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Acronyms and Abbreviations Used in This Report

ABAG	Association of Bay Area Governments
ACWA	Association of California Water Agencies
ACWD	Alameda County Water District
af	acre-feet
af/yr.	acre-feet per year
AHPS	Advanced Hydrologic Prediction Service
ARP	Aquifer Reclamation Program
ASR	aquifer storage and recovery
BAAQMD	Bay Area Air Quality Management District
BACWA	Bay Area Clean Water Agencies
BAFPAA	Bay Area Flood Protection Agencies Association
BART	Bay Area Rapid Transit
BASMAA	Bay Area Stormwater Management Agencies Association
BAWAC	Bay Area Water Agencies Coalition
Bay Area IRWMP	San Francisco Bay Area Integrated Regional Water Management Plan
BAWN	Bay Area Watershed Network
Bay Region	San Francisco Bay Hydrologic Region
BCDC	Bay Conservation and Development Commission
BMO	Basin Management Objective
CALFED	CALFED Bay-Delta Program
Cal EMA	California Emergency Management Agency
CASGEM	California Statewide Groundwater Elevation Monitoring
CC	Coordinating Committee
CCWD	Contra Costa Water District
CDPH	California Department of Public Health
CCCSD	Central Contra Costa Sanitary District
cm	centimeters

CNRA	California Natural Resources Agency
COG	Council of Government
CRS	Community Rating System
CVP	Central Valley Project
CWC	California Water Code
DAC	disadvantaged community
Delta	Sacramento-San Joaquin Delta
DFW	California Department of Fish and Wildlife
DPR	California Department of Pesticide Regulation
DSRSD	Dublin San Ramon Service District
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utilities District
ECCC IRWMP	East Contra Costa County Integrated Regional Water Management Plan
EI	energy intensity
ERP	Ecosystem Restoration Program
FCWCD	Flood Control and Water Conservation District
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GAMA	Groundwater Ambient Monitoring and Assessment
GHG	greenhouse gas
gpd	gallons per day
gpm	gallons per minute
GWMP	groundwater management plan
HIP	high-population growth scenario
IRWMP	integrated regional water management plan
JPA	Joint Powers Authority
JPC	Joint Policy Committee
kWh/af	kilowatt hours per acre-foot

LGVSD	Las Gallinas Valley Sanitary District
LID	low-impact development
LLNL	Lawrence Livermore National Laboratory
LOMU	letter of mutual understanding
LOP	low-population growth scenario
maf	million acre-feet
mgd	million gallons per day
MHI	median household income
MMWD	Marin Municipal Water District
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
MWh	megawatt-hour
NBA	North Bay Aqueduct
NFIP	National Flood Insurance Program
NMWD	Novato Sanitary District/North Marin Water District
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
OPR	Governor's Office of Planning and Research
PA 201	North Bay Planning Area
PCB	polychlorinated biphenyl
PDA	priority development area
PUT	Plan Update Team
RWMG	regional water management group
RWQCB	regional water quality control board
SB	Senate Bill
SBA	South Bay Aqueduct
SBWR	South Bay Water Recycling
SCVWD	Santa Clara Valley Water District

SCWA	Sonoma County Water Agency
SFBJV	San Francisco Bay Joint Venture
SFEI	San Francisco Estuary Institute
SFEP	San Francisco Estuary Project
SFPUC	San Francisco Public Utilities Commission
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SVCSD	Sonoma Valley County Sanitation District
SWN	State Well Number System
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TDS	total dissolved solids
TMDL	total maximum daily load
UFMP	urban forest management plan
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WRCC	Western Regional Climate Center
WSIP	Hetch Hetchy Water System Improvement Program
Zone	Zone 7 Water Agency

San Francisco Bay. San Francisco Bay serves as the hub for this hydrologic region, which relies on imported water for 70 percent, and local sources for 30 percent, of its total supply. In this view from Treasure Island, the Embarcadero Building sits on the waterfront, with downtown San Francisco and the Transamerica Building behind it.

San Francisco Bay Hydrologic Region

San Francisco Bay Hydrologic Region Summary

The San Francisco Bay Hydrologic Region (Bay Region) has many significant water management challenges — sustaining water supply, water quality, and the ecosystems in and around San Francisco Bay; reducing flood damages; and adapting to impacts from climate change. In addition to these topics, a thorough discussion of climate change is presented including precipitation variability, reduced snowpack accumulation in the Sierra Nevada, and vulnerability of developed bay and coastal areas to sea level rise. With strong water planning and governance and several resource management strategies that can be applied, the region is poised to address these challenges effectively.

Current State of the Region

Setting

The Bay Region includes all of San Francisco County and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties. It occupies approximately 4,500 square miles; from southern Santa Clara County to Tomales Bay in Marin County; and inland to near the confluence of the Sacramento and San Joaquin rivers at the eastern end of Suisun Bay (Figure SFB-1). The eastern boundary follows the crest of the Coast Ranges, where the highest peaks are more than 4,000 feet above mean sea level.

Some water agencies in the region have imported water from the Sierra Nevada for nearly a century to supply their customers. Water from the Mokelumne and Tuolumne rivers accounts for about 38 percent of the region's average annual water supply. Water from the Sacramento-San Joaquin Delta (Delta), via the federal Central Valley Project (CVP) and the State Water Project (SWP), accounts for another 28 percent. Approximately 31 percent of the average annual water supply is from local groundwater and surface water; and 3 percent is from miscellaneous sources such as harvested rainwater, recycled water, and transferred water. Population growth and diminishing water supply and water quality have led to the development of local surface water supplies, recharge of groundwater basins, and incorporation of conservation guidelines to sustain water supply and water quality for future generations.

The Sacramento and San Joaquin rivers flow into the Delta and into San Francisco Bay. The Delta is the largest estuary on the West Coast, receiving nearly 40 percent of the state's surface water from the Sierra Nevada and the Central Valley. The interaction between Delta outflow and Pacific Ocean tides determines how far salt water intrudes into the Delta. The resulting salinity distribution influences the distribution of many estuarine fish and invertebrates, as well as the distribution of plants, birds, and animals in wetlands areas. Delta outflow varies with precipitation, reservoir releases, and upstream diversions. An average of 18.4 million acre-feet (maf) of fresh water flows out of the Delta annually into the bay (California Data Exchange Center 2000–2008). Daily tidal flux through the Carquinez Strait is much greater than the freshwater flows.

Figure SFB-1 San Francisco Hydrologic Region

The Bay Region boasts significant Pacific Coast marshes such as the Pescadero and Tomales Bay marshes, as well as San Francisco Bay itself. San Francisco Bay is relatively shallow, with 85 percent of its area less than 30-feet deep. Much of the perimeter of the bay is shallow tidal mud flats, tidal marshes, diked or leveed agricultural areas, and salt ponds. These tidal baylands support important aquatic and wetland habitats and have been the focus of many restoration activities over the past 30 years. The physical extent of the bay in the future will depend on the balance between sea level rise, sediment loading, and potential tectonic subsidence or uplift.

The north lobe of San Francisco Bay is brackish and is known as San Pablo Bay. It is surrounded by Marin, Sonoma, Napa, and Solano counties. Suisun Marsh is between San Pablo Bay and the Delta and is the largest contiguous brackish marsh on the West Coast of North America, providing more than 10 percent of California's remaining natural wetlands. The south and central lobes of San Francisco Bay are saltier than San Pablo Bay, as the marine influence dominates.

Watersheds

The California Department of Water Resources (DWR) has grouped the watersheds in the Bay Region into six principle watersheds, as shown in Figure SFB-2. These watersheds drain into Suisun Bay, San Pablo Bay, North San Francisco Bay, South San Francisco Bay, or directly into the Pacific Ocean. Figure SFB-2 also shows large streams such as the Guadalupe River and Coyote and Alameda creeks, which drain from the Coast Ranges and generally flow northwest into San Francisco Bay. The Alameda Creek watershed is the largest in the region at nearly 700 square miles. The Napa River originates in the Mayacamas Mountains at the northern end of Napa Valley and flows south into San Pablo Bay. Sonoma Creek begins in mountains within Sugarloaf State Park, then flows south through Sonoma Valley into San Pablo Bay.

Surface Water Bodies

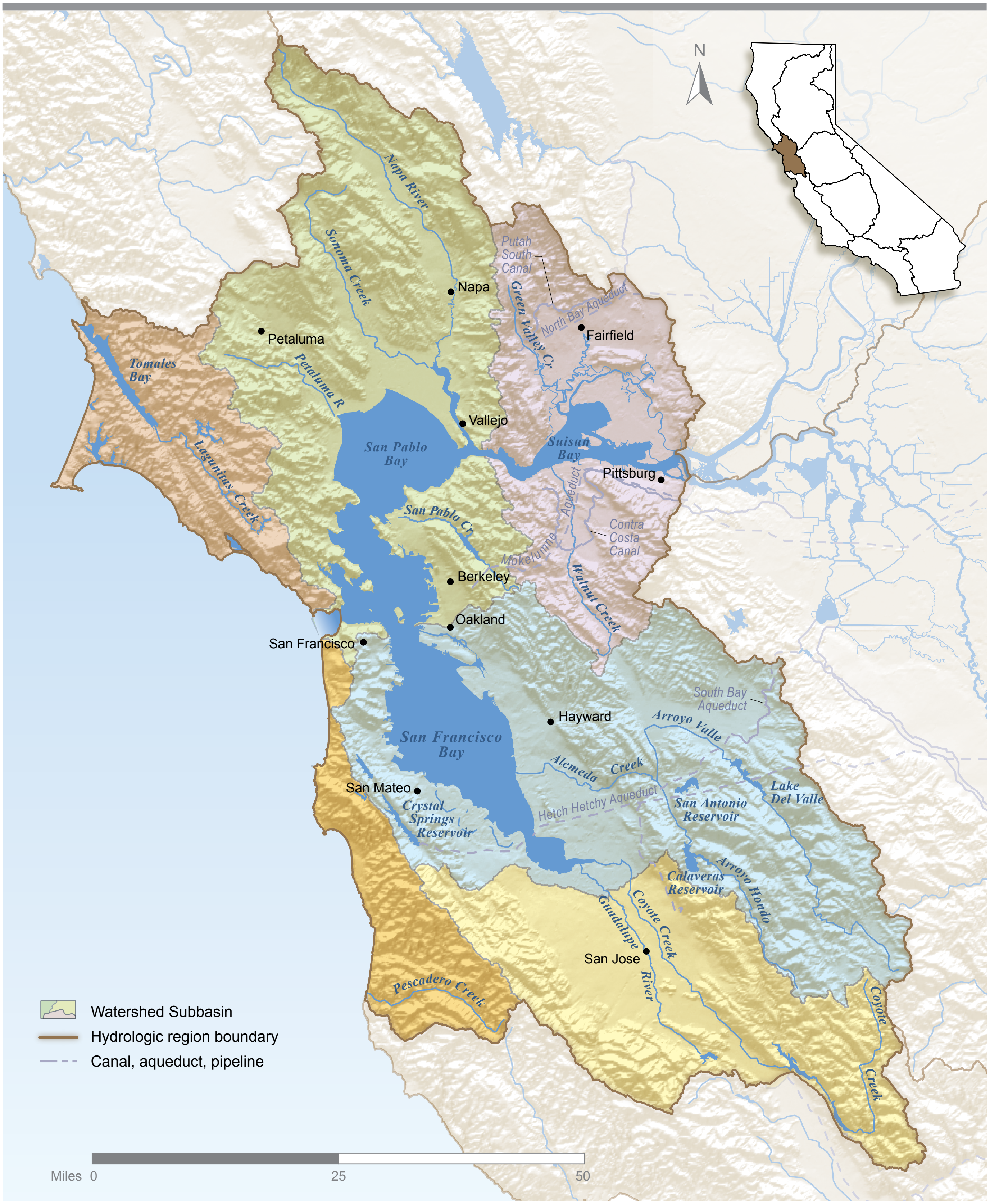
The most prominent surface water body in the Bay Region is San Francisco Bay itself. Other surface water bodies include:

- Creeks and rivers.
- Ocean bays and lagoons (such as Bolinas Bay and Lagoon, Half Moon Bay, and Tomales Bay).
- Urban lakes (such as Lake Merced and Lake Merritt).
- Human-made lakes and reservoirs (such as Lafayette Reservoir, Briones Reservoir, Calaveras Reservoir, Crystal Springs Reservoir, Kent Lake, Lake Chabot, Lake Hennessey, Nicasio Reservoir, San Andreas Lake, San Antonio Reservoir, San Pablo Reservoir, Upper San Leandro Reservoir, Anderson Reservoir, and Lake Del Valle).

Groundwater Aquifers and Wells

Groundwater resources in the Bay Region are supplied by both alluvial and fractured-rock aquifers. Alluvial aquifers are composed of sand and gravel or finer-grained sediments, with groundwater stored within the voids, or pore spaces, between the alluvial sediments. Fractured-rock aquifers consist of impermeable granitic, metamorphic, volcanic, or hard sedimentary rocks, with groundwater being stored within cracks, fractures, or other void spaces. The distribution and extent of alluvial and fractured-rock aquifers and water wells vary within the region. Municipal

Figure SFB-2 Principal Watersheds in the San Francisco Bay Hydrologic Region



and irrigation wells in the region range in depth from about 100 to 200 feet in the smaller basins, and 200 to 500 feet in the larger basins. Well yields typically are less than 500 gallons per minute (gpm) in the smaller basins, and range from less than 50 gpm to approximately 3,000 gpm in the larger basins. A brief description of the aquifers in the Bay Region is provided below.

Alluvial Aquifers

As recognized in *Bulletin 118-2003*, the Bay Region contains 33 alluvial groundwater basins and subbasins underlying approximately 1,400 square miles, or about 31 percent of the region (California Department of Water Resources 2003). The majority of the groundwater in the region is stored in alluvial aquifers. Table SFB-1 lists the associated basin and subbasin names and numbers, and Figure SFB-3 shows the location of the alluvial groundwater basins and subbasins. The most heavily used groundwater basins in the region are the Petaluma Valley and Napa-Sonoma Valley groundwater basins in the North Bay; the Santa Clara and San Mateo subbasins of the Santa Clara Valley Groundwater Basin and the Westside Groundwater Basin in the South Bay; and the Niles Cone and East Bay Plain subbasins of the Santa Clara Valley Groundwater Basin and the Livermore Valley Groundwater Basin in the East Bay.

Fractured-Rock Aquifers

Fractured-rock aquifers are generally found in the mountain and foothill areas adjacent to alluvial groundwater basins. Due to the highly variable nature of the void spaces within fractured-rock aquifers, wells drawing from fractured-rock aquifers tend to have less capacity and less reliability than wells drawing from alluvial aquifers. On average, wells drawing from fractured-rock aquifers yield 10 gpm or less. Although fractured-rock aquifers are less productive compared to alluvial aquifers, they commonly are the critical sole source of water for many communities. The majority of water used in the Bay Region comes from alluvial aquifers or from imported water supplies, so information on fractured-rock aquifers was not developed as part of *California Water Plan Update 2013*.

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

Well Infrastructure and Distribution

Well logs submitted to DWR for water supply wells completed from 1977 to 2010 were used to evaluate the distribution and uses of water wells in the Bay Region. Many wells could have been drilled prior to 1977 or without submitting well logs. As a result, the total number of wells in the region is probably higher than what is reported here. DWR does not have well logs for all the wells drilled in the region; and for some well logs, information regarding well location or use is inaccurate, incomplete, ambiguous, or missing. Hence, some well logs could not be used in the current assessment. However, for a regional scale evaluation of well installation and distribution, the quality of the data is considered adequate and informative. The number and distribution of wells in the region are grouped by county and by the six most common well-use types: domestic, irrigation, public supply, industrial, monitoring, and other. Public supply wells include all wells identified in well completion reports as municipal or public. Wells identified as "other" include a

Table SFB-1 Alluvial Groundwater Basins and Subbasins within the San Francisco Bay Hydrologic Region

Basin/Subbasin		Basin Name
2-1		Petaluma Valley
2-2		Napa-Sonoma Valley
	2-2.01	Napa Valley
	2-2.02	Sonoma Valley
	2-2.03	Napa-Sonoma Lowlands
2-3		Suisun-Fairfield Valley
2-4		Pittsburg Plain
2-5		Clayton Valley
2-6		Ygnacio Valley
2-7		San Ramon Valley
2-8		Castro Valley
2-9		Santa Clara Valley
	2-9.01	Niles Cone
	2-9.02	Santa Clara
	2-9.03	San Mateo Plain
	2-9.04	East Bay Plain
2-10		Livermore Valley
2-11		Sunol Valley
2-19		Kenwood Valley
2-22		Half Moon Bay Terrace
2-24		San Gregorio Valley
2-26		Pescadero Valley
2-27		Sand Point Area
2-28		Ross Valley
2-29		San Rafael Valley
2-30		Novato Valley
2-31		Arroyo Del Hambre Valley
2-32		Visitacion Valley
2-33		Islais Valley
2-35		Westside
2-36		San Pedro Valley

Basin/Subbasin		Basin Name
2-37		South San Francisco
2-38		Lobos
2-39		Marina
2-40		Downtown San Francisco

combination of less common well types such as stock wells, test wells, or unidentified wells (no information listed on the well log).

The well log information listed in Table SFB-2 and illustrated in Figure SFB-4 show that the distribution and number of wells vary widely by county and by use. The well log information is reported only for Napa, Marin, Alameda, San Francisco, Santa Clara, and San Mateo counties. Well log information for Sonoma, Solano, and Contra Costa counties are reported in the North Coast, Sacramento River, and San Joaquin River hydrologic regions, respectively.

The total number of wells installed in the Bay Region between 1977 and 2010 is approximately 62,900, ranging from fewer than 1,600 in San Francisco County to about 34,200 in Santa Clara County. The number of domestic wells ranges from 650 in Alameda County to about 3,000 in both Napa and Santa Clara counties (San Francisco County shows only three domestic wells). Monitoring wells make up the majority of well logs in most counties, with relatively high numbers in two counties (about 12,000 in Alameda County and about 24,500 in Santa Clara County). The one exception is Napa County, where over 60 percent of the wells are domestic wells. Communities with a high percentage of monitoring wells often indicate monitoring of groundwater quality to help characterize groundwater quality issues.

Figure SFB-5 shows that monitoring wells make up the majority of well logs in the Bay Region (66 percent), while domestic and irrigation wells account for only about 14 and 4 percent, respectively.

Figure SFB-6 shows a cyclic pattern of well installation in the Bay Region, with new well construction ranging from about 50 in 1978 to 4,500 in 1991. The average number of new wells constructed is about 1,850 wells per year.

The onset of monitoring well installation in the mid- to late-1980s is likely associated with federal underground storage tank programs signed into law in the mid-1980s. The installation of monitoring wells in the region peaked in 1990 at about 3,500 wells, with an average of about 3,200 monitoring wells installed per year from 1988 through 1992. Since 1993, monitoring well installation in the region has averaged approximately 950 wells per year.

Domestic well installation is somewhat related to hydrology and surface water availability, as shown in Figure SFB-6. The number of domestic wells drilled during dry years (e.g., 1987-1992) is generally greater than during wet years when surface water is more readily available. However, the increase in the number of domestic wells drilled from 2001 to 2003 can be attributed to the housing boom in California.

Figure SFB-3 Alluvial Groundwater Basins and Subbasins within the San Francisco Bay Hydrologic Region

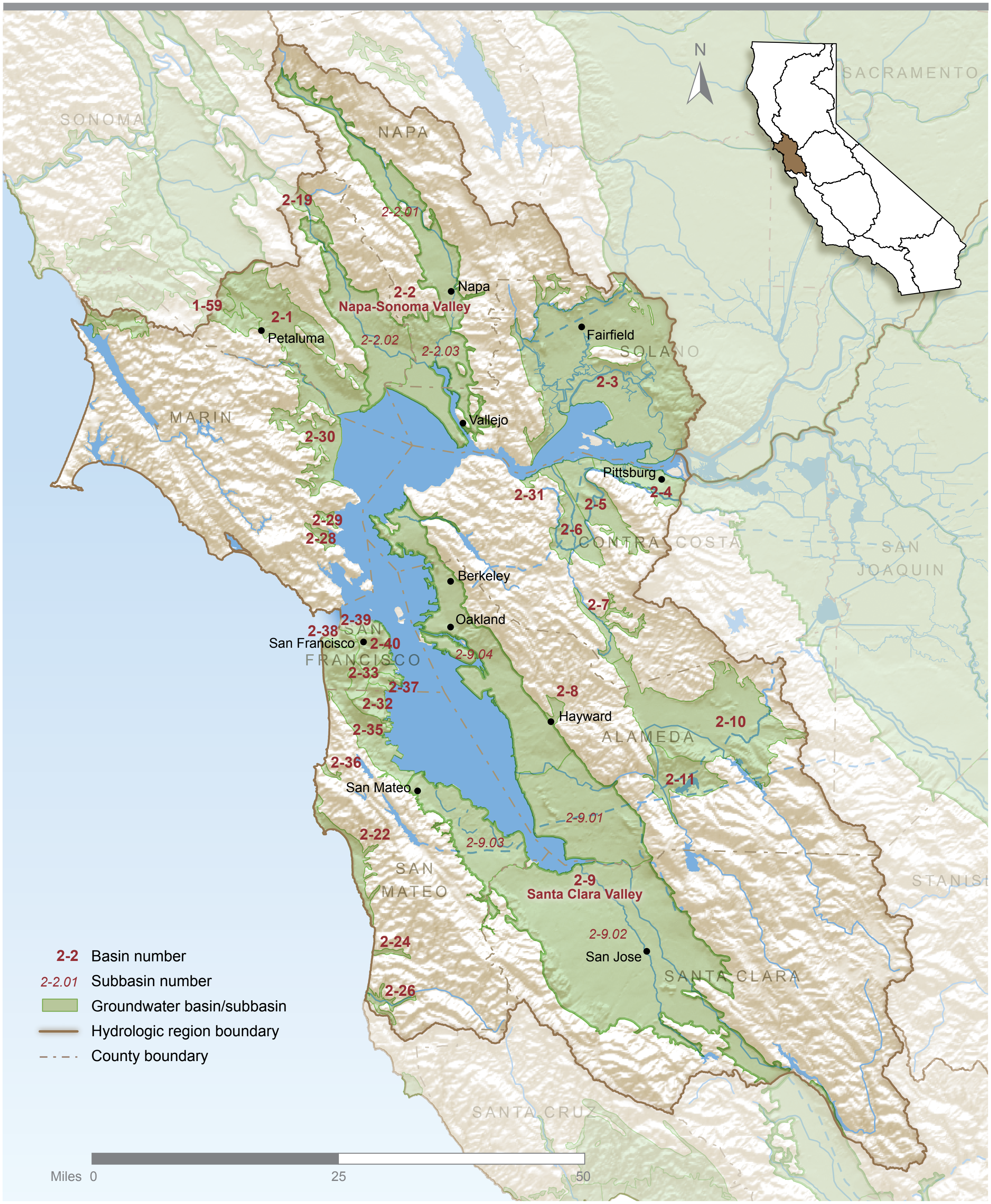


Table SFB-2 Number of Well Logs by County and Use for the San Francisco Bay Hydrologic Region (1977 - 2010)

	Total Number of Well Logs by Well Use						
County	Domestic	Irrigation	Public Supply	Industrial	Monitoring	Other	Total Well Records
Napa	3,141	1,267	90	30	492	149	5,169
Marin	867	249	33	12	748	121	2,030
Alameda	650	251	45	37	11,972	2,154	15,109
San Francisco	3	9	7	5	1,221	300	1,545
Santa Clara	2,918	356	145	62	24,522	6,187	34,190
San Mateo	1,372	462	36	8	2,532	488	4,898
Total Well Records	8,951	2,594	356	154	41,487	9,399	62,941

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

San Francisco Bay Hydrologic Region Groundwater Monitoring

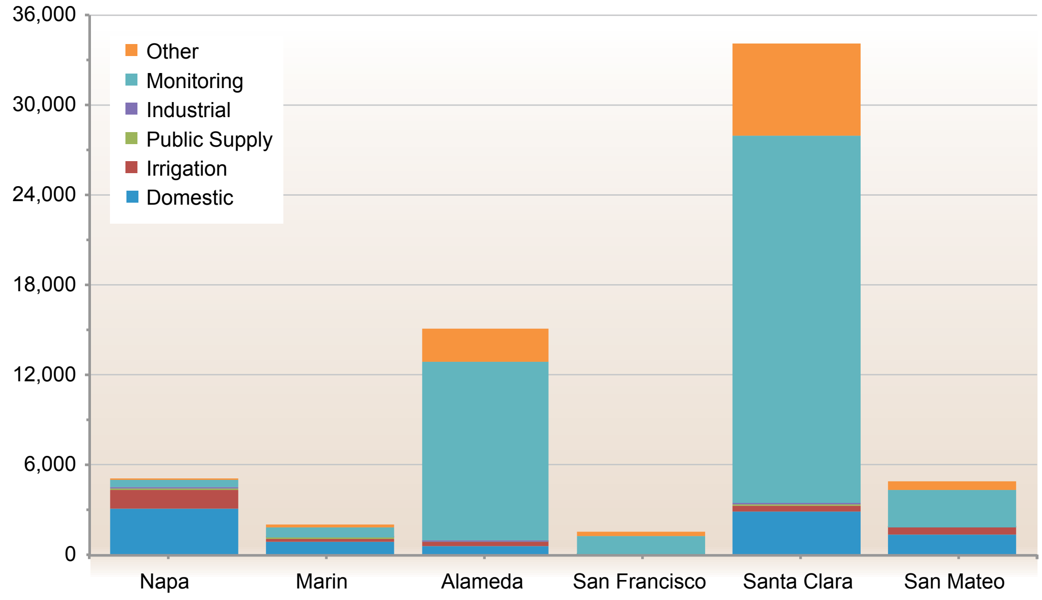
Groundwater monitoring and evaluation is a key aspect to understanding groundwater conditions, identifying effective resource management strategies, and implementing sustainable resource management practices. California Water Code (CWC) Section 10753.7 requires local agencies seeking State funds that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

Additional information regarding the methods, assumptions, and data availability associated with the groundwater monitoring is available online from *California Water Plan Update 2013*, Volume 4, *Reference Guide,* the article "California's Groundwater Update 2013."

Groundwater Level Monitoring

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

Figure SFB-4 Number of Well Logs by County and Use for the San Francisco Bay Hydrologic Region



Statewide Groundwater Elevation Monitoring (CASGEM). Additional and current information on the program is available online at http://www.water.ca.gov/groundwater/casgem/.

The locations of monitoring wells by monitoring entity and monitoring well type in the Bay Region are presented in Figure SFB-7. Observation wells, other wells, and domestic wells account for 48, 24, and 20 percent of the monitoring wells in the region; respectively. Irrigation and public supply wells comprise less than 7 and 1 percent of the monitoring wells, respectively.

A list of the number of monitoring wells in the region is provided in Table SFB-3. Groundwater levels have been actively monitored in 116 wells in the region since 2010. The USGS monitors six of the wells; and one cooperator and seven CASGEM monitoring entities monitor the remaining 110 wells.

CASGEM Basin Prioritization

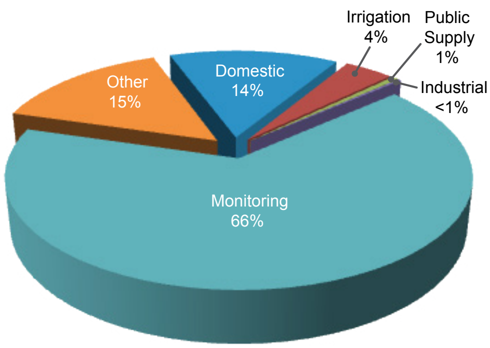
Figure SFB-8 shows the CASGEM groundwater basin prioritization for the Bay Region. Of the 33 basins within the region, one basin was identified as high priority, six basins as medium priority, one basin as low priority, and the remaining 25 basins as very low priority. Table SFB-4 lists the high-, medium-, and low-priority CASGEM groundwater basins. The seven basins designated as high or medium priority include more than 60 percent of the population and account for about 88 percent of groundwater supply in the region. Groundwater levels in many of these basins are being monitored to some extent. Basin prioritization could be a valuable tool to help evaluate, focus, and align limited resources for effective groundwater management and reliable and sustainable groundwater resources.

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

Groundwater Quality Monitoring

Groundwater quality monitoring is an important aspect to effective groundwater management and is required in groundwater management planning in order for local agencies to be eligible for State funds. Numerous State, federal, and local agencies participate in groundwater quality monitoring throughout California.

Figure SFB-5 Percentage of Well Logs by Use for the San Francisco Bay Hydrologic Region (1977-2010)

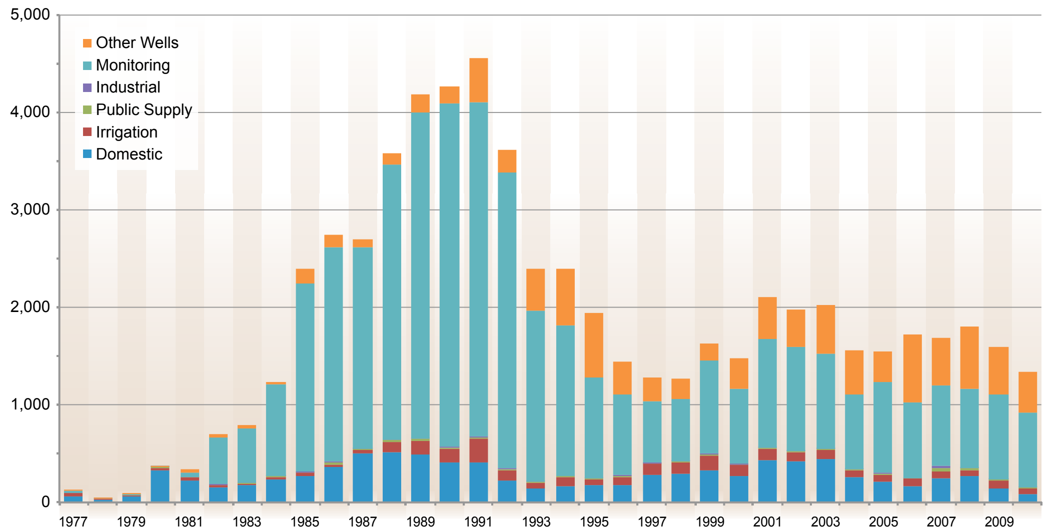


Regional and statewide groundwater quality monitoring information and data are available on the State Water Resources Control Board (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) Web site and from the GeoTracker GAMA groundwater information system, which were developed as part of the Groundwater Quality Monitoring Act of 2001. The GAMA Web site describes the GAMA program and provides links to all published GAMA and related reports. The GeoTracker GAMA groundwater information system geographically displays information and includes analytical tools and reporting features to assess groundwater quality. This system includes groundwater data from the SWRCB, regional water quality control boards (RWQCBs), California Department of Public Health (CDPH), California Department of Pesticide Regulation (DPR), DWR, USGS, and Lawrence Livermore National Laboratory (LLNL). In addition to groundwater quality data, GeoTracker GAMA has more than 2.5 million depth-to-groundwater measurements from the RWQCBs and DWR; and hydraulically fractured well information from the California Division of Oil, Gas, and Geothermal Resources. Table SFB-5 provides State and federal sources of groundwater quality information. Local agencies also are a source of groundwater quality information.

Land Subsidence Monitoring

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

Figure SFB-6 Number of Well Logs Filed per Year by Use for the San Francisco Bay Hydrologic Region (1977-2010)



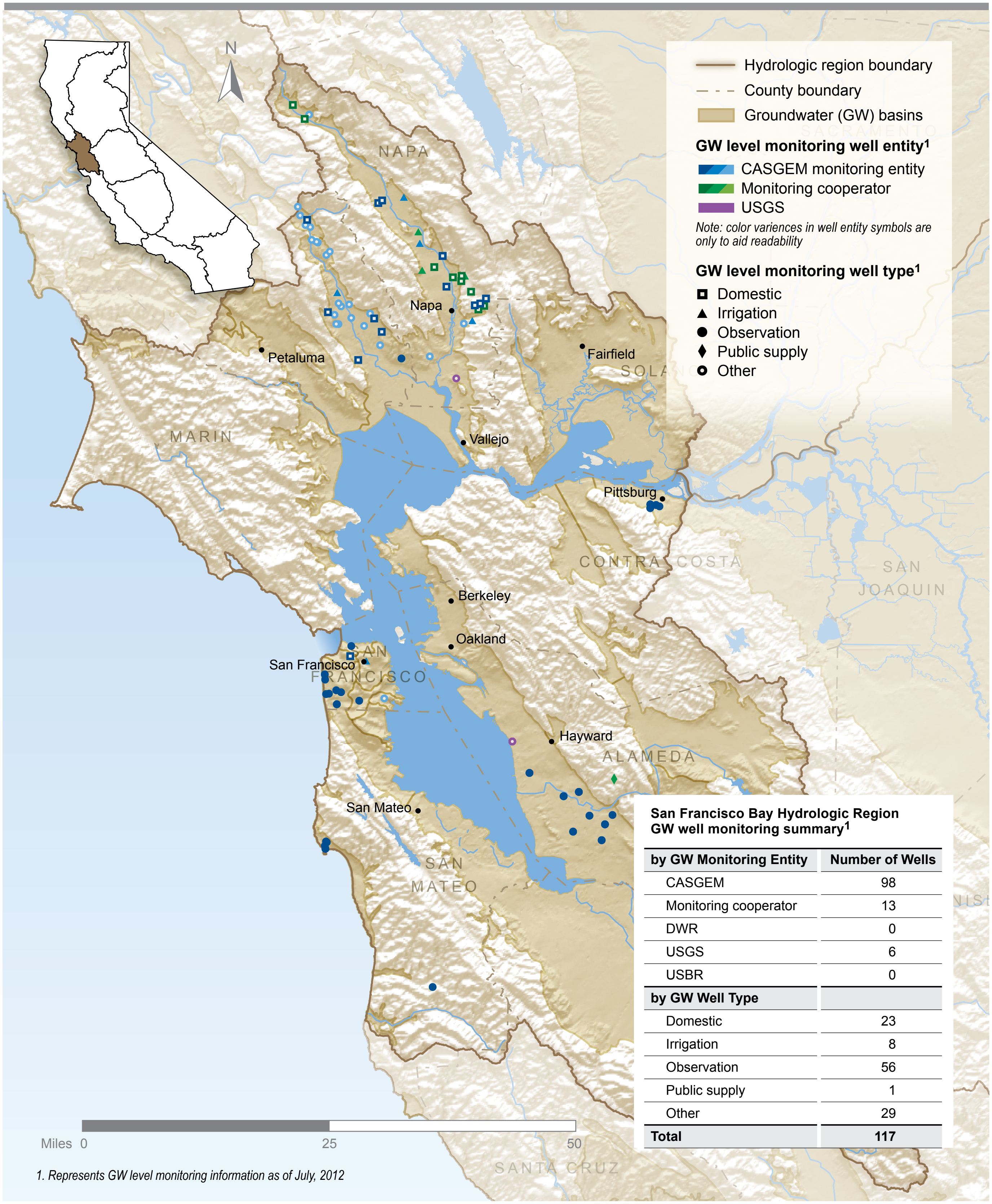
In the Bay Region, Santa Clara Valley Water District (SCVWD) monitors land subsidence in Santa Clara County; and East Bay Municipal Utilities District (EBMUD) monitors land subsidence in Alameda County. SCVWD surveys hundreds of benchmarks each year to determine changes in land surface elevations. SCVWD also monitors groundwater levels, collects data from two 1,000-foot-deep compaction wells designed to measure any changes in the land surface resulting from groundwater extraction (http://www.valleywater.org/Services/LandSubsidence.aspx), and conducts numerical modeling to monitor subsidence in the area. EBMUD monitors land subsidence in the South East Bay Plain groundwater subbasin as part of its Bayside Groundwater Project (East Bay Municipal Utilities District 2013).

Ecosystems

Two-thirds of the state's salmon pass through San Francisco Bay and the Delta each year, as do approximately half of the waterfowl and shorebirds migrating along the Pacific Flyway (San Francisco Estuary Project 2004). However, the San Francisco Bay is one of the most modified estuaries in the United States. The topography, ebb and flow tides, local freshwater and Delta inflows, and sediment availability all have been altered. Many new species of plants and animals have been introduced. These exotic and invasive species, such as the Chinese Mitten Crab and the Asian Clam, threaten to undermine the estuary's food web and ecosystem. Approximately 500 species of fish and wildlife live in the Bay Region, of which 105 wildlife species are designated by State and federal agencies as threatened or endangered.

The land between the lowest tide elevations and mean sea level are tidal flats, which support an extensive community of invertebrate aquatic organisms, fish, plants, and shorebirds. Historically, around 50,000 acres of tidal flats were situated around San Francisco Bay margins; but only about 29,000 acres remain.

Figure SFB-7 Monitoring Well Location by Agency, Monitoring Cooperator, and CASGEM Monitoring Entity in the San Francisco Bay Hydrologic Region



San Francisco Bay Hydrologic Region GW well monitoring summary[1]

by GW Monitoring Entity	Number of Wells
CASGEM	98
Monitoring cooperator	13
DWR	0
USGS	6
USBR	0
by GW Well Type	
Domestic	23
Irrigation	8
Observation	56
Public supply	1
Other	29
Total	**117**

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

Table SFB-3 Groundwater Level Monitoring Wells by Monitoring Entity in the San Francisco Bay Hydrologic Region

State and Federal Agencies	Number of Wells
U.S. Geological Survey	6
Total State and federal wells:	**6**
Monitoring Cooperators	**Number of Wells**
Napa County Flood Control and Water Conservation District	12
Total cooperator wells:	**12**
CASGEM Monitoring Entities	**Number of Wells**
Alameda County Water District	26
City of Pittsburg	9
Coastside County Water District	1
County of Napa [NOT YET DESIGNATED]	14
Montara Water and Sanitary District	6
San Francisco Public Utilities Commission	16
Sonoma County Water Agency	26
Total CASGEM Monitoring Wells	**98**
Grand total:	**116**

Notes:

CASGEM = California Statewide Groundwater Elevation Monitoring

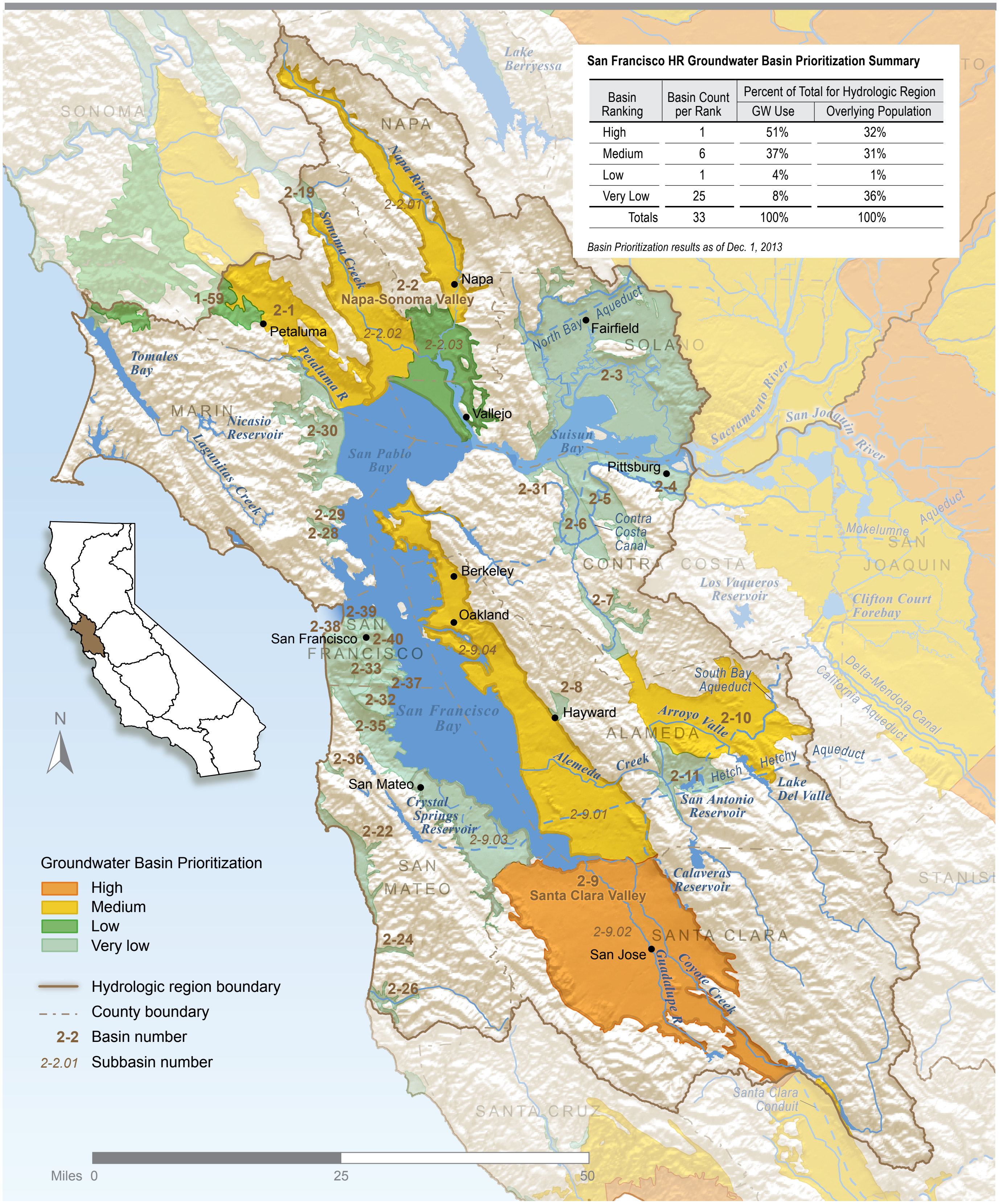
Table represents monitoring information as of July, 2012.

Additional CASGEM Monitoring Entities in the San Francisco Bay Hydrologic Region include South Westside Basin Voluntary Cooperative Groundwater Monitoring Association, Sonoma County Permit and Resource Management District, Zone 7 Water Agency, and Santa Clara Valley Water District.

Before 1800, the total area covered by the bay at high tide was about 516,000 acres; and another 190,000 acres on the fringe of the bay were wetlands. Today the bay covers about 327,000 acres at high tide, and only 40,000 acres of wetlands border the bay. Almost 80 percent of the bay's historical wetlands have been lost or altered through a variety of land use changes, such as filling the bay for urban and industrial developments, and building dikes for agricultural purposes. Filling the bay has slowed significantly due to the McAteer-Petris Act, which established the Bay Conservation and Development Commission (BCDC) in 1965, a State agency charged with permitting activities along the shore of the bay.

Channelizing and rerouting Bay Region streams for flood control has degraded or denuded riparian areas, with significant adverse impacts to aquatic and riparian habitats. Coastal streams may have an excess of fine sediments and a lack of spawning gravels and large woody debris. Excess sediment also threatens water quality and habitat in Bolinas Lagoon, the only wetland

Figure SFB-8 CASGEM Groundwater Basin Prioritization for the San Francisco Bay Hydrologic Region



San Francisco HR Groundwater Basin Prioritization Summary

Basin Ranking	Basin Count per Rank	Percent of Total for Hydrologic Region	
		GW Use	Overlying Population
High	1	51%	32%
Medium	6	37%	31%
Low	1	4%	1%
Very Low	25	8%	36%
Totals	33	100%	100%

Basin Prioritization results as of Dec. 1, 2013

Table SFB-4 CASGEM Groundwater Basin Prioritization for the San Francisco Bay Hydrologic Region

Basin Prioritization	Count	Basin/Subbasin Number	Basin Name	Subbasin Name	2010 Census Population
High	1	2-9.02	Santa Clara Valley	Santa Clara	1,633,190
Medium	1	2-2.01	Napa-Sonoma Valley	Napa Valley	91,234
Medium	2	2-10	Livermore Valley		196,658
Medium	3	2-1	Petaluma Valley		49,915
Medium	4	2-9.01	Santa Clara Valley	Niles Cone	321,494
Medium	5	2-2.02	Napa-Sonoma Valley	Sonoma Valley	31,275
Medium	6	2-9.04	Santa Clara Valley	East Bay Plain	881,718
Low	1	2-2.03	Napa-Sonoma Valley	Napa-Sonoma Lowlands	58,367
Very Low	25	See *California Water Plan Update 2013* Volume 4, the *Reference Guide* article "California's Groundwater Update 2013."			
Total:	**33**	**Population of groundwater basin area**			**5,075,243[a]**

Notes:

Senate Bill 7x 6 (SB X7 6; Part 2.11 to Division 6 of the California Water Code Sections 10920 et seq.) requires, as part of the CASGEM program, DWR to prioritize groundwater basins to help identify, evaluate, and determine the need for additional groundwater level monitoring by considering available data that include the population overlying the basin, the rate of current and projected growth of the population overlying the basin, the number of public supply wells that draw from the basin, the total number of wells that draw from the basin, the irrigated acreage overlying the basin, the degree to which persons overlying the basin rely on groundwater as their primary source of water, any documented impacts on the groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation, and any other information determined to be relevant by DWR.

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

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

on the West Coast that the U.S. Fish and Wildlife Service (USFWS) designates as a Wetland of International Significance.

The Baylands Ecosystem Habitat Goals Project, a major multi-partner, multi-disciplinary project completed in the late 1990s, developed recommendations for distributing wetlands in the Bay Region, and was a catalyst for undertaking significant wetland restoration in the region. The project now is incorporating climate change adaptation into wetland restoration recommendations. The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) provides technical input and permitting for thousands of acres of wetland and riparian restoration projects around San Francisco Bay.

Flooding

The Bay Region generally receives very little snow so floodwaters originate primarily from intense rainstorms. Flooding occurs more frequently in winter and spring and can be intense for a short duration in small watersheds with steep terrain. Urban areas can flood when storm drains and small channels become blocked or surcharged during intense short-duration storms. Valley flooding tends to occur when large, widespread storms fall on previously saturated watersheds that drain into the valley. The greatest flood damages occur in the lower reaches of streams when floodwaters spill onto the floodplain and spread through urban neighborhoods. Hillsides denuded by wildfires can exacerbate flood damages by intercepting less precipitation and generating more runoff containing massive sediment loads. Storm surges coincident with high tides can create severe flooding in low-lying areas by the mouths of rivers. Climate change-induced sea level rise is creating more extreme tides, which exacerbate flooding in these low-lying areas. See Box SFB-1 for a discussion of near-coastal issues.

Flooding in the Bay Region can be from:

- Residential and commercial facilities situated in the 100-year floodplain.
- New developments constructed in the 100-year floodplain without sufficient protection.
- Streamside and shoreline developments prone to tidal flooding.
- Reduced channel capacity because of unmanaged vegetation.
- Insufficient levee heights and levee integrity threatened by burrowing rodents.
- Insufficient mitigation of greater peak flows and runoff volumes from additional impervious areas in new developments.
- Reduced flood storage capacity at silted reservoirs.

Climate

Like most of Northern California, the climate in the Bay Region largely is governed by weather patterns originating in the Pacific Ocean. The southern descent of the Polar Jet Stream brings mid-latitude cyclonic storms in the winter. About 90 percent of the annual precipitation falls between November and April. The North Bay receives about 20 to 25 inches of precipitation annually. In the South Bay, east of the Santa Cruz Mountains, annual precipitation is only about 15 to 20 inches because of the rain shadow effect. A rain shadow is a dry area on the leeward side of a mountainous region because orographic lifting extracts most precipitation from moist air on the windward side. Historical precipitation in San Francisco since 1914 ranges from 9 to 44 inches annually, with an average of 21 inches.

The varied topography of the region creates several microclimates. Large climatic differences can occur over only a few miles. Some higher elevations in the region, particularly along west-facing slopes, average more than 40 inches of precipitation annually. The precipitation in the higher elevations typically falls as rain since the elevations are not high enough to sustain a snowpack.

Temperatures in the Bay Region generally are cool, and fog often resides along the coast. The inland valleys receive warmer, Mediterranean-like weather. Average summer high temperatures are about 80 °F, nearly 10 degrees higher than in San Francisco, resulting in higher outdoor water use. The gap in the rolling hills at Carquinez Strait allows cool air to flow from the Pacific Ocean

Table SFB-5 Sources of Groundwater Quality Information for the San Francisco Bay Hydrologic Region

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

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

into the Sacramento Valley. Most of the interior North Bay and the northern parts of the South Bay are influenced by this marine effect. By contrast, the southern interior portions of the South Bay experience very little marine air movement.

Demographics

Population

The San Francisco Bay Hydrologic Region had a population of 6,345,194 in the 2010 census, making it second only to the South Coast Hydrologic Region in population out of the 10 California hydrologic regions. About 17 percent of Californians live in the Bay Region, and 92 percent of the region lives in 101 incorporated cities. The three largest cities are San Francisco, San Jose, and Oakland. The region had a growth rate of 2.96 percent between 2006 and 2010 (187,991 people). Nine projections of population growth and 13 scenarios of future climate change can be found in "Looking to the Future" section to estimate the urban and agricultural changes in water demand in the region from 2006 to 2050.

Box SFB-1 Near-Coastal Issues

California Water Plan Update 2013 is introducing a focus on near-coastal issues. Coastal regions in California share common concerns and issues. The issues common to all coastal areas include increased coastal flooding especially as it relates to climate change, sea level rise, and the potential degradation of aquifer water quality. Desalination may be a future water supply source for drinking water, and impacts on adjacent water conditions and ecosystems are of concern. Stormwater and wastewater management are significant near-coastal issues, including the impacts of runoff and discharge on coastal water quality. Near-coastal planners and resource managers have increased attention to ecological linkages between freshwater flows, wetlands, and anadromous fish species. Conjunctive water management strategies as applied in near-coastal areas consider groundwater management for recharge and water supply for multiple land uses and objectives.

Climate change is anticipated to have profound effects on the North Coast regions, as the effects of climate change will alter rain patterns and intensity and well as temperatures. Because of the interrelationship of water supply, quality, floods and flooding, land use and fisheries, coastal managers are relying on current science and recommended strategies for adaptation and resource management. These shared concerns, issues, approaches, and strategies are discussed relevant to the San Francisco Bay Hydrological Region.

Find information on near-coastal issues in the San Francisco Bay Regional Report under the "Flood Management" and "Climate Change" sections as well as "Regional Water Planning and Management" and "Accomplishments."

Tribal Communities

The Bay Region historically had six tribal groups — the Coast Miwok, Sierra Miwok, Ohlone/Coastanoan, Northern Valley Yokuts, Patwin (Southern Wintu), and Wappo; but they did not survive conflict and disease from contact with the Spanish and the Gold Rush settlers and miners. Descendants of these tribes still have historical or cultural ties to the Bay Region. Only one tribal community currently owns land in the region — the Lytton Band of Pomo Indians. They own and operate the San Pablo Lytton Casino in the East Bay. Individual members of other tribes are dispersed throughout the region.

The federal government does not recognize any tribes in the Bay Region; however, the Muwekma Ohlone Indian Tribe of the San Francisco Bay and the Mishewal Wappo Tribe of Alexander Valley are seeking recognition. California Government Code Section 65352.3 requires cities and counties to consult with tribes during the adoption or amendment of local general plans or specific plans. A contact list of tribes and their representatives is maintained by the Native American Heritage Commission. Also, a Tribal Consultation Guideline, prepared by the Governor's Office of Planning and Research, is available online at http://opr.ca.gov/docs/09_14_05_Updated_Guidelines_922.pdf.

Disadvantaged Communities

DWR defines low income, disadvantaged communities (DACs) as communities with an annual median household income (MHI) less than 80 percent of the statewide average (that is, less than $48,706). The water agencies and nonprofit organizations working on the Bay Area Integrated Regional Water Management Plan (IRWMP) have established a high priority for the water needs of DACs. The required non-State cost share can be waived for grant-funded DAC projects. DAC projects include both construction projects and studies that identify critical water supply or water quality needs. Example projects include:

- Management of flood flows that threaten the habitability of dwellings.
- Wastewater treatment necessary to abate or prevent surface water or groundwater contamination.
- Replacement of failing septic systems with a system that provides long-term wastewater treatment.

Nine of the 23 Bay Area Regional Priority Projects (see "State Funding Received" section later in this chapter) address the critical water quality needs of DACs throughout the Bay Region. These DACs include North Richmond; the City of San Pablo; the City of East Palo Alto; Bay Point; the Town of Pescadero; and Title I disadvantaged schools in Solano, Napa, Sonoma and Marin counties. These communities are concerned about the lack of stormwater management, flood damages, and water quality impacts from flooding. Some flooded areas contain toxic sites such as power plants, weapons facilities, and chemical plants, which exacerbate the water quality and human health risks of flooding. These communities also are vulnerable to the impacts of sea level rise because of their proximity to the fringe of the bay.

Land Use Patterns

Land use in the Bay Region is truly diverse. The region is home to the world-famous Napa Valley and Sonoma County wine-growing industries, to international business and tourism in San Francisco, to technological development and production in "Silicon Valley," and to agriculture.

Agriculture uses 21 percent of the Bay Region's land area, most of which is in the north and northeast bay in Napa, Marin, Sonoma, and Solano counties. Santa Clara and Alameda counties also have significant agricultural acreage at the edge of urban development. The predominant crops are wine grapes (72 percent), fruit and nut trees, and hay production. Along the coastline south of the City of San Francisco, half of the irrigated land includes specialty crops such as artichokes, strawberries, and flowers.

Federal land in the Bay Region includes Point Reyes Seashore, John Muir Wood Monument and John Muir Historic Site, Golden Gate National Recreation Area, Alcatraz Island, Fort Point Historic Site, Presidio of San Francisco, San Francisco Maritime Historic Park, Eugene O'Neill Historic Site, Rosie the Riveter World War II Home Front Park, and Port Chicago Naval Magazine Memorial.

Residents live in urban, suburban, and rural areas. Some of these areas are on natural floodplains, which historically were used for agriculture. Now many residents are in the 100-year floodplain, as shown in Federal Emergency Management Agency (FEMA) maps. Growth in 100-year floodplains is being discouraged by limiting infill development through zoning restrictions and building regulations.

Bay Region cities and counties typically have primary authority over land use decisions while special districts, flood control agencies, investor-owned utilities, and mutual water companies typically manage water resources. Integrating land use and water resources decision-making is essential to meet existing and future resource management challenges.

Such integration includes implementing low impact development features to manage stormwater runoff and reduce flooding, assessing water supplies to determine if planned developments will have sufficient water, modifying local land use to reduce per capita water consumption, and implementing best management practices to prevent construction pollutants from contacting stormwater. Additional integration includes implementing urban and agricultural erosion control measures, agricultural fertilizer and waste management measures, urban runoff management measures, and riparian buffers and setbacks.

Regional Water Management

Water in the Environment

Water is regulated in the Bay Region to support the environment for purposes such as ecosystem health, fisheries, riparian habitat, and wetlands. Several local governments and conservation groups have initiatives to improve fish passage and to re-establish wetlands and habitat for fish, birds, and other wildlife. The most important habitats near the shore of San Francisco Bay are deep and shallow bays and channels, tidal baylands, and diked baylands. Tidal baylands include tidal flats, salt and brackish marshes, and lagoons. Diked baylands include diked wetlands, agricultural lowlands, salt ponds, and storage ponds.

The San Francisco Bay Joint Venture (SFBJV), established under The Migratory Bird Treaty Act and funded by the Interior Appropriations Act, was created to protect, restore, increase, and enhance all types of wetlands, riparian habitats, and associated uplands throughout the Bay Region to benefit birds, fish, and other wildlife. In 2001, SFBJV published a 20-year collaborative plan for the restoration of wetlands and wildlife in the region called "Restoring the Estuary: an Implementation Strategy." This strategy laid out programmatic and cooperative strategies for accomplishing specific acreage increase goals for wetlands of three distinct types — bay habitats, seasonal wetlands, and creeks and lakes. SFBJV partners have agreed to acquire, restore, or enhance 260,000 acres of wetlands over the next two decades throughout the estuary (see the San Francisco Bay Joint Venture Web site at http://www.sfbayjv.org/).

SWRCB licenses and other agreements with regulatory agencies require adequate instream flows to be provided below most major dams and diversions to promote the health of endangered coho salmon (*Oncorhynchus kisutch*), steelhead trout, and other fisheries. Coho salmon populate coastal watersheds from the Oregon border to northern Monterey Bay. The California Department of Fish and Wildlife (DFW) (formerly called the California Department of Fish and Game), with the assistance of recovery teams representing diverse interests and perspectives, created "Recovery Strategy for California Coho Salmon" (California Department of Fish and Game 2004) to outline the process of recovering coho salmon along the north and central coasts of California. The recovery strategy emphasizes cooperation and collaboration, recognizes the need for funding and public and private support, and maintains a balance between regulatory and voluntary efforts. Landowner incentives and grant programs are some of the many tools available to recover coho salmon. The success of the recovery strategy depends on the long-term commitment and efforts of all who live in, or are involved with, coho salmon watersheds.

Water Supplies

High-quality, reliable water supplies are critical to the Bay Region's economic prosperity and development. Bay Region water agencies seek to protect the quality and reliability of existing supplies through innovative water management strategies and regional cooperation. These agencies manage a diverse portfolio of water supplies, including groundwater, local surface water, Sierra Nevada water from the Mokelumne and Tuolumne rivers, Delta water from the SWP and the CVP, and recycled water. San Francisco Public Utilities Commission (SFPUC), EBMUD, and SCVWD have critical water interties to deliver water between water systems during emergencies such as earthquakes and wildfires, such as the massive 2013 Rim Fire.

SWP contractors and DWR established the Monterey Agreement in 1994 to improve water management flexibility and increase the reliability of SWP deliveries during periods of water shortage. Further details about the Monterey Agreement can be found in DWR *Bulletin 132-95* at http://www.water.ca.gov/swpao/bulletin_home.cfm.

Surface Water

EBMUD and SFPUC import surface water into the Bay Region from the Mokelumne and Tuolumne rivers via the Mokelumne and Hetch Hetchy aqueducts, respectively. Additional deliveries are made from the SWP's South Bay Aqueduct (SBA) and North Bay Aqueduct (NBA); the CVP's Contra Costa Canal, Putah South Canal, and San Felipe Unit; and Sonoma County Water Agency's (SCWA) Sonoma and Petaluma aqueducts. Reservoirs in the region capture runoff to augment local water supplies and to recharge aquifers. Some reservoirs store water at the terminus of constructed aqueducts, such as the Santa Clara Terminal Reservoir at the terminus of the SBA. Today, about 70 percent of the urban water supply is imported into the Bay Region. Table SFB-6 shows the sources of imported water, the conveyance facilities, and the volume of water that each facility delivered in 2010. Many Bay Region residents get their water from local streams. In the South Bay, local streams supply water to the SFPUC, San Jose and other cities in Santa Clara County, cities in Alameda County, and to small developments in the surrounding mountains. The Alameda County Water District (ACWD), Zone 7 Water Agency (Zone 7), and SCVWD recharge their groundwater basins with local streams, as well as with deliveries from the SWP and the CVP.

Local streams also play a large role in the North Bay, providing a majority of the water supply for Marin and Napa counties. Built in 1979, Soulajule Reservoir on Walker Creek is the newest of the seven Marin Municipal Water District (MMWD) reservoirs and provides 10,572 acre-feet (af) of storage — about 13 percent of its total reservoir capacity. Lake Hennessey on Conn Creek provides 31,000 af of storage. A 20-mile pipeline from Lake Hennessey to the City of Napa provides the city with its primary source of water.

Groundwater

Although much of the water use in the Bay Region is met by imported water from Sierra Nevada and Sacramento-San Joaquin Delta sources through various State, federal, and local projects, groundwater remains a mainstay of the overall water supply and a critical component of the water supply for agencies in the region to offset the variability of imported water.

Table SFB-6 Sources of Imported Surface Water, San Francisco Bay Hydrologic Region

Water Conveyance Facility	Water Source	Operator	Counties Served	Water Supplied to the Bay Region via Facility in 2010 (af)
San Felipe Unit of CVP	Delta via San Luis Reservoir	USBR (CVP)	Santa Clara San Benito	42,100 (6%)
Sonoma and Petaluma Aqueducts	Russian River	SCWA	Sonoma Marin	19,300 (3%)
North Bay Aqueduct - SWP	Northern Delta	DWR (SWP)	Solano Napa	31,300 (4%)
Putah South Canal	Lake Berryessa	USBR	Solano	34,500 (5%)
Contra Costa Canal	Western Delta	CCWD (CVP)	Contra Costa	54,100 (8%)
South Bay Aqueduct - SWP	Delta	DWR (SWP)	Alameda Santa Clara	133,900 (19%)
South Bay Aqueduct - SWP	Wheeled from multiple sources	DWR (SWP)	Alameda	15,000 (2%)
Mokelumne Aqueduct	Mokelumne River	EBMUD	Alameda Contra Costa	159,000 (22%)[a]
Hetch Hetchy Aqueduct	Tuolumne River	SFPUC	San Francisco San Mateo Alameda Santa Clara	218,000 (31%)[a]

Notes:

af = acre-feet

CCWD = Contra Costa Water District

CVP = Central Valley Project

EBMUD = East Bay Municipal Utility District

SCWA = Sonoma County Water Agency

SFPUC = San Francisco Public Utilities Commission

SWP = State Water Project

USBR = U.S. Bureau of Reclamation

[a] Volume does not include storage change at reservoirs along conveyance facility.

Groundwater supply estimates are based on water supply and balance information derived from DWR land use surveys, and from groundwater supply information that water purveyors or other State agencies voluntarily provide DWR. Groundwater supply is reported by water year (October 1 through September 30) and is categorized according to agriculture, urban, and managed wetland uses. The groundwater information is presented by planning area, county, and by the type of use. Although on an average groundwater accounts for only 21 percent of the region's total water supply, the majority of groundwater supplies (71 percent) are used to meet urban use while 29 percent goes to agricultural use. No groundwater is used to meet managed wetland use.

Figure SFB-9 depicts the planning area locations and the associated 2005-2010 groundwater supply in the region. The estimated average annual 2005-2010 total water supply is 1.25 maf, of which 260 thousand acre-feet (taf) is from groundwater supply (21 percent). (Reference to total water supply represents the sum of surface water and groundwater supplies in the region, and local reuse.) The figure also shows that the South Bay planning area is the larger user of groundwater in the region, being supplied with an annual average of 181 taf (70 percent of the total groundwater supply in the region).

Table SFB-7 provides the 2005-2010 average annual groundwater supply by planning area and by type of use. Groundwater supplies meet 74 percent (76 taf) of the overall agricultural water use and 16 percent (184 taf) of the overall urban water use in the region. No groundwater resources are used for meeting managed wetland uses in the region. Although the South Bay relies on groundwater supplies for only 18 percent of its overall water use, 85 percent of the agricultural water use in the South Bay is met by groundwater. The North Bay planning area provides an average annual groundwater supply of 79 taf (34 percent of the overall water supply), which meets 71 percent of the agricultural water use and 16 percent of the urban water use in the planning area.

Although groundwater extraction in the region accounts for only about 2 percent of California's 2005-2010 average annual groundwater supply, it accounts for 100 percent of the supply for some local communities and is used significantly to help facilitate local conjunctive water management.

Regional totals for groundwater based on county area will vary from the planning area estimates shown in Table SBF-7 because county boundaries do not necessarily align with planning area or hydrologic region boundaries.

Groundwater supply for Napa, Marin, Alameda, San Francisco, Santa Clara, and San Mateo counties is reported in the Bay Region; but groundwater supply for Sonoma, Solano, and Contra Costa counties is reported in the North Coast, Sacramento River, and San Joaquin River hydrologic regions, respectively. Table SFB-8 shows that groundwater contributes to 25 percent of the total water supply in the six-county area, ranging from close to zero percent in San Francisco County to 59 percent in Napa County. Groundwater supplies in the six-county area are used to meet about 60 percent of the agricultural water use and 20 percent of the urban water use.

Changes in annual groundwater supply and type of use may be related to a number of factors, such as changes in surface water availability, urban and agricultural growth, market fluctuations, and water use efficiency practices. Figures SFB-10 and SFB-11 summarize the 2002 through 2010 groundwater supply trends for the region.

The right side of Figure SFB-10 illustrates the annual amount of groundwater versus other water supply, while the left side identifies the percent of the overall water supply provided by groundwater relative to other water supply. The center column in the figure identifies the water year along with the corresponding amount of precipitation, as a percentage of the 30-year running average precipitation in the region. The figure shows that the annual water supply in the region has fluctuated between approximately 1,100 (in 2010) and 1,380 taf (in 2002). The annual groundwater supply has fluctuated between approximately 240 taf (in 2010) and 280 taf (in 2008), providing between 18 and 23 percent of the total water supply.

Figure SFB-9 Contribution of Groundwater to the San Francisco Bay Hydrologic Region Water Supply by Planning Area (2005-2010)

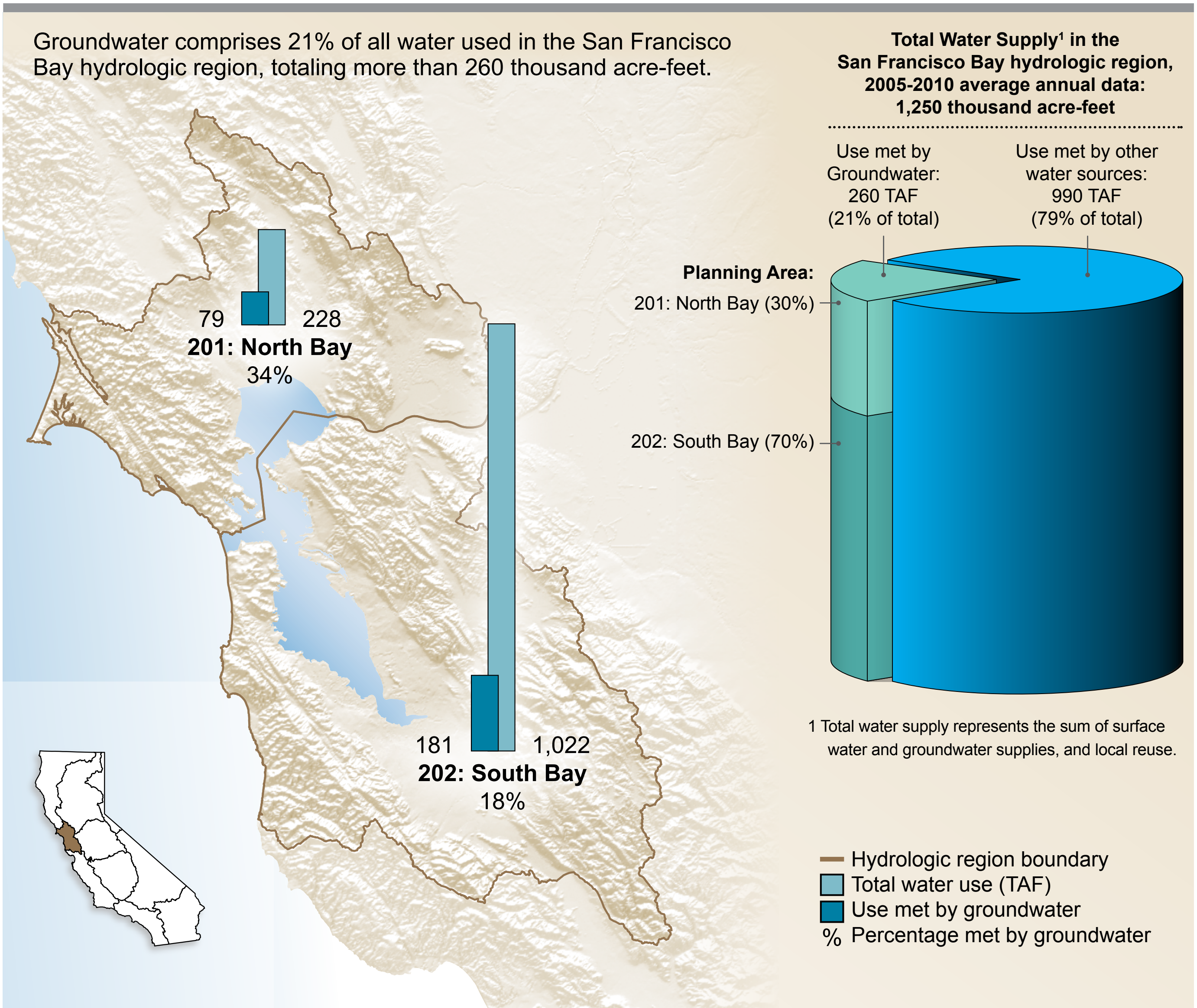


Figure SFB-11 shows the annual amount and percentage of groundwater supply to meet urban, agricultural, and managed wetland uses. The figure indicates that 65 to 80 percent of the annual groundwater supply met urban use and 20 to 35 percent of the annual groundwater supply met agricultural use. Groundwater was not used to meet any managed wetland use.

More detailed information regarding groundwater water supply and use analysis is available online from *California Water Plan Update 2013*, Volume 4, *Reference Guide*, the article "California's Groundwater Update 2013."

Table SFB-7 San Francisco Bay Hydrologic Region Average Annual Groundwater Supply by Planning Area (PA) and by Type of Use (2005-2010)

San Francisco Bay Hydrologic Region		Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
PA NUMBER	PA NAME	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT	TAF	PERCENT
201	North Bay	54.7	71	23.8	16	0.0	0	78.6	34
202	South Bay	21.4	85	159.6	16	0.0	0	181.0	18
2005-2010 annual average region total		**76.1**	**74**	**183.5**	**16**	**0.0**	**0**	**259.6**	**21**

Notes:

TAF = thousand acre-feet

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

2005-2010 precipitation equals 93% of the 30-year average for the San Francisco Bay Hydrologic Region

Recycled Water

The Bay Region has a long history of regional recycled water planning. Following years of drought in the early 1990s, and facing uncertain future water supplies, the Bay Area Clean Water Agencies (BACWA) formed a partnership with the U.S. Bureau of Reclamation (USBR) and DWR to study the feasibility of a regional approach to water recycling. The study produced the Bay Area Regional Water Recycling Program, which is the foundation of regional recycled water planning throughout the Bay Region. Recycled water is used for many applications in the Bay Region, including agricultural irrigation, landscape irrigation, commercial and industrial purposes, and wetland replenishment. The region has a large potential market for recycled water — up to 240,000 acre-feet per year (af/yr.) by 2025, as reported in the 1999 Bay Area Recycled Water Master Plan. The region increased its recycled water use over 36 percent; from 29,500 af in 2001 to 40,300 af in 2009.

Recycled water meets diverse non-potable water needs in the region. The largest use is for landscape irrigation including golf courses, which used over 15,000 af in 2009 (2009 Recycled Water Survey). Approximately 9,000 aft were used for wetlands; 8,700 af for industry; and over 5,000 af for agricultural irrigation. Unique recycled water uses also occur in the region, such as MMWD's recycled water use for car washes and Contra Costa County's recycled water use for cleaning an animal control facility.

Water suppliers in the region continue to expand recycled water use through IRWM partnerships. South Bay Water Recycling, a partnership of 10 water and wastewater agencies, provides recycled water in the San Jose area to power plants and industrial users. SCVWD and its partners are completing the region's first advanced water treatment plant to improve overall recycled water quality for South Bay Water Recycling customers and are constructing additional pipelines to expand South Bay Water Recycling.

Table SFB-8 San Francisco Bay Hydrologic Region Average Annual Groundwater Supply by County and by Type of Use (2005-2010)

San Francisco Bay Hydrologic Region	Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
COUNTY	TAF	%	TAF	%	TAF	%	TAF	%
Napa	36.6	77	7.4	29	0.0	0	44.0	59
Marin	3.1	63	1.0	2	0.0	0	4.0	9
Alameda	5.8	51	35.9	15	0.0	0	41.7	17
San Francisco	0.0	0	0.1	0	0.0	0	0.1	0
Santa Clara	34.1	49	133.7	31	0.0	0	167.7	34
San Mateo	2.0	67	8.5	8	0.0	0	10.5	9
2005-10 annual average total	**81.5**	**60**	**186.4**	**20**	**0.0**	**0**	**268.0**	**25**

Notes:

TAF = thousand acre-feet

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

2005-2010 precipitation equals 93% of the 30-year average for the San Francisco Bay Region

EBMUD is partnering with other water and wastewater agencies to expand its use of recycled water for industrial customers in the Richmond area, as well as irrigation customers in the eastern part of its service area. In the North Bay, 10 agencies are developing recycled water projects to supply the Napa Salt Marsh Restoration Project and other projects. Two of the recycled water projects are recently dedicated treatment facilities — Las Gallinas Valley Sanitary District's facility in San Rafael (September 25, 2012) and Novato Sanitary District's facility in Novato (October 11, 2012).

Additional information on statewide municipal recycled water is included in Volume 3, Chapter 12, and additional information on specific recycled water uses in the Bay Region can be found in Volume 4.

Desalinated Water

ACWD dedicated the first brackish water desalination facility in Northern California in 2003 and doubled its production capacity to 10 million gallons per day (mgd) in 2010. The Newark Desalination Facility receives water from the Niles Cone Groundwater Basin, which contains some brackish water due to previous years of seawater intrusion. Since the facility was completed, ACWD has reported improved water quality and production capacity, reduced reliance on imported supplies, and greater dry year supply reliability.

Another desalination project is headed by the Contra Costa Water District (CCWD), EBMUD, SFPUC, and SCVWD. Zone 7 joined this group in 2010, and their research led them to believe a facility could be built at CCWD's Mallard Slough Pump Station. The group agreed that a 10 to 20

Figure SFB-10 San Francisco Bay Hydrologic Region Annual Groundwater Water Supply Trend (2002-2010)

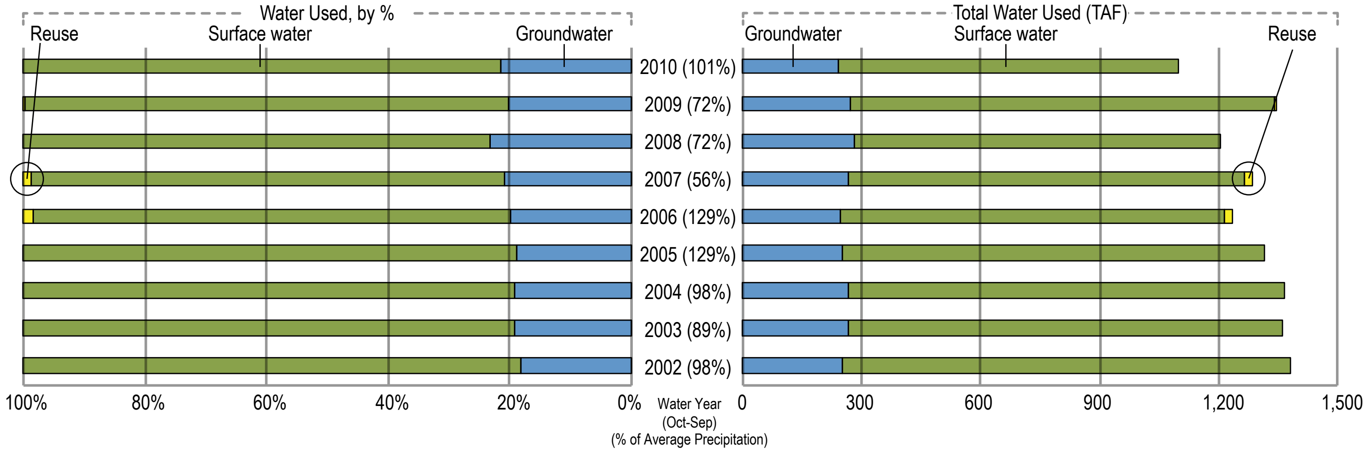
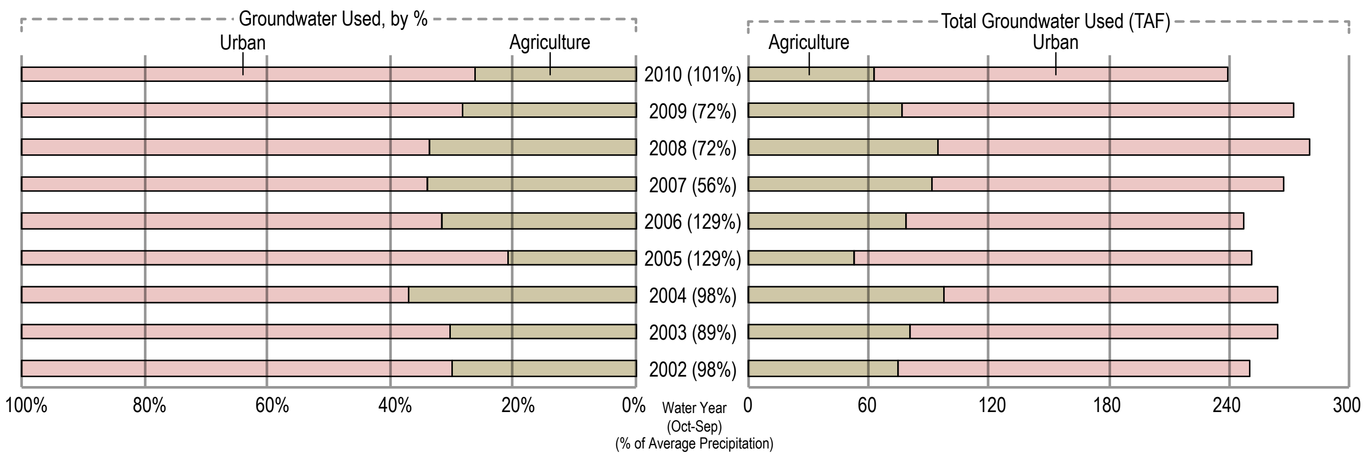


Figure SFB-11 San Francisco Bay Hydrologic Region Annual Groundwater Supply Trend by Type of Use (2002-2010)



mgd facility would be viable. As of 2013, the project still is in the planning phase, but additional studies and simulations are providing new information.

MMWD is considering a desalination project off the coast of San Rafael Bay. A recent Court of Appeal decision upheld the project's environmental document. However, voter approval is needed to finance the planning, design, and permitting of the project. As of 2013, the project is not moving forward, although it could if other sources of water become depleted.

Water Use

Drinking Water

The Bay Region has an estimated 190 community drinking water systems, as shown in Table SFB-9. Over 60 percent of them are small systems serving fewer than 3,300 people; and most of those serve fewer than 500 people. (Note that this total does not include state small water systems that generally serve less than 25 people.) Small water systems face unique financial and operational challenges to provide safe drinking water. With a small customer base, many small water systems cannot develop or access the technical, managerial, and financial resources that they need to comply with new and existing regulations. These water systems may be geographically isolated; and their staff often lacks the time or expertise to make needed infrastructure repairs; install or operate treatment facilities; and develop comprehensive source water protection plans, financial plans, or asset management plans (U.S. Environmental Protection Agency 2012).

Medium and large community drinking water systems account for less than 40 percent of the region's systems, but deliver drinking water to over 95 percent of the region's population. These water systems generally have financial resources to hire staff that oversees daily operations and maintenance and plans for future infrastructure replacement and capital improvements to help ensure that existing and future drinking water standards are met.

Municipal Use

About 70 percent of the urban water supply in the Bay Region is imported, and is relatively expensive due to the capital, operation, and maintenance costs of the projects that deliver the water. The high water rates, cool climate, small lot sizes, and high-density developments contribute to relatively low per capita urban water use. The City of San Francisco has a per capita use of around 90 gallons per day, ACWD has 130 gpd, and MMWD has 145 gpd. In contrast, water use for communities in the warmer Central Valley regions can range from 200 to 300 gpd, most of which is applied to residential landscapes.

Droughts, climate change, and population growth all could negatively impact the reliability of available water supplies. Local governments have started to require water efficient devices in new construction; and both local governments and water agencies have rebate programs to replace older, less efficient devices such as washing machines and toilets. Some agencies are offering between $0.25 and $1.00 per square foot to remove lawn area. Most water agencies have conservation tips and rebate information on their Web sites, and other Web sites such as www.saveourh2o.org/, and www.h2ouse.org promote water conservation.

Metering water use allows water purveyors to establish tiered rates, which provide customers an incentive to minimize use and avoid the higher tiers. Purveyors also provide public education on water conservation to encourage low water use. Much of the Bay Region is well-developed and is undergoing urban renewal. The older areas of Oakland and San Francisco are being replaced by new construction, which puts into service more water efficient devices.

Table SFB-9 Community Drinking Water Systems, San Francisco Bay Hydrologic Region

Water System Size by Population	Community Water Systems (CWS)	Percent of Community Systems in Region	Population Served[a]	Percent of Population Served
Large > 10,000	54	28	6,381,090	98.3
Medium 3,301 - 10,000	7	4	48,619	0.7
Small 500 - 3,300	27	14	49,051	0.8
Very Small < 500	96	51	12,484	0.2
CWS that primarily provide wholesale water	6	3	-	-
Total	**190**	**---**	**6,491,244**	**---**

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

Note:

[a] Population estimates for community drinking water systems are from the CDPH Permits, Inspection, Compliance, Monitoring and Enforcement database and may contain seasonal visitors.

Industrial Use

Industrial water use varies greatly throughout the Bay Region, from as little as 1 percent by SFPUC to as much as 29 percent by CCWD. Despite an increasing population, the region has seen little change in total industrial water use, primarily because industry is using recycled water instead. The Delta Diablo Sanitation District provides 8,600 af of recycled water annually to power plants and is looking to supply an additional 12 mgd of recycled water to the Mirant Power Plant. The City of Benicia is proposing to supply the Valero Refining Company with up to 2 mgd of high-purity recycled water to replenish cooling tower water. This would reduce Valero's annual demand for water from between 4,480 and 5,600 af to as little as 2,240 af.

Water Conservation Act of 2009 (Senate Bill X7-7) Implementation Status

Forty-four Bay Region urban water suppliers submitted 2010 urban water management plans to DWR. The urban water management plans include calculations of baseline water use and set 2015 and 2020 water use targets, as required by the Water Conservation Act of 2009, Senate Bill (SB) X7-7. The population-weighted baseline water use in the region is 153 gallons per capita per day, with a 2020 target of 133 gallons per capita per day. Baseline and target data for urban water suppliers in the region are available on DWR's Urban Water Use Efficiency Web site at www.water.ca.gov/wateruseefficiency.

SB X7-7 also requires agricultural water suppliers that serve more than 25,000 irrigated acres to prepare and adopt agricultural water management plans by December 31, 2012, and update those plans by December 31, 2015, and every 5 years thereafter. However, the Bay Region does not have any agricultural water suppliers that serve more than 25,000 acres so no agricultural water management plans were submitted.

Water Balance Summary

The Bay Region has two planning areas in which water balances were computed — the North Bay and South Bay planning areas. These areas are separated by Suisun Bay, Carquinez Strait, San Pablo Bay, and the northern lobe of San Francisco Bay. A detailed discussion of the water balance computations in the North Bay and South Bay planning areas is presented in Volume 5, *Technical Guide*, of *California Water Plan Update 2013*. The water balance for the Bay Region is a combination of the water balance computations in the North Bay and South Bay planning areas.

Figure SFB-12 shows the water balance for the Bay Region from 2001 to 2010. It gives the volume of applied water use in six categories, including the volume of depleted (irrecoverable) water use. It also gives the volume of dedicated and developed water supply in 10 categories, which indicates the water sources to meet the applied water use.

Table SFB-10 shows the sources and volumes of fresh water entering and leaving the Bay Region and the change in the region's water supply storage from 2001 to 2010. The Sacramento and San Joaquin rivers inflows are not included in the table because they are considered brackish. However, those inflows are included in Figure SFB-13 for Water Year 2010, as well as the 2010 Pacific Ocean outflow and the 2010 water imports from Table SFB-10.

Project Operations

Bay Region water projects are operated to treat wastewater, minimize flood damages, and to supply water. This section discusses the major water supply projects — the State, federal, and local conveyance systems, which were introduced in the "Surface Water" section earlier in this chapter.

These major water supply projects include:

- Contra Costa Canal: The 48-mile-long Contra Costa Canal comprises the backbone of the CCWD transmission system for the CVP. It originates at Rock Slough in East Contra Costa County and ends at the Shortcut Pipeline near the Bollman Water Treatment Plant, delivering raw water to CCWD's treatment facilities and to raw water customers.
- Hetch Hetchy Aqueduct: The 156-mile Hetch Hetchy Aqueduct conveys water from the Tuolumne River through the Hetch Hetchy Reservoir and to the San Francisco Bay Area. The aqueduct splits into four pipelines in Fremont, all of which cross the Hayward fault. Pipelines 1 and 2 cross the San Francisco Bay south of the Dumbarton Bridge, and Pipelines 3 and 4 run south.
- Mokelumne Aqueducts: Three aqueducts form the Mokelumne Aqueduct System and convey most of EBMUD's water supply from Pardee Reservoir on the Mokelumne River to Walnut Creek, a distance of 84 miles. The water can be stored in five terminal reservoirs and treated at six facilities prior to distribution to East Bay customers.
- North Bay Aqueduct: The NBA is an underground pipeline operated remotely by DWR that conveys water from the Sacramento-San Joaquin Delta. The NBA extends from Barker Slough in the Delta to Cordelia Forebay near Vallejo. The NBA conveys water from the

Table SFB-10 San Francisco Hydrologic Region Water Balance for 2001-2010 (in taf)

San Francisco (taf)	Water Year (Percent of Normal Precipitation)									
	2001 (81%)	**2002** (98%)	**2003** (89%)	**2004** (98%)	**2005** (129%)	**2006** (129%)	**2007** (56%)	**2008** (72%)	**2009** (72%)	**2010** (101%)
WATER ENTERING THE REGION										
Precipitation	4,908	6,061	5,539	6,072	8,047	8,581	3,696	4,782	4,789	6,736
Inflow from Oregon/Mexico	0	0	0	0	0	0	0	0	0	0
Inflow from Colorado River	0	0	0	0	0	0	0	0	0	0
Imports from Other Regions	872	950	1,157	1,163	1,175	1,473	1,097	1,023	1,227	1,157
Total	**5,780**	**7,011**	**6,696**	**7,235**	**9,222**	**10,054**	**4,793**	**5,805**	**6,016**	**7,893**
WATER LEAVING THE REGION										
Consumptive use of applied water[a] (Ag, M&I, Wetlands)	421	482	452	469	416	477	476	472	497	389
Outflow to Oregon/Nevada/ Mexico	0	0	0	0	0	0	0	0	0	0
Exports to other regions	0	0	0	0	0	0	0	0	0	0
Statutory required outflow to salt sink	20	21	21	21	21	18	17	17	19	17
Additional outflow to salt sink	778	759	797	605	714	801	618	572	558	527
Evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, natural and incidental runoff, ag effective precipitation & other outflows	4,770	5,700	5,314	6,024	7,892	8,397	3,938	4,811	4,996	6,844
Total	**5,989**	**6,962**	**6,584**	**7,119**	**9,043**	**9,693**	**5,049**	**5,872**	**6,070**	**7,777**
CHANGE IN SUPPLY										
[+] Water added to storage [-] Water removed from storage										
Surface reservoirs	-56	-37	40	-39	52	418	-179	-8	-99	81
Groundwater[b]	-153	86	72	155	127	-57	-77	-59	45	35
Total	**-209**	**49**	**112**	**116**	**179**	**361**	**-256**	**-67**	**-54**	**116**
Applied water[a] (ag, urban, wetlands) (compare with consumptive use)	1,237	1,406	1,386	1,399	1,347	1,280	1,328	1,262	1,400	1,152

Notes:

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

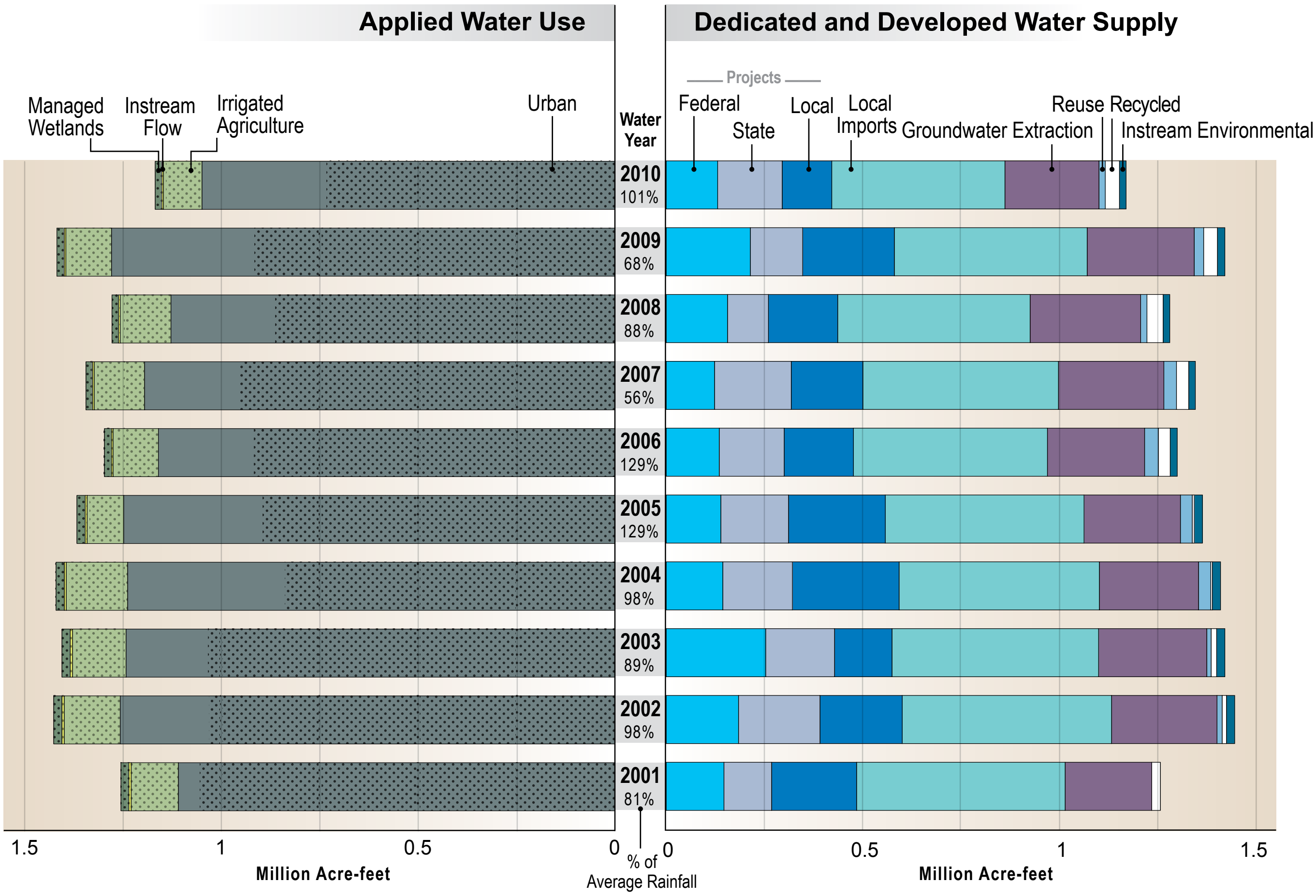
[a] Definition: Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

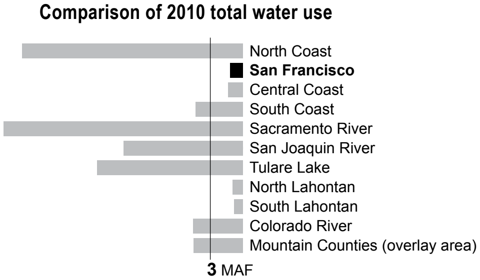
[b] Definition: Change in Supply: Groundwater – The difference between water extracted from and water recharged into groundwater basins in a region. All regions and years were calculated using the following equation: change in supply: groundwater = intentional recharge + deep percolation of applied water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

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

Figure SFB-12 San Francisco Bay Hydrologic Region Water Balance by Water Year, 2001-2010

California's water resources vary significantly from year to year. Ten recent years show this variability for water use and water supply. Applied Water Use shows how water is applied to urban and agricultural sectors and dedicated to the environment and the Dedicated and Developed Water Supply shows where the water came from each year to meet those uses. Dedicated and Developed Water Supply does not include the approximately 125 million acre-feet (MAF) of statewide precipitation and inflow in an average year that either evaporates, are used by native vegetation, provides rainfall for agriculture and managed wetlands, or flow out of the state or to salt sinks like saline aquifers (see table SF-10). Groundwater extraction includes annually about 2 MAF more groundwater used statewide than what naturally recharges – called groundwater overdraft. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years.





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

Key Water Supply and Water Use Definitions

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

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

Instream environmental. Instream flows used only for environmental purposes.

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

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

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

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

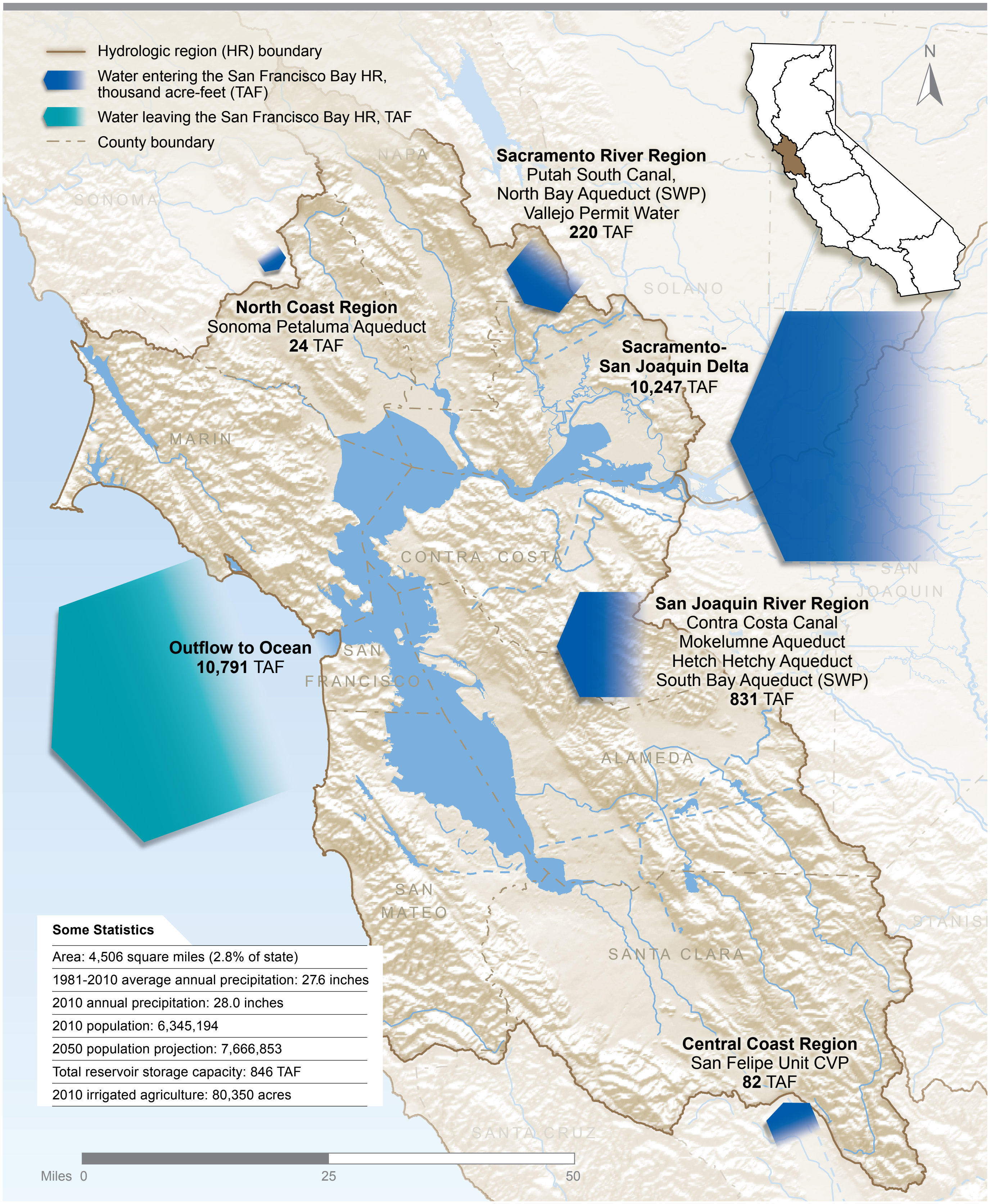
Urban water use. The use of water for urban purposes, including residential, commercial, industrial, recreation, energy production, military, and institutional classes. The term is applied in the sense that it is a kind of use rather than a place of use.

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

San Francisco Water Balance by Water Year Data Table (TAF)

	2001 (81%)	2002 (98%)	2003 (89%)	2004 (98%)	2005 (129%)	2006 (129%)	2007 (56%)	2008 (72%)	2009 (72%)	2010 (101%)
APPLIED WATER USE										
Urban	1,110	1,258	1,243	1,239	1,249	1,161	1,196	1,129	1,280	1,050
Irrigated Agriculture	120	142	136	156	93	115	128	129	116	98
Managed Wetlands	6	6	6	5	5	4	4	4	4	4
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	20	21	21	21	21	18	17	17	19	17
Wild & Scenic R.	0	0	0	0	0	0	0	0	0	0
Total Uses	**1,257**	**1,427**	**1,407**	**1,420**	**1,368**	**1,298**	**1,345**	**1,279**	**1,419**	**1,169**
DEPLETED WATER USE (STIPPLING)										
Urban	1,054	1,031	1,033	838	895	917	955	863	916	733
Irrigated Agriculture	120	128	126	147	85	106	117	118	106	90
Managed Wetlands	6	6	6	5	4	4	4	4	4	4
Req Delta Outflow	0	0	0	0	0	0	0	0	0	0
Instream Flow	20	21	21	21	21	18	17	17	19	17
Wild & Scenic R.	0	0	0	0	0	0	0	0	0	0
Total Uses	**1,200**	**1,186**	**1,186**	**1,010**	**1,006**	**1,045**	**1,093**	**1,003**	**1,045**	**844**
DEDICATED AND DEVELOPED WATER SUPPLY										
Instream	0	21	21	21	21	18	17	17	19	17
Local Projects	216	209	146	271	246	176	182	176	233	126
Local Imported Deliveries	530	532	525	509	505	493	497	489	490	440
Colorado Project	0	0	0	0	0	0	0	0	0	0
Federal Projects	147	184	253	144	139	135	123	156	214	131
State Project	121	207	175	177	172	165	195	104	133	164
Groundwater Extraction	220	250	262	264	251	247	268	281	272	239
Inflow & Storage	0	0	0	0	0	0	0	0	0	0
Reuse & Seepage	0	13	11	31	30	35	32	16	24	16
Recycled Water	22	11	14	4	5	30	31	41	35	36
Total Supplies	**1,257**	**1,427**	**1,407**	**1,420**	**1,368**	**1,298**	**1,345**	**1,279**	**1,419**	**1,169**

Figure SFB-13 San Francisco Bay Hydrologic Region Inflows and Outflows in Water Year 2010



Cordelia Forebay to Napa County, Vallejo, and Benicia. Solano County Water Agency and Napa County Flood Control and Water Conservation District (FCWCD), which contracts for water supply on behalf of cities and towns in Napa County, receive the NBA water.

- Russian River Facilities: SCWA operates diversion facilities on the Russian River and an aqueduct system (Sonoma and Petaluma aqueducts) composed of pipelines, pumps, and storage tanks. Three major reservoirs provide water to the Russian River — Lake Pillsbury on the Eel River, Lake Mendocino on the East Fork of the Russian River, and Lake Sonoma on Dry Creek.
- San Felipe Unit: The San Felipe Unit of the CVP is composed of pipelines and pumps that convey CVP water from San Luis Reservoir (a joint SWP/CVP facility) to Santa Clara and San Benito counties. The San Felipe Unit terminates at the Coyote Pumping Plant in Santa Clara County, where it connects with SCVWD's Cross-Valley Pipeline. The Cross Valley Pipeline is a source of water for drinking water treatment plants, recharge ponds, and irrigation customers.
- South Bay Aqueduct: The SBA conveys water from the Delta through more than 40 miles of pipelines and canals. Beginning at Bethany Reservoir, water is pumped through two parallel pipelines to the eastern ridge of the Diablo Range, where it then flows by gravity to Patterson Reservoir. Some water is released for delivery to the Livermore Valley, and some is conveyed into Lake Del Valle. Beyond Lake Del Valle, water flows south past Sunol and through the hills overlooking San Francisco Bay, terminating in a steel tank east of downtown San Jose. ACWD, Zone 7, and SCVWD receive SBA water.

Figure SFB-14 is a schematic of these conveyance facilities, as well as reservoirs, pumping plants, and water treatment plants.

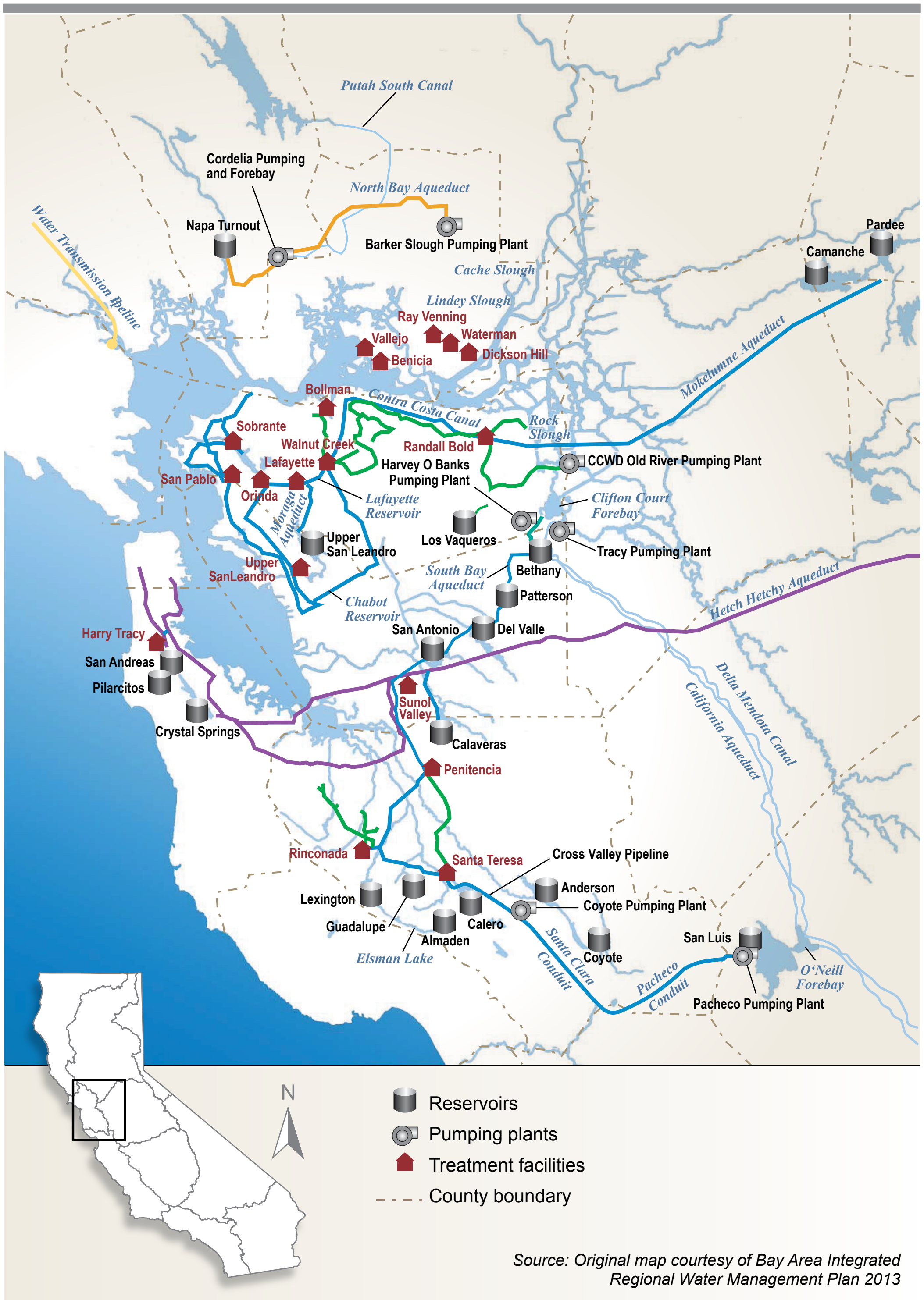
Water Quality

The SFBRWQCB is the lead agency charged with protecting and enhancing surface water and groundwater quality in the Bay Region. It implements the Total Maximum Daily Load (TMDL) Program, which involves determining a safe level of loading for each problem pollutant, determining the pollutant sources, allocating loads to all of the sources, and implementing the load allocations. It is taking a watershed management approach to runoff source issues, including TMDL implementation, by engaging all affected stakeholders in designing and implementing goals on a watershed basis to protect water quality. Representatives from all levels of government, public interest groups, industry, academic institutions, private landowners, concerned citizens, and others are involved in creating watershed action plans. The plans include actions such as improving coordination between regulatory and permitting agencies, increasing citizen participation in watershed planning, improving public education on water quality and protection issues, and prioritizing and enforcing current regulations more consistently.

Surface Water Quality

Despite successful regulation of municipal and industrial wastewater discharges through the National Pollutant Discharge Elimination System (NPDES), many significant surface water quality issues remain to be resolved. Pollutants from urban and rural runoff include pathogens, nutrients, sediments, and toxic residues. Some toxic residues are from past human activities such as mining; industrial production; and the manufacture, distribution, and use of agricultural

Figure SFB-14 Major Water Infrastructure Serving the San Francisco Bay Hydrologic Region



Source: Original map courtesy of Bay Area Integrated Regional Water Management Plan 2013 pesticides. These residues include mercury, polychlorinated biphenyls (PCBs), selenium, and chlorinated pesticides.

Emerging pollutants in the region include flame retardants, perfluorinated compounds, nonylphenol fipronil, and pharmaceuticals. The SFBRWQCB monitors these pollutants through its Regional Monitoring Program; develops management strategies; and implements actions, including pollution prevention, to reduce them.

Sanitary sewer spills can occur because of aging collection systems and treatment plants. Pollutants can spread over large areas, possibly sickening people and pets who contact them; and cleaning up the pollutants after flooding is difficult.

San Francisco Bay and a number of the streams, lakes, and reservoirs in the Bay Region have elevated mercury levels, as indicated by elevated mercury levels in fish tissue. The major source of the mercury is local mercury mining and mining activities in the Sierra Nevada and coastal mountains. Large amounts of contaminated sediments were discharged into the bay from Central Valley streams and local mines in the region. Significant impaired water bodies include the bay, the Guadalupe River in Santa Clara County (from New Almaden Mine), and Walker Creek in Marin County (from Gambonini Mine). Consequently, the SFBRWQCB has adopted TMDLs for mercury in the bay, Guadalupe River, and Walker Creek. Wastewater treatment plants and urban runoff also are a source of mercury, and some wetlands may contain significant amounts of methylmercury (the bioavailable form of mercury in the aquatic environment) from contaminated sediments.

San Francisco Bay is a nutrient-enriched (nitrogen and phosphorus) estuary, but has not suffered from some of the problems found in other similar estuaries with high nutrient concentrations. Dissolved oxygen concentrations in the bay's subtidal habitats are much higher, and phytoplankton levels are substantially lower than expected in an estuary with such high nutrient enrichment. The phytoplankton growth is limited by strong tidal mixing, reduced sunlight due to high turbidity, and grazing clams.

However, evidence suggests that the historical resilience of San Francisco Bay to the harmful effects of nutrient enrichment is weakening. Since the late 1990s, the bay has experienced significant increases in phytoplankton biomass from Suisun Bay to the South Bay (30 to 105 percent) and significant declines in dissolved oxygen concentrations (2 to 4 percent). Also, cyanobacteria and dinoflagellate (red tide) blooms are occurring in portions of the bay. The SFBRWQCB is working collaboratively with stakeholders to evaluate the impacts of nutrients on water quality and to develop a regional nutrient management strategy.

Sediments are dredged from San Francisco Bay to maintain navigation through shipping channels for commercial and recreational purposes. Long-term management strategies were established in 1998 to dispose of the sediments. These strategies include eliminating unnecessary dredging, disposing dredged material in the most environmentally sound manner, and maximizing the use of dredged material as a resource.

Before 1998, more than 80 percent of dredged sediments were disposed in the bay and less than 20 percent were disposed in the ocean or were reused on uplands. The goal of the long-term management strategies is to alter these percentages so that in-bay disposal decreases and more dredged material is used, preferably for wetland restoration. SFBRWQCB guidelines allow only sediments with acceptable levels of contaminants to be reused.

The quantity and quality of biological resources has declined in San Francisco Bay partly because of contaminants. Fewer fish and other aquatic and riparian species reside in the bay. Some species have significant levels of contaminants, which threaten their health and reproduction and necessitate health advisories discouraging consumption of the species.

Non-native invasive species are considered a growing water quality threat as they have reduced or eliminated populations of many native species, disrupted food webs, eroded marshes, and interfered with boating and other water contact recreation. San Francisco Bay is considered one of the most highly invaded estuaries in the world. Exotic and invasive species, such as the Chinese Mitten Crab, New Zealand Mud Snail, Asian Clam, and Atlantic Spartina (Cordgrass) threaten to alter the estuary's ecosystem and undermine its food web. The SFBRWQCB, DFW, and other agencies have developed the California Aquatic Invasive Species Management Plan, which focuses on early detection of invasive species, risk assessment of the primary introduction vectors, improved coordination among agencies, and rapid response actions. The State Coastal Conservancy has developed the Invasive Spartina Plan to address the threat from non-native Spartina.

The rate and timing of freshwater inflows are among the most important factors influencing the physical, chemical, and biological conditions in San Francisco Bay. Retaining adequate freshwater inflows to the bay is critical to protect migrating fish and estuarine habitat. Adequate inflows are necessary to control salinity, to maintain proper water temperature, and to flush out residual pollutants that cannot be eliminated by treatment or source management.

The Sacramento and San Joaquin rivers flow into the eastern end of Suisun Bay, contributing most of the freshwater inflows to the bay. Many small rivers and streams also contribute fresh water. Much of the fresh water is impounded by upstream dams and is diverted to various water projects, which provide vital water to industries, farms, homes, and businesses throughout the state. The SFBRWQCB, the Central Valley Regional Water Quality Control Board, the SWRCB, and other stakeholders are working to improve bay water quality by finding solutions to complex diversion issues. These agencies have formed the Bay-Delta Team to implement a long-term program that addresses impacts to beneficial uses of water in the bay and the Delta.

Another water quality problem in the Bay Region is from stream channel erosion. An excess of sediment can be conveyed downstream, which leads to loss of riparian habitat and loss of spawning habitat for native salmonids. Stream erosion is accelerated by urbanization and additional impervious surfaces, land use conversion, rural development, and grazing. Many watersheds in the region are impaired by excessive sedimentation, a lack of large woody debris, and a lack of spawning gravels. The SFBRWQCB addresses these issues through its stormwater program, which regulates construction activities and controls erosion from developments; through working with flood control agencies on stream maintenance; and through its TMDL program, which sets load limits for discharge from sources such as roads, confined animal facilities, vineyards, and grazing lands. The SFBRWQCB also directs technical assistance and grant funding to locally managed watershed programs working on restoration projects and education and outreach efforts.

The SFBRWQCB regulates wastewater discharged into coastal ocean waters from the Bay Region, and regulates implementation of the California Ocean Plan, which the SWRCB adopted in 1972. The plan established water quality standards that regulate California's coastal ocean waters and established the Regional Basin Plan. The latest ocean plan can be viewed at http://www.waterboards.ca.gov/water_issues/programs/ocean/index.shtml.

Groundwater Quality

Drought, overdraft, and pollution have impaired portions of 33 groundwater basins in the Bay Region. The basins face a perpetual threat of contamination from spills, leaks, and discharges of solvents, fuels, and other pollutants. Contamination affects the supply of potable water and water for other beneficial uses. Some municipal, domestic, industrial, and agricultural supply wells have been removed from service due to the presence of pollution, mainly in shallow groundwater zones. Overdraft can result in land subsidence and saltwater intrusion, although active groundwater management has stopped or reversed the saltwater intrusion.

A variety of historical and ongoing industrial, urban, and agricultural activities and their associated discharges have degraded groundwater quality. Such discharges include industrial and agricultural chemical spills, underground and above-ground tank and sump leaks, landfill leachate, septic tank failures, and chemical seepage via shallow drainage wells and abandoned wells. The Bay Region has over 800 active groundwater cleanup cases, about half of which are fuel cases. In many cases, the treated groundwater is discharged to surface waters via storm drains. High priority cleanup cases include Department of Defense sites such as Hunter's Point, Point Molate, Point Isabel (Moffett Field), and the "Brownfields" sites. These sites generally are contaminated former industrial sites in urban areas that are suitable for redevelopment.

The SFBRWQCB issues NPDES permits for discharge of treated groundwater polluted by fuel leaks and service stations wastes and by volatile organic compounds. It also issues permits for reverse osmosis concentrate from aquifer protection wells, for salinity barrier wells, and for high volume dewatering of structures. As additional discharges are identified, source removal, pollution containment, and cleanup must be undertaken as quickly as possible to ensure that groundwater quality is protected.

Much of the Bay Region's groundwater is considered to be an existing or potential source of drinking water. However, some groundwater is not, such as shallow or saline groundwater around the perimeter of San Francisco Bay. Successful groundwater management in the region ensures that groundwater basins provide high quality water for drinking; irrigation; industrial processes; and the replenishment of streams, wetlands, and San Francisco Bay.

The agencies in the region have implemented various quality programs to monitor and protect groundwater quality. The Sonoma Valley County Sanitation District (SVCSD), Zone 7, SCVWD, and ACWD are developing Salt and Nutrient Management Plans to ensure that Bay Region groundwater basins are protected, as required by SWRCB's Recycled Water Policy. Also, SVCSD has developed a new guidance document to help local water agencies develop their own Salt and Nutrient Management Plans. The goal of the plans is to reduce the salts and nutrients that enter the region's groundwater basins.

Drinking Water Quality

Drinking water in the Bay Region ranges from high-quality Mokelumne and Tuolumne river water to variable-quality Delta water, which constitutes about one-third of the domestic water supply. Purveyors that depend on the Delta for all or part of their domestic water supply can meet drinking water standards, but still need to be concerned about microbial contamination, salinity, and organic carbon.

In 2013, the SWRCB completed a statewide report titled, "Communities that Rely on a Contaminated Groundwater Source for Drinking Water." The report identified contaminated wells statewide that exceed a primary drinking water standard prior to any treatment or blending. In the Bay Region, 28 contaminated wells were identified that are used by 18 water systems. Most of the affected drinking water systems are small and often need financial assistance to construct a water treatment plant or another facility to meet drinking water standards. The most prevalent contaminants in the region are arsenic, nitrate, and aluminum.

Land Subsidence

Basin management objectives and monitoring protocols that relate to inelastic land subsidence and groundwater management are addressed in CWC Section 10753.7. In the Bay Region, all of the active groundwater management plans adequately address the topic of land subsidence; however, historical land subsidence has only been observed in Santa Clara County. According to SCVWD's 2012 Groundwater Management Plan (Santa Clara Valley Water District 2012), the Santa Clara subbasin in the Santa Clara Valley Groundwater Basin experienced 13 feet of inelastic land subsidence between 1915 and 1969 due to groundwater withdrawal. Serious problems developed as a result of subsidence, including flooding of lands adjacent to the San Francisco Bay, decreased ability of local streams to carry away winter flood waters, and damage to well casings. All these necessitated the construction of additional dikes, levees, and flood control facilities to protect properties from flooding. Significant inelastic land subsidence was essentially halted by about 1970 through SCVWD's expanded conjunctive use programs, which allowed groundwater levels to recover.

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

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

Groundwater Conditions and Issues

Groundwater Occurrence and Movement

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

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

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

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

Depth to Groundwater and Groundwater Elevation Contours

Groundwater monitoring makes data available to prepare the depth to groundwater and groundwater elevation contours. The depth to groundwater has a direct bearing on the costs associated with well installation and groundwater extraction. Knowing the local depth to groundwater also can provide a better understanding of the interaction between the groundwater table and the surface water systems, and the contribution of groundwater to the local ecosystem.

Depth-to-groundwater data for some of the groundwater basins in the region are available online via DWR's Water Data Library (http://www.water.ca.gov/waterdatalibrary/), DWR's CASGEM system (http://www.water.ca.gov/groundwater/casgem/), and the USGS National Water Information System (http://waterdata.usgs.gov/nwis). In addition, basin-specific information may be obtained from the following sources:

- Napa Valley Subbasin — Napa County (http://www.countyofnapa.org/).
- Sonoma Valley Subbasin — Sonoma County Water Agency (http://www.scwa.ca.gov/svgroundwater/).
- Santa Clara Valley Basin — Santa Clara Valley Water District (http://www.valleywater.org/Services/GroundwaterMonitoring.aspx).
- Niles Cone Subbasin — Alameda County Water District (http://www.acwd.org/).
- East Bay Plain Subbasin — East Bay Municipal Utilities District (http://www.ebmud.com/water-and-wastewater/project-updates/south-east-bay-plain-basin-groundwater-management).
- Livermore Valley Basin — Zone 7 Water Agency (http://www.zone7water.com/publications-reports/reports-planning-documents).
- Westside Basin — San Francisco Public Utilities Commission (http://www.sfwater.org/).

The above links also may provide groundwater elevation contour maps for some areas of the region. Groundwater elevation contours can help estimate the direction, gradient, and rate of groundwater flow.

Groundwater Level Trends

Groundwater levels within groundwater basins in the Bay Region can be highly variable because of the physical variability of aquifer systems, the variability of surrounding land use practices, and the variability of groundwater availability and recharge. Plots of depth-to-water measurements in wells over time (groundwater level hydrographs) allow analysis of seasonal and long-term groundwater level variability and trends. The hydrographs presented in Figures SFB-15A to SFB-15F help explain how local aquifer systems respond to changing groundwater pumping quantities and to resource management practices. The hydrograph name refers to the well location (township, range, section, and tract).

Figures SFB-15A and SFB-15B show hydrographs 06N04W27L002M and 05N03W05M001M, which are from domestic wells located in the Napa Valley Groundwater subbasin, approximately 4 miles apart. The hydrographs reflect the dramatically different aquifer conditions underlying the subbasin. Well 06N04W27L002M is in the upper portion of the Sonoma Volcanics within younger, unconsolidated alluvial deposits and has shown a very stable groundwater level trend since the 1960s, probably because of its relatively short distance from the Napa River. In contrast, well 05N03W05M001M is in the less-permeable portion of the Sonoma Volcanics and has shown considerable groundwater level decline (approximately 3 feet per year) since it was first monitored in 1949 (U.S. Geological Survey 2003). Napa County considers well 05N03W05M001M to be located in a “groundwater deficient area” and is subject to a countywide groundwater ordinance that was adopted in 1996.

Figure SFB-15C shows hydrograph 04N05W02B001M, which is from a domestic well located in the southern Sonoma Valley Groundwater subbasin, a predominantly agricultural area. The hydrograph illustrates the effect of in-lieu recharge on declining groundwater levels when recycled water supplies were made available to the area around 1996. Groundwater levels prior to 1990 were generally stable at around 5 feet above mean sea level, but dropped to approximately 120 feet below mean sea level by 1996 due to pumping for agricultural irrigation. The drop in groundwater level created a depression zone in southern Sonoma Valley, which increased the potential for saline water to migrate northward into the subbasin. In the mid-1990s, SVCSD made recycled water available for irrigation, which offset the need for groundwater pumping for irrigation and allowed groundwater levels to recover. Between 1996 and 1998, groundwater levels recovered and have been above mean sea level for more than 10 years.

Figure SFB-15D shows hydrograph LMMW-1S, which is from a locally-named monitoring well located in the highly urbanized Westside Groundwater Basin. The well is monitored by SFPUC, the California Water Service Company, and the cities of San Bruno and Daly City. The hydrograph shows generally stable groundwater levels in an urban environment, primarily because the area is served by surface water supplies. San Francisco County has the least number of well records of any county in the Bay Region. Groundwater in the county is not widely used for domestic, irrigation, public supply, or industrial purposes. Almost 80 percent of the available well records in the county are monitoring wells likely associated with groundwater cleanup programs. SFPUC is developing groundwater resources in the Westside Basin because the county relies heavily on imported surface water supplies.

Figure SFB-15E shows hydrograph 04S01W30E003M, which is from a well located in an urban area of the Niles Cone Groundwater subbasin. The hydrograph is another illustration of groundwater level recovery resulting from the availability of imported surface water supplies and the implementation of groundwater recharge efforts. Salt water intrusion was first noticed in the

Niles Cone subbasin in the 1920s, a result of decades of persistent pumping in the area. ACWD began importing water from the SWP in 1962 to supplement local water supplies and to increase the amount of water available for local groundwater recharge through percolation ponds. The additional water supplies and the groundwater recharge efforts resulted in decreased groundwater pumping and recovering groundwater levels. In the 1970s, ACWD constructed inflatable dams in Alameda Creek to further increase recharge capabilities in the groundwater basin.

Figure SFB-15F shows hydrograph 07S01E07R013M, which is from a municipal water supply well located in Santa Clara County. The hydrograph is a classic example of how conjunctive management of water supplies helps offset the effects of population increase and land use change on land subsidence and groundwater levels. The earliest recorded groundwater level is 100 feet above mean sea level in 1915; and by 1935, groundwater levels had dropped to approximately 5 feet above mean sea level due to intensified pumping activity. SCVWD constructed reservoirs in 1935 to capture more local surface water, which reversed the declining trend in groundwater levels. The groundwater levels improved until the mid-1940s, when increase in population and a shift in land use again intensified groundwater extraction in the region. Groundwater levels had decreased to almost 135 feet below mean sea level by 1964.

As a result of the intensified pumping, land subsidence became a significant problem in the Santa Clara Valley Groundwater Basin. A 13-foot subsidence was recorded in San Jose between 1915 and 1970. SCVWD began receiving SWP deliveries in 1964 and increased its federal deliveries in 1987. SCVWD stabilized groundwater levels at approximately 100 feet above mean sea level and halted land subsidence in the area with the help of increased surface water deliveries and with an in-lieu recharge program, technology changes, and water conservation programs.

Change in Groundwater Storage

Change in groundwater storage is the difference in stored groundwater volume between two time periods. Examining the annual change in groundwater storage over a series of years helps to characterize a groundwater basin's response to changes in climate, land use, and groundwater management. If the change in storage is negligible over a period of average hydrologic and land use conditions, then the basin is considered to be in equilibrium under the existing water use scenario and current management practices. Declining storage over a relatively short period of average hydrologic and land use conditions does not necessarily mean that the basin is managed unsustainably or is subject to overdraft. Utilization of groundwater in storage during years of diminishing surface water supply, followed by active recharge of the aquifer when surface water or other alternative supplies become available, is a recognized and acceptable approach to conjunctive water management. Some local water agencies in the region such as Zone 7 Water Agency, SFPUC, and SCVWD develop change-in-groundwater-storage estimates periodically for basins within their service areas. See the following links for further information: http://www.zone7water.com/, http://www.sfwater.org/, and http://www.valleywater.org/.

Additional information regarding the risks and benefits of conjunctive management can be found online in *California Water Plan Update 2013*, Volume 3, Chapter 9, "Conjunctive Management and Groundwater Storage."

Figure SFB-15 Groundwater Level Trends in Selected Wells in the San Francisco Bay Hydrologic Region

Aquifer response to changing demand and management practices

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

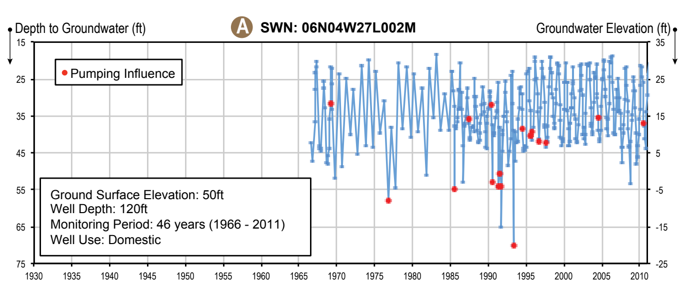
A, B Hydrograph 06N04W27L002M and 05N03W05M001M: illustrate the dramatically different aquifer conditions underlying the Napa Valley Subbasin. SWN 06N04W27L002M is completed in the upper Sonoma Volcanics where the alluvial deposits are young and unconsolidated, thus, more permeable and better connected to the surface water sources. SWN 05N03W05M001M is completed in deeper alluvial deposits which are less permeable and not well connected to the surface water source.

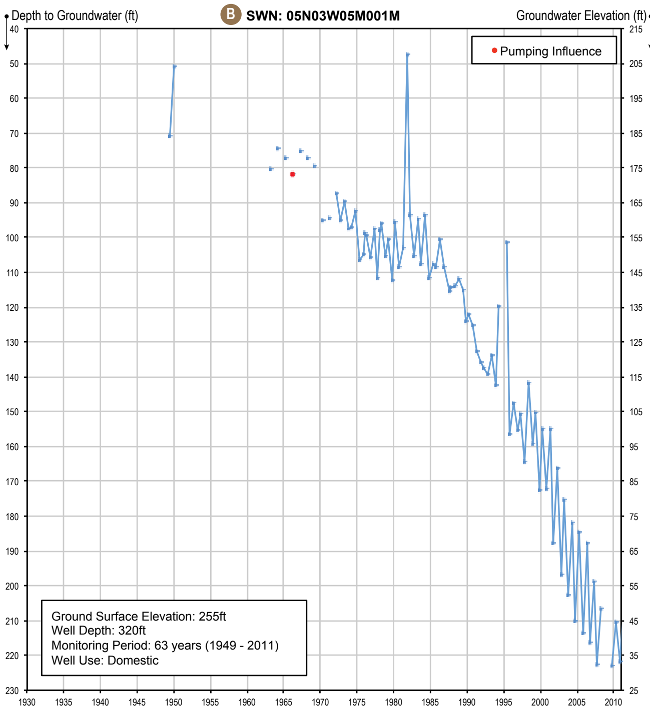
C Hydrograph 04N05W02B001M: highlights a well with recovering groundwater levels associated with the use of recycled of water in lieu of pumping groundwater to meet the local agricultural water demand.

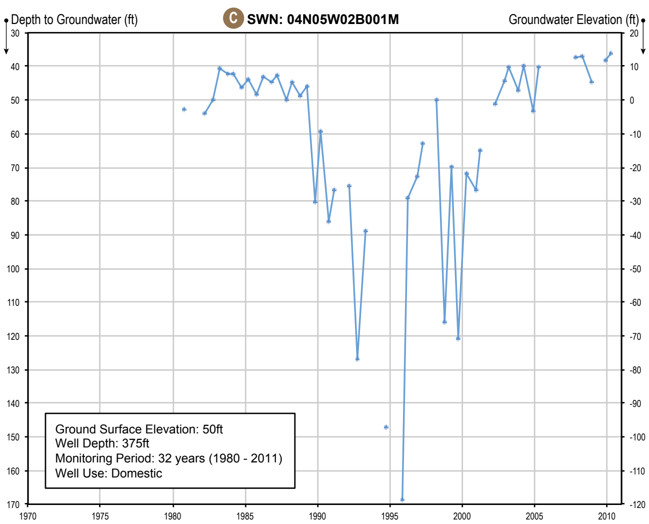
D Hydrograph LMMW-1S: illustrates an urban environment where groundwater level has generally remained stable over time, primarily due to use of surface water supplies for domestic consumption.

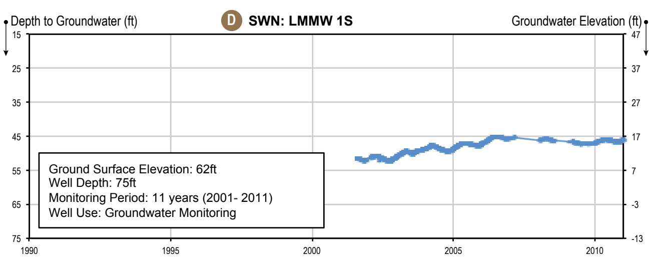
E, F Hydrograph 04S01W30E003M and 07S01E07R013M: illustrate the successful recovery of rapidly declining groundwater levels as a result of additional surface water deliveries, reduced groundwater pumping, and a local groundwater recharge program.

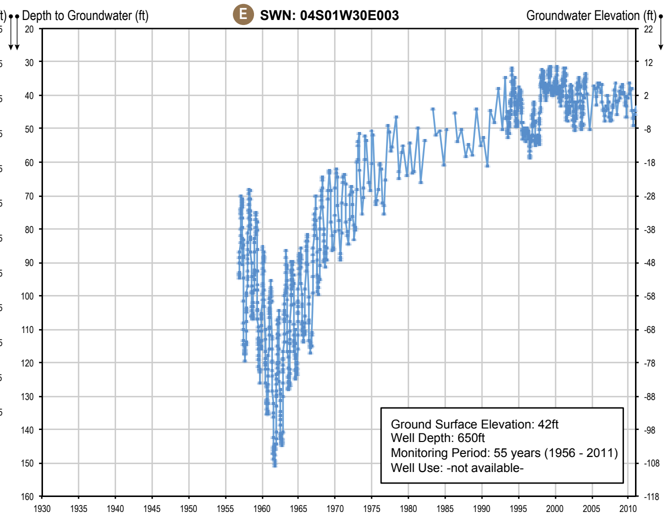
Regional locator map

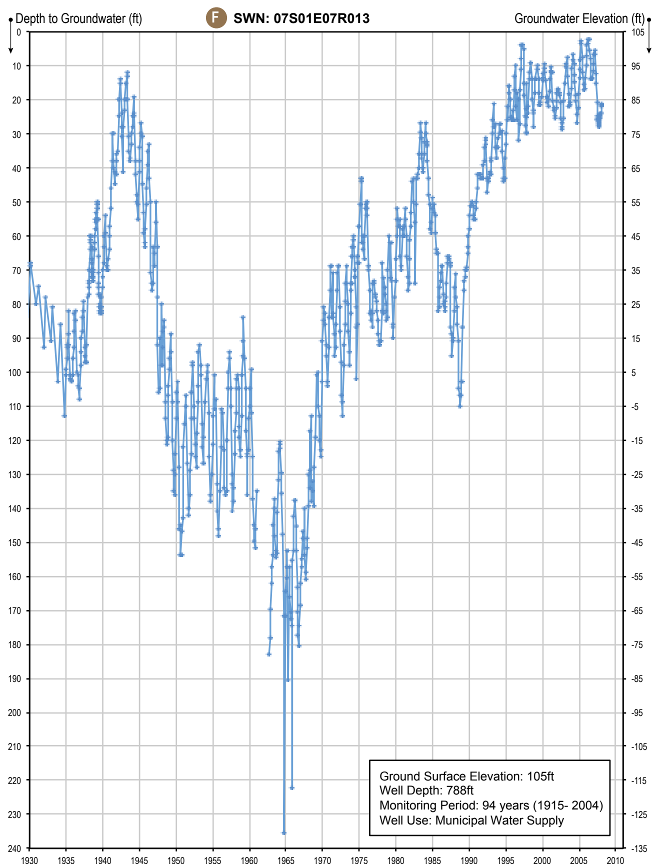



Depth to Groundwater (ft)
B SWN: 05N03W05M001M
Groundwater Elevation (ft)
Pumping Influence
Ground Surface Elevation: 255ft
Well Depth: 320ft
Monitoring Period: 63 years (1949 - 2011)
Well Use: Domestic


Depth to Groundwater (ft)
C SWN: 04N05W02B001M
Groundwater Elevation (ft)
Ground Surface Elevation: 50ft
Well Depth: 375ft
Monitoring Period: 32 years (1980 - 2011)
Well Use: Domestic


Depth to Groundwater (ft)
D SWN: LMMW 1S
Groundwater Elevation (ft)
Ground Surface Elevation: 62ft
Well Depth: 75ft
Monitoring Period: 11 years (2001- 2011)
Well Use: Groundwater Monitoring


Depth to Groundwater (ft)
E SWN: 04S01W30E003
Groundwater Elevation (ft)
Ground Surface Elevation: 42ft
Well Depth: 650ft
Monitoring Period: 55 years (1956 - 2011)
Well Use: -not available-


Depth to Groundwater (ft)
F SWN: 07S01E07R013
Groundwater Elevation (ft)
Ground Surface Elevation: 105ft
Well Depth: 788ft
Monitoring Period: 94 years (1915- 2004)
Well Use: Municipal Water Supply

Flood Management

Major floods occur regularly in the Bay Region. The floods can be from creeks and rivers, local stormwater runoff, or from levee failures. Many streams in the region flood repeatedly, such as the Napa River, which has flooded Napa Valley several times causing widespread structural losses and agricultural damages. Floods can be flash floods or debris-flow floods and can inundate urban or coastal areas. Flood damage has been recorded in the region since 1861-1862 when the devastating Great Flood inundated large areas of the West Coast, including the San Francisco Bay Area. Refer to California's Flood Future Report, Attachment C: Flood History of California for a complete list of floods (http://www.water.ca.gov/sfmp/flood-future-report.cfm).

Flood Hazard Exposure

The Bay Region has more than 350,000 people who are exposed to flooding from a 100-year flood, and more than 1 million people who are exposed to flooding from a 500-year flood. The 500-year floodplain contains approximately 550,000 acres of land and 322,000 structures. The value of the exposed structures and public infrastructure in the 500-year floodplain is over $130 billion. The value of exposed crops is only $23.9 million. The majority of exposure is in Santa Clara County, which has more than 600,000 people and over $80 billion in assets in the 500-year floodplain. Figures SFB-16 and SFB-17 illustrate the 100- and 500-year flood zones, respectively.

A wide variety of projects and programs are implemented to reduce flood damages in the Bay Region. These include structural and non-structural measures and disaster preparedness, response, and recovery.

The region has 150 public agencies that manage floods with 2,588 miles of levees and 222 dams and weirs. Table SFB-11 lists some of these agencies and their functions. To alleviate flooding, 121 local projects are planned including several projects that address coastal flooding due to sea level rise, a major concern in this densely populated region. Refer to California's Flood Future Report, Attachment G: Risk Information Inventory for a complete list of the projects (http://www.water.ca.gov/sfmp/flood-future-report.cfm).

Sea Level Rise

One of the most publicized impacts of climate change is the predicted acceleration of sea level rise. Tidal observations in San Francisco Bay between 1900 and 2000 show that mean sea level has increased by 7 inches, but mean sea level is expected to increase by 17 to 66 inches by the end of this century.

Sea level rise will exacerbate coastal flooding during significant winter storms. Residential areas and infrastructure not previously at risk will experience flooding.

California's Flood Future Report (California Department of Water Resources 2013) recommends that communities evaluate and plan for the consequences of sea level rise — determine the most vulnerable areas to flooding, develop hazard mitigation and adaptation plans, and determine the impacts of waves and erosion. Coastal erosion tends to be episodic, with long-term cliff and bluff failure occurring during severe storm events. Scientists believe these events will increase in frequency and intensity. The California Coastal Commission maintains a valuable database that monitors coastal erosion. See “Climate Change” section later in this chapter for more discussion on sea level rise.

Flood Damage Reduction Measures

Structural Measures

Structural flood damage reduction measures in the Bay Region are generally local in scope rather than part of a large-scale flood protection system. Important structural measures in the region, such as reservoirs, levees, and channel improvements, protect life and property from the consequences of high water and debris flow.

Two reservoirs in the region have a designated flood protection function — Lake Del Valle and Cull Canyon Reservoir with 38,000 and 310 af of flood control capacity, respectively. Lake Del Valle is a SWP facility that protects Pleasanton, Fremont, Niles, and Union City. Alameda County FCWCD constructed Cull Canyon Reservoir to protect Castro Valley.

Operation of the reservoirs is not coordinated according to any formal agreement. Each reservoir is operated according to its flood control diagram, which dictates the required flood space reservation throughout the flood season. The required flood space reservation is dependent on the time of year, antecedent precipitation, and runoff forecasts. Maximum reservoir evacuation rates and objective releases also are maintained to limit downstream flooding when possible.

Many channel improvement projects in the region reduce stream flooding. These projects include channel construction, enlargement, realignment, lining, stabilization, and bank protection. U.S. Army Corps of Engineers (USACE) projects were built on Alameda Creek, San Lorenzo Creek, Walnut Creek, Corte Madera Creek, Coyote Creek, Berryessa Creek, Guadalupe River, Napa River, Wildcat and San Pablo creeks, Green Valley Creek, Pinole Creek, Rheem Creek, Rodeo Creek, San Leandro Creek, and on several streams near Fairfield.

Other projects in the region include bank protection on San Francisco Bay near Emeryville (USACE), a detention basin on Pine Creek above Concord (Contra Costa County FCWCD), sedimentation basins on Wildcat and San Pablo creeks near Richmond (Contra Costa County FCWCD), reservoirs and channel work on several tributaries of Walnut Creek in Diablo Valley (Contra Costa County FCWCD), channel improvements on lower Silver Creek in San Jose (SCVWD), channel stabilization on Cull Creek east of Castro Valley (Alameda County FCWCD), channel improvements on Conn and Tulucay creeks (Napa County FCWCD), and locally constructed and maintained levees at Suisun Marsh and throughout the region. Table SFB-12 shows important flood control facilities in the region.

Maintenance of flood control facilities is critical to preserving the integrity of the facilities and to upholding sustained public protection. Maintenance is made difficult by two factors — the lack of adequate financing and increasing environmental regulations. Adequate financing is hard to obtain as property taxes and other sources of revenue shrink. Heightened public awareness of the environment has led to a multitude of regulations and required permits, which complicates the maintenance of facilities and increases costs. Ironically, if maintenance is deferred, new habitat might become established and then need to be protected, making maintenance even more difficult. The SFBRWQCB is working with flood control entities in the region to minimize

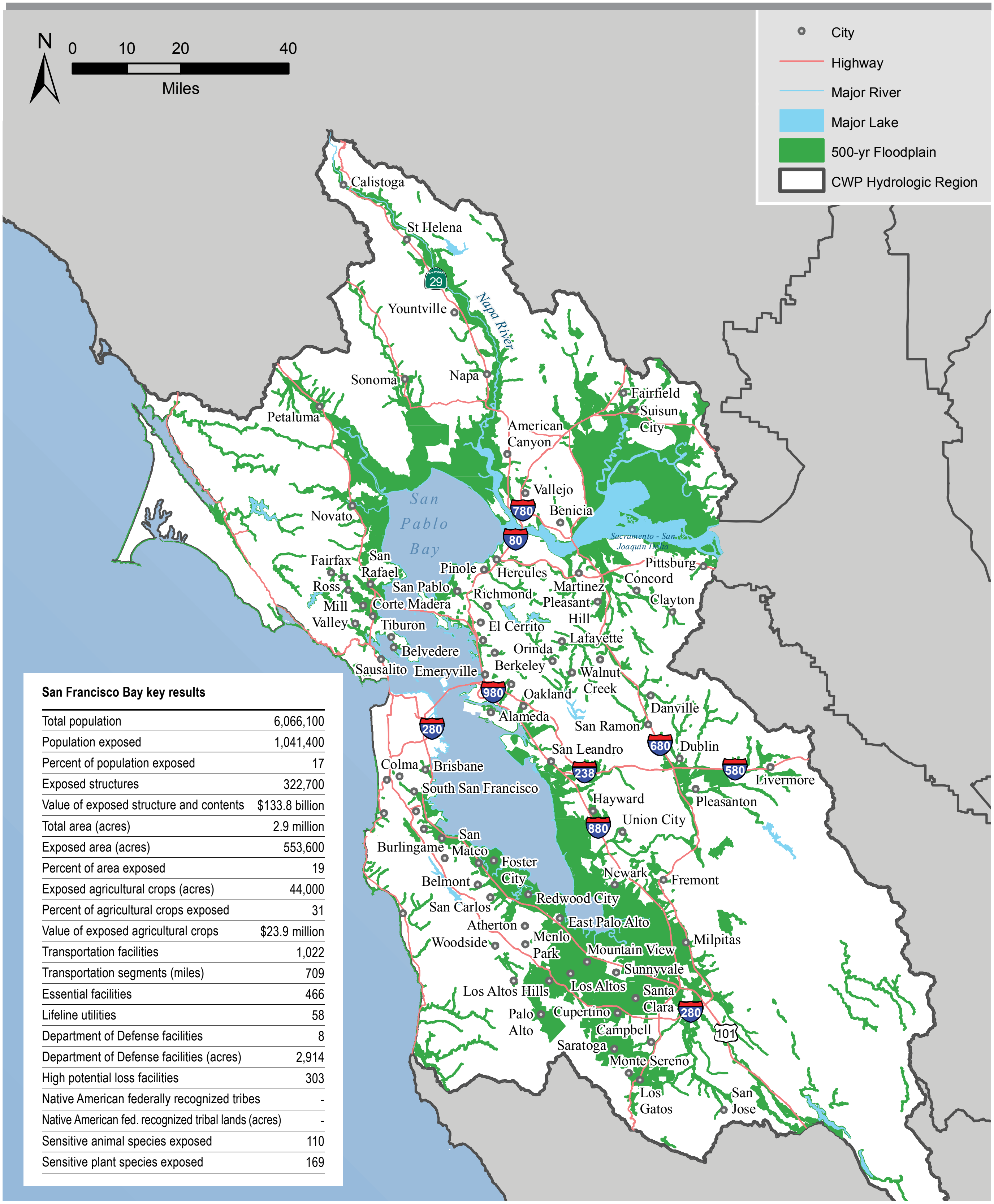
Figure SFB-16 San Francisco Bay — Statewide Flood Hazard Exposure to the 100-Year Floodplain

San Francisco Bay key results

Total population	6,066,100
Population exposed	355,000
Percent of population exposed	6
Exposed structures	109,800
Value of exposed structure and contents	$46.2 billion
Total area (acres)	2.9 million
Exposed area (acres)	446,000
Percent of area exposed	15
Exposed agricultural crops (acres)	33,300
Percent of agricultural crops exposed	23
Value of exposed agricultural crops	$17.3 million
Transportation facilities	560
Transportation segments (miles)	361
Essential facilities	140
Lifeline utilities	47
Department of Defense facilities	8
Department of Defense facilities (acres)	2,813
High potential loss facilities	168
Native American federally recognized tribes	-
Native American fed. recognized tribal lands (acres)	-
Sensitive animal species exposed	106
Sensitive plant species exposed	167

Source: California's Flood Future Report 2013

Figure SFB-17 San Francisco Bay — Statewide Flood Hazard Exposure to the 500-Year Floodplain



San Francisco Bay key results

Total population	6,066,100
Population exposed	1,041,400
Percent of population exposed	17
Exposed structures	322,700
Value of exposed structure and contents	$133.8 billion
Total area (acres)	2.9 million
Exposed area (acres)	553,600
Percent of area exposed	19
Exposed agricultural crops (acres)	44,000
Percent of agricultural crops exposed	31
Value of exposed agricultural crops	$23.9 million
Transportation facilities	1,022
Transportation segments (miles)	709
Essential facilities	466
Lifeline utilities	58
Department of Defense facilities	8
Department of Defense facilities (acres)	2,914
High potential loss facilities	303
Native American federally recognized tribes	-
Native American fed. recognized tribal lands (acres)	-
Sensitive animal species exposed	110
Sensitive plant species exposed	169

Source: California's Flood Future Report 2013

Table SFB-11 Flood Management Agencies, San Francisco Bay Hydrologic Region

	Structural Approaches						Land Use Management								Preparedness, Response, and Recovery										
	Flood Projects						Flood Plains			Flood Insurance			Reg-ulation		Data Management				Event Management						
	Financing	Development	Construction	Operation	Encroachment control	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated flood ways	Data collection	Hydrologic analysis	Data station maintenance	Flood education	Preparedness	Response management	Response personnel	System administration	Recovery funding	Recovery operations	Mitigation
FEDERAL AGENCIES																									
Federal Emergency Management Agency										x		x											x		x
National Weather Service															x	x	x	x	x	x	x				
Natural Resources Conservation Service	x	x	x															x							
U.S. Geological Survey															x	x	x								
U.S. Army Corps of Engineers	x	x	x	x	x	x									x	x	x	x	x	x	x		x	x	x
STATE AGENCIES																									
California Conservation Corps																				x	x				
Department of Corrections																					x				
Department of Forestry and Fire Protection																				x					
Department of Water Resources	x	x	x	x	x	x			x	x		x			x	x	x	x	x	x	x		x	x	
Office of Emergency Services																			x	x	x	x	x		x

	Structural Approaches						Land Use Management								Preparedness, Response, and Recovery										
	Flood Projects						Flood Plains			Flood Insurance			Reg-ulation		Data Management				Event Management						
	Financing	Development	Construction	Operation	Encroachment control	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated flood ways	Data collection	Hydrologic analysis	Data station maintenance	Flood education	Preparedness	Response management	Response personnel	System administration	Recovery funding	Recovery operations	Mitigation
LOCAL AGENCIES																									
County and city emergency services units																			x	x	x				
County and city planning departments														x											
County and city building departments													x												
Local conservation corps																				x	x				
Local initial responders to emergencies																			x	x	x				
Alameda County FCWCD	x	x			x	x																			
Contra Costa County FCWCD	x	x			x	x									x	x	x								
Marin County FCWCD	x	x			x	x									x		x								
Napa County FCWCD	x	x	x	x	x	x																			

	Structural Approaches						Land Use Management								Preparedness, Response, and Recovery										
	Flood Projects						Flood Plains			Flood Insurance			Reg-ulation		Data Management				Event Management						
	Financing	Development	Construction	Operation	Encroachment control	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated flood ways	Data collection	Hydrologic analysis	Data station maintenance	Flood education	Preparedness	Response management	Response personnel	System administration	Recovery funding	Recovery operations	Mitigation
San Francisco Department of Public Works																		x	x						
San Francisquito Creek Joint Powers Authority	x	x																							
San Mateo County Flood Control District	x																								
Santa Clara Valley Water Agency	x	x	x	x	x	x	x	x			x				x		x	x	x	x	x				
Sonoma County Water Agency	x	x	x	x	x	x												x							
Zone 7 Water Agency	x	x	x	x	x	x												x							

Note: FCWCD = Flood Control and Water Conservation District deferred maintenance by helping to establish long-term integrated county permits for stream and flood channel maintenance.

County flood control districts, such as Alameda County FCWCD and Napa County FCWCD, maintain many of the flood control facilities in the region, including USACE-constructed facilities. DWR maintains Lake Del Valle, which is part of the SBA (SWP).

Non-Structural Measures

1. **Floodplain Regulation.** All counties in the Bay Region have ordinances regulating floodplain development and floodplain management, typically as part of their general plans. A number of cities have additional ordinances that further restrict development in areas susceptible to flooding. Floodplain management regulations must be adopted, such as designating 100-year floodways to reduce potential flood damages and to qualify a community for FEMA flood insurance. Officially designated floodways in the region include Cull, Crow Canyon, Alameda, and Arroyo de la Laguna creeks in Alameda County; the Napa River in Napa County; Sonoma and San Antonio creeks in Sonoma County; and Novato Creek in Marin County.

2. **Flood Insurance.** FEMA administers the National Flood Insurance Program (NFIP), which enables property owners in participating communities to purchase insurance as protection against flood losses. About 97 percent of California communities participate in the NFIP. Of those, approximately 12 percent participate in the Community Rating System (CRS) Program, which encourages communities to go beyond minimum NFIP requirements in return for reduced insurance rates.

   CRS rates communities from 1 to 10 on the effectiveness of flood protection activities. The lower ratings bring larger discounts on flood insurance. In the Bay Region, 4 of the 9 counties and 20 cities participate in CRS. As of May 2009, Contra Costa County, Milpitas, and Petaluma are in CRS Class 6; Alameda County, Solano County, Fremont, Palo Alto, San Jose, Sunnyvale, and Walnut Creek are in CRS Class 7; Concord, Corte Madera, Cupertino, Los Altos, Mountain View, Napa, Novato, Pleasant Hill, Pleasanton, San Leandro, San Ramon, and Santa Clara are in CRS Class 8; Richmond is in CRS Class 9; and Santa Clara County is in CRS Class 10. See http://www.fema.gov/business/nfip/crs.shtm for more information on the CRS system.

   Quality mapping is critical to administering an effective flood insurance program, which includes developing accurate hydrologic and hydraulic modeling to delineate floodplain boundaries. FEMA has developed Flood Insurance Rate Maps (FIRMs) for all counties in the Bay Region. The FIRMs were updated in 2008, except for the San Francisco County FIRM which was updated in 2007.

3. **Disaster Preparedness, Response, and Recovery.** The Federal Disaster Mitigation Act of 2000 emphasizes pre-disaster mitigation and mitigation planning. In order to receive federal hazard mitigation funds, all local jurisdictions must adopt a hazard mitigation plan and provide technical support for executing the plan. A hazard mitigation plan identifies hazards, risks, and mitigation actions and their priorities. Alameda, Contra Costa, San Mateo, Santa Clara, and Solano counties have annexed the Association of Bay Area Governments (ABAG) Multi-Jurisdictional Hazard Mitigation Plan; but Marin, Napa, San Francisco, and Sonoma

Table SFB-12 Flood Control Facilities, San Francisco Bay Hydrologic Region

Facility	Stream	Owner (Sponsor)	Description	Protects
RESERVOIRS AND LAKES				
Lake Del Valle	Arroyo Valle	DWR	38 taf flood control	Pleasanton, Fremont, Niles, Union City
Cull Canyon	Cull Cr.	Alameda County FCWCD (NRCS)	310 af flood control	Castro Valley
NON-STORAGE FLOOD CONTROL FACILITIES				
Alameda Cr.	Alameda Cr.	USACE	Channel improvement	Livermore Valley, Niles Canyon, coastal plain
Emeryville Marina —Point Park	San Francisco Bay	USACE	Bank protection	Emeryville
Fairfield Streams	Ledgewood Cr., Laurel Cr., McCoy Cr., Pennsylvania Ave. Cr., Union Ave. Cr.	USACE	Channel enlargement, creek diversion	Fairfield and vicinity
San Lorenzo Cr.	San Lorenzo Cr.	USACE	Levees, concrete channel	San Lorenzo, Hayward
Walnut Cr.	Walnut Cr., San Ramon Cr., Grayson Cr., Pacheco Cr., Pine Cr., Galindo Cr.	USACE	Levees, channel stabilization, channel improvement	Walnut Creek, Concord, Pacheco, Vine Hill, Pleasant Hill
Corte Madera Cr.	Corte Madera Cr. and tributaries	USACE (Marin County FCWCD)	Channel improvement	San Anselmo, Ross, Kentfield, Larkspur, Corte Madera, Greenbrae, Fairfax
Novato Cr.	Novato Cr., Warner Cr., Avichi Cr.	Marin County FCWCD	Channel improvement	Novato
Coyote and Berryessa Crs.	Coyote Cr. (Santa Clara County), Berryessa Cr.	USACE (Santa Clara Valley WD)	Channel improvement	Alviso, Milpitas, San Jose
Guadalupe River	Guadalupe River	USACE (Santa Clara Valley WD)	Channel improvement, bypass tunnel	San Jose
NON-STORAGE FLOOD CONTROL FACILITIES				
San Francisquito Cr.	San Francisquito Cr.	San Francisquito Creek JPA	Levee restoration	East Palo Alto, Menlo Park

Facility	Stream	Owner (Sponsor)	Description	Protects
NON-STORAGE FLOOD CONTROL FACILITIES				
Napa River Basin	Napa R., Napa Cr.	USACE (Napa County FCWCD)	Levees, floodwalls, bypass, channel improvements	Napa, St. Helena
Petaluma River	Petaluma River	Sonoma County WA	Floodwalls	Petaluma
Wildcat and San Pablo Crs.	Wildcat Cr., San Pablo Cr.	USACE (Contra Costa County FCWCD)	Levees, channel, channel improvements, sedimentation basins	San Pablo, Richmond
Coyote Cr.	Coyote Cr. (Marin County)	USACE	Lined and unlined channels	Tamalpais Valley
Green Valley Cr.	Green Valley Cr., Dan Wilson Cr.	USACE	Realigned and enlarged channel	Agricultural and urbanizing lands north of Suisun Bay
Pinole Cr.	Pinole Cr.	USACE	Unlined channel	Pinole
Rheem Cr.	Rheem Cr.	USACE	Lined and unlined channels	San Pablo
Rodeo Cr.	Rodeo Cr.	USACE	Lined and unlined channels	Rodeo
San Leandro Cr.	San Leandro Cr.	USACE	Lined and unlined channels	Oakland, San Leandro
Lower Pine Cr.	Pine Creek	Contra Costa FCWCD (NRCS)	Detention basin	Concord
Napa River	Napa River	Napa County FCWCD (NRCS)	Contributions to Napa River Basin Project	Napa, St. Helena
Lower Silver Cr.	Silver Cr.	Santa Clara Valley WD (NRCS)	Channel improvement	San Jose

Notes: af = acre-feet, taf = thousand acre-feet, Cr. = creek, FCWCD = Flood Control and Water Conservation District, JPA = Joint Powers Authority, NRCS = Natural Resources Conservation Service, USACE = U.S. Army Crops of Engineers, WA= water agency, WD= water district

counties have adopted their own plans. All plans have received California Emergency Management Agency (Cal EMA) approval.

Many agencies in the Bay Region have some level of flood planning. The City of Napa has a system of road closures based on the stage of the Napa River, which reduces the risk to individuals and property in the event of flooding. The Contra Costa Resource Conservation District has a watershed management plan for Alhambra Creek, which discusses a myriad of options to reduce the risk of flooding in Martinez and surrounding areas. The Bay Area Flood Protection Agencies Association (BAFPAA) is a consortium of flood control and water agencies in the region that provides a forum for discussing flood issues, collaborating on multi-agency projects, and sharing resources.

Accurate hydrologic and hydraulic models are needed to provide valuable river flow and stage forecasts that alert flood emergency personnel where flood fighting might be necessary. The National Weather Service (NWS) has an Advanced Hydrologic Prediction Service (AHPS) that forecasts weather and river flows and stages. Its California-Nevada River Forecast Center provides forecasts at four locations in the Bay Region — Coyote Creek at Coyote Reservoir, Los Gatos Creek at Lexington Reservoir, Napa River at Saint Helena, and Napa River at Napa.

Water Governance

Water governance in the Bay Region consists of a diverse body of water supply, wastewater management, flood protection, and land use agencies. The water supply agencies have a history of working together on water resource management issues through the Bay Area Water Agencies Coalition (BAWAC). BAWAC enables the agencies to capitalize on collective resources, expertise, and knowledge to achieve water quality and water supply reliability goals.

The wastewater management agencies in the region, including cities, sanitation districts, community services districts, counties, and other local agencies, also recognize the value in regional cooperation and collaboration as a means of advancing shared interests and resolving common issues. Many wastewater agencies are represented by BAWAC, which has a long history of providing a forum for coordination on regional wastewater management issues.

Bay Region flood protection agencies have a history of working together on water resource management issues through BAFPAA. The association promotes the sharing of ideas, technologies, experiences, legislative approaches, and funding strategies. It also provides a forum for regional coordination and collaboration with State and federal regulatory and resource agencies. BAFPAA has nine agencies as signatories — Alameda, Contra Costa, Marin, Napa, and San Mateo County FCWCD; SCVWD; and Solano County, Sonoma County, and Zone 7 water agencies. These Bay Area agencies also coordinate their stormwater policies and projects through the Bay Area Stormwater Management Agencies Association (BASMAA).

Land use planning in the Bay Region typically takes place through local city and county governments as well as through ABAG, the Metropolitan Transportation Commission (MTC), and the Joint Policy Committee (JPC). As the primary regional land use planning agency, ABAG represents nearly all of the region's population. It strives to enhance cooperation and coordination between local governments to reach regional planning goals. MTC is the Metropolitan Planning Organization (MPO) for federal transportation purposes and is the transportation planning, coordinating, and financing agency for Bay Area Rapid Transit (BART) and other major regional transit systems. JPC coordinates the regional planning efforts of ABAG, the Bay Area Air Quality Management District (BAAQMD), BCDC, and MTC; and pursues implementation of the region's Smart Growth Vision. Table SFB-13 and Box SFB-2 list many of the agencies and planning organizations that govern water management in the region.

DWR has accepted two Bay Region IRWM groups. Figure SFB-18 shows the two groups — the San Francisco Bay Area IRWM group and the East Contra Costa County IRWM group. The Bay Area group conducts the majority of IRWM planning in the region. The East Contra Costa County group primarily conducts IRWM planning for Eastern Contra Costa County, but a small portion of the group is within the Bay Region boundary. These groups develop and implement IRWM plans, which are living documents that change as planning efforts mature, opportunities for collaboration and partnership are discovered, and State guidance is refined further. The water

Table SFB-13 Water Management Agencies, San Francisco Bay Hydrologic Region

Federal
U.S. Bureau of Reclamation, Federal Energy Regulatory Commission, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife Service
State
California Department of Water Resources, State Water Resources Control Board, San Francisco Bay Regional Water Quality Control Board, California Department of Public Health, California Division of Safety of Dams, California Department of Fish and Wildlife, State Coastal Conservancy, California Environmental Protection Agency, Bay Conservation and Development Commission
Local
WATER SUPPLY
Alameda County Water District, Contra Costa Water District, East Bay Municipal Utility District, Marin Municipal Water District, City of Napa, San Francisco Public Utilities Commission, Santa Clara Valley Water District, Solano County Water Agency, Sonoma County Water Agency, Zone 7 Water Agency, Hetch Hetchy Water and Power
WASTEWATER MANAGEMENT
Fairfield-Suisun Sewer District, Napa Sanitation District, North San Mateo Sanitation District, Novato Sanitary District, San Mateo County, Sausalito/Marin City Sanitary District, Sewage Agency of Southern Marin, Stege Sanitary District, Town of Yountville, Vallejo Sanitation & Flood Control District, West Bay Sanitary District, South Bay Water Recycling, City of Palo Alto, City of Sunnyvale

management priorities and stakeholder relationships of each group are unique, and they are committed to meeting regional water needs. The diverse stakeholder groups recognize that more regional or subregional collaboration is needed.

San Francisco Bay Area IRWM Group

The San Francisco Bay Area IRWM Group has developed important water management information to update its IRWM plan, which was an important resource for this San Francisco Bay Regional Report. The IRWM plan addresses 16 IRWM plan standards, including resource management strategies and climate change, which are discussed in "Looking to the Future" section later in this chapter.

The San Francisco Bay Area IRWM Group was formed through a collaborative process beginning in 2004. The original group participants include:

- Alameda County Water District.
- Association of Bay Area Governments.
- Bay Area Clean Water Agencies.
- Bay Area Water Supply and Conservation Agency.
- Contra Costa County Flood Control and Water Conservation District.

Box SFB-2 Planning Organizations, San Francisco Bay Hydrologic Region

Bay Area/North Coast/Central Coast Water Quality and Sustainability Work Group. This workgroup was formed to identify and describe the connections between water quality and climate change on the coast from central California to the Oregon border, as well as recommend actions in the water quality arena that can help reduce greenhouse gases or help solve climate change problems.

Bay Area Water Supply and Conservation Agency (BAWSCA). BAWSCA represents the interests of 26 cities and water districts and two private utilities that purchase wholesale water from the San Francisco Public Utilities Commission (SFPUC) regional water system. BAWSCA's goals are to ensure high quality, reliable water supply for the 1.7 million people residing in Alameda, Santa Clara, and San Mateo counties who depend on the SFPUC regional water system (Web site: www.bawsca.org).

Association of Bay Area Governments (ABAG). Formed in 1961, ABAG is the official comprehensive planning agency for the Bay Region. ABAG's mission is to strengthen cooperation and coordination among local governments in order to address social, environmental, and economic issues that transcend local borders (Web site: www.ABAG.ca.gov).

Bay Area Water Agencies Coalition (BAWAC). The coalition was 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. This coalition of eight water agencies was created in 2003 to advance local and regional efforts to use desalination or salinity management technologies that reduce salinity problems and improve water supply reliability for member agencies.

Bay Area Clean Water Agencies (BACWA). Founded in 1984, BACWA is an association composed of local governmental agencies that own and operate treatment works that discharge into the San Francisco Bay Estuary. BACWA's members serve more than 6 million people in the Bay Area, treating all domestic and commercial wastewater and a significant volume of industrial wastewater (Web site: www.bacwa.org).

Bay Planning Coalition (BPC). Established in 1983, the BPC is a nonprofit, membership-based organization representing the maritime industry and related shoreline business; ports and local governments; landowners; recreational users; environmental and business organizations; and professional service firms in engineering, construction, law, planning, and environmental sciences (Web site: www.bayplanningcoalition.org).

Bay Area Flood Protection Agencies Association (BAFPAA). Established in 2006 as an outgrowth of the Bay Area integrated regional water management process, membership in BAFPAA includes Bay Area counties and special districts with responsibility for flood protection and stormwater management.

San Francisco Bay Area Integrated Regional Water Management Group. The Bay Area IRWM Group is an important regional water resources planning organization. It outlines the region's water resources management needs and objectives and presents innovative strategies and a detailed implementation plan to achieve the objectives (Web site: www.bairwmp.org).

Bay Area Watershed Network (BAWN). The network was organized in 2006 to bring together a wide variety of agencies, technical experts, and nongovernmental organizations (NGOs) with diverse expertise to work on proposals and activities involving watershed management, planning, and restoration. Smaller teams work on policy, coordination with the IRWM process, assessment and monitoring tools, and education and outreach activities (Meeting information at www.sfbayjv.org).

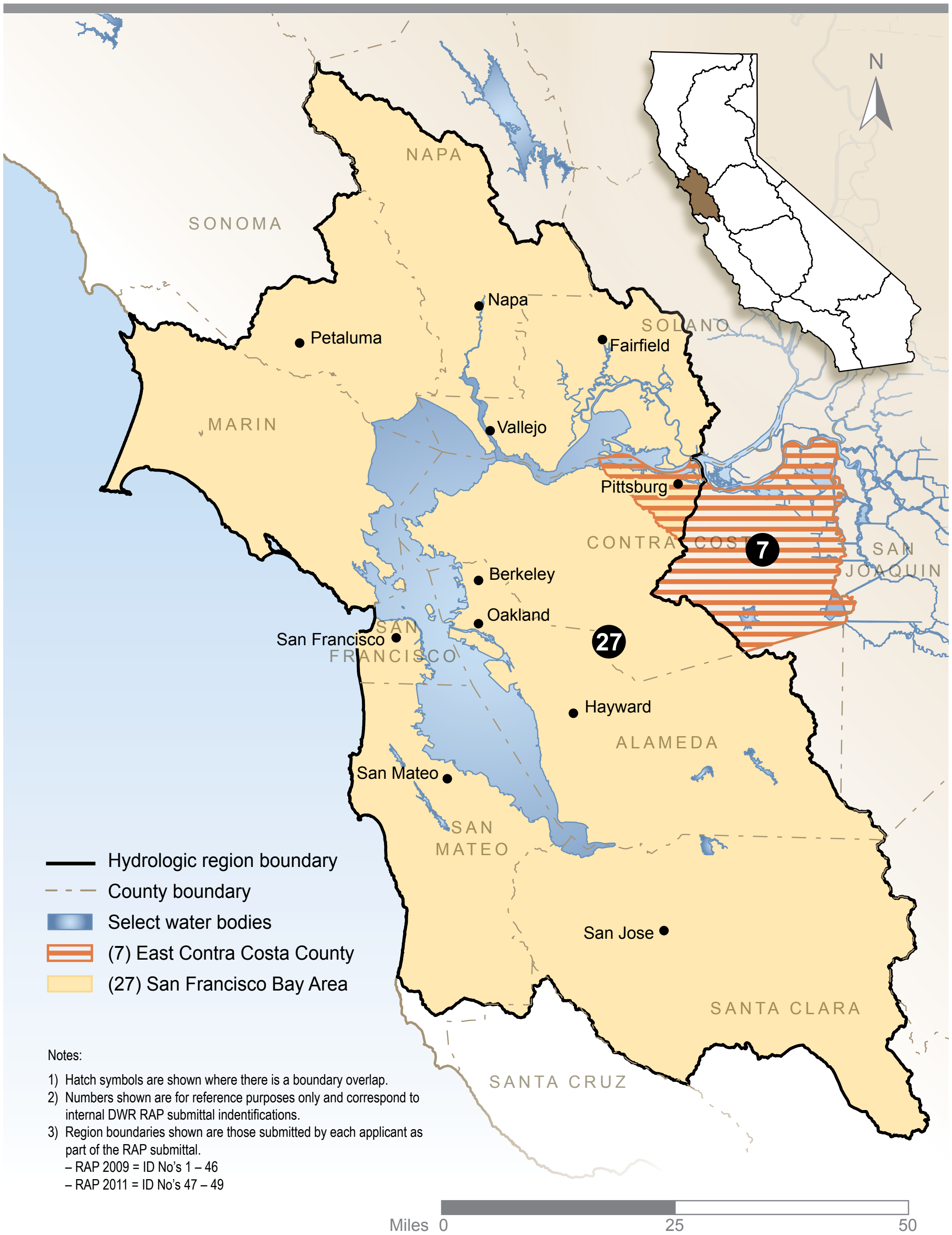
Metropolitan Transportation Commission (MTC). MTC is the transportation planning, coordinating, and financing agency for Bay Area Rapid Transit (BART) and other major regional transit systems.

Joint Policy Committee (JPC). JPC coordinates the regional planning efforts of ABAG, the Bay Area Air Quality Management District (BAAQMD), Bay Conservation and Development Commission, and MTC and pursues implementation of the Bay Region's Smart Growth Vision.

Bay Area Stormwater Management Agencies Association (BASMAA). BASMAA was started by local governments in response to the National Pollutant Discharge Elimination System (NPDES) permitting program. It promotes a regional consistency to improving the quality of stormwater runoff into the San Francisco Bay and Delta. BASMAA encourages cooperation and information-sharing to develop cost-effective regional products and programs.

San Francisco Estuary Partnership (SFEP). SFEP is a coalition of resource agencies, nonprofits, citizens, and scientists working to protect, restore, and enhance water quality and fish and wildlife habitat in and around the San Francisco Bay Delta Estuary.

Figure SFB-18 Integrated Regional Water Management Groups in the San Francisco Bay Hydrologic Region



- Contra Costa Water District.
- East Bay Municipal Utility District.
- Marin Municipal Water District.
- City of Napa.
- North Bay Watershed Association.
- City of Palo Alto.
- San Francisco Public Utilities Commission.
- City of San Jose
- Santa Clara Basin Watershed Management Initiative.
- Santa Clara Valley Water District.
- Solano County Water Agency.
- Sonoma County Water Agency.
- Sonoma Valley County Sanitation District.
- State Coastal Conservancy.
- Zone 7 Water Agency.

The group is organized into four Functional Areas:

1. Water Supply & Water Quality.
2. Wastewater & Recycled Water.
3. Flood Protection & Stormwater Management.
4. Watershed Management & Habitat Protection and Restoration.

Representatives from agencies that were active in the Functional Areas formed a Coordinating Committee (CC), which serves as the governing body of the group and provides oversight for updating the IRWM plan. The CC now includes representatives from Bay Area water supply agencies, wastewater agencies, flood control agencies, ecosystem management and restoration agencies, regulatory agencies, nongovernmental organizations, and members of the public.

The CC provides opportunities for all stakeholders and interested parties to participate in the San Francisco Bay Area IRWM Group and its update to the IRWM plan. Stakeholders include water supply agencies; recycled water and wastewater agencies; stormwater and flood control agencies; utilities, watershed and habitat conservation groups; regulatory agencies; DACs; Native Americans; environmental justice groups and communities; industrial and agricultural organizations; park districts; educational institutions; well owners; developers and landowners; elected representatives; adjacent IRWM groups; municipalities and local governments; and State and federal agencies.

The CC has developed east, west, south, and north subregion groups because integrated water management throughout the Bay Region is challenging and can be more effective by dividing the region based on demographics and geography. The subregion groups provide stakeholder outreach and project solicitation for integration into the IRWM plan.

The CC also has established four subcommittees to accomplish specific tasks for the San Francisco Bay Area IRWM Group. These subcommittees include:

1. The Plan Update Team (PUT), which is the primary work group for the IRWM plan update.
2. The Project Screening Subcommittee, which works with the subregion groups to obtain project proposals, reviews the proposals to ensure that they are in accordance with DWR guidelines, and identifies synergies and encourages collaboration.
3. The Website and Data Management Subcommittee, which ensures that the Web site is a reasonable communication and information tool for CC members and stakeholders, and ensures that data are consistent with State requirements.
4. The Planning and Process Subcommittee, which analyzes issues and performs specific work tasks as needed, and recommends potential actions to the CC.

Through its subregions, the CC has solicited stakeholders for potential projects that support DWR's IRWM Guidelines and the goals and objectives of the Bay Area IRWM Plan. A list of over 330 potential projects was compiled in 2013, including over 120 projects proposed to benefit DACs. The projects were reviewed and scored according to a sophisticated scoring methodology that assigns projects into one of three tiers. The 50 highest scoring projects were placed in the top tier and are a priority to construct. The San Francisco Bay Area IRWM Group is proposing to implement 19 of these projects soon with the help of $20 million in Proposition 84 Implementation Grant funding. See Table SFB-16 for more information on the 19 projects. Also see http://bairwmp.org/projects for full descriptions and scores of all of the potential projects.

The CC has achieved consensus on all issues requiring a decision. However, if the CC is not able to reach consensus on an issue, then a vote may be taken. Twelve members vote — three members from each of the four Functional Areas.

Groundwater Governance

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

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

Groundwater Management Assessment

Table SFB-14 lists some GWMPs in the region, while Figure SFB-19 shows the location and distribution of the GWMPs. GWMPs prepared in accordance with the 1992 AB 3030 legislation, as well as those prepared with the additional required components listed in the 2002 SB 1938

Table SFB-14 Groundwater Management Plans in the San Francisco Bay Hydrologic Region

Map Label	Agency Name	Date	County	Basin Number	Basin Name
SF-1	Santa Clara Valley Water District No signatories required	2012	Santa Clara	2-9.02	Santa Clara Subbasin
SF-2	Sonoma County	2007	Sonoma	2-2.02	Sonoma Valley Subbasin
	City of Sonoma			2-19	Kenwood Valley
	Valley of the Moon Water District				
SF-3	Zone 7 Water Agency	2005	Alameda	2-10	Livermore Valley
	No signatories on file		Contra Costa	2-7	San Ramon Valley
SR-27	Solano Irrigation District	2006	Solano	5-21.66	Solano Subbasin
	No signatories on file			2-3	Suisun-Fairfield Valley
					Non-B118 Basin

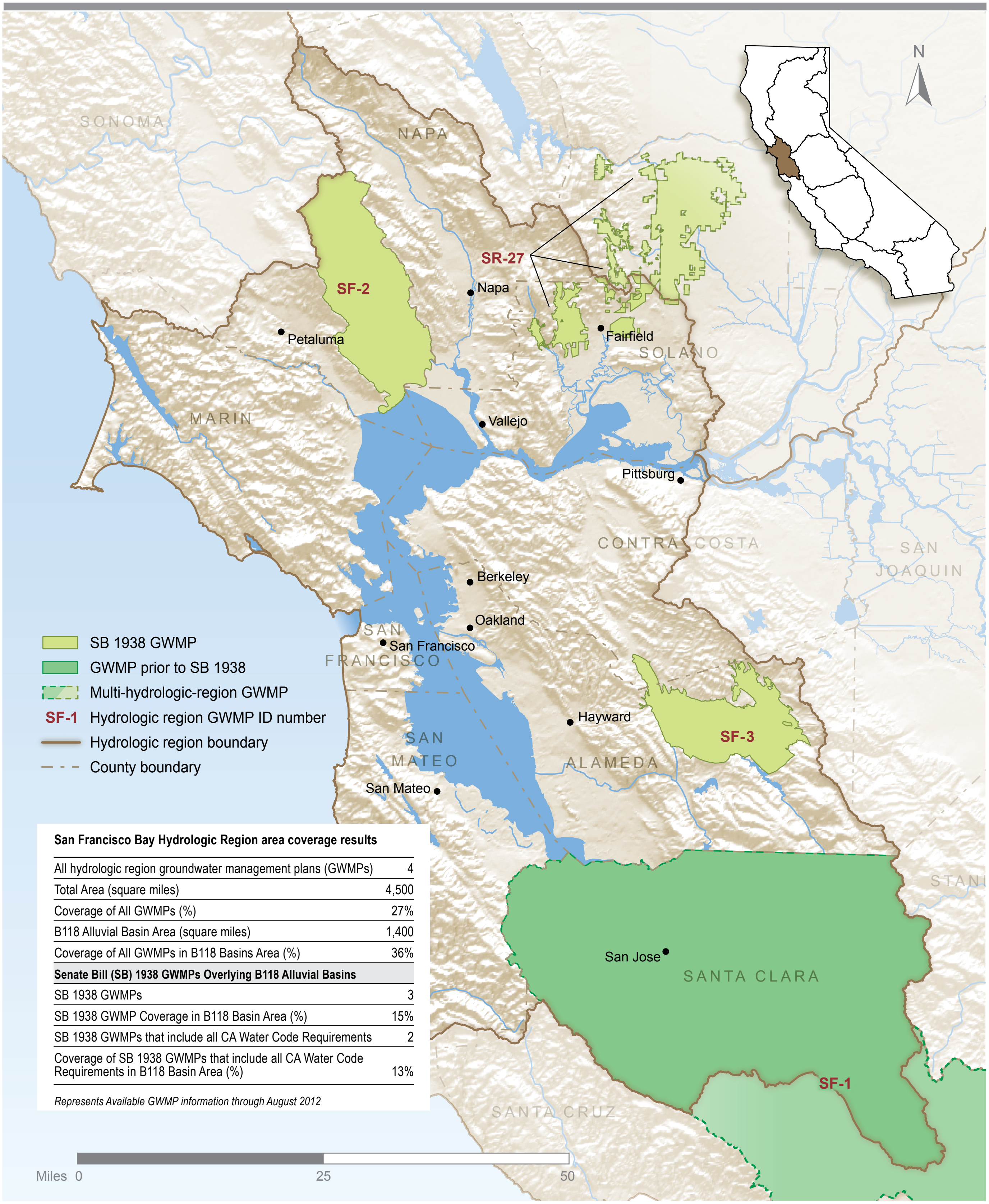
Note: Table represents information as of August, 2012.

legislation are shown. Some GWMPs were not reviewed as part of Update 2013 because they were received after the initial assessment period. These include South Westside Basin GWMP (2012) by the City of San Bruno, SCVWD GWMP (2012), and South East Bay Plain GWMP (2013) by EBMUD.

The GWMP inventory shows four GWMPs in the Bay Region, three of which are fully contained in the region. The other plan includes portions of the adjacent Sacramento River Hydrologic Region. Three GWMPs were developed or modified to include SB 1938 requirements and are considered active.

CWC Section 10753.7 requires that six components be included in a GWMP for an agency's groundwater projects to be eligible for State funding, which DWR administers. The requirement of the 2011 AB 359 (Huffman) legislation applicable to groundwater recharge mapping and reporting did not take effect until January 2013 and was not included in the assessment. Also, the

Figure SFB-19 Location of Groundwater Management Plans in the San Francisco Bay Hydrologic Region



San Francisco Bay Hydrologic Region area coverage results

All hydrologic region groundwater management plans (GWMPs)	4
Total Area (square miles)	4,500
Coverage of All GWMPs (%)	27%
B118 Alluvial Basin Area (square miles)	1,400
Coverage of All GWMPs in B118 Basins Area (%)	36%
Senate Bill (SB) 1938 GWMPs Overlying B118 Alluvial Basins	
SB 1938 GWMPs	3
SB 1938 GWMP Coverage in B118 Basin Area (%)	15%
SB 1938 GWMPs that include all CA Water Code Requirements	2
Coverage of SB 1938 GWMPs that include all CA Water Code Requirements in B118 Basin Area (%)	13%

Represents Available GWMP information through August 2012 requirement for local agencies outside of recognized groundwater basins was not applicable to any of the GWMPs in the region.

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

As a result, the GWMP assessment uses the following criteria:

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

A summary of the GWMP assessment is provided in Table SFB-15.

Factors Contributing to Success and Impediments to Groundwater Management

The survey participants were also asked to identify key factors that promoted or impeded successful groundwater management. Four survey respondents identified several key factors that contributed to the successful implementation of a GWMP. These include data collection and sharing; developing an understanding of common interest; sharing ideas and information; broad stakeholder participation; outreach and education; and having adequate surface water supplies, local and regional surface storage and conveyance, water budgets, funding, and time. State funding for groundwater planning efforts and coordination with land use agencies were also listed as contributing factors to successful implementation of a GWMP.

Three survey respondents pointed to a lack of adequate funding as an impediment to GWMP implementation. Funding is challenging for many agencies because the implementation and the operation of groundwater management projects are generally expensive and because funding typically is limited to locally raised money or to State and federal grants. Other impediments to GWMP implementation include unregulated groundwater pumping, limited participation across a broad distribution of interests, and inadequate surface storage and conveyance capacity.

All the respondents felt long-term sustainability of their groundwater supply was possible.

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

Groundwater Ordinances

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

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

Special Act Districts

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

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

Court Adjudication of Groundwater Rights

Another form of groundwater management in California is through the courts. The Bay Region does not contain any of the 24 groundwater adjudications in California.

Other Groundwater Management Planning Efforts

Groundwater management also occurs through other avenues such as IRWM plans, urban water management plans, and agricultural water management plans. Box SFB-3 summarizes groundwater management aspects included in these planning efforts.

State Funding Received

The Bay Region has received millions of dollars in State funding to implement IRWM projects since California Water Plan Update 2009. This funding includes Proposition 84 and Proposition 1E grant funding. Some noteworthy IRWM projects receiving these funds include:

Proposition 84

- **Mokelumne Aqueduct Interconnection Project (EBMUD; $10,000,000 Interregional Grant).** This project improves the reliability of the Mokelumne Aqueducts by interconnecting them on both sides of the Delta. The interconnections maximize transmission capacity should one or two of the aqueducts be damaged by earthquake or flood in the Delta. Surviving portions of the aqueducts could convey water after a major event until repairs could be made. A 10-mile above-ground portion of the aqueducts is especially vulnerable to damage in the Delta.
- **Bay Area Regional Priority Projects (BACWA; $30,093,592 Implementation Grant).** This consortium of projects incorporates a wide range of water management elements and addresses all of the regional objectives set forth in the Bay Area IRWM Plan. The 23 projects consist of 3 green infrastructure projects, 7 recycled water projects, 3 wetland ecosystem restoration projects, a regional water conservation project, and 9 integrated projects in DACs (water quality, flood management, ecosystem restoration).

Table SFB-15 Assessment for SB 1938 GWMP Required Components, SB 1938 GWMP Voluntary Components, and Bulletin 118-2003 Recommended Components

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

SB 1938 GWMP Required Components	Percent of Plans that Meet Requirement
Well Construction Policies	100
Construction and Operation	67
Regulatory Agencies	100
Land Use	67
Bulletin 118-2003 Recommended Components	**Percent of Plans that Include Component**
GWMP Guidance	67
Management Area	100
BMOs, Goals, and Actions	67
Monitoring Plan Description	67
IRWM Planning	67
GWMP Implementation	67
GWMP Evaluation	67

Notes:

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

Proposition 1E

- **Phoenix Lake IRWM Retrofit (Marin County FCWCD; $7,661,000 Stormwater Flood Management Grant).** This project helps provide 100-year flood protection in Ross Valley, improves aquatic conditions for anadromous salmonids, and enhances public enjoyment of Phoenix Lake.
- **San Francisco Stormwater and Flood Management Priority Projects (SFPUC; $24,147,000 Stormwater Flood Management Grant).** These projects are the Sunnydale Flood and Stormwater Management Sewer Improvement Project and the Cesar Chavez Street Flood and Stormwater Management Sewer Improvement Project. The projects improve San Francisco's aging combined sewer system by replacing and installing new sewer lines, which reduces flood damages and improves water quality by increasing the volume of flow receiving secondary treatment before being discharged into San Francisco Bay.
- **Lower Silver Creek and Lake Cunningham Flood Protection Project (SCVWD; $25,000,000 Stormwater Flood Management Grant).** This project consists of channel improvements and modifications at Lake Cunningham to remove 3,800 homes along Lower Silver Creek from the 100-year floodplain. Other project benefits include fewer channel bank failures, enhanced habitat and vegetation, enhanced fish passage, improved water quality, and new recreational amenities for low-income and minority neighborhoods.

Box SFB-3 Other Groundwater Management Planning in the San Francisco Bay Hydrologic Region

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

Integrated Regional Water Management Plans

There is one IRWM region that covers the entire San Francisco Bay Hydrologic Region. The Bay Area IRWM Region was approved in 2009 through the Region Acceptance Process (California Department of Water Resources) to maximize opportunities to integrate local water management activities and promote partnerships and multi-objective projects that benefit local communities and the natural environment (http://bairwmp.org/). The five overarching goals of the Bay Area IRWM Plan (2013) are to promote environmental, economic and social sustainability; improve water supply reliability and quality; protect and improve watershed health and function and Bay water quality; improve regional flood management; and create, protect, enhance, and maintain environmental resources and habitats.

Urban Water Management Plans

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

Agricultural Water Management Plans

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

- **San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project, East Bayshore Road to San Francisco Bay (San Francisquito Creek Joint Powers Authority (JPA); $8,000,000 Stormwater Flood Management Grant).** This project protects more than 1,100 properties from creek flooding when a 100-year flood occurs coincident with a 100-year tide and 26 inches of projected sea level rise.

Local Investment

Bay Region water agencies must contribute matching funds to the Proposition 84 and Proposition 1E projects listed above. These matching funds are:

- Mokelumne Aqueduct Interconnection Project (EBMUD; $2,000,000).
- Bay Area Regional Priority Projects (BACWA; $85,310,000).
- Phoenix Lake IRWM Retrofit (Marin County FCWCD; $6,089,000).
- San Francisco Stormwater and Flood Management Priority Projects (SFPUC; $43,757,500).

- Lower Silver Creek and Lake Cunningham Flood Protection Project (SCVWD; $29,992,397).
- San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project, East Bayshore Road to San Francisco Bay (San Francisquito Creek JPA; $8,700,000).

Relationships with Other Regions

The Bay Region is a major importer of water supplies from other regions of California, as shown previously with Table SFB-6. The North Bay imports water from several sources including the Russian and Eel rivers, Putah Creek, the NBA (SWP), and Vallejo Permit Water. SCWA delivers water from the Russian River (North Coast Hydrologic Region) to Sonoma and Marin counties through the Petaluma and Sonoma aqueducts. The Russian River includes water that is diverted from the Eel River via the Potter Valley Project, which now diverts significantly less water following Federal Energy Regulation Commission relicensing.

The SWP delivers water through the NBA to Solano County Water Agency and Napa County FCWCD. The NBA extends more than 27 miles from Barker Slough to the Napa Turnout in southern Napa County. The maximum SWP entitlement is 67 taf annually. Solano County Water Agency also gets water from Putah Creek (Lake Berryessa) via the Putah South Canal, a major component of USBR's Solano Project. The project began operating in 1959 and delivers a dependable annual supply of 207 taf, much of which is for agricultural users in the Sacramento River Region.

The City of Vallejo obtained a water right during World War II to divert Sacramento River water from Cache Slough to supply the city and for national defense needs. The aging diversion facilities became increasingly costly to maintain so the city opted to purchase capacity in the NBA when it was being developed. Vallejo Permit Water now is diverted from Barker Slough along with the other NBA water. The average annual diversion is 22,500 af. The old Cache Slough facilities were not abandoned and could be used for future diversions.

The South, West, and East Bay import water from the Mokelumne River, the Contra Costa Canal (CVP), the San Felipe Unit (CVP), and the SBA (SWP). EBMUD delivers Mokelumne River water to much of Alameda and Contra Costa counties through three pipelines, which serve 1.34 million people with an annual water supply of about 201 taf (2010 census). EBMUD also contracts with USBR to divert Sacramento River water at the Freeport Regional Water Facility to provide water for its customers during drought. SFPUC delivers Tuolumne River water to the City and County of San Francisco via the 150-mile-long Hetch Hetchy Aqueduct. It also sells water wholesale to 28 water districts, cities, and local agencies in Alameda, Santa Clara, and San Mateo counties. A total of approximately 250 taf is delivered and sold annually.

The CCWD delivers CVP water through the Contra Costa Canal. The source of the water can be Rock Slough, Mallard Slough, Old River, Victoria Canal, or the Sacramento River. CCWD has a 40-year contract for 195 taf annually. Approximately 550,000 people receive the water, mostly in eastern Contra Costa County; but some people are in the San Joaquin River Hydrologic Region. CCWD also has its own water right to divert water from the Delta.

SCVWD serves 1.8 million people partly through the CVP's San Felipe Unit under a contract for 152,500 af annually. The keystone of the San Felipe Unit is San Luis Reservoir.

SWP water is conveyed via the SBA to SCVWD, Zone 7, and ACWD. The SBA is over 42 miles long from the South Bay pumping plant at Bethany Reservoir to the Santa Clara Terminal Facility. The SWP water is used in the South Bay for groundwater recharge and for municipal, industrial, and agricultural purposes. Refer to Figure SFB-13 for a graphical depiction of Bay Region water imports, as well as Sacramento and San Joaquin River inflows and Pacific Ocean outflow.

Regional Water Planning and Management

Integrated Regional Water Management Coordination and Planning

The San Francisco Bay Area IRWM Group identified five overarching regional goals in its updated IRWM plan:

- Promote environmental, economic, and social sustainability.
- Improve water supply reliability and quality.
- Protect and improve watershed health and function and bay water quality.
- Improve regional flood management.
- Create, protect, enhance, and maintain environmental resources and habitats.

The group further identified 35 objectives to achieve all of the regional goals. Three of the objectives address improving regional flood management:

- Reduce flood damage to homes, businesses, schools, and transportation infrastructure.
- Minimize risks to health, safety, and property by encouraging wise management and use of flood-prone areas.
- Identify and promote integrated flood management projects.

Integrated flood management involves integration among various agencies that traditionally have had conflicting goals and objectives. Integrated flood management projects maximize the flood management benefits from limited funding and other resources. More reliable funding is needed at all levels of government.

The water management issues facing the Bay Region will change over time as regulations become more stringent and environmental conditions change. New regional goals, objectives, and priorities may emerge. The San Francisco Bay Area IRWM Group will review its IRWM plan periodically, and adjust project sequencing to reflect any new regional priorities. This process of continuous review and update will optimize the effectiveness of the IRWM plan.

To achieve many of the goals and objectives of the updated Bay Area IRWM Plan, the group proposes to implement 19 water enhancement projects and will receive $20 million in Proposition 84 Implementation Grant funding. The total cost of the projects, which are listed and described in Table SFB-16, is approximately $56.5 million.

Another initiative of the San Francisco Bay Area IRWM Group is additional data monitoring and coordination. The Bay Region has many water resources monitoring programs, but data gaps could be filled with additional data monitoring programs to better understand and manage the region's water resources. Some potential new data monitoring programs are shown in Table SFB-17.

Accomplishments

Conveyance- Regional/Local

The Hetch Hetchy Water System Improvement Program (WSIP) is one of the largest water infrastructure programs in the nation and the largest infrastructure program ever undertaken by the City of San Francisco. The $4.6 billion program reached the peak of construction in 2012 with 18 projects valued at $2.6 billion and all major projects launched. Construction of more than two-thirds of the 81 WSIP projects is complete along the landmark Hetch Hetchy Regional Water System between the Central Valley and San Francisco, which delivers water to more than 2.6 million people in the Bay Region.

Ecosystem Restoration

One of the most significant long-term projects is the South Bay Salt Pond Restoration Project, a multi-year restoration of 15,100 acres of industrial salt ponds in Alameda and Santa Clara counties and the largest wetland restoration project on the West Coast. Other bay wetland restoration projects include the Napa Sonoma Marsh, Bair Island, Sonoma Baylands, Hamilton-Bel Marin Keys, Cullinan Ranch, Sears Point Restoration, Bruener Marsh, and the Montezuma Wetland projects. In addition to providing increased habitat values, the restored wetlands may act as groundwater recharge areas, flood storage areas, and buffers to sea level rise.

Recycled Municipal Water

A significant recycled municipal water project that is nearing completion is the Silicon Valley Advanced Water Purification Center, a joint effort between SCVWD and the City of San Jose to further treat recycled water to improve its quality and expand its uses. The center will produce up to 10 mgd of highly purified recycled water. This near distilled-quality water will be blended with existing recycled water from South Bay Water Recycling to improve recycled water quality so that the water can be used for a wider variety of irrigation and industrial purposes.

Urban Runoff Management

The Sunnydale Flood and Stormwater Management Sewer Improvement Project and the Cesar Chavez Street Flood and Stormwater Management Sewer Improvement Project are significant urban runoff management projects being constructed in the Bay Region. These projects will improve San Francisco's aging combined sewer system by replacing and installing new sewer lines, which will reduce flood damages and improve water quality by increasing the volume of flow receiving secondary treatment before being discharged into San Francisco Bay. The Cesar Chavez Project has a low-impact development (LID) component which will provide an additional benefit. Coordinated with the San Francisco Department of Public Works, the LID component will include natural aesthetic streetscape features to capture more precipitation and reduce the volume of stormwater runoff that enters the sewer system.

Table SFB-16 Proposed Water Enhancement Projects, San Francisco Bay Hydrologic Region

Project ID# Project Name	Project Proponent	Project Status: Design % Complete	DAC?	Project Abstract
1. Bay Area Regional Conservation and Education Program	Zone 7 Water Agency (Zone 7)	100%	No	The Regional Water Conservation and Education Program is an existing program implemented by 12 Bay Area agencies. The IRWM Round 2 Implementation funding will expand implementing existing water conservation practices in the Bay Area, resulting in reduced potable water use and improve the existing Bay Area regional water conservation initiative. A suite of program elements will promote high-efficacy technologies and best water conservation practices that improve indoor and outdoor water use efficiency throughout the San Francisco Bay Area.
2. East Bayshore Recycled Water Project Phase 1A (Emeryville)	East Bay Municipal Utilities District	90%	Yes	The East Bayshore Recycled Water Project will ultimately provide up to 2.5 million gallons per day (mgd) (2,800 af/yr.) of tertiary treated recycled water to customers in Alameda, Albany, Berkeley, Emeryville, and Oakland.
3. Lagunitas Creek Watershed Sediment Reduction and Management Project	Marin Municipal Utilities District	50%	No	This sediment reduction project will improve water quality and streambed habitat for the benefit of coho salmon and steelhead trout in Lagunitas Creek and improve fish passage into two tributary streams to Lagunitas Creek. The project involves repairing three stream crossings along the cross Marin Trail, which is adjacent to Lagunitas Creek, to reduce fine sediment loading into Lagunitas Creek and its tributary streams. The stream crossing improvements will safeguard the Nicasio Transmission Line, a major public water supply transmission line for the area, and stabilize and restore recreational access within National Park Service and California State Parks lands along the Cross Marin Trail.
4. Marin/Sonoma Conserving Our Watersheds: Agricultural BMP Projects	Marin Resource Conservation District	15%	No	This project will implement critical environmental best management practices (BMPs) on agricultural lands in Marin and Sonoma counties. These BMPs are already identified in watershed plans in Marin County and a portion of Sonoma County. The BMP projects will focus on improving water quality, conserving water, and enhancing wildlife ecosystems on agricultural lands.
5. Napa Milliken Creek Flood Damage Reduction and Fish Passage Barrier Removal	Napa County	20%	No	The project involves three integrated elements along Milliken Creek: (1) removal of a dam and restoration of the stream, (2) construction of a flood bypass/weir to ensure a flood detention area does not overflow into neighboring homes, and (3) grading/landscape improvements to ensure adjacent low-lying properties receive a comparable level of flood protection. The project will prevent flooding of a neighborhood of more than 50 homes

Project ID# Project Name	Project Proponant	Project Status: Design % Complete	DAC?	Project Abstract
6. North Bay Water Reuse Program – Sonoma Valley County Sanitation District 5th Street East/ McGill Road Recycled Water Project	Sonoma Valley County Sanitation District	40%	No	The Sonoma Valley County Sanitation District 5th Street East/McGill Road Recycled Water Project, a Phase 2 component of the North Bay Water Reuse Program, consists of two recycled water subprojects in Sonoma Valley. The total recycled water yield from the project is approximately 200 af/yr. The project will increase use of recycled water for non-potable water demands, and will improve water supply reliability for the region through the creation of a drought-proof supply that can offset use of potable water supplies for non-potable demands.
7. Oakland Sausal Creek Restoration Project	City of Oakland	100%	Yes	This project involves restoring 754 linear feet of Sausal Creek in Dimond Park in Oakland, including 180 feet of culvert day lighting. The project includes restoration of channel function, streambank stabilization, erosion prevention, native plant restoration, native trout habitat improvement, and interpretive site features.
8. Pescadero Water Supply and Sustainability Project	San Mateo County	90%	Yes	This project will construct a new municipal groundwater well and 140,000-gallon storage tank for approximately 100 households in the Town of Pescadero. The current water supply system experienced a water outage in 2011 which left customers with no running water. The project would provide a reliable water supply to the community without increasing extracted groundwater. This project also includes implementing a water conservation program for the community.
9. Petaluma Flood Reduction, Water and Habitat Quality, and Recreation Project for Capri Creek	City of Petaluma	90%	No	This project implements improvements to an existing engineering drainage swale to restore a natural riparian corridor aesthetic. The goals of the project are to achieve flood reduction, habitat enhancement, (limited) groundwater recharge opportunities, expand recreational and educational amenities, and water quality improvements. The project complements current efforts in the Petaluma River watershed to integrate other flood control projects with multiple benefits.
10. Redwood City Bayfront Canal and Atherton Channel Flood Improvement and Habitat Restoration Project	City of Redwood	15%	No	This project will mitigate chronic and widespread flooding in the Bayfront Canal (Redwood City) and Atherton Channel (Melon Park) neighborhoods by routing flood flows from the Bayfront Canal and Atherton Channel into managed ponds that are part of the Ravenswood Pond Complex portion of the South Bay Salt Pond Restoration Project. This will provide a detention for these drainage areas and redirected runoff will be used to enhance wetland habitat.

Project ID# Project Name	Project Proponant	Project Status: Design % Complete	DAC?	Project Abstract
11. Regional Groundwater Storage and Recovery Project Phase 1A – South Westside Basin, Northern San Mateo County	San Francisco Public Utilities Commission (SFPUC)	100%	No	The SFPUC, along the cities of Daly City and San Bruno and the California Water Service Company who are partner agencies, proposes to develop a regional conjunctive use project in the South Westside groundwater basin for use during drought conditions. The purpose of the project is to use the basin as an underground reservoir to store water during periods when surface water supply can be made available to offset groundwater pumping by the partner agencies, leading to accumulation of stored groundwater that can be used during drought years. Phase 1A will include the construction of five groundwater wells.
12. Richmond Breuner Marsh Restoration Project	East Bay Regional Park District (EBRPD)	90%	Yes	EBRPD proposes to create, restore, enhance, and protect 164 acres of crucial habitat in Breuner Marsh at Point Pinole Regional Shoreline Park in the city of Richmond on the San Francisco Bay shoreline, Contra Costa County. The goal of this wetland restoration project is to provide long-term, self-sustaining tidal wetlands, seasonal wetlands, and a costal prairie to create valuable habitat for Special Status Species and for public access for compatible passive recreation and public education.
13. Roseview Heights Infrastructure Upgrades for Water Supply and Quality Improvement, Santa Clara County	Roseview Heights Mutual Water Company	95%	No	This project will replace the existing aging water infrastructure before emergency repairs or emergency replacement become necessary. The project will improve water supply reliability, water quality, and fire suppression capability by replacing and upgrading water tanks and water mains and adding fire hydrants.
14. San Francisco Bay Climate Change Pilot Projects Combining Ecosystem Adaptation, Flood Risk Management, and Wastewater Effluent Polishing	Association of Bay Area Governments	20%	No	This project construction of a demonstration ecotone slope on an existing parcel owned by the Oro Loma Sanitary District. An ecotone slope provides a cost-effective and environmentally friendly response to sea level rise. The pilot project will be studied to determine its efficacy and optimal design. The elements of the optimal design will then be built into a second phase of pilot projects at other sites in the Bay Area.

Project ID# Project Name	Project Proponant	Project Status: Dsign % Complete	DAC?	Projet Abstract
15. San Francisco International Airport Reclaimed Water Facility	City and County of San Francisco Airport Commission	30%	No	This project will provide the necessary infrastructure needed to reuse 100% of treated effluent at the airport terminals for non-potable reuse, thus reducing imported water demand on the Hetch Hetchy water system. An existing recycled water facility will be upgraded to treat 1.0 mgd of high quality industrial, sanitary, and stormwater effluent with microfiltration membrane treatment and hypochlorite disinfestation to satisfy Title 22 reclaimed water criteria.
16. San Jose Green Streets and Alleys Demonstration Projects	City of San Jose	20%	Yes	This project will construct Low-Impact Development (LID) improvements along a residential collector-type street and alley segments in a disadvantaged community to demonstrate a range of approaches for retrofitting existing urban streets with LID stormwater management features. LID permeable pavement and infiltration facilitates will be installed to eliminate sediment and ponding in the alleys, improve stormwater quality, and make the alleys a community amenity.
17. San Pablo Rheem Creek Wetlands Restoration Project	Contra Costa Water District	30%	Yes	This project will create seasonal wetlands on a ten-acre parcel adjacent to Rheem Creek and Breuner Marsh, located in the city of Richmond. The project will also improve the quality of stormwater that ultimately flows to San Pablo Bay. In addition, the project will lower potential flood impacts from Rheem Creek in neighborhoods in the cities of San Pablo and Richmond.
18. St. Helena Upper York Creek Dam Removal and Ecosystem Restoration Project	City of St. Helena	30%	No	This project will remove the upper York Creek Dam, a barrier to fish passage. The dam removal will provide access to an additional 1.7 miles of spawning and rearing habitat. The project will also restore approximately 2 acres of riparian corridor along York Creek, resulting in diverse, multi-story, shaded aquatic and riparian habitat.
19. Students and Teachers Restoring a Watershed (STRAW) Project – North and East Bay Watersheds	Point Reyes Bird Observatory Science	50 %	Yes	The STRAW project will implement a minimum of 20 habitat restoration projects in Bay Area watersheds with students and community members from Alameda, Contra Costa, Marin, Napa, San Francisco, Solano, and Sonoma counties. STRAW features professionally designed and implemented habitat restoration projects integrated with an innovative and time-tested education program that provides water quality benefits, habitat improvement, and positive impacts on economic, social, and environmental sustainability.

Table SFB-17 Potential New Data Monitoring Programs, San Francisco Bay Hydrologic Region

Program	Potential Implementing Agency	Program Description
WATER SUPPLY-WATER QUALITY		
Regional Groundwater Monitoring Program	DWR	Initiate a regional groundwater monitoring program that combines disparate or various local groundwater monitoring efforts into a single, comprehensive assessment of groundwater quantity and quality for basins within the region. Regional groundwater assessments should be conducted every five years.
Regional Monitoring of Emerging Contaminants	State Water Resources Control Board	Conduct regional monitoring of emerging contaminants, such as endocrine disrupting compounds, in water, sediment, and aquatic species. Expand upon the existing Regional Monitoring Program for Trace Substances to include emerging contaminants. Extend the Regional Monitoring Program to include monitoring of the quality of urban creeks in addition to sites in the San Francisco Bay.
WASTEWATER AND RECYCLED WATER		
Regional Recycled Water Reporting	San Francisco Bay Regional Water Quality Control Board	Regional compilation of quantity and quality of recycled water produced and used within the region. This system would track and encourage use of recycled water to conserve potable supplies. Information is already provided to the San Francisco Bay Regional Water Quality Control Board.
Non-Point-Source Pollution Control Program	State Water Resources Control Board	The State Water Resources Control Board is developing the Non-Point-Source Pollution Control Program to track and monitor non-point-source pollution in the Bay Area, but it is not in effect. The program could be expanded to collect both runoff quantity and quality information.
FLOOD PROTECTION AND STORMWATER MANAGEMENT		
Regional Monitoring of Impervious Surfaces	San Francisco Bay Regional Water Quality Control Board	Regional monitoring of trends in urbanization through tracking the extent of impervious surfaces and undeveloped lands with the use of GIS mapping. This information can be used when designing restoration efforts and to examine the effects of altered hydrology on streams and habitats. Additionally, this information will be useful for stormwater and flood control management agencies to assess application of appropriate best management practices and management measures according to the extent of imperviousness in the region.
Regional Storm Drainage Mapping	San Francisco Bay Regional Water Quality Control Board	Collaborative effort to develop a regional map showing locations of creeks, underground culverts, storm drains, and flood control channels. Use the Oakland Museum Creek Maps as an example for a region-wide effort to map storm drainage networks. This information will improve regional efforts for habitat restoration, flood control, and water quality monitoring.
Regional Monitoring of Floodplains	Bay Area Flood Protection Agencies Association	Regional mapping and monitoring of floodplains, including acreage protected connectivity and management techniques. Monitoring information would facilitate planning, design, and execution of flood-protection projects.

Program	Potential Implementing Agency	Program Description
WATERSHED MANAGEMENT, HABITAT PROTECTION, AND RESTORATION		
Regional Monitoring of Stream Channel Conditions	Department of Fish and Wildlife Service	Regional mapping and monitoring of channel bed and bank conditions, including extent of functioning riparian corridors. Regional mapping and monitoring of sediment source, transport, and depositional areas. This information will be useful to monitor the success of creek restoration projects, assess the need for future restoration efforts, and track habitat conditions for wildlife and aquatic habitat. Due to the extent of urbanization in the region, these data should be gathered in conjunction with local flood control and stormwater management agencies.
Regional Monitoring of In-Stream Habitat Conditions	U.S. Environmental Protection Agency Office of Research and Development; Department of Fish and Wildlife Service	Expand upon the Western Pilot Environmental Monitoring and Assessment Program (WEMAP) to implement standardized monitoring of instream habitat conditions (water quality, fish populations, benthic populations) within the region. Establish protocols and baseline data to assess urbanized habitat conditions.
Regional Monitoring of Wildlife Corridors, Populations, and Biodiversity	Department of Fish and Wildlife Service	Establish a regional monitoring system for wildlife corridors, populations, and species richness for amphibians, birds, and mammals. This could expand upon the California Natural Diversity Database, focusing solely on population monitoring within the region.
Regional Monitoring of Invasive Species	Department of Fish and Wildlife, U.S. Fish and Wildlife Service	Regional monitoring program for presence and absence of invasive plant species beyond Spartina. The program would provide information to target eradication and restoration activities.
Regional Monitoring of Native At-Risk and Special Status Species	Department of Fish and Wildlife, U.S. Fish and Wildlife Service	Regional program to track presence or absence of at-risk native and Special Status Species in the Bay Area.

Notes: af/yr. = acre-feet per year, BMP = best management practices

Watershed Management

The San Gregorio Creek Watershed Management Plan is an important document that was completed in 2010. The goal of the plan is to improve ecological conditions and to provide multiple benefits in the 52-square-mile San Gregorio Creek watershed in coastal San Mateo County. These benefits include protecting and enhancing native fish and wildlife populations, increasing ecosystem functions, and maintaining the rural quality of life in the watershed. Although the plan addresses some upland issues, its main focus is on protecting and restoring stream health.

Flood Risk Management

A major flood protection project on the Guadalupe River was completed in 2009. The project provides 100-year flood protection to downtown San Jose and consists of a 2,700-foot-long underground bypass channel (20 feet high and 60 feet wide) to convey flood flows. The natural channel and critical steelhead salmon runs were not adversely impacted. Additional channel work continues on the upper Guadalupe River, the last reach of the Guadalupe River Project, with completion scheduled for 2016.

Challenges

Some major water challenges facing the Bay Region include providing reliable water supplies, especially during droughts and other emergency outages; maintaining or improving drinking water quality; protecting drinking water sources; improving the health of the San Francisco Bay ecosystem; linking local land use planning with water system planning; improving water management planning; managing floodplains amid urban development and high land costs; satisfying environmental water demands; and improving water quality in receiving waters. The impacts of climate change only complicate dealing with these challenges.

Flood Challenges

Recurring floods in DACs and other communities also are a major challenge. Lives, homes, businesses, farmlands, and infrastructure are frequently at risk. Some particularly vulnerable locations in the region are on the Guadalupe, Napa, and Petaluma rivers and on Coyote and Corte Madera creeks. San Anselmo, Napa, and some communities in Santa Clara County are subject to frequent flooding. Levees are inadequate on tributaries of Alameda Creek, and railroad bridge openings are too small on major urban streams. Developed bay and coastal areas are vulnerable to sea level rise, tidal floods, and storm surges. Undesirable vegetation, beavers, and rodents pose additional challenges in urban floodways. Wildfires can denude steep erodible slopes in canyons and upland areas above urban development. The ensuing winter rains can flood developments with large debris flows, causing severe damage to structures and leaving large quantities of sediment and other detritus. Providing better protection for lives and property remains the definitive flood management challenge.

Effective flood preparedness is another challenge, but investing in flood preparedness can realize a significant return through reduced flood damages. It requires accurate evaluation of flood risk; adequate measures to mitigate flood damage; sufficient preparation for response and recovery; and effective coordination among local, State, and federal agencies. Completion of floodplain mapping, both the FEMA FIRMs and the complementary DWR Awareness Floodplain Mapping, will provide much needed information to evaluate flood risk. Mitigating flood damage may take many forms, including governmental regulation of construction and occupancy in flood-prone areas, flood-proofing, and structural protection such as levees. Response and recovery preparedness improves with the use of flood warning systems and with formal agreements that specify agency responsibilities and funding. Successful coordination between local, State, and federal agencies enhances sharing of watershed resources, maintenance of streams, community awareness of local flood risks, sustainability of the Delta water supply, and protection of infrastructure from levee failure.

Local funding for flood management and for flood maintenance and construction projects has become less effective in recent years because of several factors:

- Increased protection of the environment has increased maintenance and construction costs.
- Concern for endangered species has hindered project scheduling.
- Environmental and endangered species permitting has been difficult to obtain.

- Measures to reduce taxes, especially property tax, have hindered raising sufficient revenue.
- Inflation has increased maintenance and construction costs.

Procuring adequate funding is difficult with these funding constraints. This lack of funding challenges flood managers to certify levees that meet FEMA or USACE standards, to assess the condition of flood control facilities, and to maintain or improve aging water infrastructure.

FloodSAFE is a strategic DWR initiative that seeks a sustainable integrated flood management and emergency response system throughout California to improve public safety; protect and enhance environmental and cultural resources; and support economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and reducing flood damages. FloodSAFE is guiding development of regional flood management plans. These plans will encourage regional cooperation in identifying and addressing flood hazards, and will include risk analyses, review of existing flood protection measures, and identification of potential projects and funding strategies. The plans will emphasize multiple objectives, system resiliency, and compatibility with State goals and IRWM plans.

Sea level rise will have a significant impact on the Bay Region. Water levels in San Francisco Bay have risen 7 inches over the past century, and scientists agree that the rate of sea level rise is accelerating. Sea level rise is expected to increase the risk of erosion and flooding along the California coast and around San Francisco Bay, and higher water levels will magnify the adverse impacts of storm surges and high waves. Studies show that 330 square miles of low-lying land around the bay may be vulnerable to sea level rise over the next century. See "Climate Change" section later in this chapter for more discussion on sea level rise.

Drought Planning

Drought planning in the Bay Region is another challenge. Urban water management plans contain strategies to address drought, such as developing alternative dry-year water supplies, adopting water shortage allocation plans, and being prepared for catastrophic water supply interruptions. Many of the region's water suppliers, such as SFPUC and EBMUD, have urban water management plans in accordance with the 1983 California Urban Water Management Planning Act.

Looking to the Future

Future Conditions

Future Scenarios

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

Water Conservation

The water demand analysis includes two types of water conservation. The first is conservation that occurs without policy intervention (called background conservation). This includes purchases of efficient new appliances and shifts to more water-efficient landscaping without a specific government incentive. The second type of conservation is through implementation of the best management practices in the California Urban Water Conservation Council's Memorandum of Understanding Regarding Urban Water Conservation in California (last amended September 14, 2011). Other water conservation measures that require additional actions by water management agencies are not included in the analysis and would be considered as water management responses.

Growth Scenarios

Future water demand in the Bay Region is affected by population growth and a number of land use factors including agricultural plantings and the size and type of urban landscapes. Nine growth scenarios consisting of three population growth estimates and three future development densities were constructed to evaluate future water demand. Growth factors are varied among the scenarios to describe some of the uncertainty faced by water managers. For example, it is impossible to predict future population growth accurately so the Water Plan uses three different, but plausible population growth estimates when determining future urban water demands. In addition, the Water Plan considers up to three different alternative views of future development density. Population growth and development density determine how large the urban landscape will become in 2050 and, consequently, how large the encroachment into agricultural lands will become. See Table SFB-18 for a description of the growth scenarios.

DWR worked with researchers at the University of California, Davis and used a model called UPlan to quantify the 2050 urban footprint for the nine growth scenarios (see http://ice.ucdavis.edu/project/uplan for information on the UPlan model). UPlan is a simple rule-based urban growth model intended for regional or county-level modeling that shows the land area devoted to urban use in 2050 for each of the growth scenarios, and the change in the urban footprint from 682,000 acres in 2006. The table shows that the urban footprint grows up to 30,000 acres by 2050 under the low-population growth scenarios (LOP), depending on the assumed housing density. Although the Bay Region loses 21,500 people under the low-population growth scenarios because of insufficient births and immigration relative to deaths, the urban footprint still expands because of areas of local growth. The urban footprint grows up to 215,000 acres under the high-population growth scenarios (HIP), depending on the assumed housing density.

Table SFB-20 shows how future urban growth could affect the land devoted to agriculture in the Bay Region in 2050. The irrigated land area is the total agricultural footprint. The irrigated crop area is the total crop area, including areas where multiple crops are planted and harvested each year. The scenarios show a decline in irrigated crop acreage for all of the growth scenarios except the low-population growth scenarios. Irrigated crop acreage increases up to 5,000 acres by 2050 under low population growth, and decreases up to 16,000 acres under high population growth.

Table SFB-18 Conceptual Growth Scenarios

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

Change in Water Demand (2006 to 2050)

The change in water demand in the Bay Region from 2006 to 2050 was estimated for the agricultural and urban sectors under 9 growth scenarios and 13 climate change scenarios. The climate change scenarios include the 12 Climate Action Team scenarios, and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a "without climate change" condition. The climate change scenarios are described further in Volume 1, Chapter 5, "Managing an Uncertain Future."

Figure SFB-20 depicts the change in water demand from 2006 to 2050 for the urban and agricultural sectors under 9 growth scenarios described in Table SFB-19, with variation shown across 13 climate scenarios. The change in water demand is the difference between the historical average water demand for 1998 to 2005, and the future average water demand for 2043 to 2050. Urban water demand is the sum of indoor and outdoor demand, where indoor demand is assumed not to be affected by the climate. Outdoor water demand, however, depends on such climatic factors as precipitation and air temperature. Change in water demand is shown under a repeat of historical climate conditions and for 12 scenarios of future climate change.

Figure SFB-20 shows that urban water demand increases under all high and current trend population growth scenarios, but decreases under the low-population growth scenarios. The average urban water demand increase from the historical average of 1,070 taf is about 715 taf under the high-population growth scenarios and 250 taf under the current trend population growth scenarios. There is a decrease of about 15 taf under the low-population growth scenarios. The change in future urban water demand is most sensitive to the future population growth assumptions.

The figure also shows that agricultural water demand decreases under the high and current trend population growth scenarios due to the reduction in irrigated lands as a result of urbanization and water conservation. Agricultural water demand decreases by 20 taf from the historical average of about 120 taf under the high-population growth scenarios, and decreases by about 5 taf under the current trend population growth scenarios. However, agricultural water demand increases lightly under the low-population growth scenarios as irrigated crop area increases.

Table SFB-19 Growth Scenarios (Urban) — San Francisco Bay

Scenario[a]	2050 Population (thousand)	Population Change (thousand) 2006[b] to 2050	Development Density	2050 Urban Footprint (thousand acres)	Urban Footprint Increase (thousand acres) 2006[c] to 2050
LOP-HID	6,135.7[d]	-21.5	High	706.1	23.9
LOP-CTD	6,135.7	-21.5	Current Trends	708.9	26.7
LOP-LOD	6,135.7	-21.5	Low	712.2	30.0
CTP-HID	7,666.8[e]	1,509.6	High	770.8	88.6
CTP-CTD	7,666.8	1,509.6	Current Trends	779.1	96.9
CTP-LOD	7,666.8	1,509.6	Low	787.0	104.8
HIP-HID	11,039.4[f]	4,882.2	High	863.3	181.1
HIP-CTD	11,039.4	4,882.2	Current Trends	880.8	198.6
HIP-LOD	11,039.4	4,882.2	Low	896.9	214.7

Notes:

[a] See Table SFB-18 for scenario definitions.

[b] 2006 population was 6,157.2 thousand.

[c] 2006 urban footprint was 682.2 thousand acres.

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

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

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

Integrated Regional Water Management Plan Summary

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

All IRWM plans are different in how they are organized. Therefore, finding and summarizing the content in a consistent way proved difficult. It became clear through these efforts that a process is needed to allow those with the most knowledge of the IRWM plans, those that were involved in the preparation, to have input on the summary. It is the intention that this process be initiated following release of Update 2013 and will continue to be part of the process of the update process for Update 2018. This process will also allow for continuous updating of the content of the atlas as new IRWM plans are released or existing IRWM plans are updated.

In addition to these summaries, we will provide all of the summary sheets in one IRWM Plan Summary "Atlas" as an article included in Volume 4, *Reference Guide*. This atlas will, under one

Table SFB-20 Growth Scenarios (Agriculture) — San Francisco Bay Hydrologic Region

Scenario[a]	2050 Irrigated Land Area[b] (thousand acres)	2050 Irrigated Crop Area[c] (thousand acres)	2050 Multiple Crop Area[d] (thousand acres)	Change in Irrigated Crop Area (thousand acres) 2006 to 2050
LOP-HID	86.6	87.7	1.1	+5.1
LOP-CTD	86.2	87.3	1.1	+4.7
LOP-LOD	85.6	86.7	1.1	+4.1
CTP-HID	79.8	80.8	1.0	-1.8
CTP-CTD	79.0	80.0	1.0	-2.6
CTP-LOD	78.1	79.1	1.0	-3.5
HIP-HID	69.6	70.5	0.9	-12.1
HIP-CTD	67.5	68.4	0.9	-14.2
HIP-LOD	65.5	66.4	0.9	-16.2

Notes:

[a] See Table SFB-18 for scenario definitions.

[b] 2006 Irrigated land area was estimated by the California Department of Water Resources (DWR) to be 81.6 thousand acres.

[c] 2006 Irrigated crop area was estimated by DWR to be 82.6 thousand acres.

[d] 2006 multiple crop area was estimated by DWR to be 1.0 thousand acres.

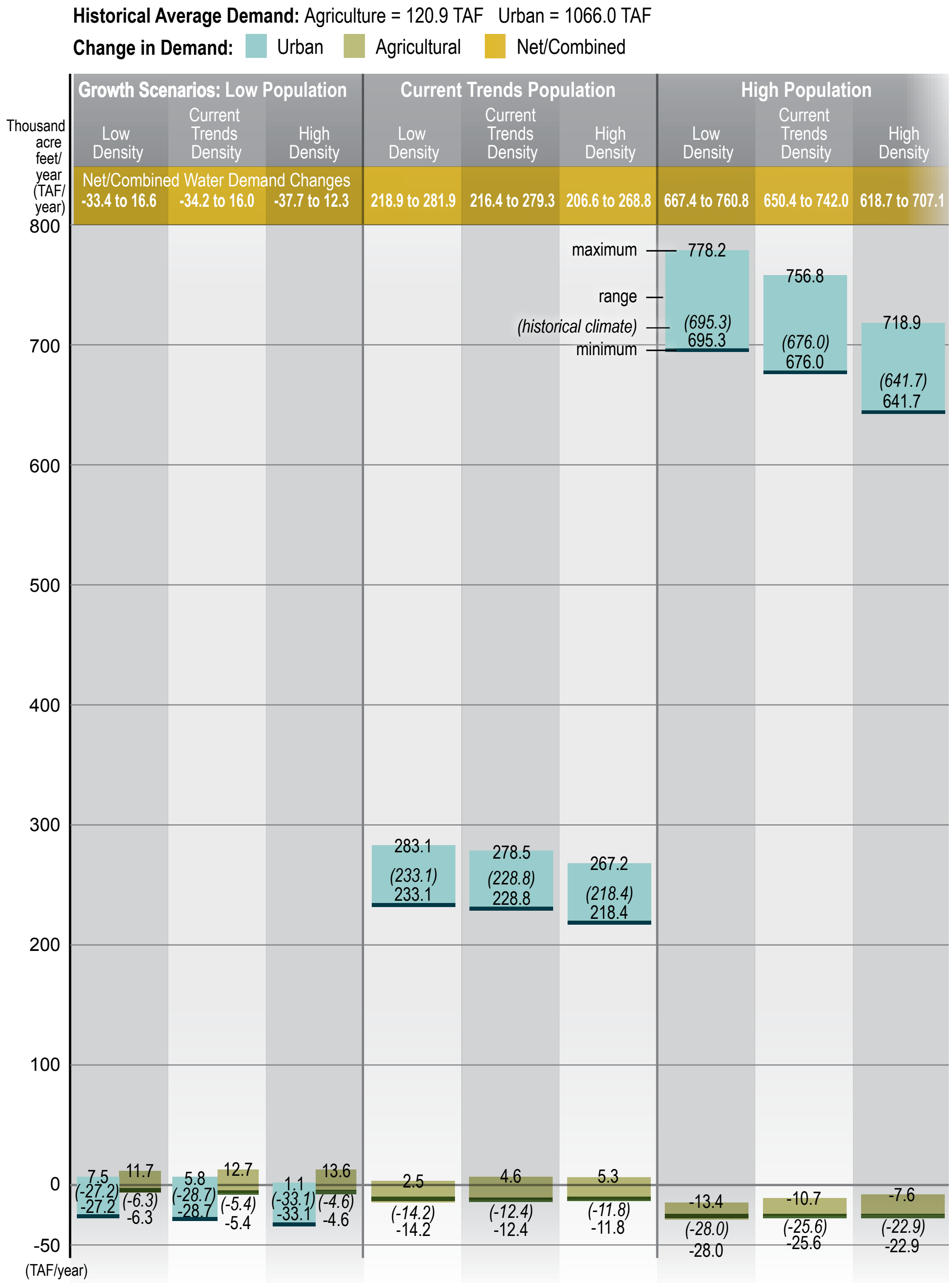
cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management accomplishments and challenges. The atlas will showcase how the dedicated efforts of individual regional water management groups (RWMGs) have individually and cumulatively transformed water management in California.

As can be seen in Figure SFB-18, there is one IRWM planning effort that is ongoing in the Bay Region. (Although a small portion of the East Contra Costa County IRWM plan is inside the San Francisco Bay Hydrologic Region, it will not be discussed in this section.)

Region Description

In the Bay Region, there is one IRWM plan that covers the entire region. The San Francisco Bay Area IRWM region boundary corresponds to the bay watershed as defined by the SFBRWQCB and includes all or portions of the nine counties that surround San Francisco Bay. The bay watershed functions as the sole drainage outlet for the Sacramento and San Joaquin rivers that enter the bay system through the Delta. The region includes three major cities — San Francisco, Oakland, and San Jose — and roughly 100 smaller cities and towns.

Figure SFB-20 **Change in San Francisco Bay Agricultural and Urban Water Demands for 117 Scenarios from 2006-2050 (thousand acre-feet)**



As of late 2013, the Bay Region has received about $662 million in funding from both State and non-State sources: $155,362,653 from the State and $506,477,065 from non-State sources. Table SFB-21 provides a funding source breakdown for the region.

Key Challenges and Goals

The Bay Region faces the following challenges:

- Regulatory compliance.
- Flood protection.
- Financial and funding.
- Environmental and watershed.
- Interagency coordination.

To address the challenges, the Bay Region has identified the following goals/objectives:

- Contribute to the promotion of economic, social, and environmental sustainability.
- Contribute to improved supply reliability.
- Contribute to the protection and improvement of hydrologic function.
- Contribute to the protection and improvement of the quality of water resources.
- Contribute to the protection of public health, safety, and property.
- Contribute to the creation, protection, enhancement, and maintenance of environmental resources and habitats.

Water Supply and Demand

The region relies on imported water, local surface water, and groundwater for water supply. Local supplies account for about 30 percent of the total, and the remaining supply is imported from the SWP, CVP, and the Mokelumne and Tuolumne watersheds. In 2010, demand in the region was 1,278,480 af/yr. Demand is projected to grow to 1,680,963 af/yr. in a normal year and 1,666,870 af/yr. in a single dry year by 2035.

Water Quality

In general, surface water and groundwater are of good quality within the region. The primary constituents of concern for groundwater are hardness, total dissolved solids (TDS), nitrate, and boron. In the areas that are located close to the bay, high levels of TDS and chloride are common due to salt water intrusion. Surface supply originating in the Delta is highly impacted by agriculture runoff and oceanic tidal fluxes, containing high levels of TDS, chloride, bromide, organic carbon, and microbes. The SFBRWQCB is currently developing over 30 TMDL projects that address impaired water bodies within the region.

Flood Management

Flooding has been identified as a major concern for the region due to the region's topography and climate. Watersheds within the region are generally characterized by urbanized valleys and bayside plains surrounded by steep, less developed hillsides. Flooding tends to occur when large storms follow several days of rain, with most flood damage seen in urban, low-gradient, low-

Table SFB-21 San Francisco Bay IRWM Plan Funding

IRWM Region	Prop. 50 Planning Grant	Prop. 50 Implementation Grant	Prop. 84 Planning Grant	Prop. 84 Implementation Grant[a]	Prop. 1E Stormwater Grant
San Francisco Bay Area	**$839,230** $520,000	**$12,500,000** $237,867,719	**$842,566** $569,761	**$30,093,592** $80,993,597	**$111,088,275** $186,525,988
Grand Total $661,839,718					

Notes:

This table is up-to-date as of late 2013.

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

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

elevation areas. The region addresses flood management by encouraging coordination with land planning entities and identifying and promoting integrated projects to protect vulnerable areas.

Groundwater Management

There are 33 identified groundwater basins within the region, which underlie roughly 30 percent of the region. There are a number of groundwater management programs in the region including several conjunctive use projects and groundwater banking programs. Several agencies are participating in inter-regional groundwater banking programs, and nearly all agencies are investigating groundwater banking options for the future. Negative impacts to several groundwater basins from seawater intrusion have been alleviated due to more effective groundwater management.

Environmental Stewardship

There are a number of existing environmental stewardship efforts within the region including protection and restoration of habitat and wetlands, groundwater banking, and sediment management projects. Roughly 32,000 acres of restorable shoreline have been acquired and are in the process of being restored. There are 1.2 million acres within the region that are currently under permanent protection, with habitat conservation plans covering the entire region.

Climate Change

Climate change is already affecting the San Francisco Bay Area IRWM region and will have significant impacts on water and other resources in the future. Changes in timing, amount, and type of precipitation and runoff will affect the availability of local and imported water supplies. With potentially $62 billion in shoreline development at risk, the region is particularly vulnerable to the projected increases in mean sea level, more intense storms, and larger storm surges. Increasing temperatures and prolonged droughts will also impact agriculture and public health in the region. As part of the IRWM plan update process, these impacts are being evaluated along with the development of adaptation strategies and mitigation measures.

Tribal Communities

The 2010 census estimates the number of American Indian and Native Alaskans in the region to be approximately 50,000 people. Tribal members are dispersed into the region population and do not live in tribal-specific communities. The process of identifying Native American tribes and tribal members within the region's jurisdiction included conducting interviews with knowledgeable contacts from nongovernmental organizations and water agencies and reviewing publicly available resources from tribes and information provided by DWR's Tribal Liaison for the region. The Lytton Band of Pomo Indians currently owns land within the region's geographic boundary and may have distinct water resource interests, needs, or challenges.

Disadvantaged Communities

Although the MHI of each of the nine San Francisco Bay Area counties is well above the 80 percent threshold for DAC status in the state, DACs are located in each county, with the majority of these communities located in Alameda and Contra Costa counties. Including DACs and water resource projects that serve DAC communities is a priority for the region. Outreach efforts include inviting DAC representatives to participate in all aspects of the IRWM planning process, making the IRWM planning process easy to understand through non-technical outreach materials, identifying and mapping the location of DACs, clarifying DAC project eligibility criteria, and conducting outreach and hands-on guidance to support identification and development of projects servicing DACs.

Governance

The planning process began in 2004 when regional and local stakeholders signed a letter of mutual understanding (LOMU) to develop an IRWM plan for the region. In 2007, after completion of the plan, the technical coordinating committee became the region's IRWM plan CC, which now serves as the RWMG for the region. CC members include water and wastewater agencies, flood control agencies, nongovernmental organizations, regulatory agencies, and members of the public.

Resource Management Strategies

Bay Region water agencies have made significant investments since *California Water Plan Update 2009* in programs and projects that implement various resource management strategies. The 23 Bay Area Regional Priority Projects are examples of implementing resource management strategies such as urban runoff management, recycled municipal water, ecosystem restoration, urban water use efficiency, and flood risk management. The projects are:

Urban Runoff Management

- San Pablo Spine and Regional Promotion of Green Infrastructure.
- Hacienda Avenue "Green Street" Improvement.
- Napa Valley Rainwater Harvesting.

Recycled Municipal Water

- Central Contra Costa Sanitary District/Concord Recycled Water Project (Phase I).

- Dublin San Ramon Service District Central Dublin Recycled Water Distribution and Retrofit Project.
- EBMUD East Bayshore Phase IA (I-80 Pipeline).
- MMWD Peacock Gap Recycled Water Extension.
- North Bay Water Reuse Authority Program.
  - Novato Sanitary District/North Marin Water District (NMWD) Novato North Service Area Project.
  - Las Gallinas Valley Sanitary District /NMWD Novato South Service Area Project.
  - Napa Sanitation District /Napa State Hospital Pipeline Construction Stage 1 Project.
  - SVCSD Recycled Water Stage 1 Project.
- SFPUC Harding Park Recycled Water Project.
- South Bay Water Recycling Industrial Expansion and Reliability.

Urban Water Use Efficiency

- Regional Water Conservation Program.

Ecosystem Restoration

- Sears Point Wetland and Watershed Restoration.
- Bair Island Restoration.
- Pond A16/17 Habitat Restoration.

Flood Risk Management/Ecosystem Restoration

- Watershed Partnership Technical Assistance.
- Stream Restoration with Schools and Community in Disadvantaged Communities of the North Bay.
- Floodplain Mapping for the Bay Area with Disadvantaged Communities Focus.
- Stormwater Improvements and Flood Reduction Strategies Pilot Project in Bay Point.
- Disadvantaged Communities Richmond Shoreline and City of San Pablo Flood Project.
- Pescadero Creek Watershed Disadvantaged Communities Integrated Flood Reduction and Habitat Enhancement Project.
- Pescadero Creek Steelhead Smolt Outmigrant Trapping.
- Stream Channel Shapes and Floodplain Restoration Guidance and Watershed Restoration in San Francisquito Creek; East Palo Alto, a Disadvantaged Community.
- Steelhead and Coho: Bay Area Indicator for Restoration Success (San Francisco Estuary Steelhead Monitoring Program).

The SFBRWQCB is involved in programs in the Bay Region that promote resource management strategies such as urban runoff management and pollution prevention. Partnering with the San Francisco Estuary Project, municipal stormwater agencies, and others, the SFBRWQCB promotes urban runoff management through LID, which is a design approach that manages stormwater runoff to replicate pre-development hydrology. LID incorporates natural on-site features to protect water quality and detain runoff.

The SFBRWQCB also promotes pollution prevention by adopting TMDLs for Bay Region watersheds to limit pollutants that impair water quality (primarily sediments, pathogens, nutrients, mercury, polychlorinated biphenyls, and urban pesticides). The TMDLs are designed to help the region meet its goals of protecting and restoring waters, and improving watershed and habitat management by attaining water quality standards. See Volume 3 in Update 2013 for detailed information on all of the resource management strategies that water managers can use to meet their goals and objectives.

Resource Management Strategies in IRWM Plans

A review of the resource management strategies addressed in the San Francisco Bay Area IRWM plan is summarized in Table SFB-22.

Conjunctive Management and Groundwater Storage

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

A DWR/ACWA survey was undertaken in 2011 and 2012 to inventory and assess conjunctive management projects in California. Box SFB-4 is a summary of the inventory effort.

The DWR/ACWA survey identified 89 agencies or programs that operate a conjunctive management or groundwater recharge program in California, of which four are located in the Bay Region. The earliest reported conjunctive use project in the region was in the 1920s by SCVWD. Zone 7 Water Agency and ACWD began conjunctive management programs in 1962, and EBMUD began one in 2009.

SCVWD operates multiple spreading basins for direct percolation of surface water in the Santa Clara Valley Groundwater Basin. The integrated water system includes 10 reservoirs, 17 miles of canals, 4 water supply diversion dams, 300 acres of recharge ponds, and 91 miles of controlled instream recharge (Bay Area Integrated Regional Water Management Plan 2013). The source of recharge water includes the SWP, CVP, and local surface water. Although capital costs to develop the projects were not reported, SCVWD indicated that operating costs were approximately $3 million annually. SCVWD reported that 104,000 af of water was used for local groundwater recharge programs and 52,000 af of water was banked with Semitropic Water Storage District in the Tulare Lake Hydrologic Region in 2010.

Zone 7 Water Agency operates spreading basins for direct percolation into the Livermore Valley Groundwater Basin using water from the SBA and local sources. It manages a groundwater basin with a capacity of 126,000 af. In addition to recharging local aquifers, Zone 7 Water Agency indicated that it had additional banking capacity with Semitropic Water Storage District (78,000 af) and Cawelo Water District (120,000 af) in Kern County.

ACWD reported that its groundwater programs in the Niles Cone Groundwater subbasin had an annual operating cost of $278,000. It uses a series of former quarry pits to recharge groundwater (Bay Area Integrated Regional Water Management Plan 2013) and reported that it had a banking capacity of 150,000 af with Semitropic Water Storage District in Kern County.

Table SFB-22 Resource Management Strategies Addressed in the San Francisco Bay Area IRWM Plan

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

Source: 2013 San Francisco Bay Area IRWM Plan (update).

Box SFB-4 Statewide Conjunctive Management Inventory Effort in California

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

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

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

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

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

EBMUD operates an aquifer storage and recovery program in the East Bay Plain Groundwater subbasin as part of its Bayside Groundwater Project. The program has the capacity to inject up to 1 mgd into a confined aquifer and make a consistent flow available to customers during dry years.

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

Climate Change

For over two decades, the State and federal governments have been preparing for climate change effects on natural and built systems with a strong emphasis on water supply. Climate change is already impacting many resource sectors in California, including public health, water, agriculture, biodiversity, and transportation and energy infrastructure (California Natural Resources Agency 2009; U.S. Global Change Research Program 2009). Climate model simulations based on the Intergovernmental Panel on Climate Change's 21st-century scenarios project increasing temperatures in California, with greater increases in the summer (Intergovernmental Panel on Climate Change 2013). Projected changes in annual precipitation patterns in California will result in changes to surface runoff timing, volume, and type (Cayan 2008). Recently developed computer downscaling techniques (model simulations that refine computer projections to a scale smaller than global models) indicate that California flood risks from warm-wet, atmospheric river-type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011).

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

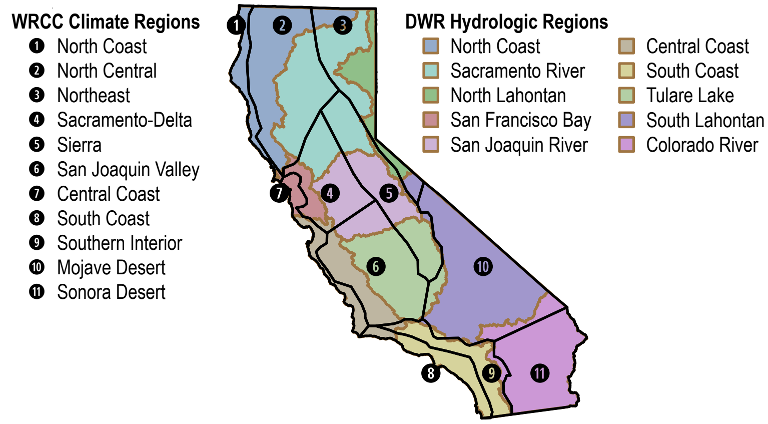
Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Because of the economic, geographical, and biological diversity of California, vulnerabilities and risks from current and future anticipated changes are best assessed on a regional basis. Many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

Observations

The region's observed temperature and precipitation vary greatly due to complex topography. Regionally specific temperature data was retrieved from the Western Regional Climate Center (WRCC) (2013). The WRCC acts as a repository of historical climate data and information. Air temperature records for the past century were summarized by the WRCC into distinct climate regions (Abatzoglou et al. 2009). DWR's hydrologic regions do not correspond directly to WRCC's climate regions. A particular hydrologic region may overlap more than one climate region and, hence, have different climate trends in different areas. For the purpose of this regional report, however, climate trends of the major climate regions are considered to be relevant trends for respective portions of the hydrologic region (see Figure SFB-21).

The Bay Region overlaps the WRCC Central Coast and Sacramento-Delta regions and also small portions of the WRCC North Coast and North Central regions. Mean temperatures in the Central Coast Region have increased about 1.1 to 2.0 °F (0.6 to 1.1 °C), with minimum values increasing more than maximums (1.6 to 2.6 °F [0.9 to 1.4 °C] and 0.45 to 1.5 °F [0.3 to 0.9 °C], respectively). Inland, temperatures in the Sacramento-Delta Region show a similar warming trend. A mean increase of 1.5 to 2.4 °F (0.9 to 1.3 °C) was recorded, with minimum temperatures increasing 2.1 to 3.1 °F (1.2 to 1.7 °C) and maximum temperatures increasing 0.8 to 2.0 °F (0.4 to 1.1 °C).

Figure SFB-21 DWR Hydrologic and Western Region Climate Center Climate Regions



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

In the 20th century, tide gages and satellite altimetry show, global mean sea level rose about 7 inches (California Department of Water Resources 2008). The change in mean sea level at the San Francisco tide gage, the nation's oldest continually operating tidal observation station, is consistent with the global average of 7 inches. However, when the current rate is adjusted for vertical land motion and atmospheric pressure the relative mean sea level is increasing at a rate of 0.04 +/- 0.06 in year-1 (1.02 +/- 1.73 mm year-1) south of Cape Mendocino, which is lower than the current rate of global mean sea level rise (National Research Council 2012).

Projections and Impacts

While historical data is a measured indicator of how the climate is changing, it cannot project what future conditions may be like under different GHG emissions scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date and indicates by 2060-2069, temperatures will be 3.4 to 4.9 °F (1.9 to 2.7 °C) higher across the state than they were from 1985 to 1994 (Pierce et al. 2012). In the Bay Region, the study projects, annual temperatures will increase 3.6 to 4.1 °F (2.0 to 2.3 °C) with a 2.9 to 3.1 °F (1.6 to 1.7 °C) increase in winter temperatures and a 4.1 to 5.2 °F (2.3 to 2.9 °C) increase in summer temperatures. Climate projections for the Bay Area from Cal-Adapt indicate that the temperatures between 1990 and 2100 will increase by as much as 4 to 5 °F (2.2 to 2.8 °C) in the winter and 5 to 6 °F (2.8 to 3.3 °C) in the summer (California Emergency Management Agency and California Natural Resources Agency 2012).

Changes in precipitation across California due to climate change could result in changes in type of precipitation (rain or snow) in a given area, in timing or total amount, and in surface runoff timing and volume. Most climate model precipitation projections for the state anticipate drier conditions in Southern California, with heavier and warmer winter precipitation in Northern California. More intense wet and dry periods are anticipated, which could lead to flooding in some years and drought in others. In addition, extreme precipitation events are projected to increase with climate change (Pierce et al. 2012). Because there is less scientific detail on localized precipitation changes, there is a need to adapt to this uncertainty at the regional level (Qian et al. 2010).

Given these projections, climate change is anticipated to present significant water resource management challenges to the Bay Region. Approximately 70 percent of the region's water supply is imported, and the majority of the imported water originates in the Sierra Nevada. The Sierra Nevada snowpack is expected to continue to decline as warmer temperatures raise snow levels, reduce spring snowmelt, and increase winter runoff — reducing water supplies for over 7 million people and agriculture in the region. The Sierra Nevada is projected to experience a 48 to 65 percent reduction of its historical average snowpack by the end of this century (Pierce and Cayan 2013). Increasing temperatures may also increase net evaporation from reservoirs by 15 to 37 percent (Medellin-Azuara et al. 2009; California Natural Resources Agency 2009). Environmental water supplies would need to be retained in reservoirs for managing instream flows to maintain habitat for endangered fish species throughout the dry season. Currently, Delta pumping restrictions are in place to protect endangered fish species. Climate change is likely to further constrain the management of these endangered species and the state's ability to provide water for other uses. For the San Francisco Bay region, this would further reduce supplies for those portions of the region that depend on imports from the SWP (Cayan 2008; Hayhoe et al. 2004).

Coastal observations and global model projections indicate that the California coast and estuaries are likely to experience increasing mean sea levels during the next century, affecting development and infrastructure in the Bay Region. Mean sea levels are projected to rise 5 to 24 inches (12-61 centimeters [cm]) by 2050 and 17 to 66 inches (42-167 cm) by 2100 (National Research Council 2012). A 55-inch rise in mean sea level would place an estimated 270,000 people in the Bay Area at risk from flooding — 98 percent more than are currently at risk — and put an estimated $62 billion worth of shoreline development at risk including major transportation infrastructure such as rail lines, freeways, and airports (Bay Conservation and Development Commission 2011). Also, the expected increase in both the intensity and frequency of storms would increase the risk of flooding in the Bay Region, from both larger storm surges and greater stream runoff.

Climate changes also are expected to substantially alter the bay ecosystem. Wetland and transitional habitats are vulnerable to inundation, erosion, and changes in sediment supply. The highly developed shoreline would constrain the ability of these habitats to migrate landward (Bay Conservation and Development Commission 2011). These habitat changes, along with changes to freshwater inflow and water quality, would impact the species composition in the bay. A shift in coastal fog patterns along with temperature and precipitation changes may also lead to range shifts in vegetation. While a shift in vegetation patterns along the coast may decrease wildfire risk (Lenihen et al. 2006), the non-coastal areas in the region would likely be at higher risk of wildfire (California Natural Resources Agency 2009).

Adaptation

Climate change has the potential to impact the region, which the state depends upon for its economic and environmental benefits. These changes would increase the vulnerability of natural and built systems in the region. Impacts to natural systems will challenge aquatic and terrestrial species with diminished water quantity and quality, and shifting ecoregions. Built systems would be impacted by changing hydrology and runoff timing and loss of natural snowpack storage, making the region more dependent on surface storage in reservoirs and groundwater sources. Increased future water demand for both natural and built systems may be particularly challenging with less natural storage and less overall supply.

Water managers and local agencies must work together to determine the appropriate planning approach for their operations and communities. While climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (U.S. Environmental Protection Agency and California Department of Water Resources 2011). However, stationarity (the idea that natural systems fluctuate within an unchanging envelope of variability) can no longer be assumed so new approaches will likely be required (Milly et al. 2008).

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

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

Numerous efforts in the Bay Region are addressing climate change. Two recent policy efforts include the BCDC Climate Change Bay Plan Amendment and the California Coastal Conservancy Climate Change Policy and Project Selection Criteria. Planning efforts in the region include the Bay Area IRWM Plan Update; the San Francisco Estuary Institute (SFEI) Baylands Ecosystem Habitat Goals Climate Change Technical Update; and the Plan Bay Area Project, which links land-use and transportation planning in the region. Numerous studies and pilot projects also are under way, including Adapting to Rising Tides, Our Coast Our Future, San Francisco Living Shoreline, San Francisco Estuary Pilot, and the Innovative Wetland Adaptive Techniques in Lower Madera Creek Project. Collaborative groups such as the Bay Area Ecosystem Climate Change Consortium, the North Bay Climate Adaptation Initiative, and the San Francisco Conservations Commons also are working to bring together technical experts, scientists, natural resource managers, and policy-makers to better understand and address the impacts of climate change on Bay Area ecosystems and communities.

The Bay Region contains a diverse landscape with different climate zones, which makes it difficult to find one adaptation strategy that works throughout the region. Water managers and local agencies must work together to determine the appropriate adaptation strategy and planning approach for their community. Whatever approach is used, water managers and communities must implement adaptation measures sooner rather than later to be prepared for an uncertain future.

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

- Safeguarding California: Reducing Climate Risk (http://resources.ca.gov/climate_adaptation/docs/ Safeguarding_California_Public_Draft_Dec-10.pdf), which identifies a variety of strategies across multiple sectors (other resources can be found at http://www.climatechange.ca.gov/adaptation/strategy/index.html).
- California Adaptation Planning Guide (http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html) developed into four complementary documents by the California Emergency Management Agency and the California Natural Resources Agency to assist local agencies in climate change adaptation planning.
- Cal-Adapt (http://cal-adapt.org/), an online tool designed to provide access to data and information produced by California's scientific and research community.
- Urban Forest Management Plan Toolkit (http://www.ufmptoolkit.com/), sponsored by the California Department of Forestry and Fire Management to help local communities manage urban forests to deliver multiple benefits such as cleaner water, energy conservation, and reduced heat-island effects.
- California Climate Change Portal (http://www.climatechange.ca.gov/).
- DWR Climate Change Web site (http://www.water.ca.gov/climatechange/resources.cfm).
- The Governor's Office of Planning and Research Web site (http://www.opr.ca.gov/m_climatechange.php).

Several of the resource management strategies found in Volume 3 of Update 2013 can be singled out as providing benefits for adapting to climate change in addition to meeting water management objectives in the San Francisco Bay Hydrologic Region. These strategies include:

- Chapter 2, "Agricultural Water Use Efficiency"
- Chapter 3, "Urban Water Use Efficiency."
- Chapter 4, "Flood Management."
- Chapter 6, "Conveyance – Regional/Local."
- Chapter 7, "System Reoperation."
- Chapter 10, "Desalination – Brackish and Sea Water."
- Chapter 12, "Recycled Municipal Water."
- Chapter 14, "Surface Storage – Regional/Local."
- Chapter 18, "Pollution Prevention."
- Chapter 21, "Agricultural Lands Stewardship. "
- Chapter 22, "Ecosystem Restoration."
- Chapter 24, "Land Use Planning and Management."
- Chapter 27, "Watershed Management."

The myriad of resources and choices available to water managers can seem overwhelming. However, managers can implement many proven strategies to prepare for climate change in the Bay Region, regardless of the magnitude of future warming. These strategies often provide multiple benefits. For example, developing "living shorelines," an approach that integrates subtidal habitat restoration with adjacent tidal and riparian areas to benefit multiple species, can also improve water quality; increase wave attenuation; and reduce shoreline erosion and flooding. Other adaptation measures include water use efficiency, wetland restoration, coastal armoring, elevating development, floating development, and in some cases, managed retreat.

Water managers need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystems, which can benefit humans by carbon sequestration, pollution remediation, and flood risk reduction. Increased collaboration between water managers, land-use planners, and ecosystem managers can identify common goals and actions that are needed to achieve resilience to climate change and other stressors.

Mitigation

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

Figure SFB-22 shows the amount of energy associated with the extraction and conveyance of one acre-foot of water for each of the major water sources in this region. The quantity of each water source used in the region is also included, as a percentage. For reference, only extraction and conveyance of raw water in Figure 3-29, "The Water Energy Connection" (Volume 1), are illustrated in Figure SFB-22. Energy required for water treatment, distribution, and end uses of the water are not included. Not all water types are available in this region. Some water types flow mostly by gravity to the delivery location and may require little or no energy to extract and convey. As a default assumption, a minimum EI of less than 250 kilowatt hours per acre-foot (kWh/af) was assumed for all water types.

Recycled water and water from desalination used within the region are not show in Figure SFB-22 because their EI differs in important ways from those water sources. The EI of both recycled and desalinated water depend not on regional factors but rather on much more localized, site, and application-specific factors. Additionally, the water produced from recycling and desalination is typically of much higher quality than the raw (untreated) water supplies evaluated in Figure SFB-22 For these reasons, discussion of energy intensity of recycled and desalinated water are found separately in Volume 3, *Resource Management Strategies*. Energy intensity is discussed in Box SFB-5.

Figure SFB-22 Energy Intensity of Raw Water Extraction and Conveyance in the San Francisco Bay Hydrologic Region

Type of Water	Energy Intensity (= 1-250 kWh/AF = 251-500 kWh/AF)	Percent of Regional Water Supply*
Colorado (Project)	*This type of water not available*	0%
Federal (Project)		12%
State (Project)		12%
Local (Project)	<250 kWh/AF	15%
Local Imports	*<250 kWh/AF	38%
Groundwater		19%

* Hetch Hetchy is a net energy provider

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

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

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Box SFB-5 Energy Intensity

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

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

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

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

Accounting for Hydroelectric Energy

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

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

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

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

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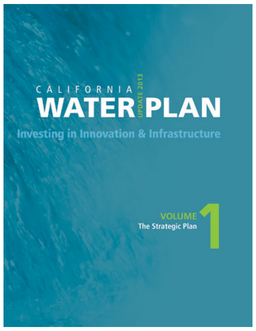
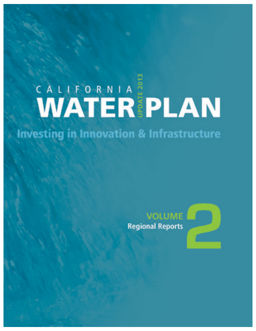
Navigating Water Plan Update 2013

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



VOLUME 1, The Strategic Plan

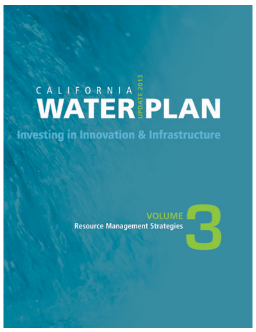
- Call to action, new features for Update 2013, progress toward implementation.
- Update 2013 themes.
- Comprehensive picture of current water, flood, and environmental conditions.
- Strengthening government alignment and water governance.
- Planning (data, analysis, and public outreach) in the face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



VOLUME 2, Regional Reports

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

VOLUME 3, Resource Management Strategies



Integrated Water Management Toolbox,
30+ management strategies to:

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

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

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

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

Edmund G. Brown Jr.
Governor
State of California

John Laird
Secretary for Natural Resources
Natural Resources Agency

Mark Cowin
Director
Department of Water Resources

October 2014