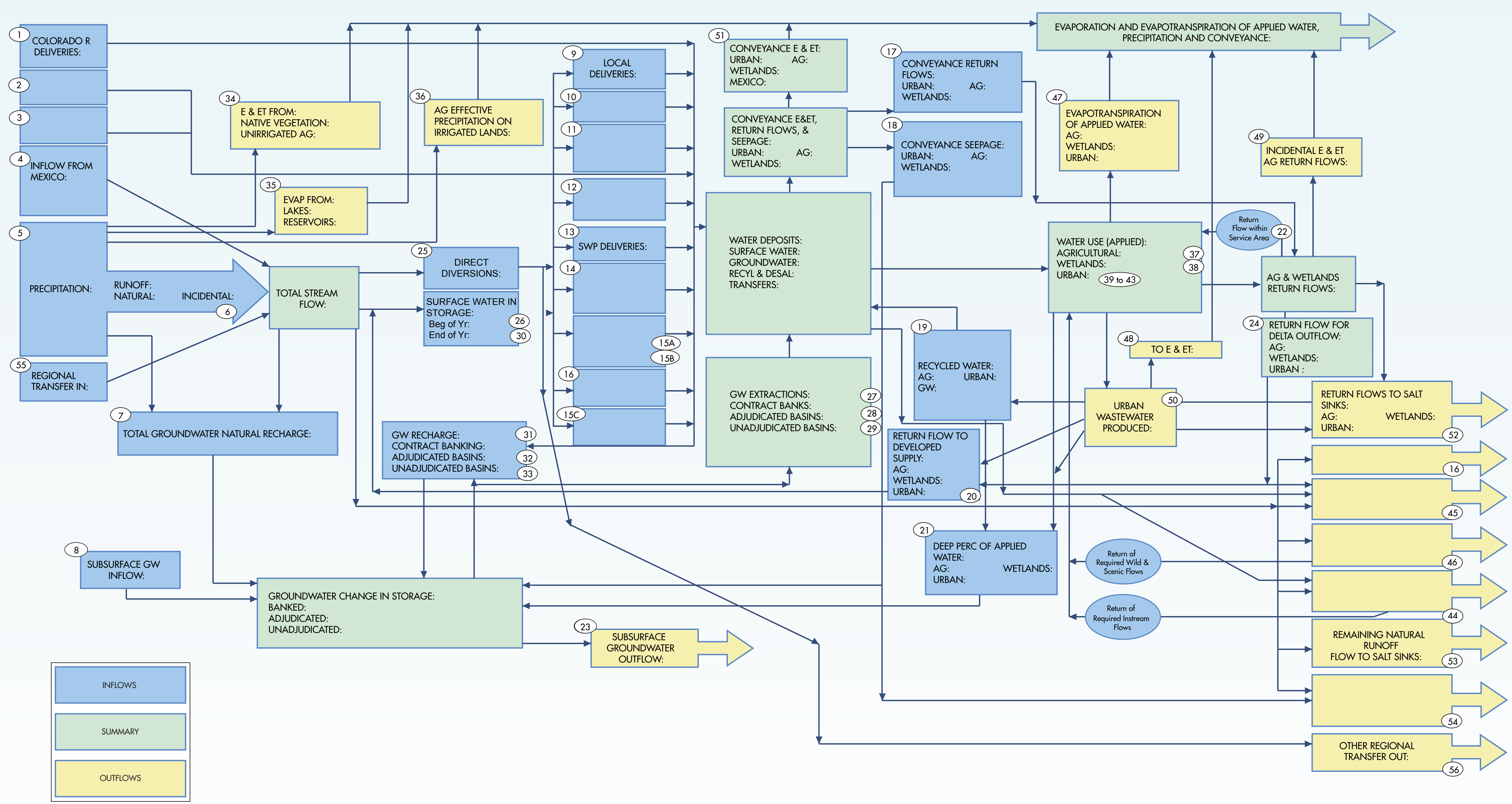
Legend: Inflows | Outflows | Green number signifies included in summary boxes

Figure 11-4 Colorado River region - illustrated water flow diagram



In this illustration of Table 11-10, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 11-5 Colorado River region - schematic flow diagram



In schematic of Table 11-10, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates whether the component is water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.

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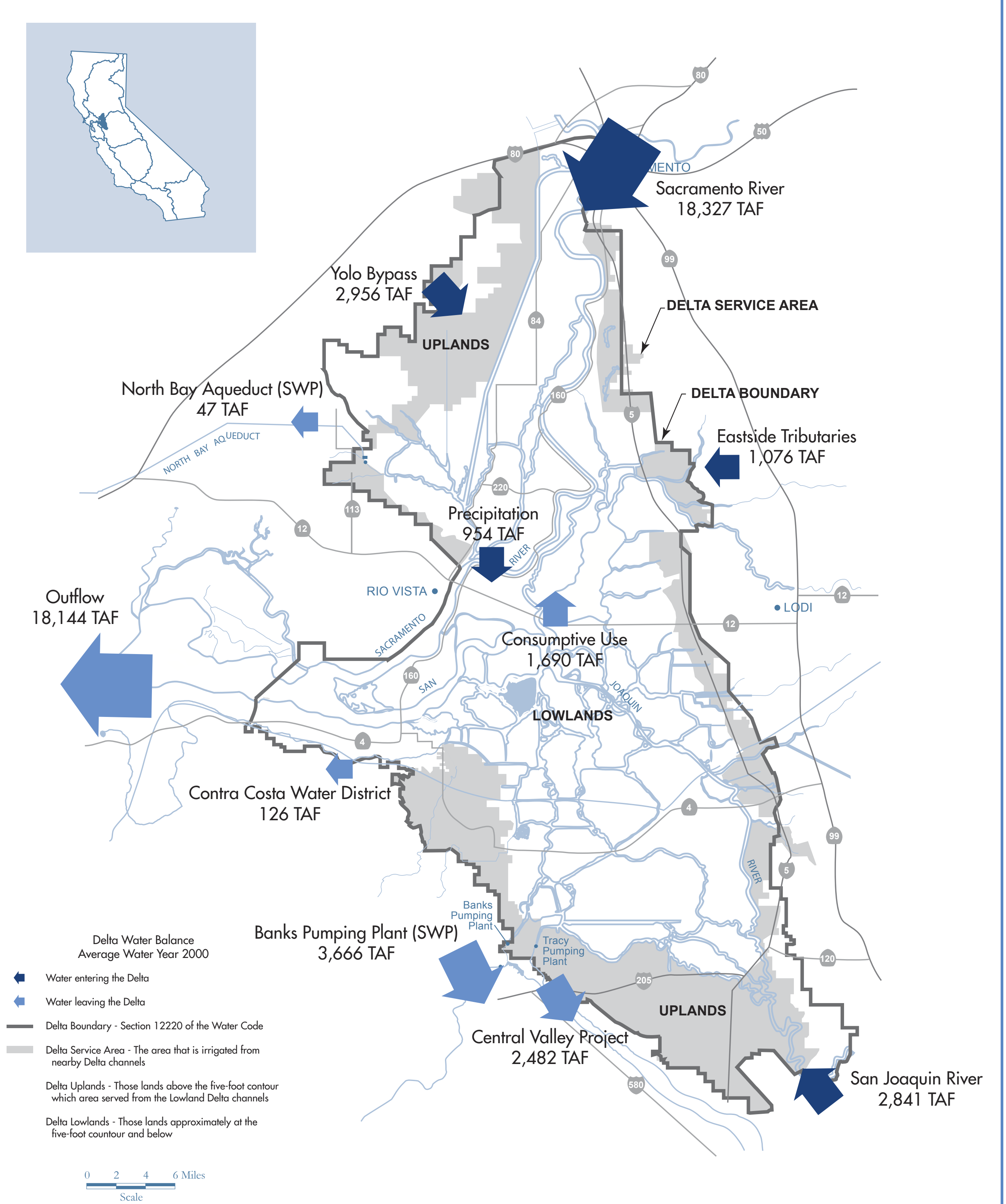
Figure12-1 Delta water balance for year 2000



Delta water balance for water year 2000 includes key annual Delta inflows, exports, precipitation, consumptive use, and Net Delta Outflow.

Chapter 12 *Sacramento-San Joaquin Delta Region*

Setting

Until 1850, the Sacramento-San Joaquin Delta (Delta) was wild, a tidal marsh with islands and river channels that changed according to nature's will. By the 1870s, settlers had built levees and turned marshland into farmland. Farming on a commercial scale became a way of life. The 1870s and 1880s saw the arrival of commercial fisheries that introduced nonnative species—striped bass and American shad. As decades passed, commerce grew, and ocean shipping began using Delta ports to transport goods between California and foreign markets. Along with international shipping came invasive aquatic species unintentionally carried to the Delta in the ballast water of these vessels. By 1951, with completion of the Delta-Mendota Canal, the Delta was forever changed. This federal project for moving water to California's Central Valley farms was the start of large-scale water supply infrastructure that would, with the addition of the State Water Project (SWP) and other smaller projects, evolve into today's multibillion dollar system.

The Delta was formally defined in the Delta Protection Act of 1959 (California Water Code Section 12220) and is composed of The Uplands Zone (lands above the 5-foot elevation contour) and the Lowlands Zone (lands at or below the 5-foot contour line). The statutory Delta Boundary that defines the Legal Delta is shown in Figure 12-1.

This massive network of canals, levees, pumps, and fish screens moves water to farms, industries, and residents hundreds of miles from the Delta. What was once a continually changing tidal marsh with a rich variety of thriving, native species is now a complex maze of natural and man-made resources providing multiple benefits to the California economy.

The challenge the region faces in the 21st century is how to sustain the viability of these resources while demand for them continues to grow.

The region's resources must be managed for generations to come. The overarching challenge involves finding ways for all the interests who benefit from the Delta to integrate a vast array of projects intended to improve water quality, ecosystem health, levee stability, and water supply in ways that provide long-term, sustainable benefits at reasonable costs to everyone.

This regional report for the Delta Region is an overview of recent efforts to carry out actions that will help the region to continue to serve society's demand for farm products, fishing, recreation, and water—all while protecting the Delta's ecosystem and water quality. The intent of the profile is to give readers a sense of the region's water resource management priorities and outline major efforts to integrate water resource management activities in the Delta. For more detailed information about actions and projects mentioned in this profile, consult the selected references noted at the end of this chapter.

Topography and Climate

The Delta is a unique and valuable resource and an integral part of California's water system. Located at the confluence of the Sacramento and San Joaquin Rivers, the Delta is part of the largest estuary system on the West Coast and is the keystone to operation of the two largest water projects in California the SWP and the federal Central Valley Project (CVP). The region extends from the confluence of the two rivers inland to Sacramento and Stockton and spans roughly 750,000 acres. A large part of this land is below sea level, and relies on more than 1,100 miles of levees for protection against flooding along the hundreds of miles of interlaced waterways.

The Delta's network of waterways conveys runoff toward San Francisco Bay and the Pacific Ocean from over 40 percent of California's land area. Major tributaries include the Sacramento, San Joaquin, Calaveras, Cosumnes, and Mokelumne rivers. These rivers plus their tributaries carry 47 percent of the state's total annual runoff.

The Delta is at the confluence of the Sacramento and San Joaquin rivers. Its network of waterways conveys runoff toward San Francisco Bay and the Pacific Ocean to the west. (Photo courtesy of NASA)

Land Use

The vast majority of the Delta land is agricultural (about 538,000 acres). These acres are among the most highly productive in the world. Open water covers about 60,000 acres, while urban and commercial property comprises approximately 64,000 acres. The remainder of the region presently consists of undeveloped natural plant vegetation.

Population

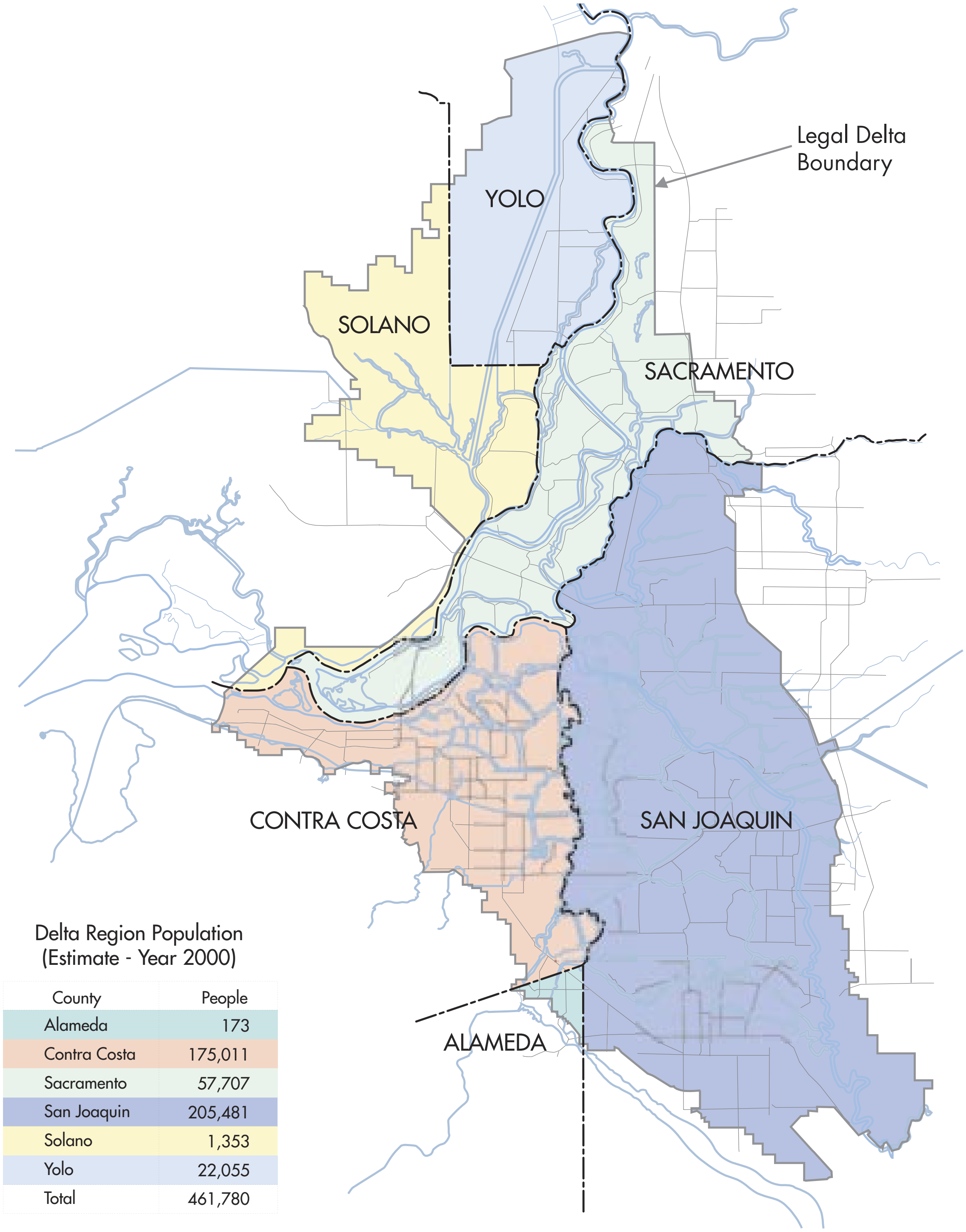
The legal Delta encompasses portions of six counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano and Yolo. According to the census figures used in the 1995 Sacramento-San Joaquin Delta Atlas, the population in the Delta was an estimated 410,000 in 1990. A more recent estimate was obtained using data from the California State Census Data Center for areas of these counties within the legal Delta, indicating that about 462,000 people resided in the Delta region as of the 2000 Census. Figure 12-2 shows a map of population estimates for each of the county areas within the legal Delta. Rapid growth is occurring in urban areas in and surrounding the Delta, especially in Elk Grove (27.0 percent growth per year – the highest growth rate in California), Tracy (5.9 percent per year), Brentwood (12.3 percent per year), and Rio Vista (11.1 percent per year)[1].

Water Use

Water use in the Delta region is mostly agricultural, with over 4,000 cubic feet per second of surface water diversions used to irrigate crops during peak summer months. Irrigation diversions from about 1,800 sites in the Delta total about 1 million acre-feet annually. The main crops grown in the Delta are corn, alfalfa, other grains, tomatoes, and safflower. Grapes are being harvested in increasing numbers within the Delta region, and are quickly becoming one of the primary crops. Table 12-1 shows the approximate number of acres planted in various crops within the Delta Service Area and the associated applied water demand, as of year 2000.

1 Growth rates are for the period between Jan. 1, 2003, and Jan. 1, 2004, and are from the California Department of Finance, E-1 City Population Estimates, May 5, 2004.

Figure 12-2 Delta region population



Delta Region Population
(Estimate - Year 2000)

County	People
Alameda	173
Contra Costa	175,011
Sacramento	57,707
San Joaquin	205,481
Solano	1,353
Yolo	22,055
Total	461,780

Data from California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for Sacramento-San Joaquin Delta.

Table 12-1 Crop Acreage and Applied Water Demand in the Delta Service Area as of 2000 (DWR Central Dist. 2004)

Crop	1,000 Acres	Applied Water (TAF)
Corn	113.2	325
Alfalfa	55.1	298
Other Grains	47.2	51
Processed Tomatoes	36.2	117
Safflower	33.8	26
Pasture	32.4	192
Vine Crops (grapes)	23.6	42
Other Truck Crops (strawberries, chili, etc.)	21.4	56
Other Deciduous Crops (apples, etc.)	18.3	78
Dry Beans	10.2	26
Other Field Crops	9.2	24
Fresh Market Tomatoes	6.6	16
Sugar beets	6.5	28
Cucurbits (cucumbers, gourds, melons, pumpkins)	4.7	10
Potatoes	3.9	12
Almonds, Pistachios	1.8	7
Rice	0.9	5
Onion and Garlic	0.6	2
Subtropical Crops (citrus, kiwis, etc.)	0.1	0.3
TOTAL[1]	425.7	1,315.3

[1] The total crop acreage listed here (425,700 acres) is less than the 538,000 acres of agricultural land listed in the Delta Atlas (1991 land survey) for several reasons. The 2000 level in Table 12-1 only includes planted irrigated acres while the 1991 number includes other types of agricultural land, and the 2000 data is for the Delta Service Area – a smaller area than the Legal Delta used in the Delta Atlas. Urbanization of agricultural lands and weather conditions at the time of surveys are among the other reasons.

Most Delta farms use water taken directly from Delta sloughs and rivers under riparian water rights, and drainage water from the islands is pumped back into the Delta waterways. Small communities in the Delta primarily use groundwater wells for their water needs, and urban water use in the Delta only accounts for a small percentage of the total developed supply[2]. The remaining portion of water in the Delta is either used by other forms of evapotranspiration or contributes to Delta outflow, through which it can provide wildlife habitat and salinity control benefits. Recreation water uses do not have a large affect on the Delta water balance, but are still important in the Delta, with an estimated 12 million "user days"[3] recorded each year for recreation purposes.

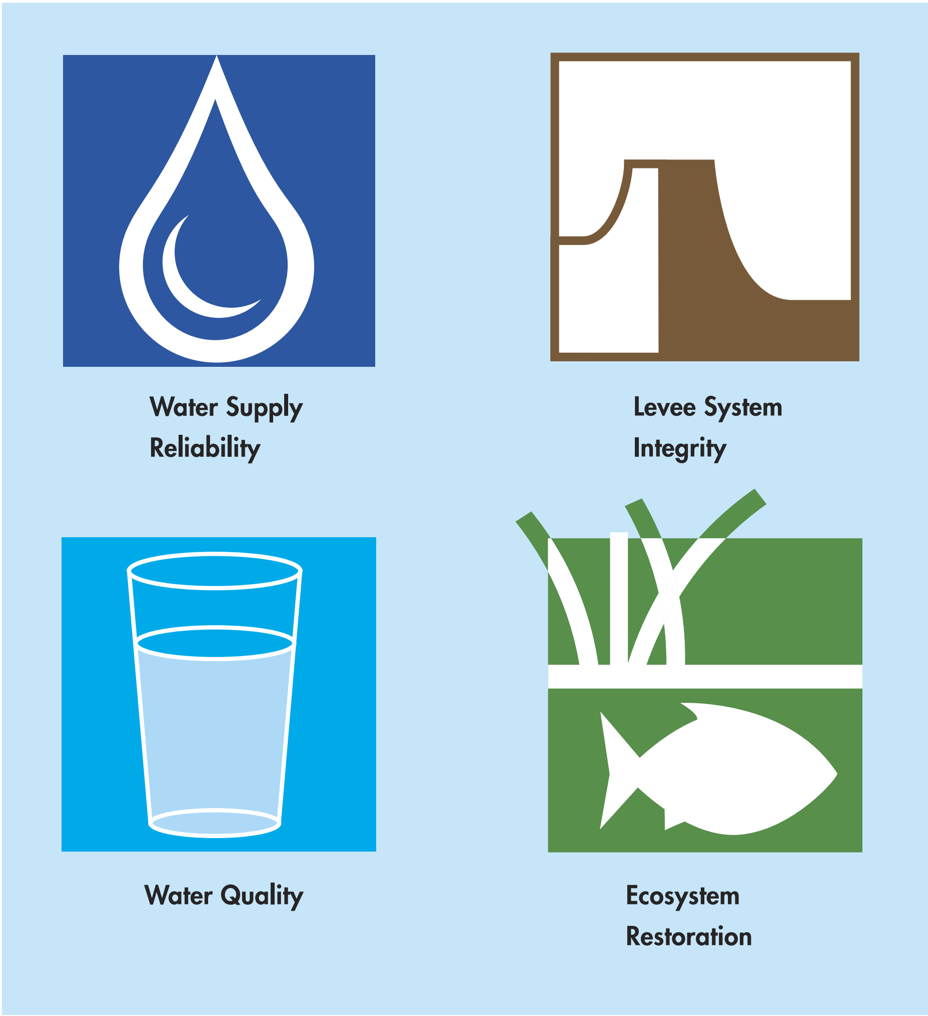
Water Exported from the Delta

The Delta is the major source of fresh water to the San Francisco Bay and provides a portion of the water supply for many other communities in the bay region. Water from the Delta supplies drinking water for over two-thirds of the state's population (over 23 million people) and irrigation water for more than 3-million acres of farmland statewide. The largest source of water for the Delta is the Sacramento River, which transports about 18.3 million acre-feet into the Delta in an average year. Additional flows from the Yolo Bypass and the San Joaquin River bring in an average of 5.8 million acre-feet, with precipitation adding about another 1 million acre-feet. Larger diversions in the Delta include the SWP (Banks Pump-

[2] One important exception is the Contra Costa Water District, which provides treated Delta surface water to roughly 500,000 people, but not all of the serviced population is within the Legal Delta.

[3] A "user day" is a measure of the number of people visiting or using a site over part or all of a given day. Since some recreation users will visit recreation areas more than once each year, the total number of people using recreation facilities over a year in the Delta is less than 12 million.

Figure 12-3 CALFED objectives



ing Plant and the North Bay Aqueduct), CVP (Tracy Pumping Plant), and Contra Costa Water District, which withdraw about 3.7 million, 2.5 million, and 126 thousand acre-feet in an average year, respectively. Figure 12-1 shows the primary locations and amounts of Delta inflows, outflows and exports, as they occurred in water year 2000. Table 12-2 summarizes the Delta water balance for years 1998 (wet), 2000 (average), and 2001 (a dry year) and identifies the major water inputs and outputs for the Delta.

Water Standards

Requirements of the State Water Resource Control Board (SWRCB) govern the release of upstream flows and curtailment of export pumping to maintain Delta water quality and outflow requirements for the San Francisco Bay. The first water quality standards for the Delta were adopted in May 1967, when the State Water Rights Board (predecessor to the SWRCB) released Water Right Decision 1275, approving water rights for the SWP while setting agricultural salinity standards as terms and conditions. These requirements were altered in 1971 under SWRCB Decision 1379 (D-1379), which added standards that the CVP and SWP are to meet for non-consumptive uses (water dedicated to fish and wildlife), along with agricultural, municipal, and industrial consumptive use standards. In 1978, the SWRCB issued D-1485 and the 1978 Delta Plan, which together revised flow and salinity standards and required the US Bureau of Reclamation (USBR) and Department of Water Resources (DWR) to reduce pumping, release stored water upstream, or both when needed to meet the standards.

Table 12-2 Water Balance for the Delta Region (IEP Dayflow Data TAF)

Water Entering the Region	1998 (wet)	2000 (average)	2001 (dry)
Precipitation	1,421	954	762
Sacramento River	28,964	18,327	10,499
Yolo Bypass (incl. Sac. Weir spill and South Putah Cr.)	8,980	2,956	366
San Joaquin River	8,441	2,841	1,729
Cosumnes River	785	372	116
Mokelumne River	969	360	127
Misc. Eastside Tribs.	339	344	128
Total	**49,899**	**26,155**	**13,727**
Water Leaving the Region			
Consumptive Use (Gross Channel Depletion for Ag, M&I, Wetlands, ET)	1,688	1,690	1,688
SWP Exports			
Banks Pumping Plant	2,111	3,666	2,599
North Bay Aqueduct	39	47	45
CVP Exports	2,470	2,482	2,328
Contra Costa WD Exports	160	126	104
Outflow to Bay/Ocean	43,430	18,144	6,963
Total	**49,899**	**26,155**	**13,727**

In 1986, Congress passed the CVP-SWP Coordinated Operation Agreement (Title I of Public Law 99-546), requiring that the CVP be operated in coordination with the SWP to meet state water quality standards. Also in 1986, the Supreme Court upheld the Racanelli Decision, which recognized SWRCB authority and discretion over water rights and water quality issues, including authority over CVP operations. As a result of increasing use of Delta waters combined with escalating environmental and fishery problems, the SWRCB adopted a new Bay-Delta Plan in 1991, which included objectives for salinity, dissolved oxygen, and temperature. The United States Environmental Protection Agency (EPA) followed with federal standards for the Estuary through EPA regulations in 1994. In December of 1999, the SWRCB issued a new Decision 1641 as a part of the1995 Bay-Delta Water Quality Control Plan, which replaced earlier Delta standards and conditioned the water rights permits of the SWP and CVP to implement the new objectives. The requirements set in D-1641 covered Phases 1 – 7 of the Bay-Delta Water Rights Hearings. In April of 2001, the SWRCB went on to adopt Water Rights Order 2001-05, which facilitates negotiations to settle the responsibilities for implementing and maintaining the 1995 WQCP.

Currently the SWP and the CVP coordinate project operations to maintain the standards established by D-1641, by releasing water from upstream reservoirs for Delta outflow requirements, and by curtailing export pumping at the SWP Banks and CVP Tracy Pumping Plants during specified time periods. This combination of Delta outflow requirements and export pumping limitations impose the most difficult challenges to the process of transporting water from upstream reservoirs to meet water needs in the San Joaquin Valley, San Francisco Bay Area, and Southern California.

CALFED Bay-Delta Program

The mission of the CALFED Bay-Delta Program is to develop and implement a long-term, comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Sacramento – San Joaquin Bay-Delta system. The plan was adopted by CALFED agencies when they signed the Record of Decision on August 28, 2000, approving a 30-year comprehensive plan. The ROD identifies priorities for implementing the plan for the first seven years and describes additional actions complementary to the plan. Since the ROD was adopted, CALFED agencies have been investing in collaborative regional projects that provide local benefits while helping achieve overall program objectives.

Some of the major water-related challenges facing the Delta have been summarized by the Bay-Delta Authority as "priorities and issues" for the region:

- Restore healthy ecosystems to benefit native species.
- Preserve a viable agricultural base.
- Maintain strong levees.
- Protect water quality for agricultural and urban water users in and around the Delta.
- Protect and increase recreational opportunities.

These goals incorporate the four broad CALFED resource management objectives of water supply reliability, water quality, ecosystem restoration, and levee system integrity, and respond to concerns expressed by stakeholders in the Delta and other regions of the state (Figure 12-3).

Authorized by the Delta Protection Act of 1992, the Delta Protection Commission (DPC) is the regional entity charged with protecting the natural, agricultural, and recreational resources of the Delta. The Act required the DPC to develop and adopt a resource management plan for the primary zone of the Delta (defined in Public Resources Code Section 29728). The DPC's mission is to guide the protection of the Delta's unique natural quality, cultural viability, economic viability, and recreational opportunities using three main objectives:

- Protection, maintenance, and enhancement and restoration of the overall quality of the Delta environment including agriculture, wildlife habitat, and recreational activities;
- Assurance of orderly, balanced conservation and development of Delta land resources; and
- Improvement of flood protection to ensure an increased level of public health and safety.

The CALFED Program, its implementing agencies, and the DPC recognize that activities of the CALFED Ecosystem Restoration, Conveyance, Storage, and Levee System Integrity program elements must be in concert with the Delta region's land use and recreation objectives. Therefore, CALFED and the DPC coordinate activities on a regular basis.

State of the Region

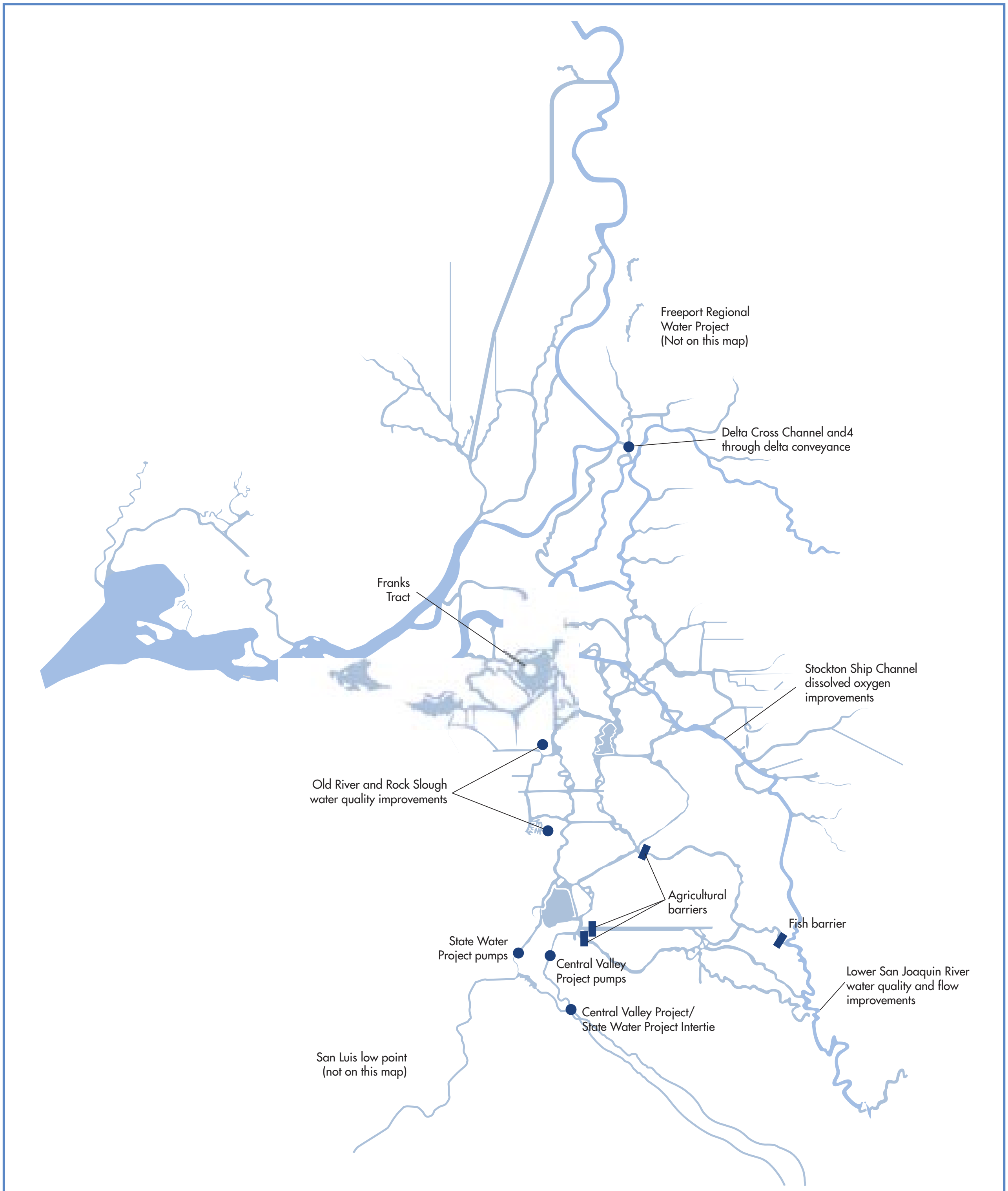
The Delta is a focal point for water management, ecosystem restoration, land use planning, and other major initiatives in California. The Delta Improvements Package, which has been identified as a critical CALFED implementation mechanism, is focused on actions within the Delta. Over $155 million has already been spent on ecosystem projects, studies, and acquisition within the Delta through this Bay-Delta Program. Urban encroachment in the Delta is becoming a critical issue, and some of the fastest growing communities in the state can be found within and around the Legal Delta. Concerns over increased water diversions from northern to southern California are based on pumping operations within the Delta. The Delta is, and will likely continue to be, a hot spot for both controversy and innovation in terms of resource management.

Two of the agencies identified with key planning roles in the Delta are the California Bay-Delta Authority and the Delta Protection Commission (DPC). The Bay-Delta Authority is responsible for implementing the Bay-Delta Program (Box 12-1) . The DPC comments on applications for CALFED ecosystem restoration grants that affect the Delta and participates in meetings with other CALFED agencies to provide input to CALFED Program management decisions. DPC staff also provides input to the following BDPAC subcommittees: Working Landscapes Subcommittee (created to pursue partnerships with private landowners in meeting CALFED ecosystem, water quality, levee, and water supply reliability goals); the Delta Levees and Habitat Advisory Committee; and the Ecosystem Restoration Subcommittee. Many projects and programs are being carried out to address local and statewide needs related to the Delta. The stakeholders involved in Delta implementation issues are increasingly aware of how complex and interrelated solutions must be to avoid adverse impacts to other stakeholders and to provide long-term, comprehensive management of Delta land and water resources. Some of the major implementation issues and achievements to date are summarized below.

Box 12-1 California Bay-Delta Authority

The California Bay-Delta Authority officially became a State agency in January 2003. The authority oversees implementation of the CALFED Bay-Delta Program to improve water supplies in California and the health of the San Francisco Bay–Sacramento/San Joaquin River Delta. The organization and focus of this Authority is being reviewed and changed in 2005.

Figure 12-4 Proposed Delta gates map



Water Supply Reliability

Because water users within the Delta divert directly from adjacent channels running through the Delta, they normally have immediate access to water. However, water levels in these channels are influenced by river inflows, ocean tidal levels, and CVP and SWP operations, especially diversions at the south Delta export pumps. Lower water levels in the south Delta channels can make it difficult for local irrigators to pump or siphon the water from the channels to their farmlands. In addition, the flow of water to the export pumps can sometimes draw water with a higher salinity into the south Delta from the western Delta.

To help address these water level problems, CALFED agencies provide assistance in creating temporary barriers in portions of the Delta to raise water levels and improve water quality for irrigators. The Environmental Water Account helps improve water supply reliability by acquiring water from willing sellers to compensate for lost supplies during periods of export pumping curtailment for fish protection.

Longer-term solutions involving the installation of flow control gates are being analyzed as part of the South Delta Improvements Program(see figure 12-4), which would eventually make possible increased pumping operations at Banks Pumping Plant to 8,500 cubic feet per second during acceptable periods of the year. Design and environmental reviews of the SDIP are ongoing. Other water supply activities in the Delta currently under investigation by CALFED include: adding an intertie between the CVP and SWP canals south of the Delta; re-operating the Delta Cross-Channel (DCC) for the benefit of fish and water quality; and feasibility studies for an in-Delta storage project. Thus far, modeling studies for the CVP-SWP intertie and two years of research experiments on DCC re-operation have been completed. In addition, a draft report about the engineering feasibility of the in-Delta storage project has been published for review and consideration.

Water Quality

The Delta is a source of drinking water for over 23 million Californians, which underscores the importance of carefully managing water quality in the region. Key drinking water constituents that are of concern are bromide and organic carbon, because they are known to contribute to the production of trihalomethanes (THMs) during the drinking water chlorination process. There are a wide range of water quality issues in the Delta, and several different initiatives have been organized in response.

Salinity

The impact of salinity on water quality in the Delta is important and directly related to water supply reliability. The balance between ocean tides, river outflows, salinity input from agricultural and urban drainage, export pumping rates, and other factors directly impacts aquatic health in the Delta and the public health of those who use Delta drinking water. One problematic component of water salinity is bromide, which is known to produce trihalomethanes (THMs) during drinking water chlorination. THMs are known carcinogens and are subject to strict federal drinking water quality standards. South Delta agricultural diverters are often faced with high levels of water salinity, which can damage crops and reduce productivity. DWR's South Delta Temporary Barriers Project is designed to limit saltwater intrusion into areas with agricultural diversions, while also raising Delta water levels (Figure 12-5).

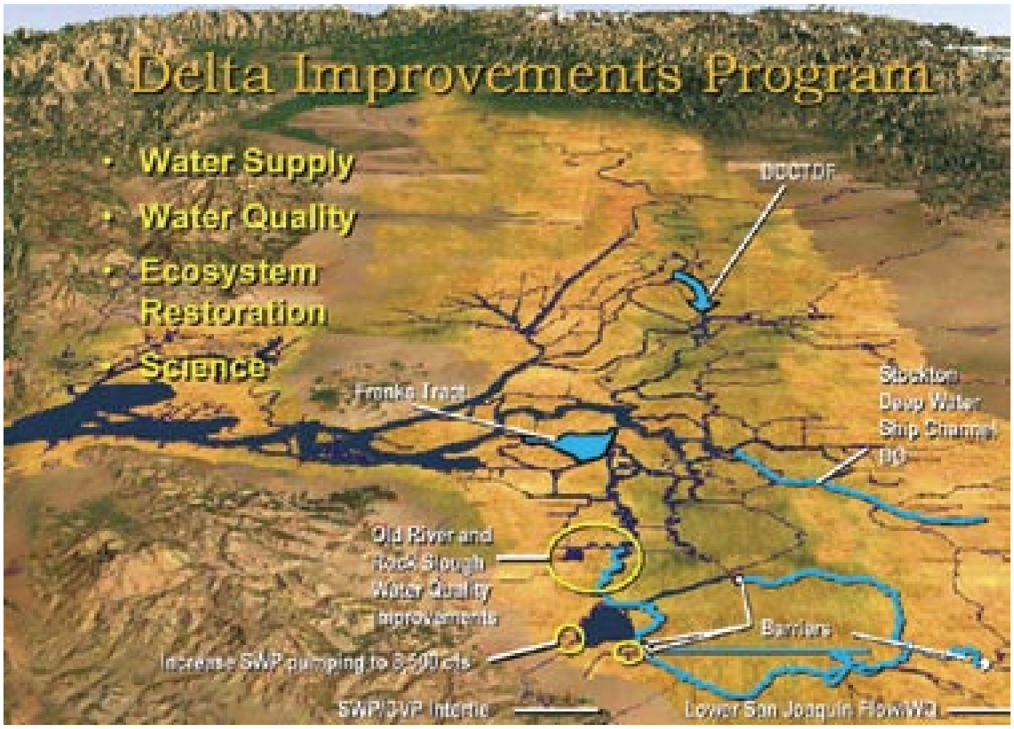
Mercury

Mercury can be found in waterways throughout the Delta as a result of historical mining activities that were widespread throughout the Sacramento Valley, such that the entire Delta is presently on the SWRCB's 303(d) list[4] for sources of mercury. Miners used mercury to separate gold from rock in the Coast Range, and abandoned gold and mercury mines continue to leach mercury today. While mercury in its natural form is usually not easily transmitted into living organisms, some natural processes encourage conversion to methyl mercury, which is a powerful neurotoxin that accumulates in fish tissue and is harmful to animals and humans. Restoration of wetlands has faced increasing scrutiny because the conversion of mercury to methylmercury (that is, methylation) may be encouraged by certain natural wetland processes.

In response to this threat, research is now under way to study mercury transport, how to reduce the risks associated with human exposure, and potential methods to reduce methylation—particularly in restoration activities. The CALFED Ecosystem Restoration Program (ERP) has invested over $4 million in two research projects that investigated a wide variety of mercury issues, and culminated in a "mercury strategy" developed by a team of independent mercury experts. The new strategy includes recommendations for how to carry out future restoration work while minimizing methylation impacts. A more intensive follow-up study is now under way to expand on this knowledge and reduce the levels of uncertainty.

[4] The Clean Water Act requires that states and territories identify impaired and threatened water bodies that are not expected to meet water quality standards, as outlined in Section 303(d) of the Act. These lists result in the development of Total Maximum Daily Loads (TMDLs), which establish the maximum amount of pollutants the water body can receive while still meeting water quality standards.

Figure 12-5 Delta Improvements Program



The Department of Conservation with assistance from ERP has created two workgroups to deal with mercury source issues related to abandoned mines. A "fish consumption workgroup" has also been organized to coordinate funding and management efforts between the various agencies in order to educate people about reducing consumption risks resulting from mercury contamination. Other agencies and organizations working to address mercury include the Delta Tributary Mercury Council, the Central Valley Regional Water Quality Control Board, the San Francisco Bay Regional Monitoring Program, the Office of Environmental Health Hazard Assessment (OEHHA), the Department of Health Services, the San Francisco Bay Regional Water Quality Control Board, EPA, the Sierra Trinity Abandoned Mine Lands Agency Group, and the Bay-Delta Public Advisory Subcommittee on Environmental Justice.

Dissolved Oxygen (DO)

Current water quality standards call for at least 5 milligrams per liter of dissolved oxygen in Delta water to protect aquatic organisms (including fish), allow for successful fish reproduction and juvenile rearing, and prevent odor problems. Discharges into the San Joaquin River and the Delta sometimes contain material with a high biochemical oxygen demand or a high nutrient level, which can encourage algae growth and trigger subsequent oxygen depletion. These discharges, along with depleted freshwater flows, channel configuration, and water temperatures, have resulted in isolated areas in the Delta with DO levels below the current standard. On the San Joaquin River, low DO levels may pose a barrier to fall-run salmon migrating upstream to spawn.

The DO problem is not a new phenomenon, and has been studied for some time. DWR and the Inter-agency Ecological Program (IEP) have maintained monitoring efforts on the San Joaquin River and the Stockton Deep Water Channel since the 1980s. CALFED ERP expenditures of about $4 million have been spent on monitoring and research activities related to DO, including development of models to better understand thermal stratification in the San Joaquin River. ERP has also begun a feasibility study for using water aeration techniques to increase DO levels, and several aeration and nonaeration methods are under development.

Organic Carbon (TOC)

Organic carbon is itself not a harmful constituent—In fact it is essential for aquatic life (Box 12-2). Problems occur when water containing high levels of organic carbon is treated in drinking water treatment plants, which use chemicals to inactivate harmful pathogens. Some forms of organic carbon react with these beneficial disinfection agents, such as chlorine, and produce potentially carcinogenic disinfection byproducts (for example, trihalomethanes). Since wetland restoration efforts could potentially increase the level of vegetation and organic carbon in Delta water supplies, there may be conflicting objectives between ecosystem restoration and water quality initiatives, as is also the case with mercury.

Because some organic carbon processes are still poorly understood, much of the current work is focused on investigating how carbon is used in the aquatic food web and how natural and anthropogenic factors affect the type and amount of organic carbon released into the system. As part of approximately $10 million in funds designated for CALFED ERP organic carbon projects, one research project, funded jointly with the CALFED Drinking Water Quality Program, is attempting to determine if coagulants could be used to remove organic carbon from Delta island drainage. The U.S. Geological Survey (USGS) is spearheading much of the organic carbon efforts, working in conjunction with ERP. The CALFED DWQ Program is also involved, investing $1.7 million in 2003 in four drinking water quality projects to monitor and assess organic carbon sources and processes in the Delta. DWR's Municipal Water Quality Investigations (MWQI) Program has also funded organic carbon projects in the Delta, including real-time monitoring, source assessment, and studies of byproduct formation potential.

Selenium

Selenium enters the Delta region from multiple sources, including groundwater discharges from selenium-containing soils, agricultural runoff, and refinery water input from the San Francisco Bay. Selenium, like mercury, bioaccumulates in aquatic life and has been shown to have negative affects on fish and waterfowl. High selenium concentrations could cause disruptions in drinking water and agricultural water deliveries, and are often correlated with high salinity levels as well.

CALFED's ERP is currently implementing several projects to study the sources, transport, and biological affects of selenium in the Delta. One ERP project is also examining the potential for using bacteria to reduce selenium contamination in agricultural return water. The DWQ Program is also coordinating projects that focus on selenium in irrigation drainage water from the San Joaquin Valley.

Other agencies involved with the selenium issue include the USGS, which has worked on ERP projects and other initiatives to forecast selenium discharges and study its affects on the aquatic environment. In the San Joaquin Valley, USBR and the San Luis & Delta Mendota Water Authority have successfully developed the Grasslands Bypass Project to reduce selenium loads in agricultural drainage water before it enters the San Joaquin River. Both the Central Valley and San Francisco Regional Water Quality Control Boards are now developing Total Maximum Daily Loads (TMDLs) for the San Joaquin River and San Francisco Bay, respectively. The University of California, Davis has also participated in selenium research, particularly with bioaccumulation and the use of microalgae to treat agricultural drainage water.

Pesticides

Pesticides include insecticides, herbicides, fungicides, and other substances used to prevent, destroy, repel, or prevent pests. In the Delta, several types of chemical pesticides are widespread, including organophosphates, organochlorines, and pyrethroids. Each of these materials has certain risks for humans and aquatic organisms because they are, by design, meant to disrupt biological processes[5].

Organophosphates (also called organophosphorous pesticides) affect the nervous system and were used in World War II as nerve agents in addition to being used as insecticides (such as chlorpyrifos and diazinon). While usually not persistent in the environment, organophosphates have been found in the Bay-Delta watershed and could impact the distribution and abundance of aquatic species. Organochlorines, which

Box 12-2 Organic Carbon

Organic carbon can be found in different forms in nature, including dissolved organic carbon (DOC) and particulate organic carbon. Total organic carbon (TOC) is a measurement of all forms of organic carbon, and is usually primarily made up of DOC. The sources and fate of DOC and TOC are nearly identical, and the terms are often used interchangeably.

[5] Much of the pesticide information is taken from U.S. EPA Pesticide Program Web site (www.epa.gov/pesticides).

include DDT and chlordane, were used extensively in the past but now are much less widely used because of their toxicity and persistence. Like mercury, organochlorines accumulate in fish tissue and could contaminate humans and animals who consume them. Pyrethroids are synthetic versions of a naturally occurring pesticide in chrysanthemums, and some forms can be extremely toxic to the nervous systems of fish and invertebrates. Pyrethroids are becoming more widely used, but current monitoring equipment is unable to measure concentrations in the environment.

Several projects are now under way to evaluate practices that could reduce pesticide and fertilizer use in the Delta, limit urban pesticide applications in Sacramento and Contra Costa counties, and to study the impact of pesticides on aquatic life. CALFED ERP is involved with many of these efforts, along with a study to develop water quality criteria for the organophosphates diazinon and chlorpyrifos.

Toxicity of Unknown Origin

In addition to the above described constituents that are known to impact organisms in the Delta, there is the possibility that other substances yet to be identified may be contributing to toxicity problems. The CALFED ERP is funding several projects to monitor and attempt to identify the source of certain episodes of toxicity in the Delta. Studies regarding splittail and delta smelt exposures to unknown toxics are being conducted as part of the ERP projects. An implementation plan is also being developed to reduce toxicity associated with these as-of-yet unknown materials.

There are many other constituents and issues related to water quality that are important in the Delta region. Like some forms of organic carbon, bromide, which is a component of salinity, can produce disinfection byproducts when treated with certain, necessary disinfection processes used in domestic water treatment plants. Various pathogens are also present in Delta waterways, and the CALFED DWQ Program is leading several projects to assess pathogen fate and transport from human and animal sources, including animal feeding operations and recreational water use. DWR's MWQI Program is also funding pathogen studies related to hydrostatic pressure, pathogen survivability, and confined animal feeding operations. Sediment is another issue of concern, particularly with respect to dredging operations to maintain the Stockton and Sacramento deepwater ports, which may re-suspend contaminants (from sediment) that are toxic to aquatic life. The US Forest Service has been involved in projects to reduce sediment loading, along with the CALFED watersheds, DWQ, and ERP programs. In addition, studies are under way to model and evaluate water quality improvements that could achieved from proposed Delta conveyance and storage alternatives.

Ecosystem Restoration

Over the past century, the health of the Delta ecosystem has declined in response to the reduction of habitat for both aquatic and terrestrial biota. Remaining habitat quality has also declined due to several factors including water diversions, toxic pollutants, and the introduction of exotic species. In fact, few aquatic ecosystems in North America have been invaded and changed by as many exotic species as those in the Bay-Delta. The Delta no longer provides the broad diversity or quality of habitat necessary to maintain ecological functions and support healthy populations of native plants and animals. Conversion of agricultural land to accommodate ecosystem improvements under the Bay-Delta Program could provide some relief, but these actions are also a major concern for Delta agricultural interests, who rely on the land for their economic survival.

During the past several decades, as water diversions and the recognition of environmental water needs have increased, so have the conflicts among different interests. Water flow and timing requirements have been established for certain fish and wildlife species in response to declining fish and wildlife populations. These requirements restrict the amount of water that can be diverted from the Delta, and constrain the time over which these withdrawals can be made. Over the past decade, a number of other protective actions have been implemented to protect fish and wildlife, including the Central Valley Project Improvement Act (CVPIA) and the 1994 Bay-Delta Accord. While the programs that have resulted have helped provide flows and habitat essential to endangered and threatened species, they have also reduced the ability of the CVP and SWP to meet the water demand of their contractors at the time of year that supplies are needed. This timing issue has contributed to the false perception of a zero-sum game, in which ecosystem or water supply interests can only benefit to the other's detriment, and has created heightened tension between various groups.

To address ecosystem health issues, the CALFED ERP has invested in cooperative projects such as wildlife-friendly agricultural practices, which have shown that different interest groups do not have to compete against each other to prosper in the Delta. Other ecosystem efforts underway include wetlands protection studies, invasive species eradication initiatives, and fish studies to monitor the effects of pesticides on aquatic health. About $155 million has been spent on 107 ecosystem projects in the Delta, representing one of the largest investments in ecosystem restoration in the United States. The ERP has also funded major studies to examine the effects of pesticides on fish in the Bay-Delta system and the release of dissolved organic carbon and methyl mercury from restored wetlands.

Closely associated with ERP, the CALFED Multi-species Conservation Strategy (MSCS) is a comprehensive regulatory plan for the CALFED Program developed in accordance with the federal Endangered Species Act (ESA), the California ESA (CESA), and the Natural Community Conservation Planning Act (NCCPA). The MSCS establishes the programmatic State and federal regulatory requirements for numerous species and habitat types within the MSCS-ERP Focus Area. By implementing and adhering to the MSCS, the CALFED Program can be implemented in compliance with the ESA, CESA, and NCCPA.

Levee System Integrity

The Delta levees confine flow to channels and protect Delta lands from daily flooding by the tidal fluctuations. Without the levees, the Delta would be a 740,000-acre brackish inland sea. In the late 1800s and early 1900s, levees were originally built using the peat soils native to the Delta. This material is weak and highly compressible, which has left many of the levees vulnerable to failure, especially during earthquakes or floods.

The high organic content in the soil contributes to rapid decomposition and settling, and decreases the integrity of the levee structures and their ability to hold back water flows. Delta island farmland, residential land and homes, wildlife habitat, and critical infrastructure could be flooded as a result of a levee failure. Flooding in the Delta has historically resulted in millions of dollars of damages. The State formed a partnership with local agencies in 1986 to improve the condition of the extensive Delta levee system. As a result of that partnership, a new levee maintenance assistance program was implemented, and incidents of levee failure from winter floods have decreased compared to prior years.

Levee failures during the summer (the most recent in June 3, 2004) or fall that inundate islands under non-flood conditions can also cause impacts by pulling salty water into the Delta from San Francisco Bay. The resulting increased salinity in the Delta could shut down CVP and SWP exports from the Delta until fresh water inflows return. Increased salinity in the Delta would be of particular concern in a low water year, when less freshwater is available to flush the salt out of the Delta. This damaging scenario occurred in 1972, when the Brannan-Andrus Island levee failed, resulting in the depletion of about 400,000 acre-feet of water supplies and requiring the removal of about 50 tons of salt. Long-term flooding of specific Delta islands could also affect water quality over a longer time horizon by changing the rate of saltwater intrusion and the area of the mixing zone. A long interruption of water supply for in-Delta uses and exports would affect both urban and agricultural users, until the salt water could be flushed from the Delta channels.

CALFED's Levee System Integrity efforts work in conjunction with the DWR Delta Levees Program to maintain and strengthen the levee system. DWR in turn works with local groups and agencies, particularly with reclamation boards, to assist in the planning and funding of levee projects. Under Base Level Protection efforts, non-project levees[6] are maintained and strengthened, with the ultimate goal of bringing all appropriate levies to a uniform base level of protection. DWR also provides partial funding and assistance for CALFED's Special Improvement Projects, which help establish protection above base level standards in regions with particular public interests – such as highly populated islands. Special cost share requirements are used with levee projects, which allocate costs between the local participants and the State, and DWR oversees two funding mechanisms that are used to provide the State contribution.

In addition to levee maintenance and enlargement, other levee-related efforts include levee subsidence studies, emergency response coordination (including the distribution of flood fight boxes containing emergency materials such as sandbags and hand tools), analysis of levee risks associated with seismic events, and dredged material management. The Levee System Integrity efforts have incorporated a number of ecosystem-related projects, such as the habitat development work currently underway at Decker Island, and certain provisions of the Program require that levee activities must result in net habitat improvement. Other agencies involved with the Delta Levee efforts include the U.S. Army Corps of Engineers and the California Department of Fish and Game, which serve along with DWR as Implementing Agencies of the Levee System Integrity Program.

Recreation

According to figures used in the 1995 Sacramento-San Joaquin Delta Atlas, the Delta is estimated to support more than 12 million recreational user days a year. According to surveys conducted in 1996 by the Delta Protection Commission (DPC) and the Department of Parks and Recreation (DPR), 23.5

[6] A "non-project" levee is defined by State Water Code as "a local flood control levee in the delta that is not a project facility under the State Water Resources Law of 1945".

percent of registered boat owners and 23 percent of licensed anglers in the State of California participated in recreation activities within the Delta. Fishing, cruising, water skiing, swimming, and sailing are all popular ways of recreating in the Delta, as well as sightseeing and wildlife viewing. As a result of the growing population within the Delta and across the State, the popularity and use of the Delta as a major recreational location is expected to increase.

The DPC, DPR, and the Department of Boating and Waterways (DBW) have important oversight and regulatory roles for Delta recreation. In addition to the 1996 surveys, DBW cooperated with DPC's Recreation Citizen's Advisory Committee in December of 2002 to produce a Boating Needs Assessment, which inventoried existing recreational boating infrastructure in the Delta and projected future boating needs.

This assessment followed a 1995 Report conducted by DPC, which made recommendations to improve recreation conditions and access. A detailed Delta Recreation Master Plan is currently being prepared by the Delta Protection Commission, with assistance from DPR and the California Coastal Commission. The first phase of this study addresses Delta user and facility needs for water-based and water-enhanced recreation. The resulting estimates of recreation use in the Delta confirm that recreation is a key component in management of Delta resources. When completed, the second phase of this master plan will focus more on land-based recreation needs, and present a "big picture" summary of all recreation within the Delta. As a public resource and economic benefit, recreation opportunities in the Delta are highly valued.

Looking to the Future

On a long-term continuing basis, a wide variety of studies and projects are being undertaken to protect water quality, maintain and improve ecosystem health, maintain the stability of levees, and improve water supply reliability (Box 12-3). Most of these activities are being conducted by state and federal agencies in partnership with local landowners and Delta interests, and many of the major projects are critical to implementing the CALFED Bay-Delta Program Plan.

Efforts are continuing to develop major programs and projects that are intended to address long-standing Delta water management issues. Interest groups and government agencies are grappling with how to package interdependent actions and programs in a manner that will protect the Delta's water quality and ecosystem, and keep the levee system stable. Among the many challenges facing this effort is the issue of how to reconcile the engineering and technical realities with the economic and political realities.

CALFED implementing agencies, in conjunction with other Delta interests, are attempting to move critical projects forward through the Delta Improvements Package. These projects are outlined in the CALFED Bay-Delta Program Record of Decision (ROD), which calls for balanced implementation of CALFED program elements. In the Delta Region, implementation of the CALFED resource management objectives includes the following priorities: improving the environment so that threatened and endangered species populations can recover; making continual improvements in Delta water quality; increasing conveyance

Box 12-3 Ongoing Planning Efforts

- American Farmland Trust study of Delta agriculture.
- Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) for the Delta, lead by DFG.
- SAFCA study of new flood control projects for Sacramento and West Sacramento in Yolo Bypass.
- Yolo Flyway Center – proposed public education facility adjacent to Yolo Bypass.
- Delta Science Center – proposed public education facility at Big Break Regional Shoreline (East Bay Regional Park District).
- Rio Vista--proposed public education and recreation facility at former military property recently transferred to City of Rio Vista.
- New Research Facility proposed by CALFED Science Consortium at former military property recently transferred to City of Rio Vista.
- Delta Protection Commission study of Delta recreation
- California Bay-Delta Authority, various investigations for implementation of the Bay-Delta Plan

capacity of the Delta pumping plants (to improve water supply reliability statewide); assuring adequate water levels for agricultural diverters; and improving levee system integrity.

The Delta Improvements Package is a framework for moving forward in several of these areas simultaneously while making considerations beyond what is required by the ROD. For example, although the CALFED ROD did not require that Delta water quality improvements occur before increasing the pumping capacity of Delta pumping plants, DWR and USBR are working with Delta interests to improve salinity levels in the south Delta while proceeding with studies for the SDIP, which is included as a part of the overall Delta Improvements Package.

The following is a summary of major programs and actions that are critical to achieving desired benefits for the Delta region. In addition to listing major project milestones established for Stage 1 (years 1 through 7) of the CALFED Bay-Delta Program, other Delta initiatives, including recreation efforts, are also included.

Water Supply Reliability

Many of the proposed future water supply activities in the Delta are included as part of the Delta Improvements Package, while others are being considered independently as described below.

Delta Improvements Package

The Delta Improvements Package (DIP) could eventually include several components related to water supply reliability:

- South Delta Improvements Project/8,500 cfs – Under the SDIP, permitted pumping at Banks Pumping Plant would be increased to 8,500 cfs. To mitigate the affects of the higher pumping rate, interim actions would be taken to maintain water levels for South Delta agriculture, protect water quality, prevent fish entrainment, and comply with environmental obligations. More permanent mitigation measures would include the construction of permanent operable barriers, development of a comprehensive San Joaquin River Salinity Management Plan, construction of water quality projects for Old River and Rock Slough, complying with Natural Community Conservation Planning Act[7] (NCCPA) and ESA requirements, and developing a long-term Environmental Water Account.
- SWP/CVP Integration Plan – Excess capacity at Banks Pumping Plant, part of the SWP, could be used to convey up to 50,000 acre-feet of Level 2 CVP refuge water in return for using up to 37,000 acre-feet of CVP water to meet SWP in-basin water quality and flow requirements. These quantities could be raised if pumping at Banks is allowed to reach 8,500 cfs.
- SWP/CVP Intertie – SWP and CVP operations could be more closely linked through the construction of an intertie between the California Aqueduct and the Delta-Mendota Canal just south of the Delta. This intertie would provide enhanced flexibility between the two systems, and create additional conveyance capacity for the CVP.

In-Delta Storage Project

DWR and USBR are also investigating the In-Delta Storage Project as part of the Bay-Delta Program. The Project would include two storage islands (Webb Tract and Bacon Island) and two habitat islands (Holland Tract and Bouldin Island), and could provide for about 217,000 acre-feet of new storage for a wide variety of potential uses, including exports and Delta outflow.

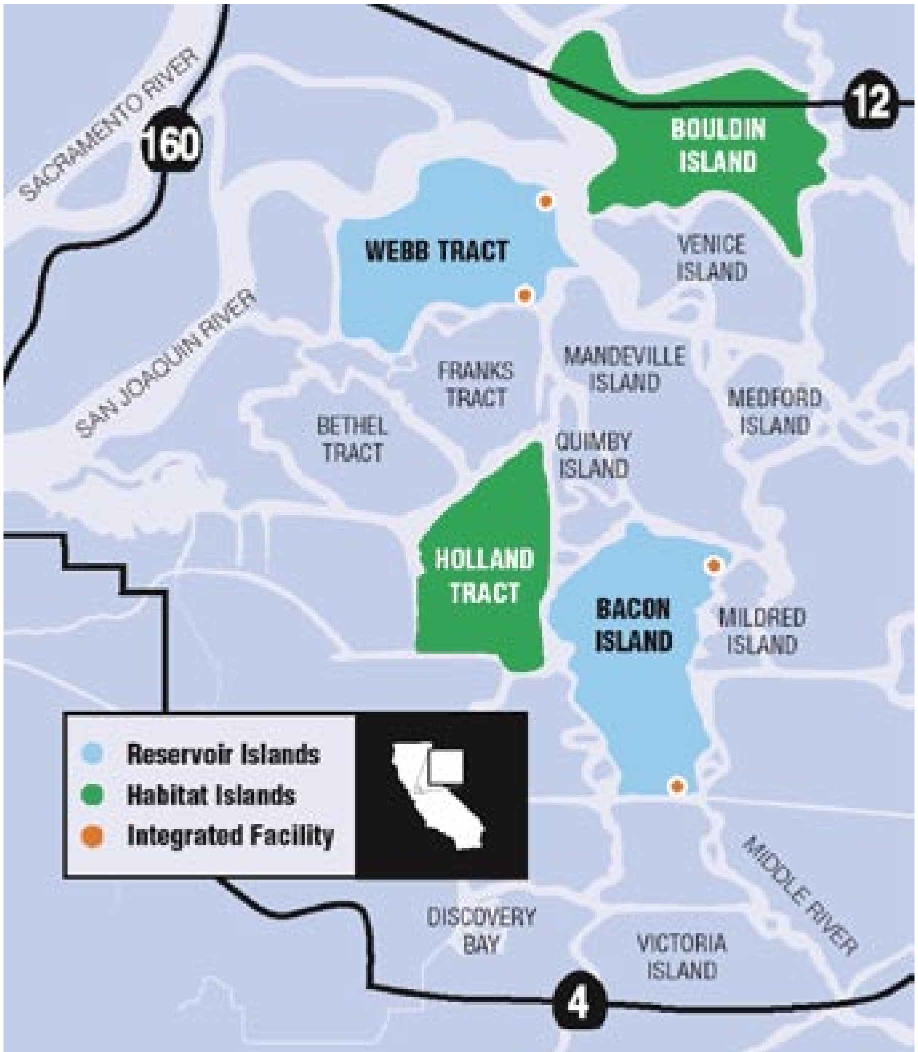
A State feasibility study for the project was completed in January 2004, and a final EIR/EIS is anticipated in December 2005. Initial estimates from the feasibility study showed an equivalent annual cost for the project of $60 million, with annual water supply benefits between $23 and 26 million and another $2 million in annual recreation, flood damage reduction and avoided levee maintenance benefits. Evaluations on how In-Delta Storage would impact organic carbon and salinity levels in the Delta are ongoing, and will be important in determining the overall feasibility of the project.

Los Vaqueros Reservoir Expansion

Contra Costa Water District (CCWD) owns and operates Los Vaqueros Reservoir, a 100,000 acre-foot, offstream reservoir that, while located outside of the Legal Delta, diverts water from the Delta. Planning studies are underway to evaluate expansion of this reservoir's capacity up to a maximum of 500,000 acre-feet through the construction of a new, larger dam. Depending on how the reservoir would be operated, a portion of the storage at Los Vaqueros could be used by the Environmental Water Account. CCWD customers voted in March 2004 to continue planning studies for the project, and final feasibility studies and environmental documentation are scheduled for completion by the winter of 2007.

[7] California Department of Fish and Game Code.

Figure 12-6 In - Delta Storage Project



Water Quality

Projects designed to improve Delta water quality are prominently included within the Delta Improvements Package, as well as in other initiatives. A few of the most important water quality efforts that can currently be identified as important to the future of the Delta are listed below.

Delta Improvements Package

A large number of water quality projects have been included in the Delta Improvements Package, some of which were included in the CALFED ROD and others that were more recently conceived.

- South Delta Improvements Package/Permanent Operable Barriers – Permanent operable barriers would be required before full implementation of 8,500 cfs pumping capacity at SWP Banks Pumping Plant. One of the primary reasons for the barriers would be to improve water circulation and water levels within the south Delta.
- San Joaquin River Salinity Management Plan – To comply with the salinity requirements in SWRCB Water Right Decision 1641, DWR and USBR are developing a comprehensive plan, in cooperation with SWRCB and the Central Valley Regional Water Quality Control Board. The proposed San Joaquin River Salinity Management Plan would address agricultural drainage issues, salt load reduction from Salt and Mud Sloughs, recirculation of Delta exports into the San Joaquin River, voluntary water transfers for

quality benefits, and real-time water quality monitoring.

- Vernalis Flow Objectives – Water Right Decision 1641 also included flow requirements at Vernalis on the lower San Joaquin River, which have also been addressed in the Delta Improvements Package. The USBR and DWR, along with the CALFED agencies in the Water Operations Management Team, would work together to meet flow requirements that protect fish and wildlife dependent on San Joaquin River flows.
- Old River and Rock Slough Water Quality Improvement Projects – Before any permanent operable barriers are used, agricultural drains on the Veale and Byron Tracts would be relocated. In addition, efforts would be made to reduce seepage into the Contra Costa Canal to protect the quality of the District's water supply.
- San Joaquin River Dissolved Oxygen – DWR and USBR, in coordination with other CALFED agencies and local participants, would develop a comprehensive strategy to alleviate dissolved oxygen problems in the Stockton Deep Water Channel. These improvements could go beyond water project obligations, and would be coordinated with SWRCB and Central Valley Regional Water Quality Control Board.
- Franks Tract – Salinity levels at the major export pumps in the Delta may be significantly reduced through water quality actions at Franks Tract (Box 12-4). Reconfiguration of levees and modification of water circulation are possible alternatives for the Franks Tract project.
- Delta Cross Channel Program – Building on completed studies of the Delta Cross Channel, USBR and other agencies would continue, under the Delta Improvements Package, to develop methods for improving central and south Delta water quality while encouraging fish passage around the channel.
- Relocation of CCWD Water Intake – If the Delta water quality improvements from the above measures do not provide acceptable continuous improvements in water quality, the State and federal agencies will evaluate alternatives to move the Contra Costa Canal intake to the lower part of Victoria Island. This project would require appropriate environmental review, as well as agreement on cost sharing requirements. CCWD is conducting studies to evaluate this location as an alternative point of diversion.
- Through-Delta Facility – As identified in the CALFED ROD, a screened diversion facility on the Sacramento River could be used to move 4,000 cfs of water through the Delta to the Mokelumne River to enhance water quality. The Through-Delta Facility (TDF) could also have water supply and environmental benefits, although Delta salinity impacts could be difficult to predict due to the complex flow regime of the Delta. Overall impacts on water quality in the Delta will be dependent on other projects and operational strategies, such as how the Delta Cross Channel would be managed in conjunction with the TDF.

Box 12-4 Franks Tract Description

Once a reclaimed tidal marsh, Franks Tract was flooded in 1938 following a levee breach, and has since become a focus of water supply and water quality initiatives in the Delta. Franks Tract is used for recreation purposes, and also plays an important role in Delta water circulation. Saline water from ocean tides tends to become "stuck" within the tract, creating water quality problems for the export pumps and the Delta as a whole. The proliferation of egeria densa, an invasive species known commonly as Brazilian waterweed, is also a problem in Franks Tract.

In response to these and other issues, DWR and the Bay-Delta Authority are conducting studies to see if levee modifications, salinity tidal gates, and other measures could be used not only to solve current problems, but to create additional benefits for the Delta. Recreation interests and state agencies have also identified potential sites for islands in the tract, which could be used for recreation and ecosystem habitat while providing erosion protection for the southern levees. The addition of trenches in certain segments could also enhance boating opportunities while limiting the spread of egeria densa, which requires shallow water for optimum growth.

The CALFED Science Program and DWR's Franks Tract Project are leading the way in developing alternatives to improve conditions in Franks Tract while providing new benefits for the Delta. CALFED efforts in the tract are ongoing, and a DWR-led feasibility study is now underway, with full implementation expected by 2011.

Delta Region Water Quality Management Plan

This plan is being developed by Solana County Water Agency, CCWD, and the City of Stockton, all three of which are interested in new water supply diversions from the Delta. In addition to evaluating the potential for additional Delta water intake structures, these entities are also investigating water treatment technologies and source water protection actions as part of management plan.

DWR MWQI Program

The Municipal Water Quality Investigations (MWQI) Program under DWR investigates water quality issues for State Water Contractors and other Delta water users. Issues that MWQI intends to pursue in the near future are greater use of real-time data in modeling and O&M applications, expanded investigations into organic carbon loading from wetlands, and greater coordination with the CALFED Bay-Delta Public Advisory Committee's Drinking Water Subcommittee.

CALFED Storage Projects

Investigations are currently underway to determine if CALFED storage projects could be used to enhance water quality conditions in the Delta by releasing water of the appropriate temperature and quantity at the beneficial times, or used in lieu of surface diversions to maintain the quality of Delta inflows. New reservoirs could also have negative water quality impacts, however, such as additional organic carbon input, and the overall affect will have to be considered for each project.

Ecosystem Restoration

Ecosystem restoration efforts will continue to be critical in the future for the Delta. Many of the efforts listed here will also benefit as better scientific information is obtained to develop specific, quantitative habitat objectives for ecosystem restoration. The population objectives that are being developed for listed species of anadromous fish (via processes under the Endangered Species Act) will also be of use towards measuring the success of restoration efforts.

Delta Improvements Package

The Delta Improvements Package includes several programs with ecosystem restoration components. While this list is still under development, a preliminary outline is included here.

- OCAP ESA Consultation – DWR and USBR have prepared a Biological Assessment for the Operations Criteria and Plan (OCAP), which provides a detailed explanation and analysis of the criteria and procedures used to coordinate operations of the SWP and CVP. USFWS and NOAA Fisheries will later respond with Biological Opinions based on the OCAP Biological Assessment, and DWR and USBR will continue to work with the federal agencies and the California Department of Fish and Game to develop future policies for integrated CVP/SWP operations.
- SDIP ESA Consultation – DWR and USBR are also working on an Action Specific Implementation Plan (ASIP) for species covered under the CALFED ROD Multi-species Conservation Strategy (MSCS). USFWS and NOAA Fisheries will review the SDIP Preliminary Biological Opinions and the ASIP to determine if SDIP consultation should be reinitiated, and DFG will review the ASIP to consider if it should receive Natural Community Conservation Plan (NCCP) authorization.
- Update of CALFED ROD Programmatic Regulatory Commitments – The CALFED ROD required that USFWS, NOAA Fisheries, and DFG review and approve the programmatic regulatory commitments established in the ROD by September 30, 2004. A Notice of Determination for the Environmental Water Account EIS/EIR was signed in 2004, the Record of Decision was signed, and the Notice of Determination was issued in October 2004. Implementation of the EWA through 2007 has been authorized, and the EWA Operating Principles have been extended to December 31, 2007. The State and federal agencies that are signatories to the CALFED Multi Species Conservation Strategy ("Conservation Agreement") have also agreed to extend these regulatory commitments to December 31, 2007 to support protection and recovery of the covered species.
- Environmental Water Account – Work will continue on determining if and how a long-term Environmental Water Account (EWA) could be established beyond the short-term EWA set up for the CALFED Stage 1 period. DWR, USBR, USFWS, NOAA Fisheries, and DFG are the lead agencies working to develop a long-term EWA which will protect Delta fisheries while providing water supply reliability benefits to SWP and CVP exporters.
- Delta Regional Ecosystem Restoration Implementation Plan – The Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) is a long-term regional planning effort under the CALFED ERP to help examine the Program's actions, targets, and milestones for the Delta. The DRERIP process includes agency review and public input, and will be the primary forum for revising ERP targets. DRERIP is currently being prepared by the Department of Fish and Game in cooperation with the Bay-Delta Authority, USFWS, NOAA Fisheries, other CALFED agencies, academic institutions, science advisors,

and stakeholder scientists. Through DRERIP, the ERP expects to refine and prioritize actions, evaluate the scientific foundation for actions and milestones, and use adaptive management feedback. The Bay-Delta Public Advisory Committee's Ecosystem Subcommittee provides public input for DRERIP activities, and additional opportunities for future public participation in the Program will continue in the future.

- Focused Study on South Delta Hydrodynamics and Fish – As a science-related action, DWR, USBR, USGS,DFG and USFWS will study fish movement, distribution, and entrainment in the south Delta to better understand the impacts of the Delta export pumps and barrier operations.
- South Delta Fish Facilities – The fish facilities for both the SWP and CVP will be evaluated by USBR and DWR, and recommendations for modifying operations to better manage changing environmental conditions will be developed. Alternative facilities and intake locations will be included as options, and special consideration will be made for future SWP pumping operations.

Delta Region Farmland Preservation and Private Lands Stewardship Program

The DPC has partnered with the American Farmland Trust to prepare an inventory of Delta agriculture resources and their economic value. This inventory will help identify and preserve the best farmland in the DPC jurisdiction and the five Delta counties, while developing "wildlife friendly" practices on as much of the agricultural land as possible. The resulting DPC plan could help in the implementation of the CALFED ecosystem restoration goal of protecting and enhancing 45,000-75,000 acres of wildlife friendly agriculture in the Delta.

Other CALFED ERP Projects

While DRERIP represents ERP's focus for long-term regional ecosystem restoration planning, there are many other activities that the Program intends to carry forward into the future. The CALFED Programmatic EIS/EIR identified six strategic goals for the 30-year planning horizon of the Bay-Delta Program, which include issues such as endangered species recovery, invasive species, ecological processes, harvested species, habitats, and water and sediment quality. The CALFED ERP has developed multiple objectives for each of these goals, which include developing strategies for high priority topics, conducting a long-term program of milestone assessment for ecosystem-related CALFED programs, and identification of funding allocations to support a unified CALFED-wide restoration and recovery process.

Levee System Integrity

The future of levee management in the Delta is currently evolving, and several recent developments may play a role in future levee implementation activities. Key issues that will have a strong influence on future levee work can be grouped into three main categories: oversight, funding, and ecosystem integration.

Oversight

In recent history, levee maintenance and construction in the Delta has primarily been the responsibility of reclamation districts and, to a lesser extent, the U.S. Army Corps of Engineers. In the extreme northern part of the Delta near Sacramento, the Sacramento Flood Control Agency (SAFCA) was created in 1989 to manage levies in the Sacramento region as a joint powers agency, and it now has management responsibilities in the Delta as well. The Department of Water Resources has provided financing, planning, engineering, research and monitoring capabilities to assist local groups (reclamation districts), and the California Department of Fish and Game and Bay-Delta Authority have also played important management and oversight roles.

In the future, the form and magnitude of responsibility shouldered by the participating levee agencies could be modified. Recently proposed State legislation (AB 1983) could increase the responsibilities of the Reclamation Board, which monitors reclamation districts and collects their tax revenues. The CALFED Record of Decision (ROD) envisioned a larger federal role through the Army Corps in levee maintenance and improvements than has yet materialized, and the Corps has been discussing ways to play a greater role with other participating agencies. A recent court decision regarding the liability of the State in the event of levee failures is another driving force that could lead DWR and other agencies to reexamine how levee responsibilities and oversight are assigned within the Delta.

Funding

As already mentioned, the CALFED ROD recommended greater levels of federal participation, including financial participation, than has actually occurred. The majority of funding for Delta levees work over the last decade has come from State and local sources, with only a small amount of federal contributions. The federal government has historically identified flood protection as a national goal eligible for federal financing, and Delta interests could attempt to obtain more Congressional appropriations for future levee projects. Congress approved recent CALFED Legislation to authorize additional federal funds for levee programs, but very little of those funds have actually been appropriated by the federal budget process.

Following the CALFED principle of "beneficiary pays", the sources for levee funding could also be modified to draw more contributions from those receiving benefits from Delta levees. Because of the location of the Delta levees and the important role they play in protecting the drinking water supply for the majority of Californians, some have argued that a greater portion of levee costs should be assigned to consumers of Delta water exports. The Bay-Delta Authority is currently conducting studies to attempt to quantify ranges of benefits associated with all CALFED Program Elements, including the Levee System Integrity Program. Potential alternative revenue sources identified by a draft Bay-Delta Authority "Finance Options" report include recreational boating fees and a state-administered water user fee assessed on CVP and SWP water users, with the possible inclusion of non-project water users as well.

Ecosystem Integration

The degree in which levee programs include ecosystem restoration activities could also be changed in the future. The same legislation that would increase the role of the Reclamation Board in levee improvement work (AB 1983) would also allow the Board to directly finance habitat restoration work, instead of having to partner with other state agencies as is currently required. While the legislation could potentially streamline required restoration work and allow levee maintenance and enlargement to move forward more quickly, it can also be argued that ecosystem responsibilities should be limited to agencies such as the Department of Fish and Game so that Reclamation Districts can focus on preventing and fighting floods. Delta levee initiatives in the future will have to consider what level ecosystem management should be involved in levee efforts, and what groups and agencies should participate in ecosystem activities.

The North Delta Flood Control and Ecosystem Restoration Project is an example of how the Department of Water Resources is addressing levee and ecosystem restoration issues in the North Delta. Also known as the North Delta Improvements Project (NDIP), the Project is considering several "wildlife-friendly" modifications to levees in the North Delta, including setback levees. A draft EIR/EIS for the Project is currently being developed, and alternatives have already been identified that include a number of levee-related initiatives.

Recreation

Recreation-related activities in the Delta will continue to be important in the future, and several new initiatives are being planned to better characterize current recreational resources while developing a vision for future Delta recreation activities. One major effort is the Delta Recreation Master Plan. In 2003, DPC received funding for preparation of phase one of the Delta Recreation Master Plan, which has now been completed and addresses water-based recreation needs The second phase of this plan will evaluate land-based recreation needs in the Delta, as soon as funding for the study is secured. The Master Plan intends to draw from existing Delta recreation studies and documents, use public outreach and stakeholder involvement, and include new GIS mapping technologies to produce a Delta-wide recreation plan.

Other Activities

Many other potential actions that could be taken by the California Bay-Delta Authority and others in the upstream Sacramento River and San Joaquin River hydrologic regions can benefit the Delta, especially with respect to water quality and flood flows. These actions may include improvements for conveyance, storage, levee stability, water quality, water use efficiency, and watersheds. A few of these additional initiatives are listed here.

- **WUE Agricultural and Urban Water Use Measurement** - One of the Bay-Delta Program's Water Use Efficiency projects being developed throughout California is the Agricultural and Urban Water Use Measurement initiative. This program to produce consistent, complete, and compatible water measurement practices statewide is critical for monitoring and managing diversions and instream flows within Delta, and in other parts of the state as well. Considerable stakeholder input has been obtained for the WUE measurement efforts, and assistance from the State legislature will also be required for the project to be fully implemented.

- **Lower Sacramento River Regional Flood Control Project** - The Sacramento Area Flood Control Agency (SAFCA) is currently considering a project to expand the Yolo Bypass and use the Sacramento Deep Water Channel to convey floodwaters for the protection of urban areas. This project could potentially be integrated with CALFED activities, which have to date included studies on the modification of the Yolo Bypass to enhance fisheries, easement acquisitions, and modeling efforts led by the California Reclamation Board. Local governments, particularly the City of Rio Vista, would need to be included in planning and implementation to address downstream flooding concerns.

The above projects will provide incremental improvements in water supply, water quality, levees, and ecosystem, but will not totally achieve the desired goals for the Delta in themselves. To achieve the desired cumulative benefits, integration and linkage of these projects is essential. Coordination of the CALFED Program, its implementing agencies, local and regional stakeholders, and the Delta Protection Commission with adequate funding will help the region to continue to serve society's demand for farm products, fishing, recreation, and water—all while protecting the Delta's ecosystem and water quality.

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Chapter 13 Mountain Counties Area

Chapter 13 Mountain Counties Area

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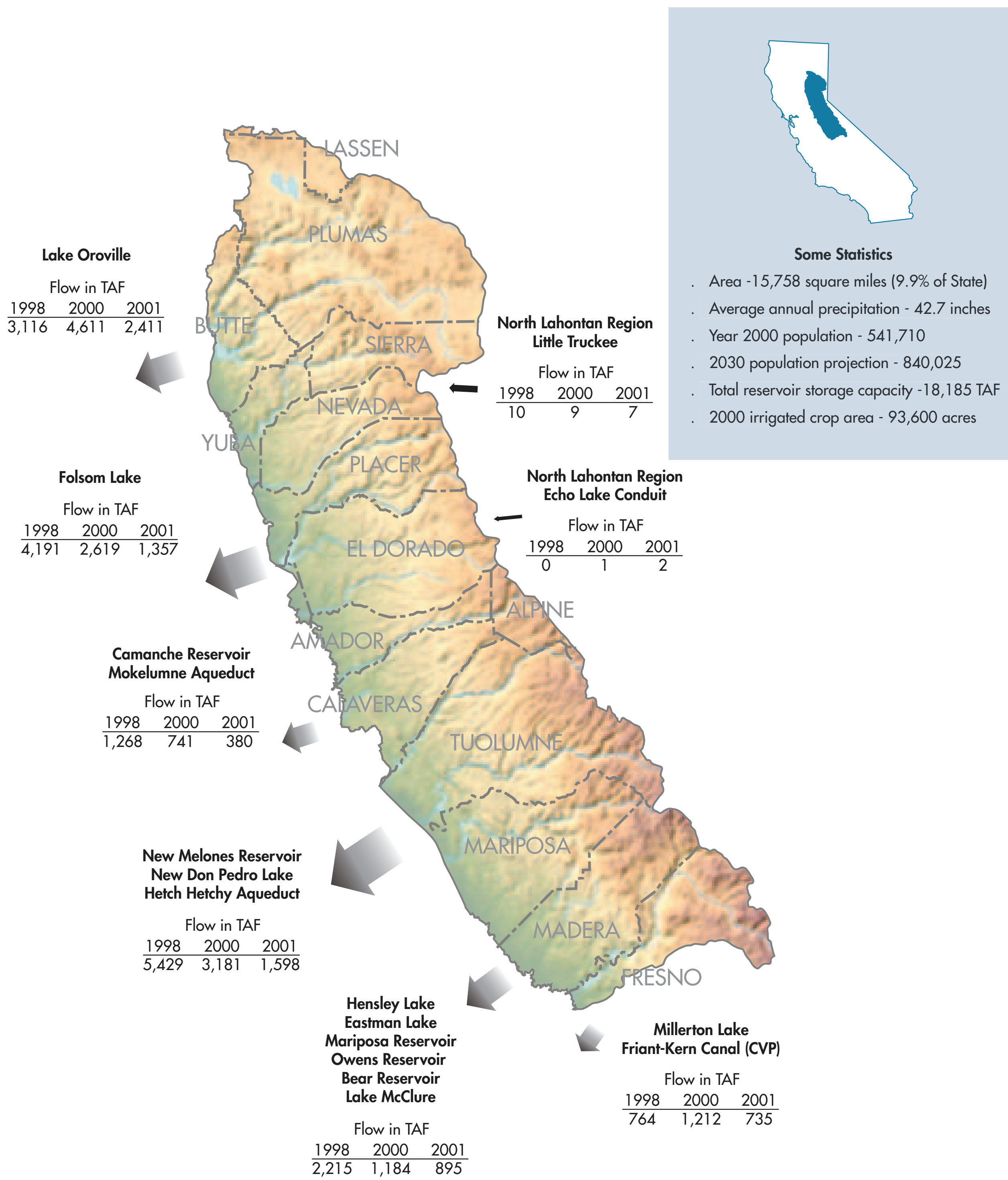


The Mountain Counties area includes the foothills and mountains on the western slopes of the Sierra Nevada, extending from Lassen County on the north to Fresno County on the south. Arrows indicate annual flows entering and leaving the region for water years 1998, 2000, and 2001.

Chapter 13 *Mountain Counties Area*

Setting

The Mountain Counties Area of California includes the foothills and mountains of the western slope of the Sierra Nevada and a portion of the Cascade Range. The area extends from the southern tip of Lassen County to the northern part of Fresno County (Figure 13-1) and covers the eastern portions of the Sacramento River and San Joaquin River hydrologic regions. The foothill and mountain areas of these two hydrologic regions are grouped together for the purpose of presenting their common characteristics.

The area generally includes all or portions of Shasta, Lassen, Plumas, Butte, Sierra, Yuba, Nevada, Placer, El Dorado, Amador, Alpine, Calaveras, Tuolumne, Mariposa, Madera, and Fresno counties. Elevations vary from around 100 feet near the edge of the valley floor to more than 10,000 feet at locations along the Sierra Nevada and Cascade Range crest line. The major rivers in the area include the Feather, Yuba, Bear, Rubicon, and American rivers in the Sacramento River region; and the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, Fresno, and San Joaquin rivers in the San Joaquin River region.

Climate

The climate is closely tied to the topography and varies widely throughout the area; mean annual precipitation ranges from more than 80 inches at Strawberry Valley, east of Lake Oroville, to less than 12 inches at Fresno County. Much of the precipitation falls as snow in the higher elevations in the winter. Water managers throughout the area rely on this natural storage as snow in the winter months and capture or divert spring snowmelt runoff.

Population

The 2000 population of the area was about 541,710, less than 2 percent of the state's total population. However, the effects of urbanization are beginning to affect some of the foothill areas. Population growth in the area from 1990 to 1995 was almost 10 percent. The state's growth rate during the same five-year period was about 7 percent. Although total population in the area is low, the area's rate of growth is projected to continue to out pace that of the state as a whole. The projected population increase between 2000 and 2030 is about 55 percent for this foothill and mountain area, while the state's growth is projected at about 41 percent.

Land Use

The economies of these mountain and foothill areas have historically been tied to the land. Tourism, ranching, timber harvesting, limited mining, and agriculture, primarily in the lower elevations, continue as an economic base for many communities. A limiting factor for the area's population growth is the relatively small amount of land in private ownership. The federal government is the dominant landowner in the area, with most of the higher elevation lands being under the management of the U.S. Forest Service or National Park Service.

Much of the state's developed water supply originates in this upland area, including several CVP and SWP reservoirs. Although the region has abundant surface water supplies, most of it is unavailable locally because of prior water rights appropriations for downstream or out-of-basin users. Local use of water originating within this region is less than 3 percent of the total statewide consumption.

Water Supply and Use

Locally developed surface water supplies account for almost 70 percent of the public consumptive water supply for this region. Water is either diverted directly from the area's streams and lakes or from local storage reservoirs and conveyance facilities.

Many of the residents in the unincorporated areas are dependent on small, independent municipal water systems, and a few areas still use untreated water diverted directly from raw-water ditch delivery systems (see Box 13-1). In addition, many

The Mountain Counties Area had less than 2 percent of the state's total population in the 2000 Census. However, the effects of urbanization are beginning to affect some of the foothills like those east of Sacramento. (DWR photo)

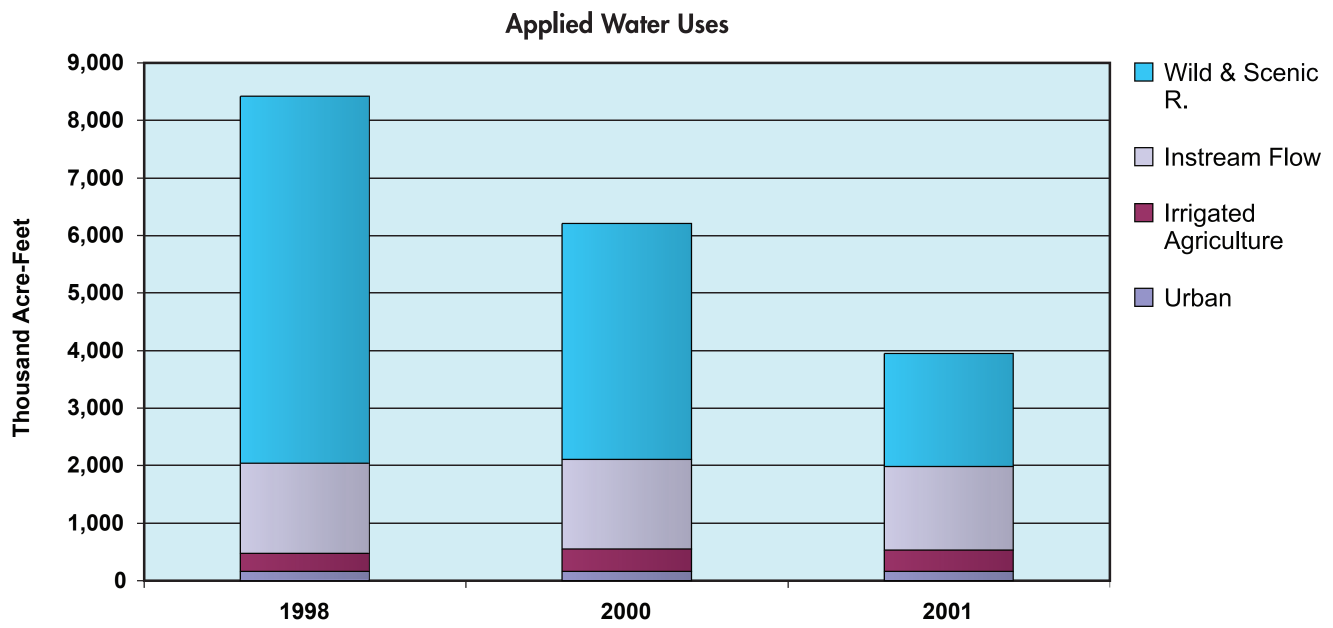
individual water users throughout the area have developed their own supplies, typically groundwater for domestic use and small surface storage or in limited cases, groundwater for agricultural use. Figure 13-2 provides a graphical presentation of all of the water supply sources that are used to meet the developed water uses within this hydrologic subarea for 1998, 2000, and 2001.

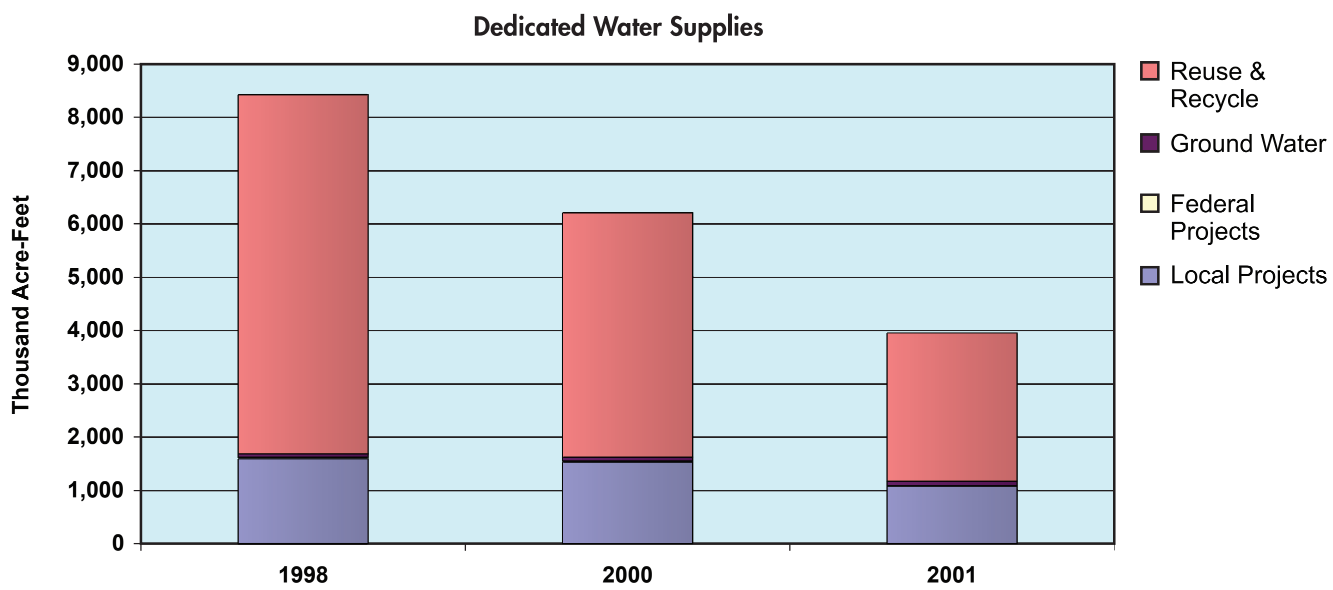
Mining operations, especially hydraulic mining, from the Gold Rush Era marked the beginning of much of the water supply development to the foothill and mountain areas. Many of those early mining water systems were later taken over by other water users. Pacific Gas & Electric Co. and other hydropower utilities subsequently developed an extensive hydroelectric power and consumptive water use delivery system through-

Box 13-1 Regulation of Ditch Water

Regulation of Ditch Water – Water users in the foothills who obtain their water from ditches are no longer able to use that water for domestic purposes. New rules promulgated by the California Department of Health Services and the U.S. Environmental Protection Agency prohibit residential customers from cooking, drinking or brushing teeth with ditch water, including water processed by home treatment systems. In order to meet these requirements, several water districts are requiring customers to receive 5 gallons of bottled drinking water per month. This quantity meets the state's minimum estimate of what a normal household would use in a month.

Figure 13-2 Mountain Counties water balance for water years 1998, 2000, 2001





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

out the Sierra Nevada, often incorporating some of the old mining ditches. Most of the early water conveyance facilities were later transferred to local water agencies for consumptive water deliveries. Some of these water agencies still use the ditch systems as a primary means of water delivery to both their water treatment plants and to the individual water users along the route to the treatment plants. Many of these old and unimproved conveyance systems, including ditches, flumes, and pipes have been in use for more than 100 years.

While logging and mining operations have decreased, recreation and tourism have increased in the Mountain Counties region which produces different effects on water use and quality. Second homes and vacation rentals are a growing trend in many of the foothill and mountain areas. This type of residential usage means that, although there is no permanent population associated with these homes, water use can be high on most weekends during the popular summer and winter vacation periods. For example, Groveland Community Services District, near Yosemite National Park in southern Tuolumne County, estimates that the service area population more than doubles during peak vacation periods. Tourism water use, which is most significant in the central Sierra, tends to inflate the area's per capita water use because the volume of water consumed is greater than the permanent residential population would indicate.

Most of the area's irrigated acres are found in the foothills and mountains of the Sacramento River Region. The dominant crop is pasture, which constitutes about 70 percent of the total irrigated acreage. Other crops with significant acreage include alfalfa, grain, wine grapes, apples and other deciduous fruit, and olives. Projections indicate almost no change in future irrigated acreage, with a slight change in crop mix. Significant amounts of unirrigated lands are also used as rangeland for livestock.

Environmental water use in the region consists of instream flow requirements and Wild and Scenic River designations. Instream flow requirements within the area are found on the Stanislaus River, below Goodwin Dam, and the Tuolumne River, below La Grange Dam. The controlling instream minimum flow requirements for the remainder of the area's major rivers are located on the valley floor, which is downstream and outside of the Mountain Counties region. In addition, there are many smaller reservoirs in the area that do have instream flow requirements, which are met by the project operators. However, only the largest instream flow requirements for the major rivers have been counted as the instream demands for this water use tabulation. Documented Wild and Scenic River designations in this region include portions of the Feather River (north fork), Yuba River, American River, Tuolumne River and Merced River. Figure 13-2 presents a bar chart that summarizes all of the dedicated and developed urban, agricultural, and environmental water uses within the Mountain Counties region for 1998, 2000, and 2001.

Groundwater constitutes less than 10 percent of region's water supply and is generally used as a supply for single family homes. Groundwater availability is often limited to fractured rock and small alluvial deposits immediately adjacent to the area's many streams. In the rural areas, many individual residences are wholly dependent upon groundwater for domestic use. In addition, many homes are not connected to a municipal water system and are typically dependent upon individual wells, which are often unreliable during drought periods. A limited number of farmers have developed wells with enough production to irrigate their lands in all but the driest of years. In general, groundwater is an inadequate and unreliable supply for large scale usage in this region, due to the limitations of the fractured granite formations that constitute much of the Sierra Nevada foothills and the western slopes of the mountains.

In addition to locally supplied surface water, some water is provided by storage facilities of the federal Central Valley Project, other federal water facilities, locally developed imports, and reclaimed wastewater. In the American River basin, the Foresthill Public Utility District has a water supply contract for CVP water. Calaveras County Water District and Union Public Utility District receive water from New Hogan Reservoir, which is operated by the U.S. Army Corps of Engineers. Irrigated pasture in Sierra County receives a small amount of water imported from the Little Truckee River in the North Lahontan Hydrologic Region. In addition, PG&E imports water from Echo Lake near Lake Tahoe in the North Lahontan Hydrologic Region as part of a hydropower diversion into the American River basin. Reclaimed wastewater is used to a limited extent to irrigate golf courses and meet other landscaping and agricultural needs throughout the region.

The water use and water supply graphs in Figure 13-2 summarize the detailed regional water accounting contained in the water portfolio tables at the end of this regional description. As shown on the map in Figure 13-1, most of the area's surface water either flows to or is diverted to other regions outside of the Mountain Counties area.

State of the Region

Challenges

By virtue of their location in the upstream watersheds, domestic water users in the Mountain Counties generally benefit from higher quality surface water than most other areas of the state. Many water supplies originate from pristine foothill or mountain sources, which are largely unaffected by agricultural or urban pollution. Unfortunately, this higher quality surface water is often degraded as it flows downstream or is diverted through the numerous canals and delivery systems (see Box 13-2). Water drainage from abandoned mines, including Penn Mine in the Mokelumne River watershed, contributes metals and other water quality problems downstream. Mercury was imported into this region as part of the gold mining activities of past eras, and it remains in some water supplies as a water quality issue. Erosion from natural flooding, logging and land development, and areas devastated from forest fires, introduces sedimentation and nutrients to waterways, as well as causing elevated stream temperatures due to the reduction of riparian shade canopy. This is a concern to both domestic water treatment operations and to spawning and migration of salmonids, particularly below the major dams on the Stanislaus, Tuolumne, and Merced rivers. The conversion of agricultural land to residential use, and undeveloped land to both agricultural and residential use, could present new and different water quality problems in the future.

The biggest water issue facing users in the area is the need to improve the water supply reliability of the various water delivery systems throughout the area. The population of some areas is increasing rapidly because people are migrating to the foothills from the metropolitan areas. Despite rapid population growth, the customer base for many of the water districts is still relatively small and widely dispersed. This smaller base, coupled with previous development of the less costly reservoir sites, as well as the mountainous topography, makes water system improvements expensive and makes interconnections between systems impractical. Also, a limited array of options are available to meet current and projected needs, due to the local water users' limited ability to pay the costs of improvements and the lack of groundwater aquifers to facilitate groundwater banking and conjunctive use strategies. Some local officials directly responsible for water delivery within the Mountain Counties Area are evaluating the potential use of California's "Area of Origin and Watershed Protection" water laws as a method for meeting projected growth within their respective areas as well as improving water supply reliability to existing users. These legal statutes provide for the reservation of water supplies for counties in which the water originates when a state water right filing is assigned for use elsewhere, as well as setting aside water for future development in the area. Typically, however, the upland areas have not had the population and financial base to contract with SWP or CVP for a water supply, nor has the SWP or CVP had adequate supplies of unallocated water to meet the needs of most Mountain Counties communities.

Historically many small water systems in the foothills and mountains of California have relied on surface water or local springs with minimal or no water treatment. Some small rural water systems have also relied upon water from open ditch systems, sometimes in use for over 100 years, that were intended primarily for agriculture or hydropower purposes and used only incidentally for domestic water. However, with a greater recognition of the health risk posed by pathogens in drinking water sources, these systems must now maintain reliable filtration and disinfection facilities and in most cases required improvements are being made. In addition, low housing densities in this region result in a large number of isolated, small water systems, which individually do not have the technical or financial capacity to upgrade their treatment facilities and infrastructure, and cannot consolidate to take financial advantage of a larger water utility customer base. When such treatment upgrades are infeasible, water purveyors are instead requiring customers to use bottled water for drinking purposes.

Another common problem for the older open ditch delivery systems within the Mountain Counties region is the tendency to have significant conveyance seepages and evaporation, as well as sanitary hazards associated with open water systems. Repairs and replacement of some open ditch systems have sometimes been opposed by various groups and landowners who argue

Box 13-2 1997 Flood Damage to Canals

After the 1997 floods, a landslide destroyed a 30-foot section of Georgetown's canal, which supplies water to 9,000 customers in six towns in rural El Dorado County. Nearby, El Dorado Irrigation District also lost use of it flume from the forebay on the American River due to a separate landslide.

against the reduction of the aesthetics of the flowing canal, and of vegetation and wildlife sustained by leakage and percolation. Many other water users in this region are on private wells, which are unregulated statewide and, thus, have never been assessed for potential water quality contamination.

Most areas within the Mountain Counties region are very concerned with forest fires and the damage they cause to the watersheds and the wooden infrastructure associated with the ditch systems. Every year, numerous forest fires occur in the Sierra Nevada which expose the watersheds to soil erosion. Sediment loads from erosion can obstruct water flow in open ditches, reduce reservoir capacity, add nutrient loading, diminish water quality and cause excessive algae growth. Fires have damaged components of the ditch systems including diversion structures and flume sections. As a result some small communities have been left without water for extended periods of time.

Water supply managers in the area are concerned about federal and State designations of Wild and Scenic streams (see Box 13-3). When a river or stream is designated as Wild and Scenic, the accompanying regulations can sometimes preclude water resources development. Environmental interests are concerned about preserving the few undeveloped streams or sections of streams remaining in the area. Federal statutes prohibit federal agencies from constructing, authorizing, or funding water resources projects that would have a direct and adverse effect on the values for which the river was designated. The state wild and scenic law prohibits construction of any dam, reservoir, diversion, or other water impoundment in specific regions. However in some situations where a diversion is needed to supply domestic water to residents of an area through which the wild and scenic river flows, such diversions may sometimes be authorized. Like surface water, groundwater in this region is generally of good quality, but it may be contaminated by naturally occurring radon, uranium, or sulfide mineral deposits containing heavy metals. In particular, radon contamination is associated with granite, such as the granite batholith of the Sierra Nevada. Meeting State secondary standards for both iron and magnesium can also be difficult for some groundwater sources. Also, because of the lack of community wastewater systems, individual septic tanks are prevalent for rural residential development in this region. The failure of septic tank systems can create sewage flows that have the potential to adversely affecting nearby wells and groundwater quality.

Accomplishments

In 1997, Sacramento area interests released the Draft Recommendations for the Water Forum Agreement. This group is pursuing two objectives: (1) provide a reliable water supply for the region through 2030 and (2) reserve the fishery, wildlife recreation, and aesthetic values of the Lower American River. The proposed draft solution includes an integrated package of seven actions. Generally, foothill water interests would increase their diversions from the American River in average and wet years and decrease those diversions in drier and driest years. Placer County Water Agency would be providing excess water from non-American River sources to many of the participating water agencies during drier water years to help make up the decreased American River diversions in those years. PCWA's participation in many of these specific agreements is dependent upon State Water Resources Control Board approval for changes to conditions of its existing water rights.

Box 13-3 1996 Sierra Nevada Ecosystem Study

In 1996, the University of California released its "Sierra Nevada Ecosystem Study," as a part of a project by the same name. The report is the result of a three year congressionally mandated study of the entire Sierra Nevada, with a primary emphasis on gathering and analyzing data to assist Congress and other decision-makers in future management of the mountain range. The project goal is to maintain the health and sustainability of the ecosystem while providing resources to meet human needs. The study states that, "excluding the hard-to-quantify public good value of flood control and reservoir-based recreation, the hydroelectric generating, irrigation and urban use values of water are far greater than the combined value of all other commodities produced in the Sierra Nevada." The report estimates the value of water at 60 percent of all commodities produced in the foothills and mountains of the Sierra Nevada. This commodity-based view of water leads to some of the study's related conclusions that, "increased concern about the ecological impacts of diversions as well as the social decisions about who should bear the financial burdens of plans to reduce, or at least stop the growth of, these impacts requires a greater understanding of how diversions, economic benefits, and ecological impacts are linked."

Relationship to Other Regions

Much of the state's developed water supply originates from the Sierra Nevada in the upland portions of this region. Many surface storage and diversion facilities capture and export water, including several CVP and SWP reservoirs, and local facilities operated by Yuba County Water Agency, East Bay Municipal Utility District, the city of San Francisco, Modesto and Turlock Irrigation districts, and Merced Irrigation District. The map in Figure 13-1 provides information about the volume of water exports from the Mountain Counties region for years 1998, 2000 and 2001.

Looking to the Future

Urban and agricultural water users in most of the Mountain Counties region have limited water supply options to meet future needs, because of the mountainous topography, lack of significant groundwater aquifers, limited financial resources for water development, and the fact that most water originating in the area was previously allocated to downstream users and exports through the water rights process. However, most water agencies are actively pursuing a wide variety of supply augmentation and demand reduction actions to secure water for future needs. For example, El Dorado Irrigation District is considering feasibility studies for development of a 31,000 acre-feet Alder Reservoir, which would provide drought storage, enhanced environmental flows, and hydropower generation benefits. In addition to its ongoing water conservation and water recycling programs, the district is planning on lining a 2.5-mile ditch system to save an estimated 1,300 acre-feet that is currently lost through seepage.

At the southern end of the Mountain Counties region in the Upper San Joaquin River basin, the California Bay-Delta Authority is conducting feasibility studies for development of additional surface storage in the upper watershed. Several alternative sites will be evaluated including one called Temperance Flat. If it is determined to be feasible, such storage could help to contribute to restoration and improvement of water flows and quality in the lower San Joaquin River, and would facilitate conjunctive water management and water exchanges among downstream water agencies.

Throughout California there are more than 100 existing hydroelectric projects that hold Federal Energy Regulatory Commission (FERC) licenses which will be up for federal license renewal within the next ten years. A large number of these projects are located on river systems within the Mountain Counties region. As part of the FERC license renewal process, the project owners must conduct studies to evaluate the future use, impacts and alternatives for each hydroelectric project. For local water agencies this process will provide key opportunities to develop and improve integrated resource planning, so that the proposed reoperation and federal re-licensing of hydroelectric projects can also consider improved benefits to local water supplies, instream flows, and recreation uses.

Regional Planning

The Mountain Counties Water Resources Association assists water agencies and local governments in coordinating water resource matters important to the region. The association also interfaces with applicable state officials and departments on water resource matters. Some agencies are looking for new supplies from expansion of existing storage, re-operation of existing hydroelectric storage, or construction of new storage. For example, Lyons Reservoir, in the Tuolumne Utilities District is a 5,800 acre-foot joint use facility, supplying both hydroelectric power and consumptive water storage. TUD is considering the expansion of Lyons Reservoir to 50,000 acre-feet. While large quantities of groundwater are not generally available in the Sierra-Cascade Mountain Area, a number of local agencies are implementing groundwater management strategies to help ensure the reliability of local groundwater supplies.

Some counties and water districts meet regularly to discuss regional water issues. One example is the Mokelumne River Forum. The Forum consists of thirteen entities that have an interest in the Mokelumne Watershed and have signed an MOU to have DWR facilitate regional collaboration to help resolve the complex water supply issues.

Several local agencies and governments are developing recycled water projects. A few examples are:

- El Dorado Irrigation District is investigating construction of up to 5,000 acre-feet of seasonal storage to more efficiently use recycled water in the district. The storage would allow for meeting recycled water demands, without supplemental water or shortages through 2025.
- The city of Auburn is developing a proposal to sell up to 5,000 acre-feet of recycled water to agricultural users by 2020. The water is expected to be delivered near Lincoln, on the valley floor. This option is included in the Sacramento River Region management plan.
- The city of Angels Camp in Calaveras County is developing plans to expand its reclaimed water deliveries by 300 acre-feet to agricultural, environmental, and landscape users by 2020.

- Two other projects in Calaveras County will deliver 470 acre-feet for landscape irrigation.
- Groveland Community Services District, in southern Tuolumne County anticipates 425 acre-feet being made available to agricultural customers by 2020.
- The Sierra Conservation Center in Tuolumne County is planning a project to deliver almost 300 acre-feet for agriculture and landscape irrigation by 2020.

Urban growth, with an average of 1,800 new homes each year in the city of Lincoln, has created a need for new drinking water in an area that has been served agricultural water since 1926. An association consisting of the Nevada Irrigation District, Placer County Water Agency, and the city of Lincoln, is investigating how to accommodate this change in water use in order to eliminate the need to find additional water supplies or to continue groundwater pumping to meet the domestic water needs.

In February 2000, South Sutter Water District, Camp Far West Irrigation District, and the California Department of Water Resources entered an agreement to meet the State Water Resource Control Board's water quality objectives -- Phase 8 of the Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary. In exchange for up to 4,400 acre-feet of water from Camp Far West Reservoir in each dry and critical year, DWR agreed to assume all responsibility for all Bear River water rights holders' obligations under Phase 8. In addition, South Sutter Water District is implementing its Conveyance Canal Improvement Plan to increase the system conveyance capacity (see Box 13-4). The additional water for conveyance will be obtained from increases in diversion of stored water and water that is spilled from Camp Far West Reservoir.

Water Portfolios for Water Years 1998, 2000, and 2001

The following tables and graphs present actual information about the water supplies and uses for the Mountain Counties hydrologic region. Water year 1998 was a wet year for this region, with annual precipitation at 154 percent of normal, while the statewide annual precipitation was 171 percent of average. Year 2000 represents nearly normal hydrologic conditions with annual precipitation at 107 percent of average for the Mountain Counties region, and 2001 reflected dryer water year conditions with annual precipitation at 65 percent of average. For comparison, statewide average precipitation in year 2001 was 72 percent of normal. Table 13-1 provides more detailed information about the total water supplies available to this region for these three specific years from precipitation, imports and groundwater, and also summarizes the uses of all of the water supplies.

A more detailed tabulation of the portion of the total available water that is dedicated to urban, agricultural and environmental purposes is presented in Table 13-2. Table 13-3 also provides detailed information about the sources of the developed water supplies, which are primarily from surface water systems and include a large percentage of water imports from other regions. These developed water use and supplies for the three years are also presented graphically in Figures 13-2. The three Water Portfolio tables included in Table 13-3 and companion Water Portfolio flow diagrams (Figures 13-3 and 13-4) provided more detailed information about how the available water supplies are distributed and used throughout this region.

Box 13-4 South Sutter Water District's Canal Improvement Plan

- Increase the flexibility, timing, and reliability of surface water supplies.
- Replenish groundwater supplies for extraction in drier years.
- Recharge the groundwater basin to reduce the effect of declining groundwater levels.
- Provide the ability to meet additional water needs (including Bay Delta Authority environmental objectives) outside of SSWD.
- Replace older conveyance structures with advanced control technology.
- Enhance SSWD's conjunctive water management activities.
- Reduce the need for cropping changes during drier water years.
- Increase power generation and decrease power use for pumping.
- Increase water use efficiency by installing state-of-the-art water control and measurement structures.

Table 13-1 Mountain Counties Water Balance Summary - TAF

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

	Water Year (Percent of Normal Precipitation)		
	1998 (154%)	2000 (107%)	2001 (65%)
Water Entering the Region			
Precipitation	55,206	38,412	23,445
Inflow from Oregon/Mexico	0	0	0
Inflow from Colorado River	0	0	0
Imports from Other Regions	10	10	9
Total	**55,216**	**38,422**	**23,454**
Water Leaving the Region			
Consumptive Use of Applied Water * (Ag, M&I, Wetlands)	237	279	264
Outflow to Oregon/Nevada/Mexico	0	0	0
Exports to Other Regions	19,983	13,548	7,376
Statutory Required Outflow to Salt Sink	1,227	1,090	654
Additional Outflow to Salt Sink	81	174	180
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	31,274	24,153	17,781
Total	**52,802**	**39,244**	**26,255**
Storage Changes in the Region			
[+] Water added to storage			
[-] Water removed from storage			
Change in Surface Reservoir Storage	2,420	-802	-2,721
Change in Groundwater Storage **	-6	-20	-80
Total	**2,414**	**-822**	**-2,801**

Applied Water * (compare with Consumptive Use)	402	472	452

***Footnote for applied water**

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

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

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

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

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

Selected References

- 2002 California 305(b) Report on Water Quality, State Water Resources Control Board
- California's Groundwater Bulletin 118-03, Update 2003, California Department of Water Resources
- Nonpoint Source Program Strategy and Implementation Plan, 1998-2013, State Water Resources Control Board, California Coastal Commission, January 2000
- Strategic Plan, State Water Resources Control Board, Regional Water Quality Control Boards, November 15, 2001
- Water Needs Assessment, Mountain Counties Water Resources Association, March 1999.
- Water Quality Control Plan, Regional Water Quality Control Board
- Watershed Management Initiative Chapter, Regional Water Quality Control Board

Table 13-2 Mountain Counties of California Water Use and Distribution of Dedicated Supplies (TAF)

	1998			2000			2001		
	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion	Applied Water Use	Net Water Use	Depletion
WATER USE									
Urban									
Large Landscape	11.2			11.0			11.4		
Commercial	11.8			12.1			12.2		
Industrial	14.6			14.6			14.8		
Energy Production	0.0			0.0			0.0		
Residential - Interior	40.4			40.3			41.4		
Residential - Exterior	63.6			63.5			66.1		
Evapotranspiration of Applied Water		59.7	59.7		55.4	55.4		57.1	57.1
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		59.2	59.2		64.6	64.6		66.8	66.8
Conveyance Applied Water	19.9			15.7			18.9		
Conveyance Evaporation & ETAW		10.1	10.1		8.1	8.1		9.7	9.7
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		9.8	9.8		7.6	7.6		9.2	9.2
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Urban Use	**161.5**	**138.8**	**138.8**	**157.2**	**135.7**	**135.7**	**164.8**	**142.8**	**142.8**
Agriculture									
On-Farm Applied Water	260.2			330.6			306.5		
Evapotranspiration of Applied Water		177.1	177.1		223.9	223.9		206.5	206.5
E&ET and Deep Perc to Salt Sink		6.0	6.0		7.8	7.8		6.0	6.0
Outflow		63.4	8.4		80.8	80.8		82.6	82.6
Conveyance Applied Water	49.1			59.6			58.1		
Conveyance Evaporation & ETAW		10.6	10.6		22.8	22.8		22.7	22.7
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		26.3	3.7		21.3	21.3		21.5	21.5
GW Recharge Applied Water	0.0			0.0			0.0		
GW Recharge Evap + Evapotranspiration		0.0	0.0		0.0	0.0		0.0	0.0
Total Agricultural Use	**309.3**	**283.4**	**205.8**	**390.2**	**356.6**	**356.6**	**364.6**	**339.3**	**339.3**
Environmental									
Instream									
Applied Water	1,569.5			1,563.0			1,450.6		
Outflow		313.0	313.0		326.5	326.5		340.9	340.9
Wild & Scenic									
Applied Water	6,381.6			4,098.7			1,968.8		
Outflow		914.1	914.1		763.0	763.0		313.3	313.3
Required Delta Outflow									
Applied Water	0.0			0.0			0.0		
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Managed Wetlands									
Habitat Applied Water	0.0			0.0			0.0		
Evapotranspiration of Applied Water		0.0	0.0		0.0	0.0		0.0	0.0
E&ET and Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Applied Water	0.0			0.0			0.0		
Conveyance Evaporation & ETAW		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Deep Perc to Salt Sink		0.0	0.0		0.0	0.0		0.0	0.0
Conveyance Outflow		0.0	0.0		0.0	0.0		0.0	0.0
Total Managed Wetlands Use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Environmental Use	**7,951.1**	**1,227.1**	**1,227.1**	**5,661.7**	**1,089.5**	**1,089.5**	**3,419.4**	**654.2**	**654.2**
TOTAL USE AND OUTFLOW	**8,421.9**	**1,649.3**	**1,571.7**	**6,209.1**	**1,581.8**	**1,581.8**	**3,948.8**	**1,136.3**	**1,136.3**
DEDICATED WATER SUPPLIES									
Surface Water									
Local Deliveries	1,582.1	1,582.1	1,506.3	1,514.9	1,514.9	1,514.9	1,064.4	1,064.4	1,064.4
Local Imported Deliveries	9.7	9.7	9.2	10.4	10.4	10.4	8.5	8.5	8.5
Colorado River Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CVP Base and Project Deliveries	25.7	25.7	24.5	26.3	26.3	26.3	18.4	18.4	18.4
Other Federal Deliveries	1.6	1.6	1.5	1.1	1.1	1.1	1.6	1.6	1.6
SWP Deliveries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Required Environmental Instream Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater									
Net Withdrawal	29.0	29.0	29.0	27.9	27.9	27.9	42.2	42.2	42.2
Deep Percolation of Surface and GW	37.3			38.4			36.7		
Reuse/Recycle									
Reuse Surface Water	6,735.3			4,588.9			2,775.8		
Recycled Water	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
TOTAL SUPPLIES	**8,421.9**	**1,649.3**	**1,571.7**	**6,209.1**	**1,581.8**	**1,581.8**	**3,948.8**	**1,136.3**	**1,136.3**
Balance = Use - Supplies	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***

Water Portfolios

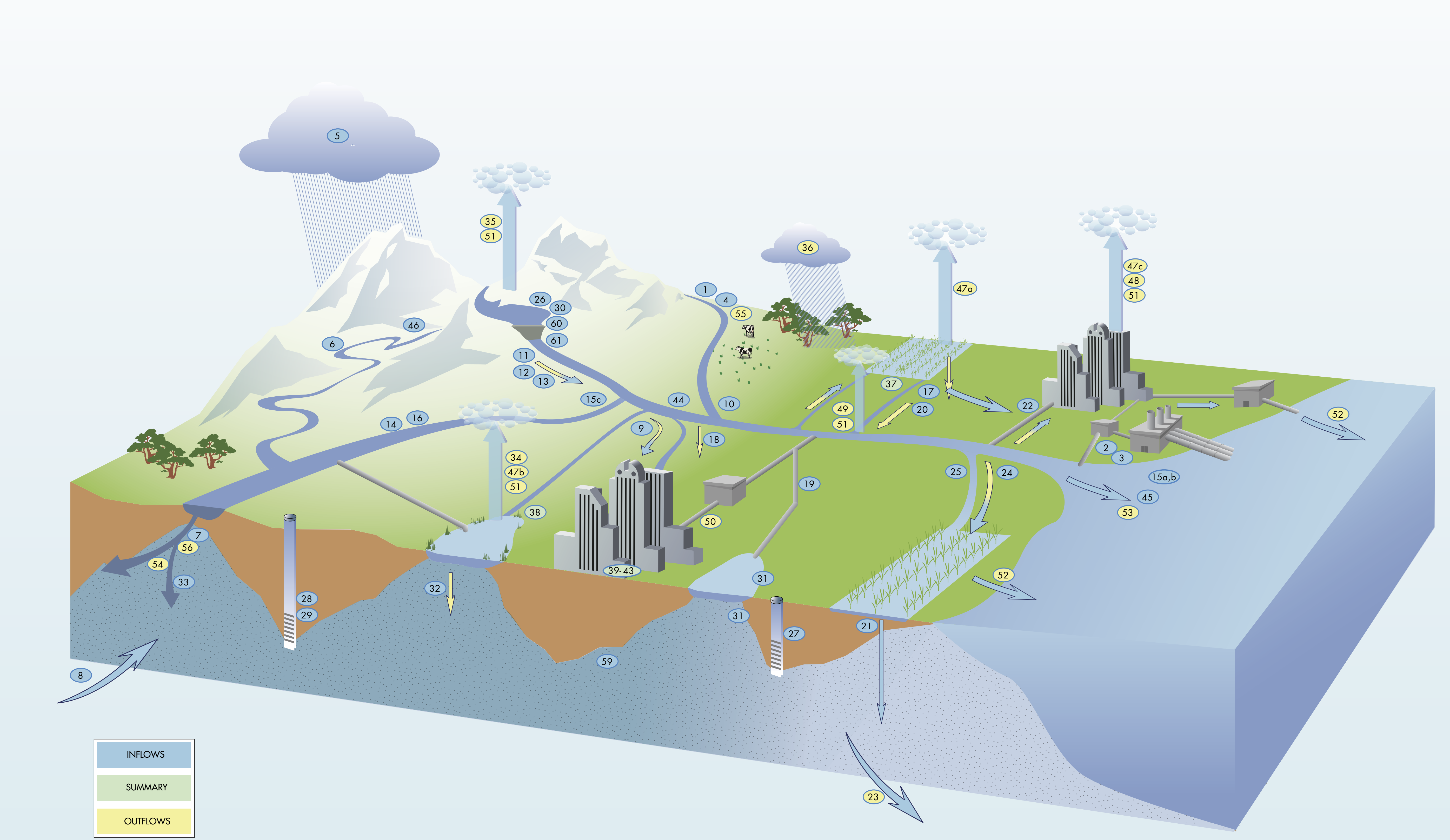
Mountain Counties Area

Table 13-3 Mountain Counties water portfolios (TAF)

ID Number:	Flow Diagram Component (see legend)	Mountain Counties 1998	Mountain Counties 2000	Mountain Counties 2001
1	Colorado River Deliveries	-	-	-
2	Total Desalination	-	-	-
3	Water from Refineries	-	-	-
4a	Inflow From Oregon	-	-	-
b	Inflow From Mexico	-	-	-
5	Precipitation	55,205.7	38,412.2	23,444.5
6a	Runoff - Natural	N/A	N/A	N/A
b	Runoff - Incidental	N/A	N/A	N/A
7	Total Groundwater Natural Recharge	N/A	N/A	N/A
8	Groundwater Subsurface Inflow			
9	Local Deliveries	1,582.1	1,514.9	1,064.4
10	Local Imports	9.7	10.4	8.5
11a	Central Valley Project :: Base Deliveries	-	-	-
b	Central Valley Project :: Project Deliveries	25.7	26.3	18.4
12	Other Federal Deliveries	1.6	1.1	1.6
13	State Water Project Deliveries	-	-	-
14a	Water Transfers - Regional	-	-	-
b	Water Transfers - Imported	-	-	-
15a	Releases for Delta Outflow - CVP			
b	Releases for Delta Outflow - SWP			
c	Instream Flow Applied Water	1,569.5	1,563.0	1,450.6
16	Environmental Water Account Releases	-	-	-
17a	Conveyance Return Flows to Developed Supply - Urban	-	-	-
b	Conveyance Return Flows to Developed Supply - Ag	22.6	-	-
c	Conveyance Return Flows to Developed Supply - Managed Wetlands	-	-	-
18a	Conveyance Seepage - Urban	-	-	-
b	Conveyance Seepage - Ag	3.6	4.7	3.7
c	Conveyance Seepage - Managed Wetlands	-	-	-
19a	Recycled Water - Agriculture	1.2	1.2	1.2
b	Recycled Water - Urban	-	-	-
c	Recycled Water - Groundwater	-	-	-
20a	Return Flow to Developed Supply - Ag	55.0	-	-
b	Return Flow to Developed Supply - Wetlands	-	-	-
c	Return Flow to Developed Supply - Urban	-	-	-
21a	Deep Percolation of Applied Water - Ag	6.0	6.1	4.5
b	Deep Percolation of Applied Water - Wetlands	-	-	-
c	Deep Percolation of Applied Water - Urban	22.7	21.5	22.0
22a	Reuse of Return Flows within Region - Ag	7.7	12.0	6.9
b	Reuse of Return Flows within Region - Wetlands, Instream, W&S	6,724.0	4,572.2	2,765.2
24a	Return Flow for Delta Outflow - Ag	-	-	-
b	Return Flow for Delta Outflow - Wetlands, Instream, W&S	1,227.1	1,089.5	654.2
c	Return Flow for Delta Outflow - Urban Wastewater	-	-	-
25	Direct Diversions	N/A	N/A	N/A
26	Surface Water in Storage - Beg of Yr	11,595.4	12,504.6	11,702.6
27	Groundwater Extractions - Banked	-	-	-
28	Groundwater Extractions - Adjudicated	-	-	-
29	Groundwater Extractions - Unadjudicated	66.3	66.3	78.9
23	Groundwater Subsurface Outflow	-	-	-
30	Surface Water Storage - End of Yr	14,015.1	11,702.6	8,982.1
31	Groundwater Recharge-Contract Banking	-	-	-
32	Groundwater Recharge-Adjudicated Basins	-	-	-
33	Groundwater Recharge-Unadjudicated Basins	-	-	-
34a	Evaporation and Evapotranspiration from Native Vegetation	N/A	N/A	N/A
b	Evaporation and Evapotranspiration from Unirrigated Ag	N/A	N/A	N/A
35a	Evaporation from Lakes	92.4	92.4	92.4
b	Evaporation from Reservoirs	630.2	630.2	630.2
36	Ag Effective Precipitation on Irrigated Lands	82.3	57.8	77
37	Agricultural Water Use	260.2	330.6	306.5
38	Managed Wetlands Water Use	-	-	-
39a	Urban Residential Use - Single Family - Interior	29.1	28.8	29.7
b	Urban Residential Use - Single Family - Exterior	59.3	58.8	61.4
c	Urban Residential Use - Multi-family - Interior	11.3	11.5	11.7
d	Urban Residential Use - Multi-family - Exterior	4.3	4.7	4.7
40	Urban Commercial Use	11.8	12.1	12.2
41	Urban Industrial Use	14.6	14.6	14.8
42	Urban Large Landscape	11.2	11.0	11.4
43	Urban Energy Production	-	-	-
44	Instream Flow	313	326.5	340.9
45	Required Delta Outflow	-	-	-
46	Wild and Scenic Rivers	914.1	763	313.3
47a	Evapotranspiration of Applied Water - Ag	177.1	223.9	206.5
b	Evapotranspiration of Applied Water - Managed Wetlands	-	-	-
c	Evapotranspiration of Applied Water - Urban	59.7	55.4	57.1
48	Evaporation and Evapotranspiration from Urban Wastewater	-	-	-
49	Return Flows Evaporation and Evapotranspiration - Ag	6	7.8	6
50	Urban Waste Water Produced	45.6	53.2	54.9
51a	Conveyance Evaporation and Evapotranspiration - Urban	10.1	8.1	9.7
b	Conveyance Evaporation and Evapotranspiration - Ag	10.6	22.8	22.7
c	Conveyance Evaporation and Evapotranspiration - Managed Wetlands	-	-	-
d	Conveyance Outflow to Mexico	-	0	0
52a	Return Flows to Salt Sink - Ag	12.1	102.1	104.1
b	Return Flows to Salt Sink - Urban	69	72.2	76
c	Return Flows to Salt Sink - Wetlands	0	0	0
53	Remaining Natural Runoff - Flows to Salt Sink	0	0	0
54a	Outflow to Nevada	-	-	-
b	Outflow to Oregon	-	-	-
c	Outflow to Mexico	-	-	-
55	Regional Imports	49.7	39.8	31.9
56	Regional Exports	2153.1	2476.7	1561.2
59	Groundwater Net Change in Storage	-5.5	-20.1	-79.5
60	Surface Water Net Change in Storage	2,419.7	-802.0	-2,720.5
61	Surface Water Total Available Storage	18,185.0	18,185.0	18,185.0

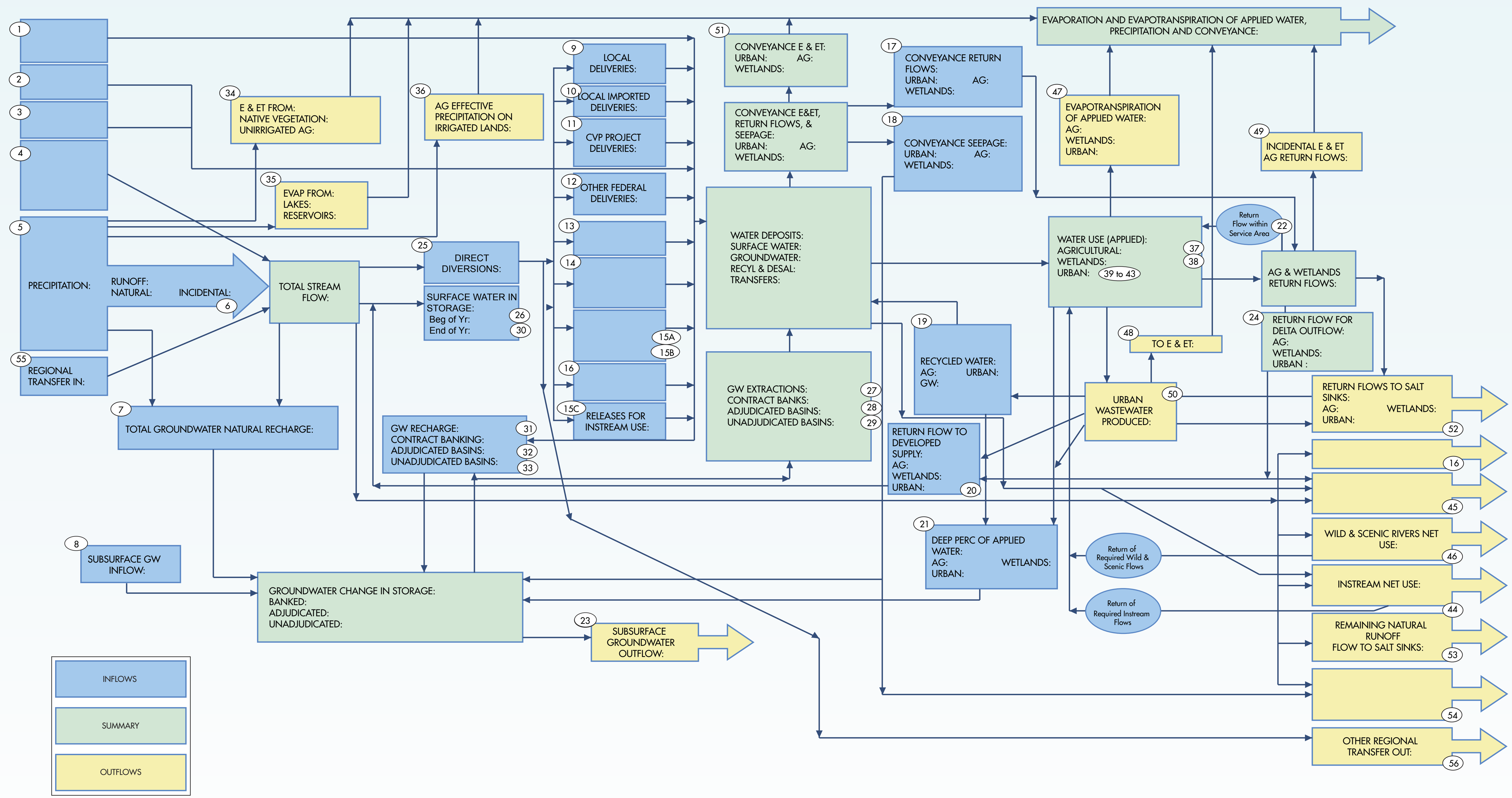
Inflows   Outflows   Green number signifies included in summary boxes

Figure 13-3 Mountain Counties area - illustrated water flow diagram

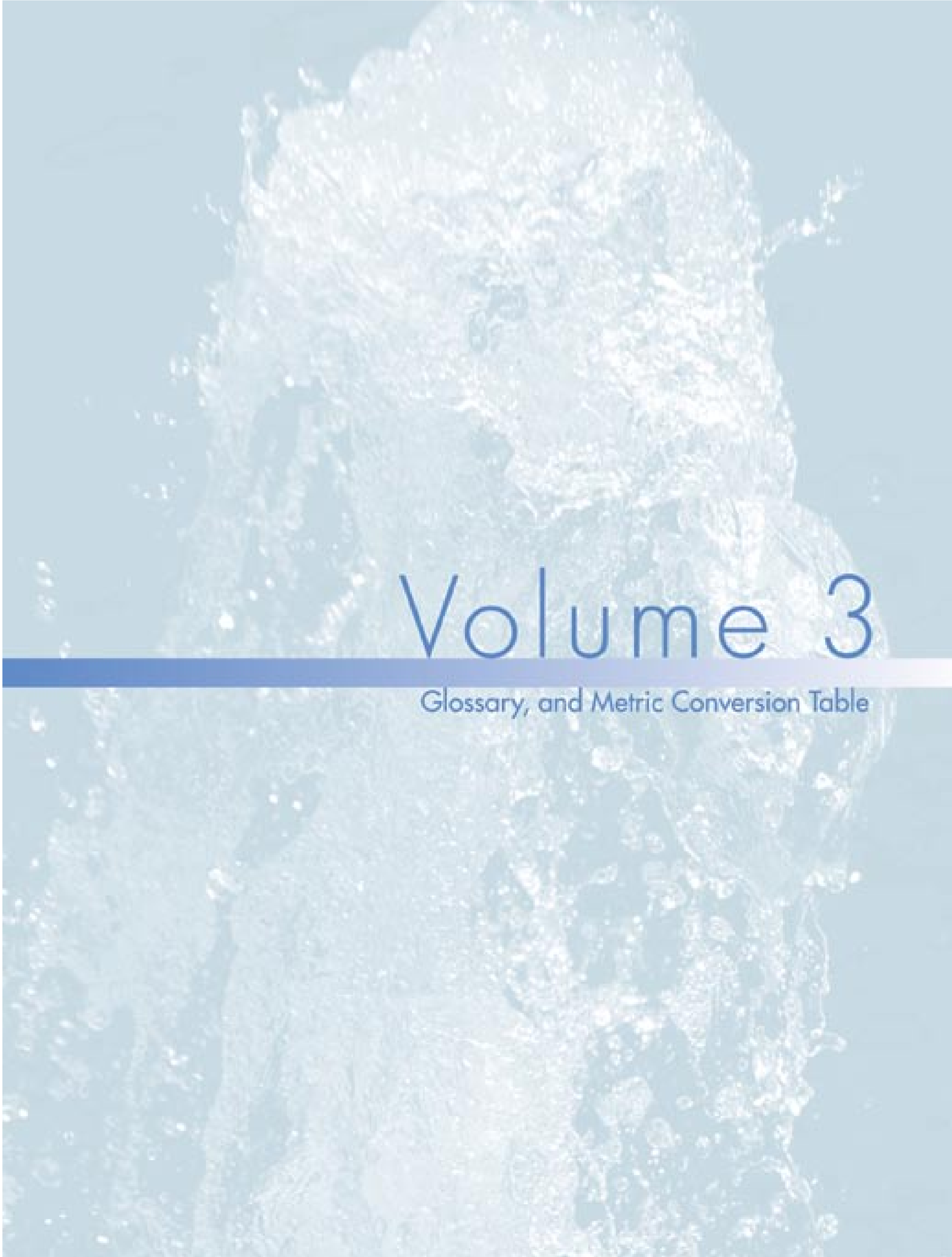


In this illustration of Table 13-3, key components of the flow diagram are shown as characteristic elements of the hydrologic cycle. Circled numbers correspond to the identification number of flow diagram components in the table; its color indicates whether the component is water input, output, or summary.

Figure 13-4 Mountain Counties area - schematic flow diagram



In schematic of Table 13-3, key components of the flow diagram are shown as boxes and connectors in a flow chart. Circled numbers correspond to the identification number of flow diagram components in the table; box color indicates if the component is a water input, output, or summary. Blank boxes are flow diagram components not relevant to the region.



Volume 3

Glossary, and Metric Conversion Table

Glossary

A

acre-foot (af) – The volume of water that would cover one acre to a depth of one foot; equal to 43,560 cubic feet or 325,851 gallons.

adjudication –The act of judging or deciding by law. In the context of an adjudicated groundwater basin, landowners or other parties have turned to the courts to settle disputes over how much groundwater can be extracted by each party to the decision.

agricultural discharge standards – State and federal water quality regulations regarding discharge of water used for agricultural production to streams, rivers, groundwater aquifers, or evaporation ponds. Context: Scenario Factor.

agricultural lands stewardship – Conserving natural resources and protecting the environment by compensating owners of private farms and ranches for implementing stewardship practices. Context: Resource Management Strategy.

agriculture water reliability (average) – A measure of a water system's ability to sustain the social, environmental, and economic agricultural systems that it serves during a year of average precipitation

agricultural water use efficiency – The ratio of applied water to the amount of water required to sustain agricultural productivity. Efficiency is increased through the application of less water to achieve the same beneficial productivity or by achieving more productivity while applying the same amount of water. Context: Scenario Factor, Resource Management Strategy.

allocation of long-term contractual imports – Interregional allocation of water for periods of time more than one year through mechanisms such as the State and federal water projects. Context: Scenario Factor.

alluvial – Of or pertaining to or composed of alluvium.

alluvium – A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream or other body of running water, as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, as a cone or fan at the base of a mountain slope.

anthropogenic – Of human origin or resulting from human activity.

applied water – The amount of water from any source needed to meet the demand for beneficial use by the user. It includes consumptive use, reuse, and outflows.

applied water reduction – A decrease in the amount of water needed to meet the demand for beneficial use; can be a supply for both new (real) water and reused water. Context: Resource Management Strategy. See also new water.

appropriative right – The right to use water that is diverted or extracted by a nonriparian or nonoverlying party for nonriparian or nonoverlying beneficial uses. In California, surface water appropriative rights are subject to a statutory permitting process while groundwater appropriation is not.

aquifer – A body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant (i.e. economic) quantities of groundwater to wells and springs.

aquifer remediation – See groundwater remediation/aquifer remediation

aquitard – A confining bed or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores groundwater.

artesian aquifer – A body of rock or sediment containing groundwater that is under greater than hydrostatic pressure; that is, a confined aquifer. When an artesian aquifer is penetrated by a well, the water level will rise above the top of the aquifer.

artesian pressure – Hydrostatic pressure of artesian water, often expressed in terms of pounds per square inch; or the height, in feet above the land surface, of a column of water that would be supported by the pressure.

artificial recharge – The (intentional) addition of water to a groundwater reservoir by human activity, such as putting surface water into dug or constructed spreading basins or injecting water through wells.

available groundwater storage capacity – The volume of a groundwater basin that is unsaturated and capable of storing groundwater.

available soil water – The amount of water held in the soil that can be extracted by a crop; often expressed in inches per foot of soil depth. It is the amount of water released between in situ field capacity and the permanent wilting point.

average annual cost of implementing option – Annualized total monetary cost of option required for "turn key" implementation including environmental and third party impact mitigation, storage, conveyance, energy, capitalized operations and maintenance, administrative, planning, legal and engineering costs. Context: Evaluation Criteria; Planning Concept/Consideration.

average annual runoff – The average value of total annual runoff volume calculated for a selected period of record, at a specified location, such as a dam or stream gage.

average year water demand – Demand for water under average hydrologic conditions for a specific level of development.

B

basin irrigation – Irrigation by flooding areas of level land surrounded by dikes. Used interchangeably with level border irrigation, but usually refers to smaller areas.

basin management objectives (BMOs) – See management objectives

beneficial use – Use of water either directly by people or for their overall benefit. There are 24 categories of beneficial uses identified by the State Water Resources Control Board.

border irrigation – Irrigation by flooding strips of land, rectangular in shape and cross leveled, bordered by dikes. Water is applied at a rate sufficient to move it down the strip in a uniform sheet. Border strips having no downfield slope are referred to as level border systems. Border systems constructed on terraced lands are commonly referred to as benched borders.

C

catastrophic vulnerability – The probability and magnitude of potential negative economic, public health, and environmental impacts associated with water management actions. Context: Scenario Factor, Evaluation Criteria..

Central Valley Project deliveries – The volume of water imported to a given area through the Central Valley Project. Context: Scenario Factor.

check irrigation – Modification of a border strip with small earth ridges or restrictions (checks) constructed or inserted at intervals to retain water as it flows down the strip.

CIMIS – California Irrigation Management Information System- A network of automated weather stations that are owned and operated cooperatively between the DWR and local agencies. The stations are installed in most of the agricultural and urban areas in the State and provide farm and large landscape irrigation managers and researchers with "real-time" weather data to estimate crop and landscape ET rates and make irrigation management decisions.

climate change – Changes in average annual temperature and precipitation and their monthly patterns in 2050 compared to today.

Colorado River supply – The volume of water California has the right to import from the Colorado River. California's allocation is 4.4 million acre-feet per year plus 50% of any declared surplus. Context: Scenario Factor.

commercial activity mix – The mix of high- and low-water using commercial activity. Note that commercial activity is broken into two factors: total commercial activity and commercial activity mix. The latter factor allows designation of the type of commercial activity that is occurring. See also total commercial activity. Context: Scenario Factor.

community water system – A public water system that serves at least 15 service connections used by yearlong residents or regularly serves at least 25 yearlong residents. See also public water system.

consumed fraction – the portion of agricultural applied irrigation water that satisfies evapotranspiration.

conveyance – Provides for the movement of water and includes the use of natural and constructed facilities including open channels, pipelines, diversions, fish screens distribution systems and pump lifts.

conveyance facilities – Canals, pipelines, pump lifts, ditches, etc. used to move water from one area to another. Context: Study Plan Building Block, Resource Management Strategy.

confined aquifer – An aquifer that is bounded above and below by formations of distinctly lower permeability than that of the aquifer itself. An aquifer containing confined groundwater. See also artesian aquifer.

conjunctive management and groundwater storage – Coordinated operation of surface water storage and use, ground water storage and use, and conveyance facilities. Context: Resource Management Strategy.

conjunctive use – Application of surface and groundwater to meet the demand for a beneficial use. Coordinated and planned management of both surface and groundwater resources in order to maximize the efficient use of the resource; that is, the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure. Water is stored in the groundwater basin for later and planned use by intentionally recharging the basin during years of above-average surface water supply.

conservation tillage – A tillage practice that leaves plant residues on the soil surface for erosion control and moisture conservation

consumptive use – A quantity of applied water that is not available for immediate or economical reuse. It includes water that evaporates, transpires, or is incorporated into products, plant tissue, or animal tissue. Consumptively used water is removed from available supplies without return to a water resource system (uses such as manufacturing, agriculture, landscaping, food preparation, and in the case of Colorado River water, water that is not returned to the river.)

contaminant – Any substance or property preventing the use or reducing the usability of the water for ordinary purposes such as drinking, preparing food, bathing washing, recreation, and cooling. Any solute or cause of change in physical properties that renders water unfit for a given use. (Generally considered synonymous with pollutant.)

cost recovery – Designates who (marginal or existing users) pays the marginal and existing water costs. Also specifies circumstances where other revenue sources are used to recover costs. Costs can include capital, O&M, financing, environmental compliance (documentation, permitting and mitigation), etc. Context: Scenario Factor

cost of reliability enhancement – The total cost required to add an increment of reliability. Context: Evaluation Criteria.

cost of unreliability – The sum of the forgone long-term value and short-term costs incurred to the users. Context: Evaluation Criteria

critical conditions of overdraft – A groundwater basin in which continuation of present practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts. The definition was created after an extensive public input process during the development of the Bulletin 118-80 report.

cover crop – Close growing crop, that provides soil protection, seeding protection, and soil improvement between periods of normal crop production, or between trees in orchards and vines in vineyards. When plowed under and incorporated into the soil, cover crops may be referred to as green manure crops.

crop coefficient – A numerical factor (normally identified as Kp or Kc) that relates the evapotranspiration (ET) of the individual crop (ETc) to reference evaporation or some other index.

crop idling – The temporary or permanent fallowing of land previously under irrigation that results in a reduction in stresses to a water system (e.g., alternate land use must result in a reduction in water use and/or enhancement of water quality, etc.). Context: Scenario Factor.

crop rotation – A system of farming in which a succession of different crops are planted on the same land area, as opposed to growing the same crop time after time (monoculture).

crop unit water use –The volume of irrigation water used per unit area of land, commonly expressed in acre feet per acre. As used in scenario evaluation, a change in unit water use can be a function of evapotranspiration rates and cultural practices, but NOT use efficiency. Agricultural use efficiency is captured under its own distinct factor. Context: Scenario Factor.

D

deep percolation – Percolation of water through the ground and beyond the lower limit of the root zone of plants into groundwater

deep percolation of surface and groundwater – Water that is applied for agricultural, urban, and managed wetlands in excess of the net use requirements. Water either is applied for groundwater recharge or percolates naturally to the water table. This does not include reuse, evaporation, evapotranspiration of applied water, or flows/percolation to a salt sink. Context: Water Portfolio

depletion – Water consumed through evapotranspiration, flows to salt sinks or is otherwise no longer available as a source supply.

desalination – Water treatment process for the removal of salt from water for beneficial use. Source water can be brackish (low salinity) or seawater. Context: Study Plan Building Block.

dewvaporation (Atmospheric Pressure Desalination) – Desalination through humidification and subsequent dehumidification (collection of evaporated water). Context: Resource Management strategy.

distribution system – System of ditches or conduits and their controls that conveys water from the supply canal to the farm points of delivery domestic well – A water well used to supply water for the domestic needs of an individual residence or systems of four or fewer service connections.

drinking water standards – State and federal regulations regarding water delivered by water purveyors that is used as a potable supply. Context: Scenario Factor.

drinking water system – see public water system

drinking water treatment and distribution – Treatment is the physical, biological and chemical processes that make water suitable for potable use. Distribution includes storage, pumping, and pipe systems to protect and deliver the treated water to customers. Context: Study Plan Building Block.

drip irrigation – A method of micro irrigation wherein water is applied to the soil surface as drops or small streams through emitters. Discharge rates are generally less than 8 L/h (2 gal/h) for a single-outlet emitters and 12 L/h (3 gal/h) per meter for line-source emitters.

drought preparedness– The magnitude and probability of economic, social or environmental consequences that would occur as a result of a sustained drought under a given study plan. Evaluation criteria measure the “drought tolerance” of study plans. Context: Water Management Objective

drought condition – Hydrologic conditions during a defined period, greater than one dry year, when precipitation and runoff are much less than average.

drought year supply – The average annual supply of a water development system during a defined drought period.

duty of water – The total volume of irrigation water required to mature a particular type of crop. It includes consumptive use, evaporation, and seepage as well as the water returned to streams by percolation and surface water.

E

earthquake vulnerability – see seismic vulnerability

economic incentives – Financial assistance and pricing policies intended to influence water management including, for example, amount of use, time of use wastewater volume, and source of supply. Context: Resource Management Strategy.

ecosystem restoration – The activity of improving the condition of natural landscapes and biotic communities. Context: Study Plan Building Block.

effective precipitation – That portion of precipitation that supplies crop evapotranspiration. It includes precipitation stored in the soil before and during the growing season

effective porosity – The volume of voids or open spaces in alluvium and rocks that is interconnected and can transmit fluids.

effective rooting depth – The depth from which soil moisture is extracted; it is determined by the crop rooting characteristics and soil depth limitations.

electrical conductivity (EC) – The measure of the ability of water to conduct an electrical current, the magnitude of which depends on the dissolved mineral content of the water.

energy availability – The energy consumption to facilitate water management-related actions such as desalting, pump-storage, groundwater extraction, conveyance or treatment. This criterion pertains to the economic feasibility of a proposed water management action in terms of O&M costs. Context: Evaluation Criteria.

energy costs – Refers to the cost of energy use related to producing, conveying and applying water. It also refers to the cost of energy use for processes and inputs not directly related to water, but which can affect the demand for water (e.g., the cost of nitrogen fertilizer, tractor manufacturing, etc.). Context: Scenario Factor.

energy production – Both instantaneous capacity (megawatt) and energy produced (kilowatt hours). Context: Evaluation Criteria.

environmental justice – The fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. (Section 65040.12. (c) Government code)

environmental water (flow based) – The amount of water dedicated to instream fishery uses, Wild and Scenic rivers, Bay-Delta outflow and aquatic habitat.

environmental water (land based) – The amount of water used for fresh-water managed wetlands and native vegetation.

environmental water quality – Water quality in terms of ecosystem health, recreation, salinity intrusion, usability per sector, treatment costs, etc. Aquatic species and water bodies are vulnerable to changes to water quality.

ETo (Reference Evapotranspiration) – The evapotranspiration rate from an extended surface of 3 to 6 inch (8–15 cm) tall green grass cover of uniform height, actively growing, completely shading the ground, and not short on water (the reference ET reported by CIMIS).

evaluation criteria – The technical information that will be used to compare the favorability of different response packages of resource management strategies against future scenarios in California Water Plan Update 2010. They are designed to identify and measure potential effects on water supply, the environment, energy use or production, recreational opportunities, groundwater overdraft, and many more.

evaporation – The physical process by which a liquid or solid is transformed to a gaseous state.

evaporative demand – The collective influence of all climatic factors on the rate of evaporation of water.

evapotranspiration (ET) – The quantity of water transpired by plants, retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces

evapotranspiration of applied water (ETAW) – The portion of ET satisfied by applied irrigation water.

F

flood irrigation – Method of irrigation where water is applied to the soil surface without flow controls, such as furrows, borders, or corrugations

floodplain management – Actions designed to reduce risks to life, property, and the environment due to flooding. Actions can include watershed management, infrastructure construction and operation, variations in land use practices, floodway designations, etc. Context: Study Plan Building Block.

flood risk – The magnitude and probability of consequences that would occur as a result of flood-induced infrastructure damage under a given study plan. Context: Evaluation Criteria.

flow diagram – Diagram that characterizes a region's hydrologic cycle by documenting sources of water such as precipitation and inflows and tracks the water as it flows (through many different uses) to its ultimate destinations.

flow diagram table – An itemized listing of all the categories contained in the Flow Diagram including more detailed information, organized by "inputs" and "withdrawals."

full cost – (1) all monetary costs associated with project planning, implementation, financing, or impact mitigation plus any recurring costs required to sustain benefits; PLUS (2) all nonmonetary costs that are incurred either at implementation or on a recurring basis such as unmitigable environmental or cultural impacts, public trust, environmental justice, or other nonmarket-based societal values. (Coincides with CEQA/NEPA study and other permitting requirements.) Context: Planning Concept/Consideration.

furrow irrigation – Method of surface irrigation where the water is supplied to small ditches or furrows for guiding across the field.

G

groundwater – Water that occurs beneath the land surface and fills the pore spaces of the alluvium, soil, or rock formation in which it is situated. It excludes soil moisture, which refers to water held by capillary action in the upper unsaturated zones of soil or rock.

groundwater basin – An alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and having a definable bottom.

groundwater budget – A numerical accounting, the groundwater equation, of the recharge, discharge and changes in storage of an aquifer, part of an aquifer, or a system of aquifers.

groundwater in storage – The quantity of water in the zone of saturation.

groundwater management – The planned and coordinated management of a groundwater basin or portion of a groundwater basin with a goal of long-term sustainability of the resource.

groundwater management plan – A comprehensive written document developed for the purpose of groundwater management and adopted by an agency having appropriate legal or statutory authority.

groundwater mining – The process, deliberate or inadvertent, of extracting groundwater from a source at a rate in excess of the replenishment rate such that the groundwater level declines persistently, threatening exhaustion of the supply or at least a decline of pumping levels to uneconomic depths.

groundwater monitoring network – A series of monitoring wells at appropriate locations and depths to effectively cover the area of interest. Scale and density of monitoring wells is dependent on the size and complexity of the area of interest, and the objective of monitoring.

groundwater overdraft – The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions.

groundwater quality – See water quality

groundwater recharge facility – A structure that serves to conduct surface water into the ground for the purpose of replenishing groundwater. The facility may consist of dug or constructed spreading basins, pits, ditches, furrows, streambed modifications, or injection wells.

groundwater recharge – The natural or intentional infiltration of surface water into the zone of saturation.

groundwater remediation/aquifer remediation – Groundwater Remediation involves extracting contaminated groundwater from an aquifer, treating it, and then either putting it back in the aquifer or using it for agricultural or municipal purposes. Aquifer Remediation is usually accomplished by treating groundwater while it is still in the aquifer, using in-situ methods involving biological, physical, or chemical treatment or electrokinetics. Context: Study Plan Building Block, Resource Management Strategy.

groundwater source area – An area where groundwater may be found in economically retrievable quantities outside of normally defined groundwater basins, generally referring to areas of fractured bedrock in foothill and mountainous terrain where groundwater development is based on successful well penetration through interconnecting fracture systems. Well yields are generally lower in fractured bedrock than wells within groundwater basins.

groundwater storage capacity – Volume of void space that can be occupied by water in a given volume of a formation, aquifer, or groundwater basin.

groundwater subbasin – A subdivision of a groundwater basin created by dividing the basin using geologic and hydrologic conditions or institutional boundaries.

groundwater table – The upper surface of the zone of saturation in an unconfined aquifer.

groundwater quality – Water quality can affect supply integrity. Many pollutants are hydrophilic and not easily filtered by soil. Treated groundwater can be added to water supply. Context: Evaluation Criteria.

H

hazardous waste – Waste that poses a present or potential danger to human beings or other organisms because it is toxic, flammable, radioactive, explosive, or has some other property that produces substantial risk to life.

hydraulic barrier – A barrier created by injecting fresh water to control seawater intrusion in an aquifer, or created by water injection to control migration of contaminants in an aquifer.

hydraulic conductivity – A measure of the capacity for a rock or soil to transmit water; generally has the units of feet/day or cm/sec.

hydrograph – A graph that shows some property of groundwater or surface water as a function of time at a given point.

hydrology – A science related to the occurrence and distribution of natural water on the earth including the annual volume and the monthly timing of runoff.

hydrologic cycle – The circulation of water from the ocean through the atmosphere to the land and ultimately back to the ocean.

hydrologic region – A study area consisting of multiple planning subareas. California is divided into 10 hydrologic regions.

hydrostratigraphy – A geologic framework consisting of a body of rock having considerable lateral extent and composing a reasonably distinct hydrologic system.

hyporheic zone – The region of saturated sediments beneath and beside the active channel and that contain some proportion of surface water that was part of the flow in the surface channel and went back underground and can mix with groundwater.

I

in-lieu recharge – The practice of providing surplus surface water to historic groundwater users, thereby leaving groundwater in storage for later use.

industrial activity mix – The mix of high and low water using industrial activity. Note that Industrial Activity is broken into two factors: Total Industrial Activity and Industrial Activity Mix. The latter factor allows designation of the type of industry that is occurring. This is necessary to account for the large variation in water demands by industry type. See also total industrial activity. Context: Scenario Factor.

infiltration – The flow of water downward from the land surface into and through the upper soil layers.

infiltration capacity – The maximum rate at which infiltration can occur under specific conditions of soil moisture.

infrastructure – the underlying foundation or basic framework of a system

integrated regional water management – A comprehensive, systems approach for determining the appropriate mix of demand and supply management options that provide long-term, reliable water supply at lowest reasonable cost and with highest possible benefits to customers, economic development, environmental quality, and other social objectives.

intercropping – The simultaneous planting of two or more crops in the same field. The practice is used to help control pest populations that can occur on monoculture crops, sometimes called "polycropping" or "plant stratification."

interregional import projects – Movement of water between regions through mechanisms such as the State and federal water projects. Context: Scenario Factor.

irrecoverable water – the amount of applied water that is not available for supply or reuse, including discharge to saline sinks, evaporation, and evapotranspiration. See recoverable water

irrigation efficiency (IE) – The efficiency of water application and use, calculated by dividing a portion of applied water that is beneficially used by the total applied water, expressed as a percentage The two main beneficial uses are crop water use (evapotranspiration, ETc) and leaching to maintain a salt balance.

irrigation water requirements – The quantity of water exclusive of precipitation that is required from various uses.

J

joint powers agreement (JPA) – An agreement entered into by two or more public agencies that allows them to jointly exercise any power common to the contracting parties. The JPA is defined in Ch. 5 (commencing with Section 6500) of Division 7 of Title 1 of the California Government Code.

L

land subsidence – The lowering of the natural land surface due to groundwater (or oil and gas) extraction.

leaching requirements – The fraction of water entering the soil that must pass through the root zone in order to prevent soil salinity from exceeding a specific value.

leaching efficiency – The ratio of the average salt concentration in drainage water to an average salt concentration in the soil water of the root zone when near field capacity.

leaky confining layer – A low-permeability layer that can transmit water at sufficient rates to furnish some recharge from an adjacent aquifer to a well.

lithologic log – A record of the lithology of the soils, sediments and/or rock encountered in a borehole from the surface to the bottom.

lithology – The description of rocks, especially in hand specimen and in outcrop, on the basis of such characteristics as color, mineralogic composition, and grain size.

M

management objectives – Objectives that set forth the priorities and measurable criteria of water management. Examples include improve water quality, augment water supplies, improve use efficiency, etc.

matching water quality to use – a resource management strategy that recognizes not all water uses require the same quality water. High quality water sources can be used for drinking and industrial purposes that benefit from higher quality water, and lesser quality water can be desirable for some uses, such as riparian streams with plant materials benefiting fish. Context: Resource Management Strategy.

maximum contaminant level (MCL) – The highest drinking water contaminant concentration allowed under federal and State Safe Drinking Water Act regulations.

microirrigation – The frequent application of small quantities of water as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line. Microirrigation encompasses a number of methods or concepts such as bubbler, drip, trickle, mist, or spray.

multicropping – The practice of consecutively producing two crops (double cropping) or more of either like or unlike com modities on the same land within the same year. An example of double cropping might be to harvest a wheat crop by early summer and then plant corn or beans on that acreage for harvest in the fall. Suitable climates and reliable water supplies are important factors with this practice.

N

naturally occurring conservation – The amount of background conservation occurring independent of the BMP and EWMP programs (e.g., plumbing codes, etc.). Context: Scenario Factor.

natural recharge – Natural replenishment of an aquifer generally from snowmelt and runoff; through seepage from the surface.

net groundwater withdrawal - groundwater extraction in excess of percolation into a groundwater basin. Context: Water Portfolio net water use (demand) – the amount of water needed in a water service area to meet all requirements or demands. It is the sum of several components including evapotranspiration of applied water in an area, the irrecoverable water from the distribution system, and the outflow leaving the service area; does not include reuse of water within a service area.

new water – Water that is legally and empirically available for a beneficial use; can be developed through many strategies such as capturing surplus water, desalination of ocean water and reductions in depletions. (Same meaning as real water) Context: Planning Concept/Consideration.

nonpoint source – Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, etc., carried to lakes and streams by surface runoff. See also point source

O

operational flexibility – The temporal or spatial operational efficiency of existing and proposed infrastructure to maximize benefits. Context: Evaluation Criteria.

operational yield – An optimal amount of groundwater that should be withdrawn from an aquifer system or a groundwater basin each year. It is a dynamic quantity that must be determined from a set of alternative groundwater management decisions subject to goals, objectives, and constraints of the management plan.

ordinance – A law set forth by a governmental authority.

other interregional import deliveries – This factor is intended to capture the interregional movement of water for "projects" such as Russian River, Trinity River Exports or Putah South Canal. Note that the project name must be specified in the study plan narrative. Context: Scenario Factor.

overdraft – See groundwater overdraft

overlying right – Property owners above a common aquifer possess a mutual right to the reasonable and beneficial use of a groundwater resource on land overlying the aquifer from which the water is taken. Overlying rights are correlative (related to each other) and overlying users of a common water source must share the resource on a pro rata basis in times of shortage. A proper overlying use takes precedence over all non-overlying uses.

P

pelagic fish – fish that spawn in open water, often near the surface. Many river-dwelling anadromous fishes, such as shad are also pelagic spawners

perched groundwater – Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater.

percolation – Process in which water moves through a porous material, usually surface water migrating through soil toward a groundwater aquifer.

perennial yield – The maximum quantity of water that can be annually withdrawn from a groundwater basin over a long period of time (during which water supply conditions approximate average conditions) without developing an overdraft condition.

permeability – The capability of soil or other geologic formations to transmit water.

pesticide – Any of a class of chemicals used for killing insects, weeds, or other undesirable entities. Most commonly associated with agricultural activities, but has significant domestic use in California.

point source – A specific site from which wastewater or polluted water is discharged into a water body. See also nonpoint source

pollution (of water) – The alteration of the physical, chemical, or biological properties of water by the introduction of any substance into water that adversely affects any beneficial use of water.

pollution prevention – Improving water quality for all beneficial uses by protecting water at its source, reducing the need and cost for other water management actions and treatment. Context: Resource Management Strategy.

population density – The average number of people per square mile for a planning area. Context: Scenario Factor.

population distribution – The geographic location within California of the population projection. Context: Scenario Factor.

population projection – The 2030 forecast of population made by the California Department of Finance or other agencies. Context: Scenario Factor.

porosity – The ratio of the voids or open spaces in alluvium and rocks to the total volume of the alluvium or rock mass.

possible contaminating activity (PCA) – Human activities that are actual or potential origins of contamination for a drinking water source. PCAs include sources of both microbiological and chemical contaminants that could have an adverse effect upon human health.

precipitation enhancement – The action of artificially stimulating clouds "cloud seeding" to produce more rainfall/snowfall than would naturally occur. Context: Resource Management Strategy.

prescriptive right – Rights obtained through the open and notorious adverse use of another's water rights. By definition, adverse use is not use of a surplus, but the use of non surplus water to the direct detriment of the original rights holder.

public trust doctrine–A legal doctrine recognizing public rights in the beds, banks, and waters of navigable waterways, and the State's power and duty to exercise continued supervision over them as trustee for the benefit of the people.

public water system – A system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year.

pueblo right – A water right possessed by a municipality which, as a successor of a Spanish or Mexican pueblo, entitled to the beneficial use of all needed, naturally occurring surface and groundwater of the original pueblo watershed Pueblo rights are paramount to all other claims.

R

rate structure – Designates the rate basis for cost recovery (e.g., flat, uniform, tiered, etc.). Block/Tiered rates are assumed to provide cost signals to consumers. Costs can include capital, O&M, financing, environmental compliance (documentation, permitting and mitigation), etc. Context: Scenario Factor.

real water – See new water. Context: Planning Concept/Consideration.

recharge – Water added to an aquifer or the process of adding water to an aquifer. Groundwater recharge occurs either naturally as the net gain from precipitation or artificially as the result of human influence. See also artificial recharge.

recharge area protection – The action of keeping recharge areas from being paved over or otherwise developed and guarding the recharge areas so they don't become contaminated Context: Resource Management Strategy.

recharge basin – A surface facility constructed to infiltrate surface water into a groundwater basin.

recoverable water – the amount of applied water that is available for supply or reuse; including surface runoff to non-saline bodies of water and deep percolation that becomes groundwater.
See irrecoverable water

recreation – Water-dependent recreation activities that are consumptive (e.g., parks), flat-water (e.g., boating), or flow-based (e.g., whitewater rafting). Context: Scenario Factor.

recreation (reservoir-based) – Flat water recreation, such as boating and skiing, in the form of future storage facilities as well as operation of existing surfaces storage facilities. Context:

recreation sport-fish populations – Populations of fish species that support recreational fishing.

recreation (watercourse-based) – Activities that are dependent on instream flows such as whitewater rafting. Context:

recycled water – Treated municipal, industrial, or agricultural wastewater to produce water that can be reused. Context: Resource Management Strategy

regional self-sufficiency – The degree to which a study plan involves implementation of regional water management options. Context: Evaluation Criteria.

reliability planning – Water reliability management planning is done by comparing the costs of taking actions to maintain or increase reliability to the costs of accepting less reliability. On this basis, accepting of the costs of adverse effects of less than 100 percent reliability could be a legitimate planning decision. Providing full water supply to meet 100 percent of projected future water demand is not the planning goal, rather, the goal is to find the justified level of reliability. Context: Planning Concept/Consideration.

resource management strategy – A project, program, or policy that helps federal, State or local agencies manage water and related resources. Resource Management Strategies can reduce water demand, improve operational flexibility, increase water supply, improve water quality, or practice resource stewardship.

response packages – Additional sets of resource management strategies to be tested against future scenario conditions for performance comparison. This analysis will take place in California Water Plan Update 2010. Comparing the performance of different response packages will provide useful information to decision-makers and water managers as they choose actions to achieve a desirable future water condition.

return-flow system – A system of pipelines or ditches to collect and convey surface or subsurface runoff from an irrigated field for reuse.

reused agricultural water – Water that is used by more than one grower and is, therefore, not available for reallocation should one grower become increasingly efficient (i.e., applied water reductions minus real water equal zero). Context: Planning Concept/Consideration.

riparian right – A right to use surface water, such right derived from the fact that the land in question abuts the banks of streams.

root zone – The portion of the soil profile through which plant roots readily penetrate to obtain water and plant nutrients, expressed in inches or feet of depth.

runoff – The volume of surface flow from an area.

S

safe yield – The maximum quantity of water that can be continuously withdrawn from a groundwater basin without adverse effect

saline soil – A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most plants.

saline intrusion – The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater bodies.

salinity – Generally, the concentration of mineral salts dissolved in water. Salinity may be expressed in terms of a concentration or as electrical conductivity. When describing salinity influenced by seawater, salinity often refers to the concentration of chlorides in the water.

saturated zone – The zone in which all interconnected openings are filled with water, usually underlying the unsaturated zone.

scenarios – Sets of plausible future conditions based on different assumptions of factors such as population size, density, and distribution, per capita income, commercial and industrial activity, and crop area and water use. In California Water Plan Update 2005, the three scenarios for 2030 are strictly narrative and are "no action" (i.e., they do not reflect any additional resource management strategies in the form of response packages beyond those currently planned, such as new water efficiency programs).

seasonal vs. permanent crop mix – Shifts in crop type between seasonal and permanent. This factor depicts the diminished ability to reduce water use during times of increased water scarcity (due to shifting from seasonal to permanent crops). In other words, shortage losses increase when shifting from season to permanent. Context: Scenario Factor.

seawater intrusion barrier – A system designed to retard, cease or repel the advancement of seawater intrusion into potable groundwater supplies along coastal portions of California. The system may be a series of specifically placed injection wells where water is injected to form a hydraulic barrier.

secondary porosity – Voids in a rock formed after the rock has been deposited; not formed with the genesis of the rock, but later due to other processes. Fractures in granite and caverns in limestone are examples of secondary openings.

seepage – The gradual movement of water into, through, or from a porous medium. Also, the infiltration of water into the soil from canals, ditches, laterals, watercourse, reservoir, storage facilities, or other body of water, or from a field.

semi-confined aquifer – A semi-confined aquifer or leaky confined aquifer is an aquifer that has aquitards either above or below that allow water to leak into or out of the aquifer depending on the direction of the hydraulic gradient.

service area – The geographic area served by a water agency.

soil moisture – The water in soils. Usually expressed as a percentage of the dry weight of the soil. Can also be expressed on a wet weight or a volume basis.

soil texture – Soil texture refers to the percentage of sand, silt, and clay particles in a soil. Sand, silt, and clay particles are defined by their size. Soil texture has important effects on soil properties. Water-holding capacity, drainage class, consistence, and chemical properties are just a few examples of properties that are affected by soil texture.

specific retention – The ratio of the volume of water a rock or sediment will retain against the pull of gravity to the total volume of the rock or sediment.

specific yield – the ratio of the volume of water a rock or soil will yield by gravity drainage to the total volume of the rock or soil.

spring – a location where groundwater flows naturally to the land surface or a surface water body.

sprinkler irrigation – Method of irrigation in which the water is sprayed, or sprinkled, through the air to the ground surface.

stakeholder – individuals or groups who can affect or be affected by an organization's activities. or: Individuals or groups with an interest or "stake" in what happens as a result of any decision or action. Stakeholders do not necessarily use the products or receive the services of a program.

State Water Project deliveries – The volume of water imported to a given study area from the State Water Project. Context: Scenario Factor.

statewide water management systems – These include physical facilities (more than 1,200 State, federal, and local reservoirs, as well as canals, treatment plants, and levees), which make up the backbone of water management in California, and statewide water management programs, which include water-quality standards, monitoring programs, economic incentives, water pricing policies, and statewide water-efficiency programs such as appliance standards, labeling, and education.

strategic plan – The long-term goals of an organization or program and an outline of how they will be achieved (e.g., adopting specific strategies, approaches, and methodologies).

stratigraphy – The science of rocks. It is concerned with the original succession and age relations of rock strata and their form, distribution, lithologic composition, fossil content, geophysical and geochemical properties—all characters and attributes of rocks as strata—and their interpretation in terms of environment and mode of origin and geologic history.

stress irrigation – Management of irrigation water to apply less than enough water to satisfy the soil water deficiency in the entire root zone. (Preferred term is limited irrigation.)

subirrigation – Application of irrigation water below the ground surface by raising the water table to within or near the root zone.

subsurface drip irrigation – Application of water below the soil surface through emitters, with discharge rates generally in the same range as drip irrigation. This method of water application is different from and not to be confused with subirrigation where the root zone is irrigated by water table control.

surface irrigation – Irrigation in which the soil surface is used as the conduit, as in furrow and border irrigation, and as opposed to sprinkler, drip, and subirrigation.

surface storage facilities – The volume and yield of usable reservoir storage in a given area. Context: Resource Management Strategy.

surge irrigation – A surface irrigation technique wherein flow is applied to furrows (or less commonly, borders) intermittently during a single irrigation set.

subsidence – See land subsidence

subterranean stream – Subterranean streams "flowing through known and definite channels" are regulated by California's surface water rights system.

surface supply – Water supply obtained from streams, lakes, and reservoirs.

surplus water – Water that is not being used directly or indirectly to benefit the environmental, agricultural or urban use sectors. Context: Planning Concept/Consideration.

sustainability – A specific resource that avoids complete depletion over a specified time horizon. The continued feasibility of a specified economic activity over a specified time horizon, usually influenced by management and policy actions t Context: Economic Activity.

system reoperation – Changing existing water system operation and management procedures or priorities to either meet competing beneficial uses or derive more total benefits from the water system by operating more efficiently. Context: Resource Management Strategy.

T

third party impacts – The occurrence of incidental economic impacts to parties not directly related to (impact-causing) water management actions. For example, agricultural land retirement can impact local tax revenues and/or labor conditions, etc. Context: Evaluation Criteria.

total capital cost – Total monetary cost of option required for "turn key" implementation including environmental and third party impact mitigation, storage, conveyance, energy, capitalized O&M, administrative, planning, legal and engineering costs. Context: Planning Concept/Consideration.

total commercial activity – The amount of commercial activity (e.g., employment, productivity, commercial land use, etc) that occurs in a given study area. This factor is a driver of (and indicator for) commercial water use and includes institutional water use (government offices, schools, etc.) as well. See also commercial activity mix. Context: Scenario Factor.

total industrial activity – The total amount of industrial activity (e.g., employment, productivity, industrial land use, etc) that occurs in a given study area. This factor is a driver of (and indicator for) industrial water use. Context: Scenario Factor.

total irrigated crop area – The total area of irrigated crops (by type) planted in a planning area during a given year. This number includes multiple cropping. Context: Scenario Factor.

total population – The statewide total population projection regardless of geographical distribution. Context: Scenario Factor.

transpiration – An essential physiological process in which plant tissues give off water vapor to the atmosphere.

U

unconfined aquifer – An aquifer which is not bounded on top by an aquitard. The upper surface of an unconfined aquifer is the water table.

underground stream – Body of water flowing as a definite current in a distinct channel below the surface of the ground, usually in an area characterized by joints or fissures. Application of the term to ordinary aquifers is incorrect.

unit applied water – The quantity of water applied to a specific crop per unit area (sometimes expressed in inches of depth).

unsaturated zone – The zone below the land surface in which pore space contains both water and air.

urban land use management – Planning for the housing and economic development needs of the growing population while providing for the efficient use of water and other resources.

urban runoff management – A broad series of activities to manage both storm water and dry weather runoff.

Urban Water Management Planning Act – Sections 10610 through 10657 of the California Water Code. The Act requires urban water suppliers to prepare urban water management plans which describe and evaluate sources of water supplies, efficient uses of water, demand management measures, implementation strategies and schedules, and other relevant information and programs within their water service areas. Urban water suppliers (CWC Section 10617) are either publicly or privately owned and provide water for municipal purposes, either directly or indirectly, to more than 3,000 customers or supply more than 3,000 acre-feet of water annually.

[urban] water reliability (average) – A measure of a system's ability to sustain the social, environmental and economic systems that it serves during a year of average participation. Context: Evaluation Criteria.

[urban] water reliability (dry) – A measure of a system's ability to sustain the social, environmental and economic systems that it serves during a dry year. Context: Evaluation Criteria.

[urban] water reliability (wet) – A measure of a system's ability to sustain the social, environmental and economic systems that it serves during a wet year. Context: Evaluation Criteria.

urban water use efficiency – Methods or technologies resulting in the same beneficial residential, commercial, industrial, and institutional uses with less water or increased beneficial uses from existing water quantities. Context: Scenario Factor, Resource Management Strategy.

usable storage capacity – The quantity of groundwater of acceptable quality that can be economically withdrawn from storage.

V

volatile organic compound (VOC) – A manmade organic compound that readily vaporizes in the atmosphere. These com pounds are often highly mobile in the groundwater system and are generally associated with industrial activities.

W

water bag transport/storage technology – Water diverted in areas that have unallocated fresh water supplies, storing the water in large inflatable bladders, and towing to an alternate coastal region. Context: Resource Management Strategy.

water balance – An analysis of the total developed/dedicated supplies, uses, and operational characteristics for a region.

water demand – The desired quantity of water that would be used if the water is available and a number of other factors such as price do not change. Demand is not static.

water demand elasticity – The desire to use water is based on a number of factors such as the intended use for the water, the price of water, and the cost of alternative ways to meet the intended use.

water portfolio – A picture of the water supply and use for a given year statewide or by region, subject to availability of data; includes the flow diagram, flow diagram table, water balances, and summary table.

water quality – Description of the chemical, physical, and biological characteristics of water, usually in regard to its suitability for a particular purpose or use.

water reliability (dry) – A measure of a system's ability to sustain the social, environmental, and economic systems that it serves during a dry year.

water reliability (wet) – A measure of a system's ability to sustain the social, environmental, and economic systems which it serves during a wet year.

water supply exports – The amount of water that a region transfers to another to meet needs. Context: Regional Reports.

water supply imports – The amount of water that needs to be brought in from other regions to meet needs. Context: Regional Reports.

water table – See groundwater table

water transfers – A temporary or long-term change in the point of diversion, place of use, or purpose of use due to a transfer or exchange of water or water rights. A more general definition is that water transfers are a voluntary change in the way water is usually distributed among water users in response to water scarcity. Context: Scenario Factor, Resource Management Strategy.

water year – A continuous 12-month period for which hydrologic records are compiled and summarized. Different agencies may use different calendar periods for their water years.

watershed – The land area from which water drains into a stream, river, or reservoir.

watershed management – The process of evaluating, planning, managing, restoring, and organizing land and other resource use within an area that has a single common drainage point. Context: Resource Management strategy.

Metric Conversion Factors

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit By	To Convert to Metric Unit Multiply Customary Unit By
Length	millimeters (mm)	inches (in)	0.03937	25.4
	centimeters (cm) for snow depth	inches (in)	0.3937	2.54
	meters (m)	feet (ft)	3.2808	0.3048
	kilometers (km)	miles (mi)	0.62139	1.6093
Area	square millimeters (mm^2)	square inches (in^2)	0.00155	645.16
	square meters (m^2)	square feet (ft^2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometers (km^2)	square miles (mi^2)	0.3861	2.590
Volume	liters (L)	gallons (gal)	0.26417	3.7854
	megaliters (ML)	million gallons (10*)	0.26417	3.7854
	cubic meters (m^3)	cubic feet (ft^3)	35.315	0.028317
	cubic meters (m^3)	cubic yards (yd^3)	1.308	0.76455
	cubic dekameters (dam^3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic meters per second (m^3/s)	cubic feet per second (ft^3/s)	35.315	0.028317
	liters per minute (L/mn)	gallons per minute (gal/mn)	0.26417	3.7854
	liters per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megaliters per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekameters per day (dam^3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lbs)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb.)	1.1023	0.90718
Velocity	meters per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	feet head of water	0.32456	2.989
Specific capacity	liters per minute per meter drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per liter (mg/L)	parts per million (ppm)	1.0	1.0
Electrical conductivity	microsiemens per centimeter (µS/cm)	micromhos per centimeter (µmhos/cm)	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(1.8X°C)+32	0.56(°F-32)

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