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San Francisco Bay Hydrologic Summary

The San Francisco Bay Hydrologic Region (Bay Region) occupies approximately 4,500 square miles; from southern Santa Clara County to Tomales Bay in Marin County; and inland to the confluence of the Sacramento and San Joaquin rivers near Collinsville. The 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. 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. However, with strong water planning and governance and several resource management strategies that can be applied, the region is poised to address these challenges effectively.

PLACEHOLDER Table SFB-1 Water Governance, San Francisco Bay Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

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 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.

PLACEHOLDER Figure SFB-1 Map of the San Francisco Bay Hydrologic Region

For nearly a century, water agencies in the region have relied on importing water from the Sierra Nevada 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 River 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 freshwater flows out of the Delta annually into the bay (California Data Exchange Center [CDEC] 2000–2008). Daily tidal flux through the Carquinez Strait is much greater than the freshwater flows.

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 seven hydrologic units, as shown in Figure SFB-2. The Suisun, San Pablo, and Bay Bridges hydrologic units drain into Suisun, San Pablo, and North San Francisco Bays, respectively. The South Bay and Santa Clara hydrologic units drain into South San Francisco Bay, and the Marin Coastal and San Mateo hydrologic units drain directly into the Pacific Ocean. Figure SFB-2 also shows 16 principal watersheds in the region. The Guadalupe River and Coyote and Alameda creeks drain from the Coast Ranges and generally flow northwest into San Francisco Bay. The Alameda Creek watershed is the largest in the region at 633 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.

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

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 (see above)
- 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, and Lake Del Valle)

Groundwater Aquifers

This section is under development.

Groundwater basins underlie approximately 1,400 square miles or 30 percent of the Bay Region, and account for about 15 percent of the region's average annual water supply. The Bay Region has 28 identified groundwater basins, as shown in Figure SFB-3. The Santa Clara Valley, Livermore Valley, Westside, Niles Cone, Sonoma Valley, Napa Sonoma Lowlands, and Petaluma Valley are heavily used groundwater basins.

PLACEHOLDER Figure SFB-3 Groundwater Basins in the San Francisco Bay Hydrologic Region

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 Regional Water Quality Control Board 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.

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 regulatory changes and the creation of 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 on the West Coast that the U.S. Fish and Wildlife Service (USFWS) has designated 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 Regional Water Quality Control Board (SFRWQCB) provides technical input and permitting for thousands of acres of wetland and riparian restoration projects around San Francisco Bay.

Flood

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 rainfall 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. The Bay Region is a complex of local watersheds and receiving embayment from the Central Valley runoff of snowmelt and rain storms. In general, these watersheds are developed urban valleys or bayside alluvial plains and less-developed uplands areas. The region is characterized by flooding events when large widespread storms follow several days of rainfall. Flooding occurs locally when flood facilities and natural drainages' capacities are exceeded. In low-lying areas near the bay, including the Carquinez Strait and portions of the Delta, flooding may be exacerbated by high tides and storm surges that back up the natural riverine flows or flood channels. Thus, flooding in this region is marked by a complex and diverse range of the nature and character of storms, river flows, sea level, and topography. Added to this mix is the diverse development patterns from range lands, orchards and field crops, coastal and rural development, dense urban, suburban and hillside development affecting local runoff. Geology, soils, and topography are important aspects of flood events. Climate change-induced sea level rise is creating a new flood hazard from extreme tides on higher sea levels. (See Box SFB-1 New Feature — Near Coastal.)

PLACEHOLDER Box SFB-1 New Feature—Near-Coastal

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. 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 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 people 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 the Looking to the Future chapter to estimate the urban and agricultural changes in water demand in the Bay Region from 2006 to 2050.

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 Spanish contact and then 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 §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 disadvantaged communities (DACs) as communities with an annual median household income (MHI) less than 80 percent of the statewide average (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 low-income 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) 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 the "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 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 WWII Home Front Park, and Port Chicago Naval Magazine Memorial.

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. 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.

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 Resource Management Conditions

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 Bay 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 San Francisco Bay Joint Venture Web site, http://www.sfbayjv.org/).

State Water Resources Control Board (SWRCB) licenses and other agreements with regulatory agencies require adequate in-stream 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), with the assistance of recovery teams representing diverse interests and perspectives, created "Recovery Strategy for California Coho Salmon" (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.

The Ecosystem Restoration Program (ERP) conservation strategy for the Delta and the Suisun Marsh Planning Area provides leadership for conservation and restoration. It was developed by DFW in collaboration with USFWS and National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries). The conservation strategy is intended to facilitate coordination and integration of all resource planning, conservation, and management decisions affecting the Delta and Suisun Marsh. It is integrally linked to the Delta Vision and the conceptual models developed under the Adaptive Management Planning Team, and takes into account sea level rise projections and the effects of potential seismic events. *Environmental restoration in the Delta is discussed more in the Delta Regional Report, Volume 2 of the Water Plan Update 2013.*

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), East Bay Municipal Utilities District (EBMUD), and Santa Clara Valley Water District (SCVWD) have critical water interties to deliver water between water systems during emergencies such as earthquakes and wildfires.

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.dwr.water.ca.gov/swpao/bulletin.cfm.

For an overview of the San Francisco Bay's water flows see Figure SFB-4.

PLACEHOLDER Figure SFB-4 San Francisco Bay Regional Inflows and Outflows

Surface Water

East Bay Municipal Utility District (EBMUD) and San Francisco Public Utility Commission (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-2 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 San Francisco Water Department, the City of San Jose, cities in Alameda County, and to small developments in the surrounding mountains. The Alameda County Water District (ACWD) and Zone 7 Water Agency (Zone 7) recharge their groundwater basins with local streams, as well as with deliveries from the SWP.

PLACEHOLDER Table SFB-2 Sources of Imported Surface Water, San Francisco Bay Hydrologic Region

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 of storage — about 13 percent of its total reservoir capacity. Lake Hennessey on Conn Creek provides 31,000 acre-feet of storage. A 30-mile pipeline from the lake to the City of Napa provides the city with its primary source of water.

Groundwater

This section is under development.

Groundwater is a critical component of water supply for SCVWD, ACWD, and Zone 7 to reduce the demand on imported water. These agencies have implemented conjunctive use programs to optimize the use of groundwater and surface water resources, and water quality programs to monitor and protect groundwater quality. Additional groundwater resources, such as EBMUD's Bayside Groundwater Facility which supplies customers up to 1 million gallons per day (mgd) during dry years, are being developed throughout the region to expand the role of conjunctive use programs.

Municipal and irrigation wells 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 to approximately 3,000 gpm in the larger basins.

Recycled Water

Recycled water is used for many applications in the Bay Region, including agriculture, 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 by 2025 as reported in the 1999 Bay Area Recycled Water Master Plan. The latest SFRWQCB report states that 58,000 acre-feet of water is recycled per year of the approximately 600,000 acre-feet of wastewater generated in the region per year.

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.

The IRWM planning process has created partnerships among Bay Region agencies to further develop recycled water projects. The San Francisco Bay Area IRWMP and East Contra Costa County (ECCC) IRWMP identify several proposed recycled water projects. Collaboration between the Bay Area and the ECCC IRWM groups intends to develop joint recycled water projects.

Through IRWM, the Bay Area Regional Water Recycling Program Authorization Act was enacted in 2008. This act enabled USBR to fund eight recycled water projects under Title 16. The act also enabled the Santa Clara Valley Water District (SCVWD) to receive federal stimulus money for two recycled water projects. One project is to improve the South Bay Advanced Recycled Water Treatment Facility, a joint effort between SCVWD and the City of San Jose to treat wastewater byproducts. The other project is to develop short- and long-term content for SCVWD’s South County Recycled Water Master Plan. Two additional recycled water treatment facilities were dedicated recently — Las Gallinas Valley Sanitary District’s facility on September 25, 2012, in San Rafael; and Novato Sanitary District’s facility on October 11, 2012, in Novato.

Desalinated Water

In 2003, the ACWD dedicated the first brackish water desalination facility in Northern California and expanded it in 2010 to double its production capacity to 10 mgd. The Newark Desalination Facility receives its water from the Niles Cone Groundwater Basin, which contains some brackish water due to previous years of seawater intrusion. This was made possible as a result of ACWD Aquifer Reclamation Program (ARP), which has been working to eliminate seawater intrusion from the Niles Cone Groundwater Basin. 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 headed by the Contra Costa Water District (CCWD), EBMUD, SFPUC, and SCVWD has been considered since 2003. In 2010, Zone 7 joined this group. Their research led them to believe a facility could be built at CCWD Mallard Slough Pump Station. In order for it to be viable and reasonable, the group agreed that a 10 to 20 mgd facility would be best. As of 2013, this project is in the planning phase, but progress is being made in the form of studies and simulations.

MMWD is processing a desalination project off the coast of San Rafael. A recent decision by a Court of Appeal upheld the environmental document. Voter approval is needed for financing the planning, design, and permitting. As of 2013, there are no plans to move forward, although this could change depending on other sources of water.

Water Uses

Drinking Water

The SFRWQCB works with local water and sanitary districts to reduce the need for water imports by promoting the recycling of wastewater and the collection of stormwater in cisterns, groundwater basins, and local retention basins for safe uses in the Bay Region.

The region has an estimated 190 community drinking water systems (Table SFB-3). Over 60 percent are small systems serving fewer than 3,300 people; with most of them serving fewer than 500 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).

PLACEHOLDER Table SFB-3 Community Drinking Water Systems, San Francisco Bay Hydrologic Region

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 that 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 100 gallons per day (gpd); ACWD 160 gpd; and MMWD 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.

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 and a reduction in total industry per capita water use over time. Currently, the Delta Diablo Sanitation District provides 8600 acre-feet per year of recycled water 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 undertaking another large industrial project with the Valero Refining Company to supply up to 2 mgd of high purity recycled water to Valero's Benicia refinery for use as cooling tower make-up water. This project would reduce Valero's demand for water from 4,480 to 5600 acre-feet per year to as little as 2,240 acre-feet per year.

Water Conservation Act of 2009 (SB x7-7) Implementation Status and Issues

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 Law of 2009 (SBx7-7). 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 website at www.water.ca.gov/wateruseefficiency.

SBx7-7 also required agricultural water suppliers which 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. The Bay Region does not have any agricultural water suppliers which serve more than 25,000 acres; so none of them submitted an agricultural water management plan.

Water Balance Summary

The Bay Region consists of two planning areas, which are separated by the natural waterways of the Delta. The North Bay Planning Area (PA 201) lies north of the confluence of the Sacramento and San Joaquin rivers, Suisun Bay, San Pablo Bay, and Golden Gate. The urban applied water ranges between 145 and 160 thousand acre-feet (taf), about two-thirds of which is residential and the remainder commercial and industrial uses. Agricultural applied water averages about 92 taf, depending on the amount of rainfall in a particular year.

There are three rivers with instream flow requirements in PA 201 — Lagunitas Creek, Milliken Creek, and the San Joaquin River. The instream flows range from 0.4 to 1.5 maf. There are a few managed wetlands using about 1 taf per year. Brackish water that supplies the Suisun Marsh is not accounted for in the Water Balances as this supply is not a freshwater source of supply.

The instream supplies for PA 201 come from local rivers (primarily the San Joaquin River). Much of the urban supply comes from SWP (30-40 taf), federal deliveries (31-38 taf), or are locally imported (20-33 taf). Some groundwater is also extracted (75-100 taf), probably for agricultural use.

The South Bay Planning Area (PA 202) is primarily urban. Urban applied water ranges from about 0.9 to

1 maf, with about 60 percent being used for residential interior and exterior and the remainder commercial and industrial. From 60 to 115 taf of urban applied water are recharged into the groundwater basin. Agriculture uses about 20 to 25 taf in the planning area.

Environmental water use consists of about 3 taf annually applied to managed wetlands. There are no instream or wild and scenic requirements in PA 202.

Water supply comes from a variety of sources — locally (90-190 taf), locally imported (420-470 taf), CVP (90-176 taf), SWP (65-160 taf), groundwater (170-180 taf, most or all of which is offset by intentional recharge), reuse (3-25 taf), recycle (27-35 taf), and desalination (1.4 taf annually). Figure SFB- 5 and Table SFB-4 shows the Bay Region's water balance for 2001-2010.

PLACEHOLDER Figure SFB-5 San Francisco Bay Hydrologic Region Water Balance by Water Year, 2001-2010

PLACEHOLDER Table SFB-4 San Francisco Bay Hydrologic Region Water Balance Summary for 2001-2010 (thousand acre-feet)

Project Operations

State, federal, and local conveyance systems deliver water to the Bay Region, as described in the Water Supplies section. The water is stored in over 30 reservoirs throughout the region. This section lists some of the larger reservoirs and their capacities, and discusses ongoing seismic retrofits to dams that impound some of the reservoirs.

East Bay Reservoirs

- San Pablo Reservoir (38,600 acre-feet)
- Lafayette Reservoir (4,300 acre-feet)
- Del Valle Reservoir (77,000 acre-feet)
- Lake Anza (268 acre-feet)
- Lake Temescal (200 acre-feet)
- Lake Chabot (10,280 acre-feet)
- Cull Canyon Reservoir (310 acre-feet)
- Calaveras Reservoir (100,000 acre-feet)

Santa Clara County Reservoirs

- Almaden Reservoir (2,000 acre-feet)
- Anderson Reservoir (90,000 acre-feet)
- Calero Reservoir (9,850 acre-feet)
- Coyote Reservoir (23,666 acre-feet)
- Lexington Reservoir (21,430 acre-feet)
- Stevens Creek Reservoir (3,800 acre-feet)
- Vasona Reservoir (410 acre-feet)
- Chesbro Reservoir (3,000 acre-feet)

Marin County Reservoirs

- Lagunitas Reservoir (341 acre-feet)
- Alpine Reservoir (8,892 acre-feet)

- Bon-Tempe Reservoir (4,300 acre-feet)
- Kent Reservoir (32,900 acre-feet)
- Phoenix Reservoir (612 acre-feet)
- Nicasio Reservoir (22,400 acre-feet)
- Soulajule Reservoir (10,572 acre-feet)

SCVWD operates 10 reservoirs for water supply and groundwater recharge. The reservoirs have a total capacity of 169,000 acre-feet. The largest is Anderson Reservoir near the City of Morgan Hill with a capacity of 90,000 acre-feet. However, five of the reservoirs, including Anderson Reservoir, are kept low while their dams undergo seismic retrofits. Approximately 46,300 acre-feet of water storage, 27 percent of the total capacity, is lost during the retrofits which will take years. Additional water storage is lost while SFPUC's Calaveras Dam (100,000 acre-foot capacity) is retrofitted.

Water Quality

The SFRWQCB 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 the different 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 pesticides. These residues include mercury, PCBs, selenium, and chlorinated pesticides. Emerging pollutants in the region include flame retardants, perfluorinated compounds, nonylphenol fipronil, and pharmaceuticals. The SFRWQCB 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. Cleaning up 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 Bay 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). The SFRWQCB 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 SFRWQCB 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 reverse these percentages so that in-bay disposal decreases and more dredged material is used, preferably for wetland restoration. SFRWQCB 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 SFRWQCB, 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 SFRWQCB, 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 SFRWQCB 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 SFRWQCB also directs technical assistance and grant funding to locally managed watershed programs working on restoration projects and education and outreach efforts.

The SFRWQCB regulates wastewater discharged into coastal ocean waters in the Bay Region and regulates use of the California Ocean Plan, which SWRCB adopted in 1972. The plan establishes water quality standards that regulate California's coastal ocean waters and 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 28 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 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, and the "Brownfields" sites (in general, these are contaminated former industrial sites in urban areas that are suitable for redevelopment).

The SFRWQCB 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 Sonoma Valley County Sanitation District (SVCSD), Zone 7, and SCVWD 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 is developing 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 River 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.

The SFRWQCB contributed to the 2012 Draft Report, "Communities that Rely on Contaminated Groundwater", which assesses community drinking water systems in the region. While most community drinking water systems comply with drinking water standards, the report identifies 28 wells in 18 water systems that rely on contaminated groundwater. A well is considered contaminated if a primary drinking water standard is exceeded. Most of the affected systems are small systems which often need financial assistance to construct a water treatment plant or another facility to meet drinking water standards. The most prevalent contaminants are nitrate, arsenic, and aluminum.

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 Bay 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 the California 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. Table SFB-6 shows the region's exposure to flooding from the 100- and 500-year floods. Figure SFB-6 illustrates the FEMA 100- and 500-year flood zones.

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.

PLACEHOLDER Table SFB-5 Exposure to 100-year and 500-year floods, San Francisco Bay Hydrologic Region

PLACEHOLDER Figure SFB-6 FEMA 100-year and 500-year Flood Zones, San Francisco Bay Hydrologic Region

The region has 150 public agencies that manage floods with 2,588 miles of levees and 222 dams and weirs (Table SFB-6). An additional 121 local projects are planned to alleviate flooding, including several projects which address coastal flooding due to sea level rise, which is a major concern in this densely populated region. Refer to the California Flood Future Report, Attachment G: Risk Information Inventory for a complete list of projects (http://www.water.ca.gov/sfmp/flood-future-report.cfm).

PLACEHOLDER Table SFB-6 Flood Management Agencies, San Francisco Bay Hydrologic Region

Sea Level Rise

One of the most publicized impacts of climate change is a predicted acceleration of sea level rise. This acceleration would increase the historical rate of sea level rise, which has been measured in San Francisco Bay for over 140 years. Between 1900 and 2000, the level of the Bay increased by 7 inches. Depending on which end of the range of projected temperature increases comes about, the California Climate Action Team found that water levels in San Francisco Bay could rise an additional 5 inches to 3 feet, or nearly one meter by the end of this century.

More recent analyses indicate that sea level rise from warming oceans may be 1.43 meters (about 55 inches) over the next 100 years, or even higher depending upon the rate at which glaciers and other ice sheets on land melt. Using GIS data, BCDC has prepared illustrative maps showing that a one-meter rise in the level of the bay could flood over 200 square miles of land and development around the Bay. Using financial support from Caltrans and the California Energy Commission, the Pacific Institute is working in partnership with BCDC to determine the value of the development threatened with inundation. Initial estimates indicate that over $100 billion worth of public and private development could be at risk. Impacts from sea level rise are most likely to occur in concert with other forces that already contribute to coastal flooding. When superimposed on higher sea levels these conditions will combine to create short-term extremely high water levels that can inflict damage to areas that were not previously at risk. For example, computer models indicate that a one-foot rise in sea level will increase the likelihood that the most extreme storm surge event which now occurs once a century, will occur once every 10 years. While storm impacts cannot be mapped as easily as sea level rise can, it is likely that larger areas will flood during future storm events.

Sea level rise will affect and threaten coastal communities, facilities and infrastructure through more frequent flooding and gradual inundation, as well as increased erosion of coastal bluffs, and river surges affecting local flooding. This will affect roads, utilities, wastewater treatment plants, outfalls, and storm water facilities and systems as well as large wetland areas in addition to towns and cities. Where land is rising — tectonic effects — the rate of sea level rise may be exceeded by the rate of coastal uplift. However, in the North Coastal area the rate of tectonic uplift is greater than current rate of sea level rise.

The risk assessment for flooding is incorporating the vulnerability of the North Coast region based on the rate and magnitude of sea level rise and its impacts. Those communities and facilities at risk are incorporating hazard mitigation measures into planning and management strategies. As the California Flood Futures report identifies, the first strategy is to identify and evaluate sea level rise risks and determine the areas that are most vulnerable to future flooding, inundation, erosion and wave impacts, and to develop hazard mitigation and adaptation plans.

Where coastal bluff erosion is high, coastal cliff retreat is dramatic with collapsed roadways, undermined foundations, dangling decks and stairways and structures. Coastal erosion tends to be episodic, with long-term cliff and bluff failure occurring during a few severe storm events. Scientists consider the probability that these events will increase in frequency and intensity. The California Coastal Commission database for coastal erosion is a valuable resource and available on CD (Dare 2005). A key component to coastal management is understanding the adaptive capacity of the affected areas. This capacity is the ability to prepare for, respond to, and recover from sea level rise impacts.

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.

Three important reservoirs in the region have a designated flood protection function — Lake Chesbro, Lake Del Valle, and Cull Creek Reservoir with 3,000; 38,000; and 310 acre-feet of flood control capacity, respectively. SCVWD constructed Lake Chesbro to protect San Jose. Lake Del Valle is a SWP facility that protects Pleasanton, Fremont, Niles, and Union City. Alameda County Flood Control and Water Conservation District (Alameda County FCWCD) constructed Cull Creek 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-7 shows important flood control facilities in the region.

PLACEHOLDER Table SFB-7 Flood Control Facilities, San Francisco Bay Hydrologic Region

Maintenance of flood control facilities is critical to preserve the integrity of the facilities and to uphold sustained public protection. Maintenance is made difficult by two factors — adequate financing and 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 SFRWQCB is working with flood control entities in the region to minimize 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 plan. 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 administer 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 update 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; while Marin, Napa, San Francisco, and Sonoma 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 enables the agencies to capitalize on collective resources, expertise, and knowledge to achieve water quality and water supply reliability goals.

There are many wastewater management agencies in the Bay Region, including cities, sanitation districts, community services districts, counties, and other local agencies. Like water supply agencies, wastewater management agencies have recognized the value in regional cooperation and collaboration as a means of advancing shared interests and resolving common issues. Many wastewater agencies are represented by BACWA, which has a long history of providing a forum for coordination on regional wastewater management issues.

The 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 10 agencies as signatories: Alameda, Contra Costa, Marin, Napa and San Mateo County FCWCD; the City and County of San Francisco Department of Public Works; 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). ABAG is the Council of Government (COG) for the Bay Area. 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. (See Box SFB-2.)

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

In July 2013, ABAG and MTC adopted the Plan Bay Area, which is an integrated transportation and land-use strategy to meet the requirements of Senate Bill 375 for a Sustainable Communities Strategy to accommodate future population growth and reduce greenhouse gas emissions from cars and light trucks (Steinberg 2008). The plan provides a strategy for meeting 80 percent of the region's future housing needs in Priority Development Areas (PDAs) or neighborhoods within walking distance of frequent transit service and mixed uses of residential and commercial.

DWR has accepted two Bay Region IRWM groups. Figure SFB-7 shows the two groups — the San Francisco Bay Area IRWM group and the ECCC IRWM group. The Bay Area group conducts the majority of IRWM planning in the region. The ECCC 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 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 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.

PLACEHOLDER Figure SFB-7 Integrated Regional Water Management Groups in the San Francisco Bay Hydrologic Region

San Francisco Bay Area IRWM Group

The Bay Area IRWM Group is developing 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 the Looking to the Future chapter.

The 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
- 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 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, disadvantaged communities, 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 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, including over 120 projects proposed to benefit disadvantaged communities. 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 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 Project Implementation for more information on the 19 projects. Also see http://bairwmp.org/projects for full descriptions and scores of all 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.

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 million 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 San Francisco Bay Area IRWMP. The 23 projects consist of 3 green infrastructure projects, 7 recycled water projects, 3 wetland ecosystem restoration projects, a water conservation project, and 9 integrated projects in DACs (water quality, flood management, ecosystem restoration).

Proposition 1E

- **Phoenix Lake IRWM Retrofit (Marin County FCWCD; $7.661 million 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 million 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 million 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.
- **San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project, East Bayshore Road to San Francisco Bay (San Francisquito Creek JPA; $8 million 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)

Current Relationships with Other Regions and States

The Bay Region is a major importer of water supplies from other regions of California, as shown previously by Table SFB-2. The North Bay imports water from several sources including the Russian and Eel rivers, Putah Creek, the NBA (SWP), and Vallejo Permit Water. Sonoma County Water Agency 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 FERC 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 acre-feet. The old Cache Slough facilities were not abandoned and could be used for future diversions.

The southern and eastern areas of the Bay Region import water from the Mokelumne and Tuolumne rivers, 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, Sacramento River, or Victoria Canal. 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 1.7 million people through the CVP's San Felipe Unit under a contract for 152,500 acre-feet 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. See Figure SFB-8 for a graphical depiction of Bay Region water imports, as well as Sacramento and San Joaquin River inflows and Pacific Ocean outflow.

PLACEHOLDER Figure SFB-8 Water Imports to the San Francisco Bay Hydrologic Region

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 IRWMP:

- 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 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.

Project Implementation

To achieve many of the goals and objectives of the updated Bay Area IRWMP, the group is proposing to implement 19 water enhancement projects with the help of $20 million in Proposition 84 Implementation Grant funding. The total cost of the projects, which are listed and described in Table SFB-8, is estimated to be approximately $56.5 million.

PLACEHOLDER Table SFB-8 Proposed Water Enhancement Projects, San Francisco Bay Hydrologic Region

Another initiative for the San Francisco Bay Area IRWM 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 understand and manage the region’s water resources better. Some potential new data monitoring programs are shown in Table SFB-9.

PLACEHOLDER Table SFB-9 Potential New Data Monitoring Programs, San Francisco Bay Hydrologic Region

Accomplishments

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.

Another significant restoration project is part of the Napa River Flood Control Project. The project includes the restoration of 659 acres of wetlands, 2 miles of lower Napa Creek, and 3.2 miles of floodplain and marsh plain terrace along the lower Napa River. The SFRWQCB has partnered with local, State, and federal agencies to restore an additional 4.5 miles of floodplain, riparian habitat, and fish habitat. Plans to restore the river from Oak Knoll Avenue to Oakville would extend the restored river corridor 13 miles upstream.

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 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 and beaver colonies in urban floodways pose additional challenges. 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. 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.

The San Francisco Bay Area IRWM 2013 Plan states that sea level rise is expected to increase the risk of coastal erosion and flooding along the California coast, and higher water levels due to sea level rise could magnify the adverse impact of storm surges and high waves. Impacts to assets from extreme high tides in addition to net increases in sea level will likely result in increased inundation frequency, extents, and depths leading to catastrophic flooding and coastal erosion. Understanding the extent, depth, and duration of inundation and the patterns of erosion will be necessary for characterizing infrastructure vulnerability in coastal areas. The picture is further complicated by the concurrent vertical movement of the land due to tectonic activity. Projections of the relative sea level, the sum of both sea level rise and vertical land movement, are therefore important in the Bay Region.

Sea level rise will have a significant impact on the Bay Region. Water levels in San Francisco Bay have risen nearly 8 inches over the past century, and scientists agree that the rate of sea level rise is accelerating. While exact future increases in sea level rise are uncertain, scientists believe it is likely that the bay will rise 10 to 17 inches by 2050, 17 to 32 inches by 2070, and 31 to 69 inches at the end of the century. Between 1850 and 1960, about a third of the bay (240 square miles) was filled high enough to be above current sea level, but not above future sea level. Also, large portions of the South Bay are below current sea level. Studies show that 330 square miles of low-lying land around the bay may be vulnerable to sea level rise over the next century.

Present sea level rise projections suggest that global sea levels in the 21st century can be expected to be much higher than the recorded increase rise since 1854 of 7.6 inches. These projections are summarized in the State of California Sea-Level Rise Guidance Document (Ocean Protection Council 2013)

Drought Planning

Many of the water suppliers in the Bay Region have urban water management plans, in accordance with the 1983 California Urban Water Management Planning Act. Suppliers such as SFPUC and EBMUD have urban water management plans, which contain strategies to address drought. These strategies include developing alternative dry-year water supply options, adopting water shortage allocation plans, and being prepared for catastrophic water supply interruptions.

Looking to the Future

Future Conditions

Future Water Demands

In this section, a description is provided for how future San Francisco Bay Hydrologic Region water demands might change under scenarios organized around themes of growth and climate change described earlier. The change in water demand in the Bay Region from 2006 to 2050 is estimated for agriculture and urban sectors under 9 growth scenarios and 13 scenarios of future climate change. The climate change scenarios included the 12 Climate Action Team scenarios described earlier and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a “without climate change” condition. Urban and agricultural demand changes are illustrated in box plots. A box plot is a graphical representation showing the minimum, 25th percentile, median, 75th percentile, and maximum values. The red dot shows the mean or average value. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050. (See Box SFB-3)

PLACEHOLDER Box SFB-3 Scenario Descriptions

Urban Demand Change

Figure SFB-7 shows a box plot of change in urban water demand under 9 growth scenarios for the San Francisco Bay Hydrologic Region with variation shown across 13 scenarios of future climate including one scenario representing a repeat of the historical climate. Urban demand is the sum of indoor and outdoor water demand where indoor demand is assumed not to be affected by climate. Outdoor demand, however, is dependent on climate factors like amount of precipitation falling and the average air temperature. Urban demand increased under all high and current trend growth scenarios tracking with population growth, but it decreased under low population scenarios. On average, it increased by about 780 taf under the three high population scenarios, 260 taf under the three current trend population scenarios, and decreased by about 10 taf under low population scenarios when compared to historical average of about 1,070 taf. The results show change in future urban water demands are less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

PLACEHOLDER Figure SFB-9 Change in Urban Water Demand

Agricultural Demand Change

Figure SFB-8 shows a box plot of statewide change in agricultural water demand in the San Francisco Bay Hydrologic Region under 9 growth scenarios with variation shown across 13 scenarios of future climate including one scenario representing a repeat of the historical climate. Agricultural water demand decreases under high and current trend population scenarios due to reduction in irrigated lands as a result of urbanization and background water conservation when compared with historical average water demand of about 120 taf. Under high population, it decreased by 15 taf; and under current trend population, it decreased by about 2 taf. But under the three low population scenarios, the agricultural water demand actually increased. This was probably due to lack of enough urbanization footprint and little loss of agricultural lands to offset the increasing agricultural water demand due to warming climate. On average, for the three low population scenarios, this increase in water demand was about 5 taf shown by the positive mean value (red circle) in Figure SFB-8.

PLACEHOLDER Figure SFB-10 Change in Agricultural Water Demand

Integrated Water Management Plan Summaries

Inclusion of the information contained in IRWMP's into the CWP 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 Integrated Water Management Plan in a consistent format for each of the regional reports. This collection of information will not be used to determine IRWM grant eligibility. This effort is ongoing and will be included in the final CWP updates and will include up to 4 pages for each IRWMP in the regional reports.

In addition to these summaries being used in the regional reports we intend to provide all of the summary sheets in one IRWMP Summary "Atlas" as an article included in Volume 4.   This atlas will, under one cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management accomplishments and challenges. The atlas will showcase how the dedicated efforts of individual regional water management groups (RWMGs) have individually and cumulatively transformed water management in California.

All IRWMP's are different in how are organized and 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 IRWMP's, 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 the CWP 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 IRWMP's are released or existing IRWMP's are updated.

As can be seen in Figure SFB-11 there is one IRWM planning effort that is ongoing in the san Francisco Bay Hydrologic Region.

PLACEHOLDER Figure SFB-11 Integrated Water Management Planning in San Francisco Bay

Hydrologic Region

Placeholder Text: At the time of the Public Review Draft the collection of information out of the IRWMP's in the region has not been completed. Below are the basic types of information this effort will summarize and present in the final regional report for each IRWMP available. An opportunity will be provided to those with responsibility over the IRWMP to review these summaries before the reports are final.

Region Description: This section will provide a basic description of the IRWM region. This would include location, major watersheds within the region, status of planning activity, and the governance of the IRWM. In addition, a IRWM grant funding summary will be provided.

Key Challenges: The top five challenges identified by the IRWM would be listed in this section.

Principal Goals/Objective: The top five goals and objectives identified in the IRWMP will be listed in this section.

Major IRWM Milestones and Achievements: Major milestones (Top 5) and achievements identified in the IRWMP would be listed in this section.

Water Supply and Demand: A description (one paragraph) of the mix of water supply relied upon in the region along with the current and future water demands contained in the IRWMP will be provided in this section.

Flood Management: A short (one paragraph) description of the challenges faced by the region and any actions identified by the IRWMP will be provided in this section.

Water Quality: A general characterization of the water quality challenges (one paragraph) will be provided in this section. Any identified actions in the IRWMP will also be listed.

Groundwater Management: The extent and management of groundwater (one paragraph) as described in the IRWMP will be contained in this section.

Environmental Stewardship: Environmental stewardship efforts identified in the IRWMP will be summarized (one paragraph) in this section.

Climate Change: Vulnerabilities to climate change identified in the IRWMP will be summarized (one paragraph) in this section.

Tribal Communities: Involvement with tribal communities in the IRWM will be described (one paragraph) in this section of each IRWMP summary.

Disadvantaged Communities: A summary (one paragraph) of the discussions on disadvantaged communities contained in the IRWMP will be included in this section of each IRWMP summary.

Governance: This section will include a description (less than one paragraph) of the type of governance the IRWM is organized under.

Resource Management Strategies

Volume 3 contains detailed information on the various strategies which can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in the available IRWMP's are summarized in Table SFB-10.

PLACEHOLDER Table SFB-10 Resource Management Strategies addressed in IRWMP's in the San Francisco Bay Hydrologic Region

Regional 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 & Regional Promotion of Green Infrastructure
- Hacienda Avenue "Green Street" Improvement
- Napa Valley Rainwater Harvesting

Recycled Municipal Water

- Central Contra Costa Sanitary District (CCCSD)/Concord Recycled Water Project (Phase I)
- Dublin San Ramon Service District (DSRSD) 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 (LGVSD)/NMWD Novato South Service Area Project
    - Napa Sanitation District NSH Pipeline Construction Stage 1 Project
    - Sonoma Valley County Sanitation District (SVCSD) Recycled Water Stage 1 Project
- SFPUC Harding Park Recycled Water Project
- South Bay Water Recycling (SBWR) 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 (S.F. Estuary Steelhead Monitoring Program)

Urban Runoff Management

The SFRWQCB, the San Francisco Estuary Project, municipal stormwater agencies, and other partners promote Low Impact Development in the Bay Region. LID is a design approach that manages stormwater runoff to replicate pre-development hydrology. It promotes using natural on-site features to protect water quality and detain runoff.

Pollution Prevention

The SFRWQCB adopts 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.

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 water, transportation and energy infrastructure, public health, biodiversity, and agriculture (USGRCP, 2009; CNRA, 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. 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 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 exists to warrant the importance of contingency plans, mitigation (reduction) of greenhouse gas (GHG) emissions, and incorporating adaptation strategies; methodologies and infrastructure improvements that benefit the region at present and into the future. While the State is taking aggressive action to mitigate climate change through GHG reduction and other measures (CARB, 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 (IPCC, 2007).

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. (EPA/DWR, 2011; Cal-EMA/CNRA, 2012).

Observations

The region's observed temperature and precipitation vary greatly due to complex topography and relation to the Pacific Ocean. Regionally-specific air temperature trendsfor the past century are available from the Western Regional Climate Center (WRCC). 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 1.1-2.0°F (0.6-1.1°C), with minimum values increasing more than maximums [1.6-2.6 °F (0.9-1.4 °C) and 0.4-1.5°F (0.2-0.8°C), respectively]. Inland, temperatures in the Sacramento-Delta Region show a similar warming trend. A mean increase of 1.5-2.4°F (0.8-1.3°C) was recorded, with minimum temperatures increasing 2.1-3.1°F (1.2-1.7°C) and maximum temperatures increasing 0.7-1.9°F (0.4-1.1°C). Mean annual precipitation in Northern California has increased slightly in the 20th century, and precipitation patterns in the region have considerable geographic and annual variation (DWR 2006)

In the 20th century, tide gages and satellite altimetry show that global mean sea level has risen about seven inches. 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 seven 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 yr-1 (1.02 +/- 1.73 mm yr-1) south of Cape Mendocino which is lower than the current rate of global mean sea level rise (NAS 2012).

Projections and Impacts

While historic data is a measured indicator of how the climate is changing, it can't project what future conditions may be like under different GHG emissions scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date, and indicates by 2060-2069, temperatures will be 3.4 -4.9oF (1.9 -2.7oC) higher across the state than they were from 1985 to1994 (Pierce et al, 2012). In the Bay Region, the study projects that annual temperatures will increase 3.6-4.1oF (2.0-2.3oC), with a 2.9-3.1oF (1.6-1.7oC) increase in winter temperatures and a 4.1-5.2oF (2.3-2.9oC) 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 4-5oF (2.2-2.8oC) in the winter and 5-6oF (2.8-3.3oC) in the summer (Cal-EMA and CNRA, 2012).

Changes in annual precipitation across California, either in timing or total amount, will result in changes in type of precipitation (rain or snow) in a given area, 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). Since there is less scientific detail on localized precipitation changes, there exists a need to adapt to this uncertainty at the regional level (Qian, Y., et al, 2010).

Given these projections, climate change is anticipated to present significant water resource management challenges to the Bay Region. Approximately 70% 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 historic average snowpack by the end of this century (van Vuuren et al., 2011).

Coastal observations and global model projections indicate that the California coast and estuaries will experience increasing mean sea levels during the next century, which will significantly affect development and infrastructure in the Bay Region. Mean sea levels are projected to rise 5 to 24 inches (12-61cm) by 2050 and 17 to 66 inches (42-167 cm) by 2100 (National Research Council [NRC], 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% 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 (BCDC, 2011). Also, the expected increase in both the intensity and frequency of storms will 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 will be vulnerable to inundation, erosion, and changes in sediment supply. The highly developed shoreline will constrain the ability of these habitats to migrate landward (BCDC, 2011). These habitat changes, along with changes to freshwater inflow and water quality, will impact the species composition in the Bay.

Adaptation

Climate change has the potential to impact the region, which the State depends upon for its economic and environmental benefits. These changes will 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 eco-regions. Built systems will be impacted by changing hydrology and runoff timing, 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 ap-proach 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 (USEPA and DWR, 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)

Integrated Regional Water Management (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 (DWR, 2010). 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 (USEPA and DWR, 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 underway, 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 policymakers 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 finding one adaptation strategy that works throughout the region difficult. 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 tools and resources to assist resource managers and local agencies in adapting to climate change, including:

- California Climate Adaptation Strategy (2009) — California Natural Resources Agency (CNRA) at: http://www.climatechange.ca.gov/adaptation/strategy/index.html
- California Climate Adaptation Planning Guide (2012) — California Emergency Management Agency (Cal-EMA) and CNRA at: http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html
- Cal-Adapt Web site at: http://cal-adapt.org/
- Urban Forest Management Plan (UFMP) Toolkit — sponsored by the California Department of Forestry and Fire Management at: http://ufmptoolkit.com/
- California Climate Change Portal at: http://www.climatechange.ca.gov/
- DWR Climate Change Web site at: http://www.water.ca.gov/climatechange/resources.cfm
- The Governor's Office of Planning and Research (OPR) Web site at: http://www.opr.ca.gov/m_climatechange.php

Many of the resource management strategies found in Volume 3 not only assist in meeting water management objectives, but also provide benefits for adapting to climate change. These strategies include:

- Agricultural and Urban Water Use Efficiency
- Conveyance – Regional/Local
- System Reoperation
- Desalination
- Recycled Municipal Water
- Surface Storage – Regional/Local
- Pollution Prevention
- Agricultural Lands Stewardship
- Ecosystem Restoration
- Land-Use Planning and Management
- Watershed Management
- Integrated Flood 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 has a large energy footprint, consuming 7.7% of statewide electricity (CPUC, 2010). Energy is used in the water sector to extract, convey, treat, distribute, use, condition, and dis-pose of water. Figure 3-26, Water-Energy Connection in Volume 1, CA Water Today 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 the 2013 California Water Plan Update are the first to provide detailed information on the water-energy connection, including energy intensity (EI) information at the regional level. This 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 deman. Since energy usage is related to Greenhouse Gas (GHG) emissions, this information can support measures to reduce GHG’s, as mandated by the State.

Figure SFB-12 shows the amount of energy associated with the extraction and conveyance of 1 acre-foot of water for each of the major sources in this region. The quantity used is also included, as a percent. For reference, Figure 3-26, Water-Energy Connection in CA Water Today, Volume 1 highlights which water-energy connections are illustrated in Figure SFB-12; only extraction and conveyance of raw water. 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 by gravity to the delivery location and therefore do not require any energy to extract or convey (represented by a white light bulb).

Recycled water and water from desalination used within the region are not show in Figure SFB-12 because their energy intensity differs in important ways from those water sources. The energy intensity 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-12. For these reasons, discussion of energy intensity of desalinated water and recycled water are included in Volume 3, Resource Management Strategies.

Energy intensity, sometimes also known as embedded energy, is the amount of energy needed to extract and convey (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 no energy for extraction, while others like groundwater or sea water 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, typically but not always a water treatment facility. Conveyance can include pumping of water up hills and mountains or can occur by gravity) an acre-foot of water from its source (e.g. groundwater or a river) to a delivery location, such as a water treatment plant or a State Water Project (SWP) delivery turnout (Energy from low-head pump lifts (less than 50 feet) used to divert water out of river channels or canals has been excluded from the calculations.). Energy intensity should not be confused with total energy—that is, the amount of energy (e.g. kWh) required to deliver all of the water from a water source to customers within the region. Energy intensity focuses not on the total amount of energy used to deliver water, but rather the energy required to deliver a single unit of water (in kWh/acre-foot). In this way, energy intensity gives a normalized metric which can be used to compare alternative water sources.

In most cases, this information will not be of 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 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. It's important to note that water supply planning must take into consideration a myriad of different factors in addition to energy impacts; costs, water quality, opportunity costs, environmental impacts, reliability and other many other factors.

Energy intensity is closely related to Greenhouse Gas (GHG) emissions, but not identical, depending on the type of energy used (see CA Water Today, Water-Energy, Volume 1). In California, generation of 1 megawatt-hour (MWh) of electricity results in the emission of about 1/3 of a metric ton of GHG, typically referred to as carbon dioxide equivalent or CO2e (eGrid, 2012). This estimate takes into account the use of GHG-free hydroelectricity, wind, and solar and fossil fuel sources like natural gas and coal. The GHG emissions from a specific electricity source may be higher or lower than this estimate.

Reducing GHG emissions is a State mandate. Water managers can support this effort by considering energy intensity factors, such as those presented here, in their decision making process. Water use efficiency and related best management practices can also reduce GHGs (See Volume 2, Resource Management Strategies).

Accounting for Hydroelectric Energy

Generation of hydroelectricity is an integral part of many of the state's large water projects. In 2007, hydroelectric generation accounted for nearly 15% of all electricity generation in California. The State Water Project, Central Valley Project, Los Angeles Aqueduct, Mokelumne Aqueduct, and Hetch Hetchy Aqueducts 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 (In-conduit generating facilities refer to hydroelectric turbines that are placed along pipelines to capture energy as water runs downhill in a pipeline (conduit).) generating facilities. Hydroelectricity is also generated at hundreds of smaller reservoirs and run-of-the-river turbine facilities.

Hydroelectric generating facilities at reservoirs provide unique benefits. Reservoirs like the State Water Project's Oroville Reservoir are operated to build up water storage at night when demand for electricity is low, and release the water during the day time hours when demand for electricity is high. This operation, common to many of the state's hydropower reservoirs, helps improve energy grid stabilization and reliability and reduces GHG emissions by displacing the least efficient electricity generating facilities. Hydroelectric facilities are also extremely effective for providing back-up power supplies for intermittent r3newable resources like solar and wind power. Because the sun can unexpectedly go behind a cloud or the wind can die down, intermittent renewables need back up power sources that can quickly ramp up or ramp down depending on grid demands and generation at renewable power installations.

Despite these unique benefits and the fact that hydroelectric generation was a key component in the formulation and approval of many of California's water systems, accounting for hydroelectric generation in energy intensity calculations is complex. In some systems like the SWP and CVP, water generates electricity and then flows back into the natural river channel after passing through the turbines. In other systems like the Mokelumne aqueduct water can leave the reservoir by two distinct out flows, one that generates electricity and flows back into the natural river channel and one that does not generate electricity and flows into a pipeline flowing into the East Bay Municipal Utility District service area. In both these situations, experts have argued that hydroelectricity should be excluded from energy intensity calculations because the energy generation system and the water delivery system are in essence separate (Wilkinson, 2000).

DWR has adopted this convention for the energy intensity for hydropower in the regional reports. All hydroelectric generation at head reservoirs has been excluded from Figure SFB-12. Consistent with Wil-kinson (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 San Francisquito, San Fernando, Foothill and other power plants on the system (downstream of the Owen's River Diversion Gates). DWR 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 energy intensity is reported as zero (0). I.e., no water system is reported as a net producer of electricity, even though several systems do produce more electricity in the conveyance system than is used (e.g., Los Angeles Aqueduct, Hetch Hetchy Aqueduct).(For detailed descriptions of the methodology used for the water types presented, see Technical Guide, Volume 5).

PLACEHOLDER Figure SFB-12 Energy Intensity of Raw Water Extraction and Conveyance in the

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Additional References

Personal Communications

Table SFB-1 Water Governance, San Francisco Bay Hydrologic Region

Local Water Supply Agencies
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
Local Wastewater Management Agencies
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
State Government Agencies
California Department of Water Resources, State Water Resources Control Board, San Francisco 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
Federal Government Agencies
Bureau of Reclamation, Federal Energy Regulatory Commission, United States Environmental Protection Agency, United States Army Corps of Engineers, National Oceanic and Atmospheric Administration Fisheries, United States Fish and Wildlife Service

Table SFB-2 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 (acre-feet)
San Felipe Unit of CVP	Delta via San Luis Reservoir	USBR (CVP)	Santa Clara and San Benito Counties	42,100 (6%)
Sonoma and Petaluma Aqueducts	Russian River	SCWA	Sonoma and Marin Counties	19,300 (3%)
North Bay Aqueduct - SWP	Northern Delta	DWR (SWP)	Solano and Napa Counties	31,300 (4%)
Putah South Canal	Lake Berryessa	USBR	Solano County	34,500 (5%)
Contra Costa Canal	Western Delta	CCWD (CVP)	Contra Costa County	54,100 (8%)
South Bay Aqueduct - SWP	Delta	DWR (SWP)	Alameda and Santa Clara Counties	133,900 (19%)
South Bay Aqueduct - SWP	Wheeled	DWR (SWP)	Alameda County	15,000 (2%)
Mokelumne Aqueduct	Mokelumne River	EBMUD	Alameda and Contra Costa Counties	159,000 (22%)[1]
Hetch Hetchy Aqueduct	Tuolumne River	SFPUC	San Francisco, San Mateo, Alameda, and Santa Clara Counties	218,000 (31%)[1]

1. Volume does not include storage change at reservoirs along conveyance facility.

Table SFB-3 Community Drinking Water Systems, San Francisco Bay Hydrologic Region

Community drinking water system	Number	Percent	Population served	Percent of population served
Large (> 10,000 people)	54	28	6,381,090	98.3
Medium (3,301 to 10,000 people)	7	4	48,619	0.7
Small (500 to 3,300 people)	27	14	49,051	0.8
Very Small (< 500 people)	96	51	12,484	0.2
Wholesale	6	3	-	-
Total	190	100	6,491,244	100
			6,976,224 in SB x7-7 sec	

Notes:

1. Sonoma County Water Agency's system is in both the North Coast and Bay Regions. It is counted only in the North Coast Region to avoid duplicative counting.

2. The City of Morgan Hill's system is in both the Central Coast and Bay Regions. It is counted only in the Central Coast Region to avoid duplicative counting.

Table SFB-5 Exposure to 100- and 500-Year Floods, San Francisco Bay Hydrological Region

Segment Exposed	100-yr Flood	500-yr Flood
Population; (% Population)	355,000; (6%)	1,041,400; (17%)
Structure and Content Value	$46.2 billion	$133.8 billion
Crop Value	$17.3 million	$23.9 million
Tribal Lands (acres)	0	0
Essential Facilities	140	466
High Potential-Loss Facilities	168	303
Lifeline Utilities	47	58
Transportation Facilities	560	1,022
Department of Defense Facilities	8	8
State and Federal Threatened, Endangered, Listed , and Rare Plants	167	169
State and Federal Threatened, Endangered, Listed , and Rare Animals	106	110

Source: SFMP California's Flood Future Report.

Table SFB-6 Flood Management Agencies, San Francisco Bay Hydrologic Region

	Structural approaches						Land use management								Preparedness, response, and recovery										
	Flood projects						Flood plains			Flood insurance			Regu-lation		Data manage-ment			Event management							
	Financing	Development	Construction	Operation	Encroachment	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated floodways	Data collection	Hydrologic	Data station	Flood education	Preparedness	Response	Response	System	Recovery funding	Recovery	Mitigation
Federal agencies																									
Federal Emergency Management Agency										□		□											□		□
National Weather Service															□	□	□	□	□	□	□				
Natural Resources Conservation Service	□	□	□															□							
U.S. Geological Survey															□	□	□								
U.S. Army Corps of Engineers	□	□	□	□	□	□									□	□	□	□	□	□	□		□	□	□
State agencies																									
California Conservation Corps																				□	□				
Department of Corrections																					□				
Department of Forestry and Fire Protection																				□					
Department of Water Resources	□	□	□	□	□	□			□	□		□			□	□	□	□	□	□	□		□	□	
Office of Emergency Services																			□	□	□	□	□		□
Local agencies																									

	Structural approaches						Land use management								Preparedness, response, and recovery										
	Flood projects						Flood plains			Flood insurance			Regu-lation		Data manage-ment			Event management							
	Financing	Development	Construction	Operation	Encroachment	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated flood ways	Data collection	Hydrologic	Data station	Flood education	Preparedness	Response	Response	System	Recovery funding	Recovery	Mitigation
County and city emergency services units																			□	□	□				
County and city planning departments														□											
County and city building departments													□												
Local conservation corps																				□	□				
Local initial responders to emergencies																			□	□	□				
Alameda County FCWCD	□	□			□	□																			
Contra Costa County FCWCD	□	□			□	□									□	□	□								
Marin County FCWCD	□	□			□	□									□		□								
Napa County FCWCD	□	□	□	□	□	□																			
San Francisco Department of Public Works																		□	□						
San Francisquito Creek Joint Powers Authority	□	□																							
San Mateo County Flood Control District	□																								
Santa Clara Valley Water Agency	□	□	□	□	□	□	□	□			□							□	□	□	□				

	Structural approaches						Land use management								Preparedness, response, and recovery										
	Flood projects						Flood plains			Flood insurance			Regu-lation		Data manage-ment				Event management						
	Financing	Development	Construction	Operation	Encroachment	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated flood ways	Data collection	Hydrologic	Data station	Flood education	Preparedness	Response	Response	System	Recovery funding	Recovery	Mitigation
Sonoma County Water Agency	□	□	□	□	□	□												□							
Zone 7 Water Agency	□	□	□	□	□	□												□							

Note: FCWCD=Flood Control and Water Conservation District

Table SFB-7 Flood Control Facilities, San Francisco Bay Hydrologic Region

Facility	Stream	Owner (sponsor)	Description	Protects
Reservoirs and lakes				
L. Chesbro	Llagas Cr.	Santa Clara Valley WD	3 taf flood control	San Jose
L. Del Valle	Arroyo Valle	DWR	38 taf flood control	Pleasanton, Fremont, Niles, Union City
Cull Cr.	Cull Cr.	Alameda Co. 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 Co. FCWCD)	Channel improvement	San Anselmo, Ross, Kentfield, Larkspur, Corte Madera, Greenbrae, Fairfax
Novato Cr.	Novato Cr., Warner Cr., Avichi Cr.	Marin Co. FCWCD	Channel improvement	Novato
Coyote and Berryessa Crs.	Coyote Cr. (Santa Clara Co.), Berryessa Cr.	USACE (Santa Clara Valley WD)	Channel improvement	Alviso, Milpitas, San Jose
Guadalupe R.	Guadalupe R.	USACE (Santa Clara Valley WD)	Channel improvement, bypass tunnel	San Jose
San Francisquito Cr.	San Francisquito Cr.	San Francisquito Creek JPA	Levee restoration	East Palo Alto, Menlo Park
Napa R. Basin	Napa R., Napa Cr.	USACE (Napa Co. FCWCD)	Levees, floodwalls, bypass, channel improvements	Napa, St. Helena
Petaluma R.	Petaluma R.	Sonoma Co. WA	Floodwalls	Petaluma
Wildcat and San Pablo Crs.	Wildcat Cr., San Pablo Cr.	USACE (Contra Costa Co. FCWCD)	Levees, channel, channel improvements, sedimentation basins	San Pablo, Richmond
Coyote Cr.	Coyote Cr. (Marin Co.)	USACE	Lined and unlined channels	Tamalpais Valley

Facility	Stream	Owner (sponsor)	Description	Protects
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
Non-storage flood control facilities				
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 R.	Napa R.	Napa Co. FCWCD (NRCS)	Contributions to Napa R. Basin Project	Napa, St. Helena
Lower Silver Cr.	Silver Cr.	Santa Clara Valley WD (NRCS)	Channel improvement	San Jose

Note: taf=thousand acre-feet

Table SFB-8 Proposed Water Enhancement Projects, San Francisco Bay Hydrologic Region (Draft)

Table SFB-10 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 that is implemented by 12 Bay Area agencies. The IRWM Round 2 Implementation funding will expand the implementation of 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-efficiency 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 (EBMUD)	90%	Yes	The East Bayshore Recycled Water Project (EBRWP) will ultimately provide up to 2.5 mgd (2,800 AFY) of tertiary treated recycled water to customers within the Cities of Alameda, Albany, Berkeley, Emeryville, and Oakland. In October 2012, EBMUD completed a segment of the East Bayshore recycled water transmission pipeline with support from DWR's Proposition 84, Round 1 Implementation Grant. The next phase of the EBRWP project (Phase 1A Emeryville) will extend the recycled water transmission pipeline by about 5,100 feet to the north.
3	Lagunitas Creek Watershed Sediment Reduction and Management Project	Marin Municipal Utilities District (MMWD)	50%	No	This sediment reduction project will improve water quality and streambed habitat for the benefit of coho salmon and steelhead trout populations in Lagunitas Creek; and improve fish passage into two tributary streams to Lagunitas Creek. The project involves repair of 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 (Marin RCD)	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 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 over 50 homes. The dam is currently a passage barrier for steelhead.
6	North Bay Water Reuse Program – Sonoma Valley CSD 5th Street East/McGill Road Recycled Water Project	Sonoma Valley County Sanitation District	40%	No	The Sonoma Valley County Sanitation District (CSD) 5th Street East/McGill Road Recycled Water Project, a Phase 2 component of North Bay Water Reuse Program, consists of two recycled water sub-projects located in Sonoma Valley. The total recycled water yield from the Project is approximately 200 acre-feet per year (AFY). The Project will increase utilization 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, California, including 180 feet of culvert daylighting. The project includes restoration of channel function, stream bank 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 within the Town of Pescadero. The current water supply system recently experienced a water outage in 2011 which left customers with no running water. Emergency connections are not available and the standby well is unreliable. 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 & 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, groundwater recharge opportunities (limited), expand recreational and educational amenities, and water quality improvements. The project compliments 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 City	15%	No	This project will mitigate chronic and widespread flooding in the Bayfront Canal (Redwood City) and Atherton Channel (Menlo 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 detention for these drainage areas, and redirected runoff will be used to enhance wetland habitat. This project will provide significant opportunity for alleviating flooding concerns, improving runoff water quality from nearby neighborhoods, and supporting additional recreational trails.
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 with Partner Agencies: the cities of Daly City and San Bruno and the California Water Service Company, 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 an accumulation of stored groundwater that can be used during drought years. Phase 1A, proposed for funding in this application, will include the construction of 5 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, California. The goal of this wetland restoration project is to provide long-term, self-sustaining tidal wetlands, seasonal wetlands, and coastal prairie to create valuable habitat for special-status species and for public access for compatible passive recreation and public education.

Project ID #	Project Name	Project Proponent	Project Status: Design % Complete	DAC?	Project Abstract
13	Roseview Heights Infrastructure Upgrades for Water Supply and Quality Improvement, Santa Clara County	Roseview Heights Mutual Water Company (RHMWC)	95%	No	This project will replace the existing, aging water system 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 (ABAG)	20%	No	This project involves 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.
15	San Francisco International Airport Reclaimed Water Facility	City and County of San Francisco (CCSF) – 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 disinfection to satisfy Title 22 reclaimed water criteria.
16	San José Green Streets & Alleys Demonstration Projects	City of San José	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 facilities will be installed to eliminate sediment and ponding in the alleys, improve stormwater quality, and make the alleys a community amenity. These projects will add to a regional collection of demonstration LID retrofit projects.
17	San Pablo Rheem Creek Wetlands Restoration Project	Contra Costa Water District (CCWD)	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 within 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; improved water quality through removal of the potential for accidental sediment releases during maintenance; and restored gravel yield to the channel downstream of the dam and the Napa River, which is sediment-starved at it confluence with York Creek.
19	Students and Teachers Restoring a Watershed (STRAW) Project – North and East Bay Watersheds	Point Reyes Bird Observatory Conservation Science (PRBO)	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. STRAW coordinates with and sustains a network of committed teachers, students, restoration specialists, landowners and managers, and other community members to complete the restoration projects.

Table SFB-9 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, which combines disparate or various local groundwater monitoring efforts in a single, comprehensive assessment of groundwater quantity and quality for basins within the region. Regional groundwater assessments should be conducted every 5 years.
Regional Monitoring of Emerging Contaminants	SWRCB	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 (RMP) to include monitoring of the quality of urban creeks in addition to sites within the San Francisco Bay.
Wastewater and Recycled Water		
Regional Recycled Water Reporting	RWQCB	Regional compilation of quantity and quality of recycled water produced and used within the region. This system would track and encourage utilization of recycled water to conserve potable supplies. Information is already provided to RWQCB.
Nonpoint Source Pollution Control Program	SWRCB	The State Water Resources Control Board is developing the Nonpoint Source Pollution Control Program to track and monitor nonpoint source pollution in the Bay Area, but it is not yet effective. The Program could be expanded to collect both runoff quantity and quality information.
Flood Protection and Stormwater Management		
Regional Monitoring of Impervious Surfaces	RWQCB	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 utilized 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 BMPs and management measures according to the extent of imperviousness in the region.
Regional Storm Drainage Mapping	RWQCB	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	BAFPAA	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.
Watershed Management, Habitat Protection, and Restoration		
Regional Monitoring of Stream Channel Conditions	CDFW	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	USEPA-Office of Research and Development, CDFW	Expand upon the Western Pilot Environmental Monitoring and Assessment Program (WEMAP) to implement standardized monitoring of in-stream 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	CDFW	Establish a regional monitoring system for wildlife corridors, populations, and species richness (for amphibians, birds, and mammals). This could expand upon the CNDDB, focusing solely on population monitoring within the region.
Regional Monitoring of Invasive Species	CDFW, USFWS	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	CDFW, USFWS	Regional program to track presence or absence of at-risk native and special status species in the Bay Area.

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

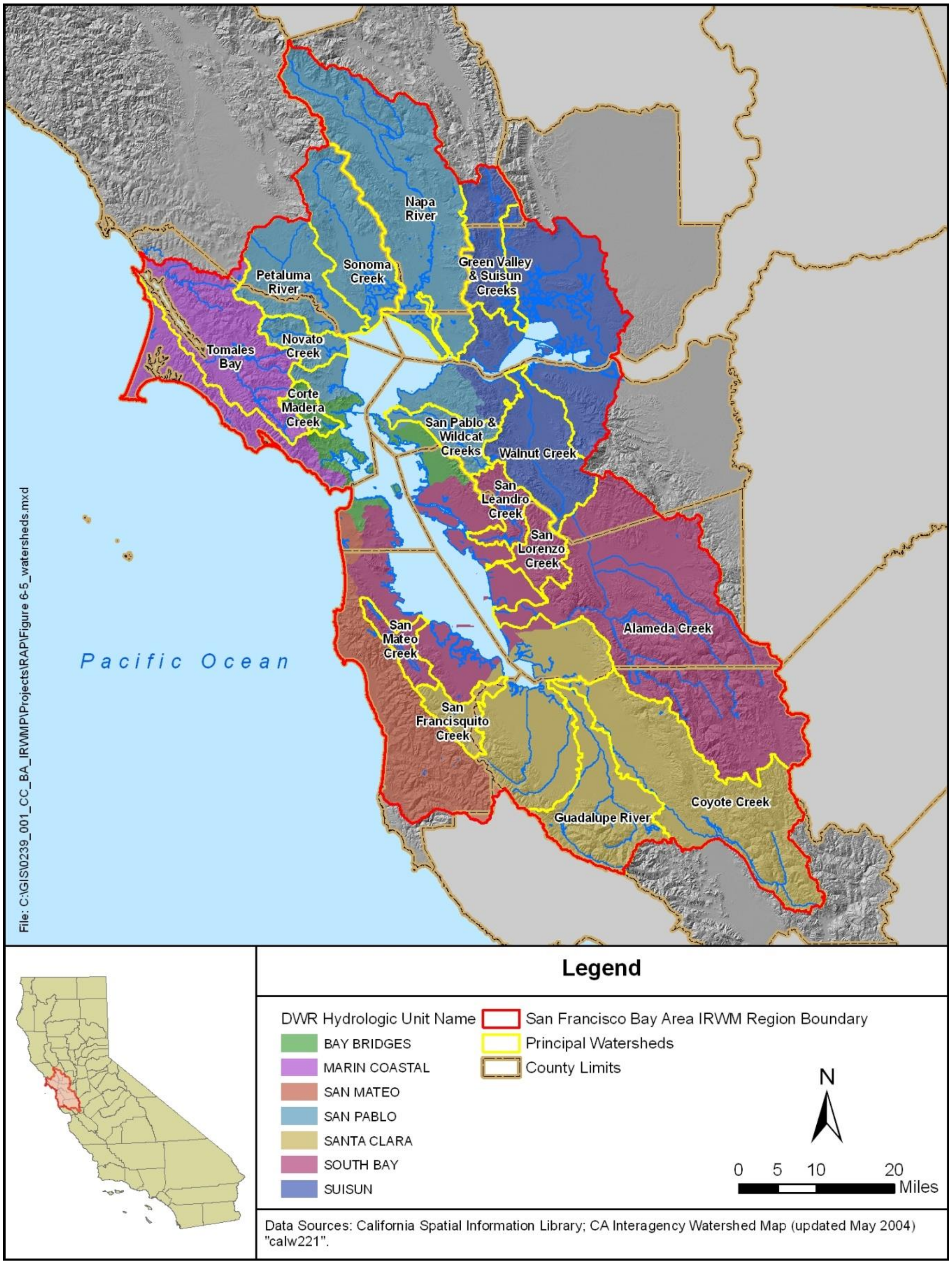
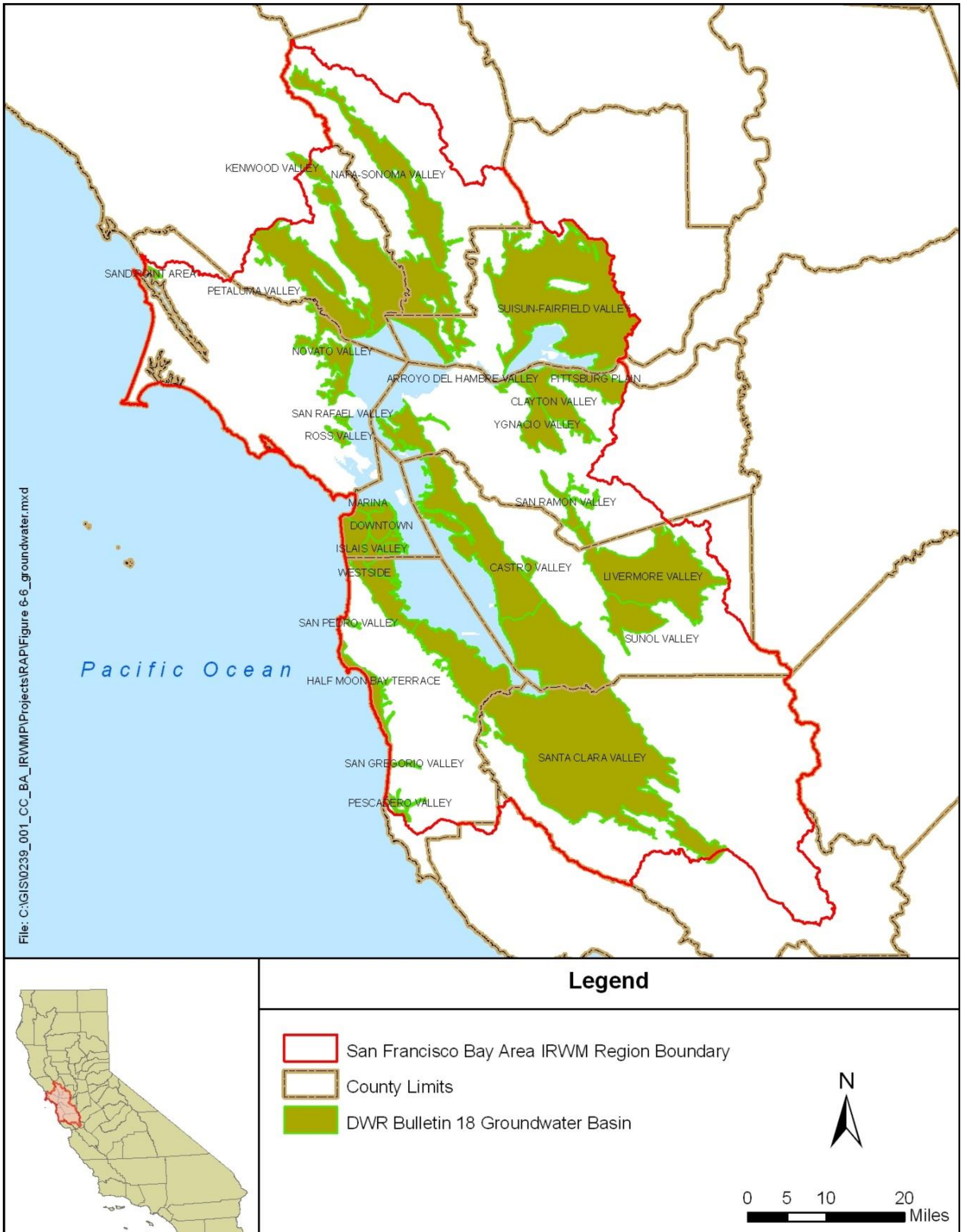


Figure SFB-3 Groundwater Basins in the San Francisco Bay Hydrologic Region



Data Sources: California Spatial Information Library; CA DWR Bulletin 118, Feb 2004.

Figure SFB-6 FEMA 100- and 500-year flood zones in the San Francisco Bay Hydrologic Region

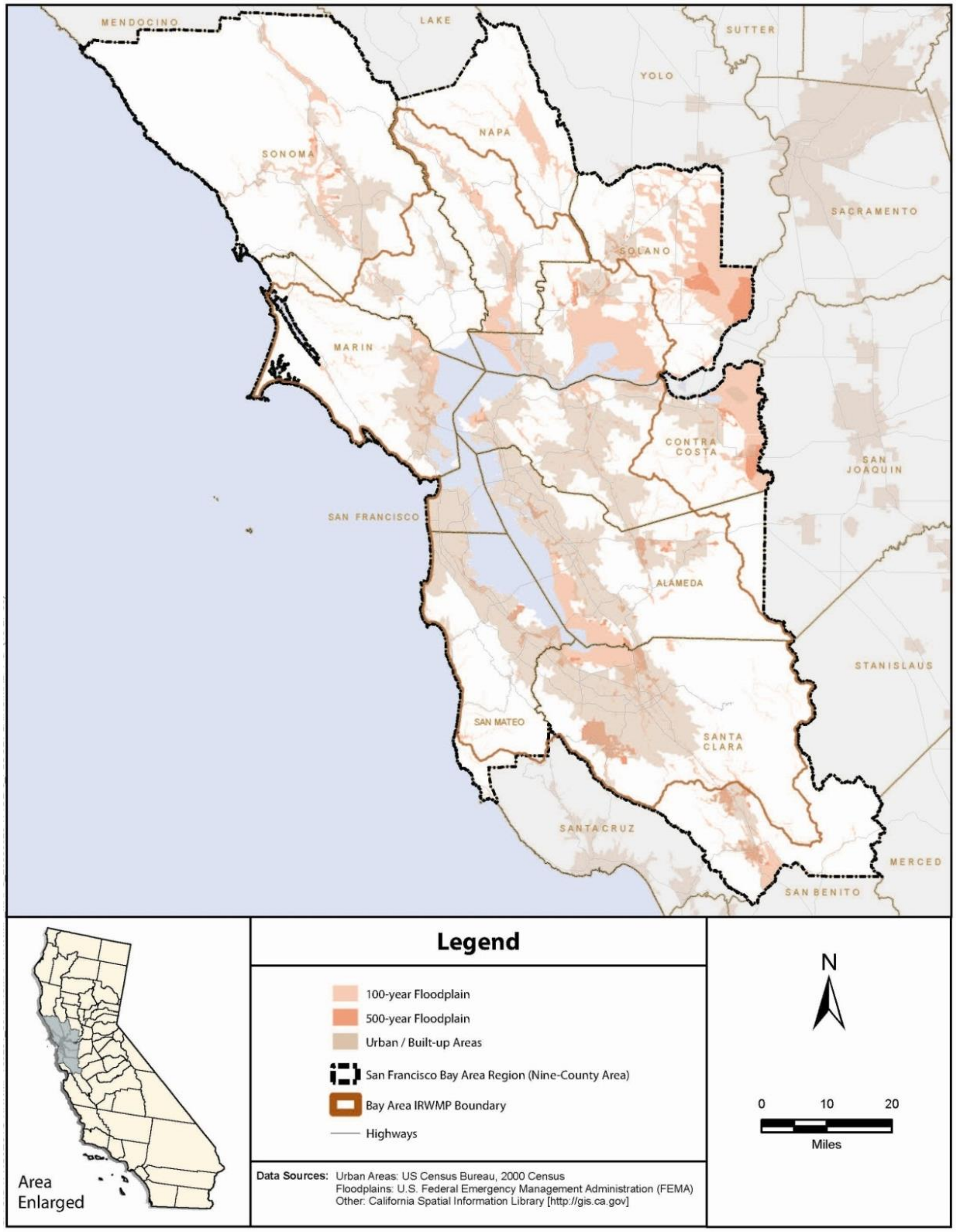


Figure SFB-9 Change in urban water demand, San Francisco Bay Hydrologic Region

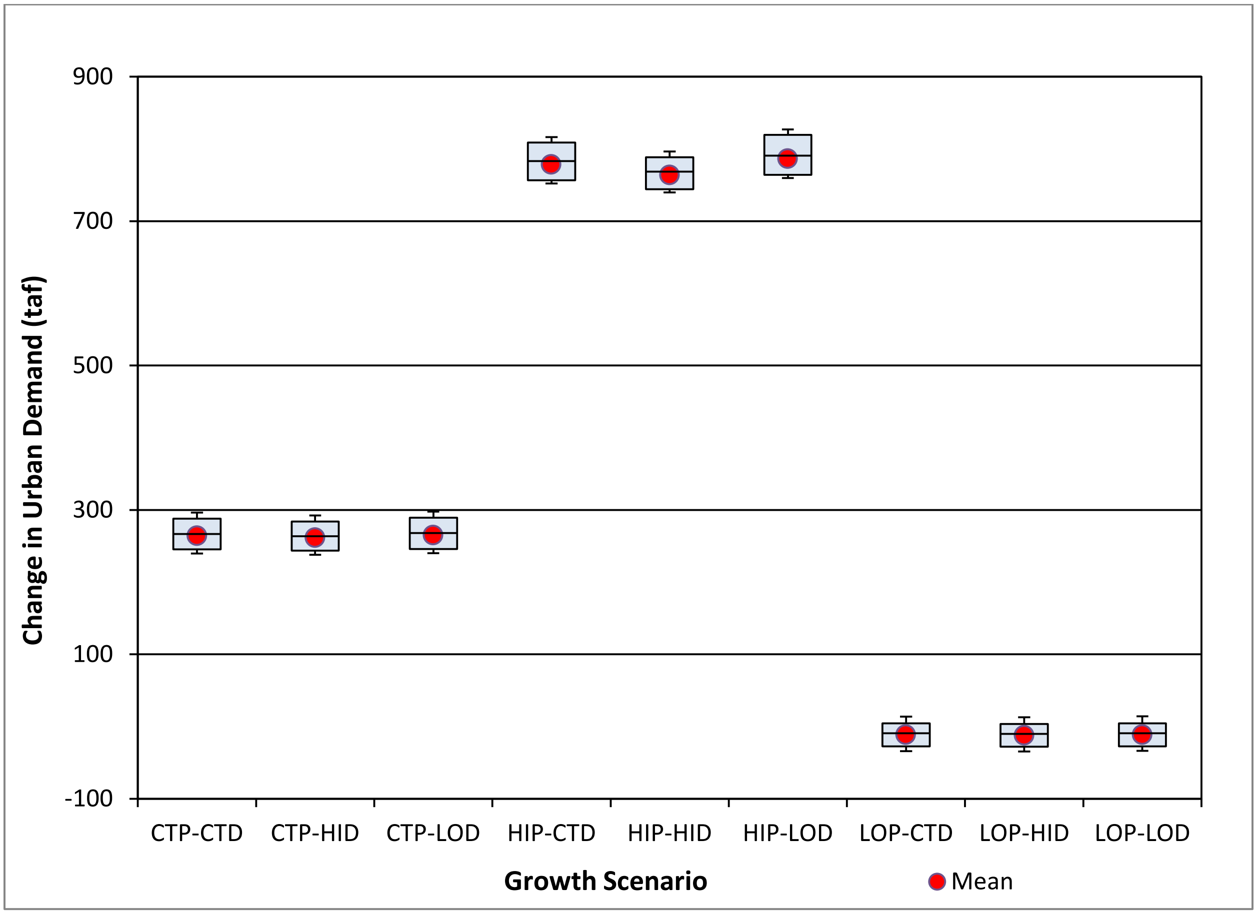
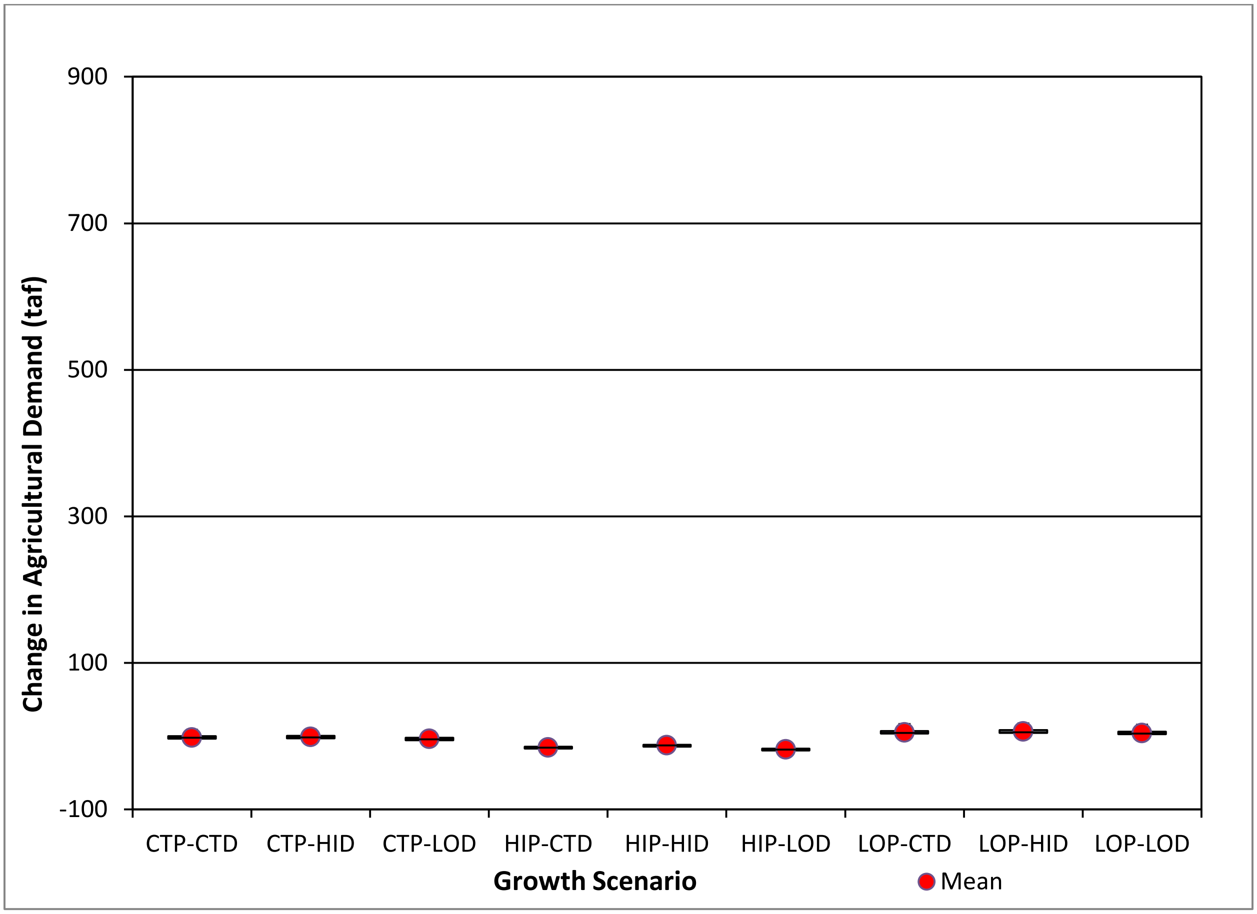


Figure SFB-10 Change in agricultural water demand, San Francisco Bay Hydrologic Region



Box SFB-1 **New Feature—Near-Coastal**

Coastal regions in California share common concerns and issues. The update of the California Water Plan 2013 is introducing a focus on near-coastal 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 region.

Find information on near-coastal issues in the San Francisco Bay region under the "Flood Management" and "Climate Change ... " sections as well as "Recent Initiatives ..." and "Ecosystem Restoration." In Volume 4, Near-Coastal Issues are discussed in an article, "XXXXXXX."

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. (Website: 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 to address social, environmental, and economic issues that transcend local borders. (Website: 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 comprised 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. (Website: 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. (Website: www.bayplanningcoalition.org)

Bay Area Flood Protection Agencies Association (BAFPAA). Established in 2006 as an outgrowth of the Bay Area IRWM process, membership in BAFPAA includes Bay Area counties and special districts with responsibility for flood protection and storm water 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. (Website: 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), BCDC, 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). SFEB is a coalition of resource agencies, non-profits, 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.