California's Groundwater Update 2013

A Compilation of Enhanced Content for California Water Plan Update 2013

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State of California
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SAN FRANCISCO BAY HYDROLOGIC REGION

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Acronyms and Abbreviations Used in This Chapter

AB	Assembly Bill
ACWA	Association of California Water Agencies
ACWD	Alameda County Water District
ASR	aquifer storage and recovery
AWMP	agriculture water management plan
BMO	basin management objective
CASGEM	California Statewide Groundwater Elevation Monitoring
CDPH	California Department of Public Health
CWS	community water system
DAU	detailed analysis unit
DPR	California Department of Pesticide Regulation
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utilities District
EPA	U.S. Environmental Protection Agency
GAMA	Groundwater Ambient Monitoring and Assessment
gpm	gallons per minute
GWMP	groundwater management plan
HAL	health advisory level
IRWM	integrated regional water management
LLNL	Lawrence Livermore National Laboratory
maf	million acre-feet
MCL	maximum contaminant level
msl	mean sea level
MTBE	methyl tertiary butyl ether
NL	notification level
PA	Planning Area
RWMG	regional water management groups
RWQCB	regional water quality control board
San Francisco Bay region	San Francisco Bay Hydrologic Region
SB	Senate Bill
SB X7-6	California 2009 Comprehensive Water Package legislation
SB X7-7	Water Conservation Bill of 2009

SCVWD	Santa Clara Valley Water District
SCWA	Sonoma County Water Agency
SFPUC	San Francisco Public Utilities Commission
SMCL	secondary maximum contaminant level
SWN	State Well Number System
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TDS	total dissolved solids
USGS	U.S. Geological Survey
UWMP	urban water management plan
VOC	volatile organic compound

Chapter 4. San Francisco Bay Hydrologic Region Groundwater Update

Introduction

The primary goal of the San Francisco Bay Hydrologic Region (San Francisco Bay region) groundwater update is to expand information about region-specific groundwater conditions for *California Water Plan Update 2013* and to guide more informed groundwater management actions and policies. A second goal is to steadily improve the quality of groundwater information in future California Water Plan (CWP) updates to a level that will enable regional water management groups (RWMGs) to accurately evaluate their groundwater resources and implement management strategies that can meet local and regional water resource objectives within the context of broader statewide objectives. The final goal is to identify data gaps and groundwater management challenges that will guide prioritizing of future data collection and funding opportunities relevant to the region.

This regional groundwater update is not intended to provide a comprehensive and detailed examination of local groundwater conditions, or be a substitute for local studies and analysis. Nonetheless, where information is readily available, this update does report some aspects of the regional groundwater conditions in greater detail.

The San Francisco Bay region shown in Figure 4-1 covers approximately 4,500 square miles. The region includes all of San Francisco County and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties. The area extends from southern Santa Clara County, north to Tomales Bay in Marin County, and inland to the confluence of the Sacramento and San Joaquin rivers near Collinsville. The eastern boundary of the hydrologic region follows the crest of the Coast Ranges, which have peaks more than 4,000 feet above sea level. Significant geographic features include the Santa Clara, Napa, Sonoma, Petaluma, Suisun-Fairfield, and Livermore valleys; the Marin and San Francisco peninsulas; San Francisco, Suisun, and San Pablo bays; and the Santa Cruz Mountains, Diablo Range, Bolinas Ridge, and Vaca Mountains of the Coast Ranges. The San Francisco Bay is an estuary with a deep central channel, broad mudflats, and fringing marsh. Streams in the region flow into the estuary or into the Pacific Ocean. While covering the least area of California’s 10 hydrologic regions, the San Francisco Bay region has the second largest population with 6.3 million people.

The groundwater update for the San Francisco Bay region provides an overview and assessment of the region’s groundwater supply and development, groundwater use, monitoring efforts, aquifer conditions, and various management activities. It also identifies challenges and opportunities associated with sustainable groundwater management. The regional update starts with a summary of findings, examines groundwater data gaps, and makes recommendations to improve the overall sustainability of this valuable resource. This is followed by a comprehensive overview of the relevant groundwater topics.

Figure 4-1 San Francisco Bay Hydrologic Region

Findings, Data Gaps, and Recommendations

The following information is specific to the San Francisco Bay region and summarizes the findings, data gaps, and recommendations.

Findings

The bulleted items in this section are adopted from more comprehensive information presented in this chapter, and generally reflect information that was readily available through August 2012. Much of the groundwater information, including well infrastructure discussions, water supply analysis, change-in-groundwater-in-storage estimates, and groundwater management plan (GWMP) reviews, is new to this update of the CWP. The groundwater data presented in this document will be used as the foundation for the next update to the California Department of Water Resources (DWR) Bulletin 118 and CWP, with the goal of generating information that can be used to make informed decisions to sustainably manage California's groundwater resources. The following information highlights the groundwater findings for the San Francisco Bay region.

Groundwater Supply and Development

- The San Francisco Bay region contains 33 alluvial groundwater basins and subbasins recognized by DWR Bulletin 118-2003. Those groundwater basins and subbasins underlie approximately 1,400 square miles, or 31 percent, of the hydrologic region (Figure 4-2 and Table 4-1).
- Based on DWR well-log records, the number of wells completed in the San Francisco Bay region between 1977 and 2010 is approximately 62,941 and ranges from a high of 34,190 wells for Santa Clara County to a low of 1,545wells for San Francisco County (Figure 4-3 and Table 4-2).
- Based on the California Statewide Groundwater Elevation Monitoring (CASGEM) Basin Prioritization completed in December 2013, one subbasin in the San Francisco Bay region is identified as high priority, six basins or subbasins are identified as medium priority, one subbasin is listed as low priority, and the remaining 25 basins or subbasins are listed as very low priority.
- The seven basins designated as high or medium priority include 88 percent of the annual groundwater use in the region and nearly 63 percent of the 2010 population living within the region's groundwater basin boundaries (Figure 4-6 and Table 4-3).

Groundwater Use and Aquifer Conditions

- The 2005-2010 average annual total water supply for the San Francisco Bay region, based on planning area boundaries, is estimated at 1.2 million acre-feet (maf). Water demands in the region are met through a combination of local and imported surface water supplies, State (State Water Project [SWP]) surface water deliveries, groundwater, and reused/recycled water supplies (Figure 4-7).
- Groundwater contributes about 21 percent (260 thousand acre-feet [taf]) of the 2005-2010 average annual total water supply for the San Francisco Bay region (Figure 4-7).
- Groundwater supplies, based on average annual estimates for 2005-2010, contribute 74 percent of the total agricultural water supply and 16 percent of the total urban water supply in the San Francisco Bay region. No groundwater resources are used for managed wetland applications in the region (Table 4-5).

- Between 2002 and 2010, annual groundwater use in the San Francisco Bay region ranged between 239 taf (2010) and 281 taf (2008), and contributed between 18 percent and 23 percent of the annual water supply (Figure 4-8).
- Of the groundwater pumped on an annual basis between 2002 and 2010, 63 percent to 79 percent of the groundwater was used for urban purposes (Figure 4-9).

Groundwater Monitoring Efforts

- The San Francisco Bay region has 117 wells that are actively monitored for groundwater-level information (Figure 4-10 and Table 4-7).
- Numerous local water agencies in the San Francisco Bay region collect depth-to-groundwater information and make that data available to the public either online or in annual groundwater reports.
- There are an estimated 184 community water systems (CWSs) in the San Francisco Bay region, with an estimated 421 active CWS wells. Twenty-eight of the CWS wells (7 percent) are identified as being affected by one or more chemical contaminants that exceed a maximum contaminant level (MCL). The affected wells are used by 18 CWSs in the region, with 12 of the 18 affected CWSs serving small communities. The most prevalent groundwater contaminants affecting community drinking water wells in the region include arsenic and nitrate (Tables 4-10, 4-11, and 4-12).
- In the San Francisco Bay region, land subsidence monitoring is conducted in Santa Clara County by the Santa Clara Valley Water District (SCVWD). In Alameda County, it is conducted by the East Bay Municipal Utilities District (EBMUD). In the San Francisco Bay region, all of the active GWMPs adequately address the topic of land subsidence, but historical land subsidence has only been observed in Santa Clara County.

Groundwater Management and Conjunctive Management

- There are four GWMPs within the San Francisco Bay region that collectively cover about 36 percent of the Bulletin 118-2003 alluvial basin area within the region and about 27 percent of the overall region.
- DWR's assessment of GWMPs in the San Francisco Bay region determined that three of the four GWMPs have been developed or updated to include the legislative requirements of Senate Bill (SB) 1938 and are considered "active" for the purposes of the GWMP assessment.
- Two GWMPs in the region address all of the required components identified in California Water Code Section10753.7 (Figure 4-12 and Table 4-15).
- Of the 89 agencies or programs identified as operating a conjunctive management or groundwater recharge program in California, four programs are located in the San Francisco Bay region. Zone 7 Water Agency, SCVWD, and Alameda County Water District (ACWD) use spreading basins to recharge groundwater. EBMUD operates an aquifer storage and recovery (ASR) project. The effort to fully characterize the 89 conjunctive management programs, as part of *California Water Plan Update 2013*, was largely unsuccessful because numerous agencies were reluctant to make details about their groundwater recharge operations publically available (Appendix D).

Data Gaps

Gaps in groundwater information are separated into three categories: data collection and analysis, basin assessments, and sustainable management. Where possible, the discussion of data gaps is specific to the San Francisco Bay region, but many of the identified gaps are applicable to several, or all, hydrologic regions in California. Addressing these data gaps at both the local level and State agency level will help ensure that groundwater resources throughout California are better characterized and sustainably managed.

Data Collection and Analysis

The characterization of the alluvial aquifers in the San Francisco Bay region is generally well-defined from a hydrogeological perspective in most areas. More data is always necessary to better understand basin-wide and region-wide groundwater levels, groundwater quality, groundwater use, and the interaction between surface water and groundwater.

Information related to groundwater extraction, groundwater use, managed and natural recharge, and groundwater basin budgets in many areas of the San Francisco Bay region is limited. Much of the related information has been estimated primarily through water supply balance and land use information derived from DWR’s land use surveys. Very little information is available about the fractured-bedrock aquifers located within the San Francisco Bay region and how they interact with the region’s alluvial groundwater system.

Many local water agencies in the San Francisco Bay region are collecting groundwater data and are managing their basins by using the authorities they are given. However, locally collected and analyzed data, which could be used by RWMGs and State agencies to better characterize the groundwater basins in the San Francisco Bay region, are in general not readily available.

Basin Assessments

Region-wide depth-to-groundwater information and annual estimates of change in groundwater in storage are not well understood for many of the groundwater basins in the San Francisco Bay region.

In general, groundwater quality throughout most of the San Francisco Bay region is suitable for most urban and agricultural uses with only local impairments. Domestic wells in the San Francisco Bay region have not been extensively sampled.

Land subsidence in the San Francisco Bay region has not been extensively investigated, but because of the documented increase in depth to water and the high reliance on groundwater from some of the region’s alluvial aquifers, land subsidence, if not already occurring, will likely occur in areas that have exhibited land subsidence in the past, or in areas that experience excessive groundwater pumping.

Although only four conjunctive management programs were identified in the San Francisco Bay region, the survey conducted as part of *California Water Plan Update 2013* was unable to collect comprehensive information about those programs. As a result, a general understanding of the effectiveness of the region’s groundwater recharge and conjunctive management programs could not be determined. In addition, it is unknown whether local agencies have complied with the groundwater recharge mapping requirements of Assembly Bill (AB) 359, which went into effect on January 1, 2013.

Sustainable Management

The three active GWMPs in the San Francisco Bay region that meet some or all of the SB 1938 groundwater management requirements cover 15 percent of the alluvial groundwater basin area. A key gap to implementing sustainable groundwater management practices at the local level is the limited authority of some agencies to assess management fees, restrict groundwater extraction, and regulate land use in groundwater-short areas.

Recommendations

While much information is known about some of the groundwater basins in the San Francisco Bay region, comprehensive information that could provide a realistic water budget to determine groundwater sustainability in the region is largely unknown. To better characterize and sustainably manage the region's groundwater resources, the following recommendations have been made for the San Francisco Bay region:

- Increase collection and analysis of groundwater level, quality, use, and extraction data, as well as information regarding the surface-water–groundwater interaction in alluvial aquifers, to a level that allows for development of groundwater budgets, groundwater supply forecasting, and assessment of sustainable groundwater management practices.
- Increase data collection in fractured-bedrock aquifers to determine the degree of interaction that the upland areas have with the region's alluvial aquifers.
- Increase land subsidence monitoring to quantify the permanent loss of groundwater storage throughout the region that has been caused by excessive groundwater pumping.
- Continue to monitor groundwater quality throughout the region to better determine sources of natural and anthropogenic contamination and comply with all groundwater quality protection strategies recommended by the San Francisco Bay Regional Water Quality Control Board.
- Update all existing GWMPs to meet the SB 1938 standards set forth in California Water Code Section10750 et seq., and ensure that GWMPs are prepared for all high- and medium-priority groundwater basins as identified by the CASGEM Prioritization process.
- Determine the extent and effectiveness of the groundwater recharge and conjunctive management programs in the San Francisco Bay region. To do this, DWR should work with local water managers to complete the conjunctive management survey information and ensure that the groundwater recharge mapping requirements of AB 359 are met.
- Ensure local agency goals, actions, and plans for sustainable groundwater management are compatible with, and roll up to, a minimum set of goals and actions established by the overlying integrated regional water management (IRWM) plan.
- Provide local and regional agencies the authority to assess fees, limit groundwater extraction, and restrict land use in groundwater-short areas as needed, to better establish a path toward sustainable groundwater management.
- Develop annual groundwater management reports that summarize groundwater management goals, objectives, and performance measures, along with the current and

projected trends for groundwater extraction, groundwater levels, groundwater quality, land subsidence, and surface-water–groundwater interaction. Annual reports should also evaluate how existing groundwater management practices contribute toward sustainable groundwater management and proposed actions for improvements.

Groundwater Supply and Development

This section provides an overview of the key aquifer systems that contribute groundwater to the regional supply, the well infrastructure used to develop these supplies, and an introduction to groundwater basin prioritization for the region.

Groundwater resources in the San Francisco Bay region are supplied by both alluvial and fractured-rock aquifers. Alluvial aquifers are comprised of sand and gravel or finer-grained sediments, with groundwater stored within the voids, or pore space, between the alluvial sediments. Fractured-rock aquifers consist of impermeable granitic, metamorphic, volcanic, or hard sedimentary rocks, with groundwater being stored within cracks, fractures, or other void spaces. The distribution and extent of alluvial and fractured-rock aquifers and water wells vary within the San Francisco Bay region. A brief description of the alluvial aquifers for the region is provided in the following paragraphs. Additional information regarding alluvial and fractured-rock aquifers is available online from DWR Bulletin 118-2003 (http://www.water.ca.gov/groundwater/bulletin118/index.cfm).

Alluvial Aquifers

DWR Bulletin 118-2003 identifies 33 alluvial groundwater basins and subbasins in the San Francisco Bay region. They underlie approximately 1,400 square miles, or 31 percent, of the hydrologic region. The majority of the groundwater used in the San Francisco Bay region is stored in alluvial aquifers. A detailed description of aquifers within this hydrologic region is beyond the scope of this chapter. Additional information regarding groundwater basins in this hydrologic region may be obtained online from DWR Bulletin 118-2003 (http://www.water.ca.gov/groundwater/bulletin118/update_2003.cfm). Figure 4-2 shows the location of the alluvial groundwater basins and subbasins. Table 4-1 lists the name and number associated with the alluvial groundwater basins and subbasins.

Groundwater extracted by wells located outside of the alluvial basins shown in Figure 4-2 is supplied largely from fractured-rock aquifers. In some cases, groundwater stored within a thin overlying layer of alluvial deposits or a thick soil horizon may also contribute to the well's groundwater supply.

For the purposes of describing the alluvial and fractured-rock aquifer systems in the San Francisco Bay region, the region is divided into three sub-areas: North Bay, East Bay, and South Bay. The alluvial aquifers of the region are described first, followed by a general description of the groundwater found in fractured bedrock. Groundwater resources to wells located outside of the alluvial basins shown in Figure 4-2 are considered to draw their supply largely from fractured-rock aquifers. A detailed description of the fractured-rock aquifers is not provided in this discussion.

Figure 4-2 Alluvial Groundwater Basins and Subbasins within the San Francisco Bay Hydrologic Region

Table 4-1 Alluvial Groundwater Basins and Subbasins in the San Francisco Bay Hydrologic Region

Basin	Subbasin	Basin Name
2-1		Petaluma Valley
2-2		Napa-Sonoma Valley
	2-2.01	Napa Valley
	2-2.02	Sonoma Valley
	2-2.03	Napa-Sonoma Lowlands
2-3		Suisun-Fairfield Valley
2-4		Pittsburg Plain
2-5		Clayton Valley
2-6		Ygnacio Valley
2-7		San Ramon Valley
2-8		Castro Valley
2-9		Santa Clara Valley
	2-9.01	Niles Cone
	2-9.02	Santa Clara
	2-9.03	San Mateo Plain
	2-9.04	East Bay Plain
2-10		Livermore Valley
2-11		Sunol Valley
2-19		Kenwood Valley
2-22		Half Moon Bay Terrace
2-24		San Gregorio Valley
2-26		Pescadero Valley
2-27		Sand Point Area
2-28		Ross Valley
2-29		San Rafael Valley
2-30		Novato Valley
2-31		Arroyo Del Hambre Valley
2-32		Visitacion Valley
2-33		Islais Valley
2-35		Westside
2-36		San Pedro Valley
2-37		South San Francisco
2-38		Lobos
2-39		Marina
2-40		Downtown San Francisco

North Bay Alluvial Aquifers

The North Bay alluvial aquifer system includes the 10 groundwater basins and subbasins located in Marin, Sonoma, Napa, and Solano counties, as shown in Figure 4-2. In this area, the more heavily utilized groundwater basins include the subbasins of the Napa-Sonoma Valley Groundwater Basin (2-2) and the Petaluma Valley Groundwater Basin (2-1) (California Department of Water Resources 2003). These areas consist of a relatively thin cover of Quaternary alluvium overlying a thick section of Neogene volcanic and sedimentary rocks, Cretaceous sedimentary rocks, Franciscan Complex sedimentary and metamorphic rocks, and Jurassic serpentinite. The main freshwater-bearing geologic unit is the alluvium and the Neogene sedimentary rocks that underlie and form the valley floors (U.S. Geological Survey 2010). The thickness of the freshwater-bearing aquifers ranges from less than 10 feet to more than 300 feet and the system is mostly unconfined. Groundwater in the mountains surrounding the Napa, Sonoma, and Petaluma valleys generally follows the dip of the geologic formations toward the center of the respective valleys, and then flows north to south toward the direction of San Pablo Bay. The Napa River drains the Napa Valley Groundwater Subbasin (2-2.01) and the Napa-Sonoma Lowlands Groundwater Subbasin (2-2.03). Sonoma Creek drains the Kenwood Valley Groundwater Basin (2-19) and the Sonoma Valley Groundwater Subbasin (2-2.02). The Petaluma Valley Groundwater Basin (2-1) is drained by the Petaluma River.

The main freshwater-bearing formations in the North Bay area include the Quaternary Alluvial Units, Glen Ellen Formation, Huichica Formation, and Sonoma Volcanics. The Petaluma Formation underlies the Sonoma Volcanics and was deposited under brackish-water conditions (U.S. Geological Survey 2006).

The Quaternary Alluvial Units consist of interbedded cobbles, sand, silt, and clay interlaced with coarse-grained stream channel deposits. Where these deposits are thick and saturated, they are the highest yielding aquifers with well yields of more than 100 gallons per minute (gpm).

The Glen Ellen Formation includes clay-rich stratified deposits of poorly sorted sand, silt, and gravel interbedded with minor beds of conglomerate and volcanic tuffs. The well yields are significantly lower in this formation (generally less than 20 gpm) than in the Quaternary alluvial deposits.

The Huichica Formation consists of thick clay with interbedded lenses of sands, gravels, and tuff beds. The well yields are generally low, typically 2 to 20 gpm, but the lower part of the formation can be higher yielding.

The Sonoma Volcanics range in age from 6 million to 3 million years old and are found throughout Napa and Sonoma counties (U.S. Geological Survey 2003). The Sonoma Volcanics are thick sequences of volcanic rocks interbedded with sedimentary deposits derived from volcanic rocks and lakebeds. This formation has the highest variability in water-bearing properties. Well yields generally range between 10 and 50 gpm, but are occasionally as much as several hundred gpm.

There is limited groundwater information available for the Suisun-Fairfield Valley Groundwater Basin (2-3), located in the northeast portion of the San Francisco Bay region. The Suisun-

Fairfield Valley Groundwater Basin is composed of low alluvial plains, with surrounding foothills and mountains, located immediately north of Suisun Bay. The foothills of the Coast Ranges, lying west of Green Valley, bound the basin on the west. The southern extent of the Vaca Mountains forms the northern boundary of the basin. The eastern extent of the basin is marked by low ridges of consolidated rock that appear near Vacaville and extend southeast to the Montezuma Hills (City of Vacaville 2011).

South Bay Alluvial Aquifers

The South Bay alluvial aquifers include the 13 groundwater basins and subbasins located in San Francisco, San Mateo, and parts of Santa Clara counties, as shown in Figure 4-2. The majority of the aquifers in the South Bay are located adjacent to San Francisco Bay. There are four small coastal basins located along the Pacific Ocean in the area of Half Moon Bay. The San Francisco Bay region coastal aquifers are generally small and consist of recent alluvium comprised of sands and silts. Groundwater in the San Francisco Bay area, north of Morgan Hill, flows north toward San Francisco Bay, while groundwater in the area south of Morgan Hill flows toward Monterey Bay (U.S. Geological Survey 2007).

The four major geologic units underlying the San Francisco and South San Francisco areas include the Mesozoic Franciscan Complex, the Pleistocene Merced Formation, the Pleistocene Colma Formation, and the Pleistocene-to-recent Dune Sands. In this area, groundwater used for water supply is generally found in the coarse-grained layers of the complex and layered Merced and Colma formations (WRIME 2012).

The Colma Formation, which generally overlies the Merced Formation, is composed of sand and thin interbedded silt and clay layers of shallow marine depositional origin. The Merced Formation consists of fine-grained sand, silty sand, and inter-fingered clay layers. The Merced Formation is subdivided into three units — lower, middle, and upper — with thicknesses of 4,000 feet, 600 feet, and 500 feet, respectively.

At the southern end of San Francisco Bay, the Santa Clara Valley, consisting of the San Mateo Groundwater Subbasin (2-9.03) and the Santa Clara Groundwater Subbasin (2.9-02), occupies a structural trough, sub-parallel to the northwest trending Coast Ranges. The water-bearing formations of the Santa Clara Valley are generally comprised of two groups, the Santa Clara Formation of Plio-Pleistocene age and the Pleistocene-to-Quaternary age alluvial deposits. Lithologic similarities make distinction between these two units difficult. The Santa Clara Formation underlies the alluvium and unconformably overlies non-water-bearing formations. The Santa Clara Formation is composed of gravel, sand, silt, and clay with various grain-size components. The alluvium consists of gravel, sand, silt, and clay with various grain-size distributions dependent upon the depositional environment. It can be as much as 1,250 feet thick (California Department of Water Resources 2003). The northern portion of this area is generally confined where overlain by a clay layer of low permeability, while the southern portion of the Santa Clara Valley is generally unconfined and contains no thick clay layers (California Department of Water Resources 2003).

East Bay Alluvial Aquifers

The East Bay alluvial aquifers include the 10 groundwater basins and subbasins located in Alameda and Contra Costa counties, as shown in Figure 4-2. The main groundwater basins along the San Francisco Bay include the subbasins of the Santa Clara Valley Groundwater Basin (2-9), while the remaining East Bay groundwater basins are separated from San Francisco Bay by several northwesterly trending ridges of the Coast Ranges.

Adjacent to the east side of San Francisco Bay are the Niles Cone Groundwater Subbasin (2-9.01) and the East Bay Plain Groundwater Subbasin (2-9.04), which are two of the four subbasins of the Santa Clara Valley Groundwater Basin. The Niles Cone Groundwater Subbasin is comprised chiefly of the alluvial fan formed by Alameda Creek as it exits the Diablo Range and flows toward San Francisco Bay; the material consists of unconsolidated gravel, sand, silt, and clay. The aquifer in this area is both unconfined and confined because of the presence of local low-permeable layers. The shoreline of the East Bay has both transgressed and regressed in the past because of glacial and interglacial cycles, creating large aquifers interbedded with aquitards. The majority of the water-bearing materials are comprised of Quaternary alluvium, though the Santa Clara Formation underlies a portion of the groundwater basin along its eastern margin and likely exceeds a thickness of 500 feet. The Hayward fault impedes the westward flow of groundwater in the Niles Cone Groundwater Subbasin and generally divides the subbasin into two separate systems. The East Bay Plain Groundwater Subbasin consists of unconsolidated sediments of Quaternary age. Deposits include the early Pleistocene Santa Clara Formation, the late Pleistocene Alameda Formation, the early Holocene Temescal Formation, and artificial fill. The cumulative thickness of the unconsolidated sediments is about 1,000 feet and extends beneath San Francisco Bay to the west (California Department of Water Resources 2003).

The eastern boundary of the San Francisco Bay region includes several alluvial groundwater basins; the largest is the Livermore Valley Groundwater Basin (2-10). The entire floor of the Livermore Valley and portions of the upland areas on all sides of the valley overlay groundwater-bearing materials that consist of continental deposits from alluvial fans, outwash plains, and lakes; these include valley-fill materials, the Livermore Formation, and the Tassajara Formation. Under most conditions, the valley-fill materials and the Livermore Formation sediments yield adequate to large quantities of groundwater. The surficial valley-fill materials exist up to 400 feet thick, while the Plio-Pleistocene Livermore Formation can be as much as 4,000 feet thick, consisting of unconsolidated to semi-consolidated beds of gravel, sand, silt, and clay. Wells tapping the Pliocene-age Tassajara Formation yield small quantities of water, and there is little hydrologic continuity between it and the overlying water-bearing units (California Department of Water Resources 2003).

Fractured-Rock Aquifers

Fractured-rock aquifers are generally found in the mountain and foothill areas adjacent to the alluvial groundwater basins. Because of the highly variable nature of the void spaces within fractured-rock aquifers, wells drawing from fractured-rock aquifers tend to have less capacity and less reliability than wells drawing from alluvial aquifers. Generally, wells drawing from fractured-rock aquifers yield 10 gpm or less. Although fractured-rock aquifers are less productive compared with the alluvial aquifers in the region, they commonly serve as the sole source of water and a critically important water supply for many communities.

The majority of the water used in the San Francisco Bay region is derived either from groundwater contained in alluvial aquifers or from imported water supplies. As a result, a detailed discussion of fractured-rock aquifers related to the region was not developed as part of *California Water Plan Update 2013.*

Well Infrastructure

A key aspect to understanding the region's groundwater supply and development is identifying the age, distribution, and type of wells that have been drilled in a region. A valuable source of well information is the well completion reports, or well logs, submitted by licensed well drillers to the landowner, the local county environmental health department, and DWR. Among other things, well logs commonly identify well location, construction details, borehole geology data, installation date, and type of well use.

Well drillers have been required by law to submit well logs to the State since 1949. California Water Code Section 13751 requires drillers that construct, alter, abandon, or destroy a well to submit a well log to DWR within 60 days of the completed work. Because of confidentiality requirements (California Water Code Section 13752), only governmental agencies conducting studies, the owners of the wells, and persons performing environmental cleanup studies are allowed access to the well logs.

Well logs submitted to DWR for wells completed from 1977 through 2010 were used to evaluate the distribution and the uses of groundwater wells in the region. DWR does not have well logs for all the wells completed in the region, and for some well logs, information regarding well location or use is inaccurate, incomplete, ambiguous, or missing. As a result, some well logs could not be used in the evaluation. However, for a regional scale evaluation of well installation and distribution, the quality of the data is considered adequate and informative. Additional information regarding assumptions and methods of reporting well-log information to DWR is provided in Appendix A.

The number and distribution of wells in the San Francisco Bay region are grouped according to their location by county and according to the six most common well use types: domestic, irrigation, public supply, industrial, monitoring, and other. Public supply wells include all wells identified on the well completion report as municipal or public. Wells identified as "other" include a combination of the less common well types, such as, stock wells, test wells, or unidentified wells (no information listed on the well log).

The San Francisco Bay region includes all of San Francisco and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties. Well-log data for counties that fall within multiple hydrologic regions were assigned to the hydrologic region containing a majority of alluvial groundwater basins within the region. For the San Francisco Bay region, well-log data for Napa, Marin, Alameda, San Francisco, Santa Clara, and San Mateo counties are included in this section. Well details for Sonoma County, Solano County, and Contra

Costa County are included in the statistics for the North Coast Hydrologic Region, Sacramento River Hydrologic Region, and San Joaquin River Hydrologic Region, respectively.

Table 4-2 lists the number of well logs received by DWR for wells drilled in the San Francisco Bay region from 1977 to 2010. Figures 4-3 and 4-4 provide an illustration of this data according to county, and for the region as a whole. The total number of wells installed in the San Francisco Bay region between 1977 and 2010 is approximately 62,941. The general distribution of these wells shows that 8,951 are listed as domestic wells, 2,594 are listed as irrigation wells, 356 are listed as public supply wells, 154 are listed as industrial wells, 41,487 are listed as monitoring wells, and 9,399 are listed as other. Santa Clara County has the greatest number of well records (34,190) and San Francisco County has the fewest (1,545).

Table 4-2 Number of Well Logs, According to Well Use and County for the San Francisco Bay Hydrologic Region (1977-2010)

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

Figure 4-3 Number of Well Logs by County and Use for the San Francisco Bay Hydrologic Region (1977-2010)

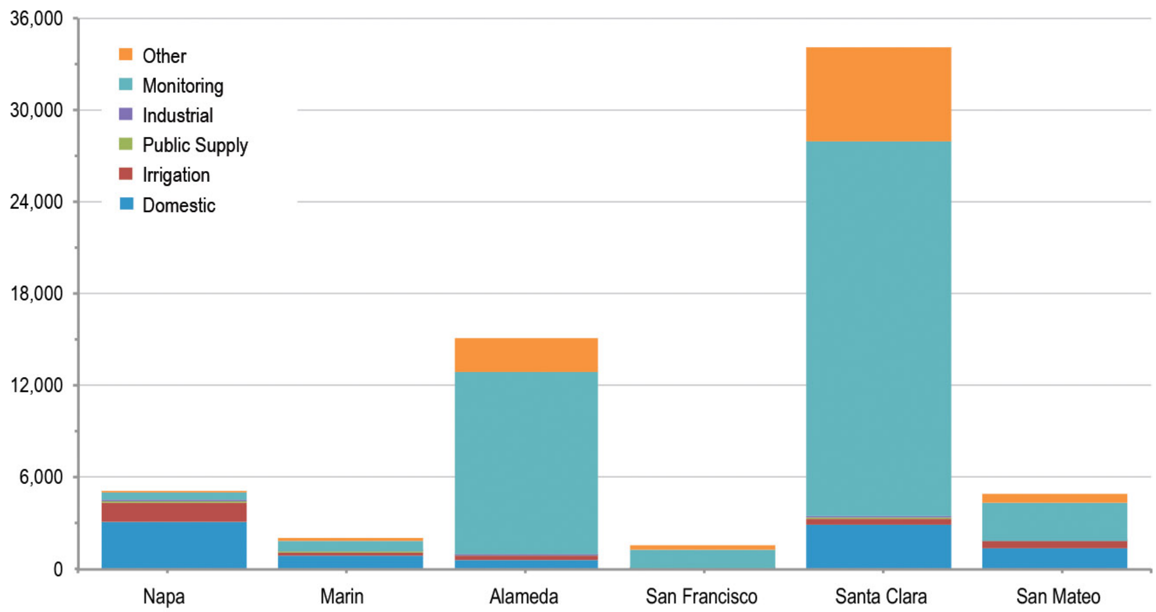

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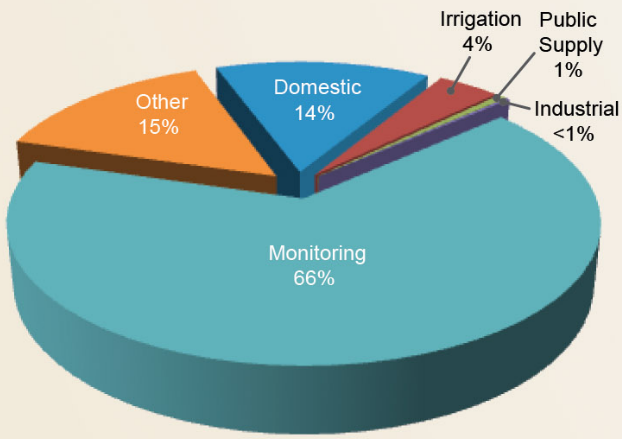
Figure 4-4 Percentage of Well Logs by Type of Use for the San Francisco Bay Hydrologic Region (1977-2010)



San Francisco Bay Well Logs Summary by Well Type

Well Type	Number of Well Logs
Domestic	8,951
Irrigation	2,594
Public Supply	356
Industrial	154
Monitoring	41,487
Other	9,399
Total	**62,941**

Prepared by California Department of Water Resources for California's Groundwater Update 2013

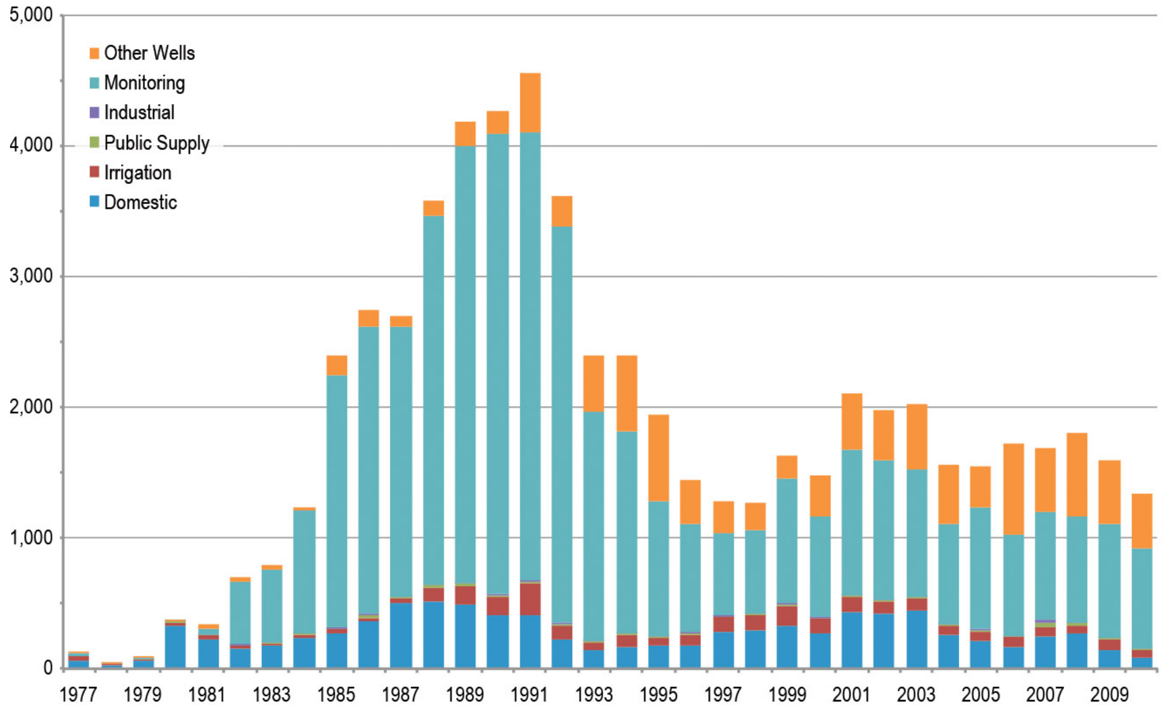
Figure 4-4 displays the percentages of wells, according to well use, for the San Francisco Bay region between 1977 and 2010. Figure 4-4 shows that domestic and monitoring wells account for 80 percent of all wells installed in the region, with domestic wells comprising 14 percent and monitoring wells accounting for about 66 percent of well logs on file. Statewide, domestic and monitoring wells comprise about 54 percent and 24 percent, respectively, of the total number of wells.

Although groundwater accounts for approximately 74 percent of agricultural water supply for the San Francisco Bay region (discussed in the "Groundwater Use" section of this chapter), irrigation wells comprise 4 percent of the total number of well logs for the region, which is lower than the statewide average of approximately 10 percent. Typically, irrigation wells are much higher capacity than domestic wells.

In addition to analyzing the number of wells according to location and use, well logs were analyzed according to well installation date (Figure 4-5). Evaluating the number and types of wells drilled over time can offer a perspective on the average age of the existing infrastructure and the general pattern of wells installed during various water years and economic cycles. Well-log records for the 2007-2010 period are known to be less complete because of constraints associated with processing and incorporating the data.

Figure 4-5 shows that well installations in the San Francisco Bay region peaked in 1991 with 4,557 wells; of those, 75 percent were monitoring wells. Between 1982 and 1992, the number of monitoring wells installed averaged approximately 2,211 wells per year. Since 1993, monitoring well installations in the San Francisco Bay Hydrologic Region have averaged approximately 949 wells per year.

Figure 4-5 Number of Well Logs Filed per Year, by Well Use, for the San Francisco Bay Hydrologic Region (1977-2010)



Prepared by California Department of Water Resources for California's Groundwater Update 2013

Domestic wells are the second-most common type of well found in the region and make up approximately 14 percent of the wells in the San Francisco Bay region. In Napa County, approximately 61 percent of the wells on record are domestic wells. In Marin and San Mateo counties, domestic wells account for 43 percent and 28 percent of the total wells, respectively. Although the statistics for Sonoma County are not included in this section, the number of domestic wells in Sonoma County account for almost 68 percent of the total wells. As the statistics reflect, groundwater for domestic use is a major component of the North Bay's water supply, and this resource will be relied upon more in dry years.

The information depicted on Figure 4-5 shows that the number of domestic wells drilled during dry years (1987-1992) was generally greater than wet years when surface water was more readily available. Also shown on Figure 4-5 were increases of domestic wells drilled during 2001-2003. While these years were not as dry as the 1987-1992 period, this time was generally considered a "housing boom" in California, and the increase in residential development could be reflected by the increased number of domestic wells drilled in the region during those years.

The onset of monitoring-well installation in the mid- to late-1980s is likely associated with federal underground storage tank programs signed into law in the mid-1980s. Starting in 1984, the California Underground Storage Tank Program took effect. The program provided partial reimbursement of expenses associated with the cleanup of leaking underground storage tanks. It quickly resulted in an increase in the installation of groundwater-quality monitoring wells. Beginning in 1987, changes in regulations also required well drillers to begin submitting well logs for monitoring-well installation. Well logs typically do not distinguish between monitoring wells installed as part of a groundwater clean-up project and those installed primarily to collect changes in groundwater levels. It is estimated that the majority of monitoring wells were completed for use in environmental assessments related to leaking underground storage tanks, waste disposal sites, and hazardous chemical spills.

CASGEM Basin Prioritization

As part of the California 2009 Comprehensive Water Package legislation (SB X7-6), DWR implemented the CASGEM program. The SB X7-6 groundwater monitoring legislation added Part 2.11 to Division 6 of the California Water Code (Section10920 et seq.), which established provisions and requirements for local agencies to develop and conduct groundwater-level monitoring programs. The legislation requires DWR to identify the current extent of groundwater elevation monitoring within each of the alluvial groundwater basins defined under Bulletin 118-2003, and to prioritize those basins to help identify, evaluate, and determine the need for additional groundwater-level monitoring. The basin prioritization process (California Water Code Section 10933[b]) directs DWR to consider, to the extent data are available, the following eight components:

1. The population overlying the basin.
2. The rate of current and projected growth of the population overlying the basin.
3. The number of public supply wells that draw from the basin.
4. The total number of wells that draw from the basin.
5. The irrigated acreage overlying the basin.
6. The degree to which persons overlying the basin rely on groundwater as their primary source of water.
7. Any documented impacts on the groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation.
8. Any other information determined to be relevant by the department.

Using groundwater reliance as the leading indicator of basin priority, DWR evaluated California's 515 groundwater basins and categorized them into four prioritization groups: high, medium, low, and very low. Table 4-3 lists the low-, medium-, and high-priority CASGEM groundwater basins for the San Francisco Bay region; Figure 4-6 identifies these basins on a map. A full listing of the CASGEM groundwater basin prioritization is provided in Appendix B.

Of the 33 groundwater basins and subbasins within the San Francisco Bay region, one subbasin is identified as high priority (Santa Clara [2-9.02]), six are identified as medium priority, one is listed as low priority, and the other 25 are listed as very low priority. The seven basins and subbasins designated as high or medium priority in the San Francisco Bay region comprise 88 percent of the annual groundwater use within the region and 63 percent of the 2010 population that overlies the groundwater basin area. The population that overlies the seven groundwater basins and subbasins designated as high or medium priority comprises 51 percent of the total population of the region.

Although the primary intent of the basin prioritization effort is to assist DWR in implementing the CASGEM Program, based on the comprehensive set of data included in the analysis, basin prioritization is also a valuable statewide tool to help evaluate, focus, and align limited resources.

Basin prioritization is also an important tool to implement effective groundwater management practices by improving the statewide reliability and sustainability of groundwater resources.

In the San Francisco Bay region, implementing sustainable groundwater resource management should focus initially on the seven high- or medium-priority basins listed in Table 4-3.

Table 4-3 CASGEM Prioritization for Groundwater Basins in the San Francisco Bay Hydrologic Region

Basin Priority	Count	Basin/Subbasin Number	Basin Name	Subbasin Name	2010 Census Population
High	1	2-9.02	Santa Clara Valley	Santa Clara	1,633,190
Medium	1	2-2.01	Napa-Sonoma Valley	Napa Valley	91,234
Medium	2	2-10	Livermore Valley		196,658
Medium	3	2-1	Petaluma Valley		49,915
Medium	4	2-9.01	Santa Clara Valley	Niles Cone	321,494
Medium	5	2-2.02	Napa-Sonoma Valley	Sonoma Valley	31,275
Medium	6	2-9.04	Santa Clara Valley	East Bay Plain	881,718
Low	1	2-2.03	Napa-Sonoma Valley	Napa-Sonoma Lowlands	58,367
Very Low	25	See Appendix B			
Total	**33**	**Population of San Francisco Bay Region Groundwater Basin Area:**			**5,075,243[a]**

Notes:

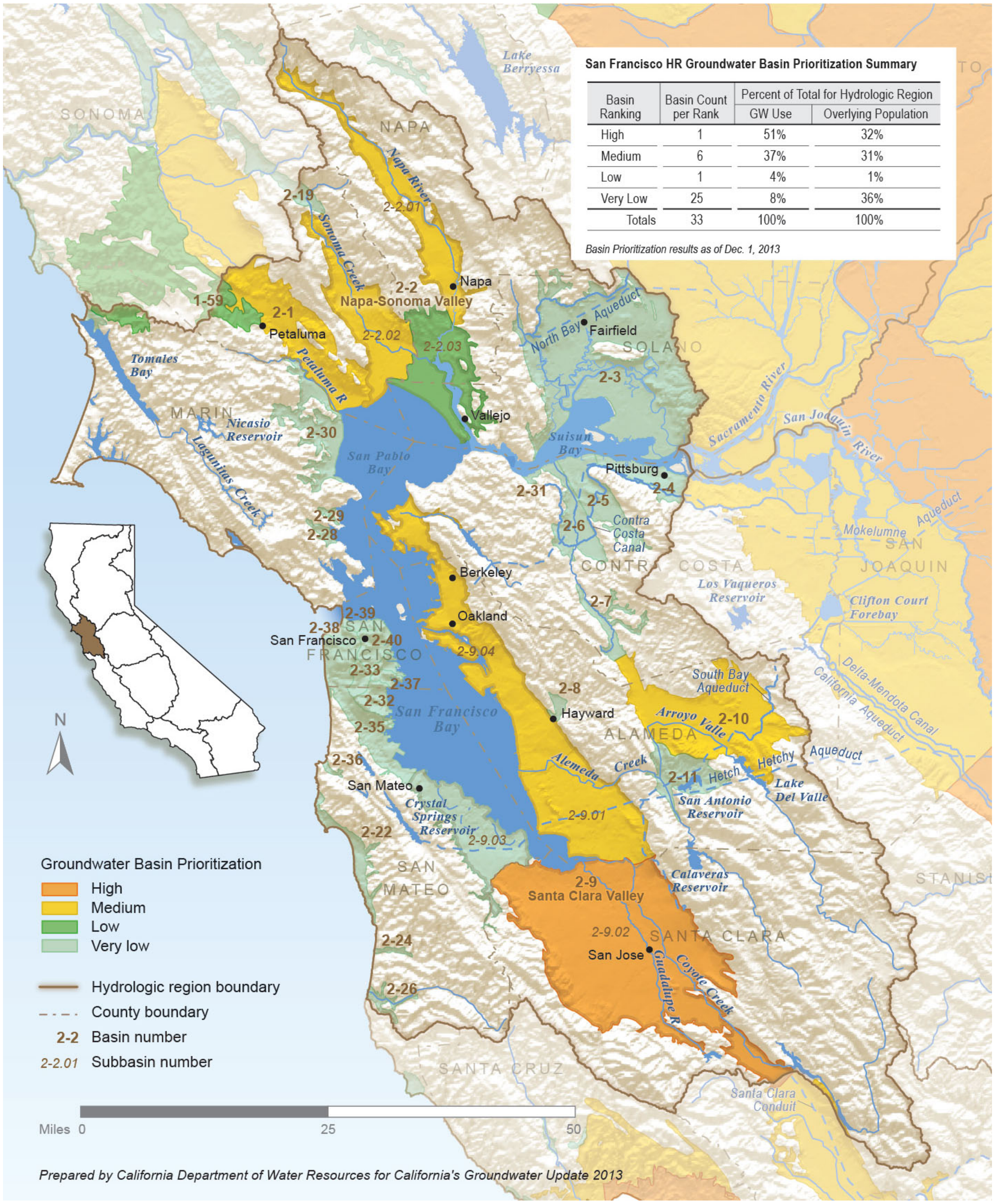
[a]Population of groundwater basin area includes the population of all basins within San Francisco Bay Hydrologic Region.

Ranking as of December 2013.

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

Using groundwater reliance as the leading indicator of basin priority, the California Department of Water Resources evaluated California's 515 alluvial groundwater basins and categorized them into four groups — high, medium, low, and very low.

Figure 4-6 CASGEM Groundwater Basin Prioritization for the San Francisco Bay Hydrologic Region



San Francisco HR Groundwater Basin Prioritization Summary

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

Basin Prioritization results as of Dec. 1, 2013

Groundwater Use

The amount and timing of groundwater extraction, along with the location and type of groundwater use, are fundamental components for building a groundwater basin budget and identifying effective options for groundwater management. While some types of groundwater uses are reported for some California basins, the majority of groundwater users are not required to monitor, meter, or publically record their annual groundwater extraction amount. Groundwater use estimates for this report are based on water supply and balance information derived from DWR land use surveys and from groundwater use information voluntarily provided to DWR by water purveyors or other State agencies.

Groundwater extraction estimates derived from land and water use methods typically assume that local surface water supplies are the first to be used to meet local water demands. Once surface water allocations have been fully allocated, if crop demand and water balance information indicates that additional water supplies are needed, groundwater supplies are then applied until the full water demand is met and the overall supply and demand for the area is balanced. For agricultural areas employing conjunctive management practices, which may involve frequent exchange between surface water and groundwater supplies, accurate estimates of annual groundwater extraction using the land and water use method can be challenging.

DWR water supply and balance data are collected and analyzed by hydrologic regions, which largely correspond to watershed boundaries. The data is first compiled and analyzed by detailed analysis units (DAUs). Water supply and balance data for DAUs are then compiled into larger planning areas, and then into hydrologic regions, and finally into a statewide water supply and balance estimate. To assist local resource planning, DWR also generates water supply and balance information according to county. Although some local groundwater management groups independently develop groundwater use estimates for their local groundwater basin areas, DWR does not currently generate groundwater use information by groundwater basin area.

Water use is reported by water year (October 1 through September 30), and categorized according to urban, agriculture, and managed wetland uses. Reference to *total water supply* for a region represents the sum of surface water supplies, groundwater supplies, and reused or recycled water supplies. Reused and recycled water supplies also include desalinated water supplies. Groundwater use information is presented according to planning area, county, and type of use. Additional information regarding water use analysis is provided in Appendix A and in Appendix C.

2005-2010 Average Annual Groundwater Supply

Water demands in the San Francisco Bay region are met through a combination of supplies, including imported surface water, local surface water, local groundwater extraction, and recycled water supply. Approximately two-thirds of the San Francisco Bay region's water supply is imported from Sierra Nevada and Sacramento-San Joaquin River Delta sources through various State, federal, and local projects. Nearly all of the region's water agencies depend on imported water as an important component of their water supply (Bay Area Integrated Regional Management Plan 2013).

Groundwater Use by Planning Area Boundaries

The San Francisco Bay region includes two planning areas; the North Bay Planning Area (PA) and the South Bay PA. Table 4-4 lists the 2005-2010 average annual total water supply met by groundwater, according to planning area and type of use. Groundwater use in Table 4-4 is reported in taf and by the percentage that groundwater contributes to the total water supply for the region. Table 4-5 identifies the percentage of groundwater used to meet the San Francisco Bay region's annual supply according to planning area and type of use. Figure 4-7 shows the planning area locations for the region and illustrates the groundwater use information presented in Table 4-4 and Table 4-5.

Assuming the planning area boundaries for the San Francisco Bay region, the 2005-2010 average annual total water supply is estimated at 1,250 taf (including 8 taf of reuse). Approximately 260 taf of the total supply is met by groundwater. According to the Bay Area IRWM Plan, EBMUD receives approximately 90 percent of its water supply from the Pardee and Camanche reservoirs in the Mokelumne River Watershed, and the San Francisco Public Utilities Commission (SFPUC) receives approximately 85 percent of its water supply from the Hetch Hetchy Regional Water System in the Tuolumne River Watershed. The Russian River Watershed, operated by the Sonoma County Water Agency (SCWA), provides approximately 4 percent of the total water supplied to the San Francisco Bay region.

Groundwater extraction in the San Francisco Bay region accounts for about 2 percent of California's 2005-2010 average annual groundwater use, which is estimated at 16,461 taf. For some communities in the region, groundwater accounts for 100 percent of the supply. It is also used to help facilitate local conjunctive management of water resources in the region. In the San Francisco Bay region, 70 percent of the total groundwater use is in the South Bay PA.

As shown in Table 4-4, while 21 percent of the San Francisco Bay region's total water supply is met by groundwater sources, those groundwater sources meet about 16 percent (184 taf) of the region's total urban water use and 74 percent (76 taf) of the region's total agricultural water use. No groundwater resources are used for managed wetland applications in the region.

Table 4-4 Average Annual Total Water Supply Met by Groundwater, According to Planning Area and Type of Use, for the San Francisco Bay Hydrologic Region (2005-2010)

San Francisco Bay Hydrologic Region		Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use[a] Met by Groundwater	
PA Number	**PA Name**	**taf**	**%[b]**	**taf**	**%[b]**	**taf**	**%[b]**	**taf**	**%[b]**
201	North Bay	54.7	71%	23.8	16%	0.0	0%	78.6	34%
202	South Bay	21.4	85%	159.6	16%	0.0	0%	181.0	18%
2005-2010 Annual Average HR Total		**76.1**	**74%**	**183.5**	**16%**	**0.0**	**0%**	**259.6**	**21%**

Notes:

HR = hydrologic region, PA = planning area, taf = thousand acre-feet

[a]Total water use = groundwater + surface water + reuse

[b]Percentage use is the percentage of the total water supply that is met by groundwater, according to type of use.

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

Table 4-5 Average Annual Total Water Supply Met by Groundwater, According to Planning Area and Type of Use, for the San Francisco Bay Hydrologic Region (2005-2010)

San Francisco Bay Hydrologic Region		Agriculture Use of Groundwater	Urban Use of Groundwater	Managed Wetlands Use of Groundwater	Groundwater Use by PA
PA Number	**PA Name**	**%[a]**	**%[a]**	**%[a]**	**%[b]**
201	North Bay	70%	30%	0%	30%
202	South Bay	12%	88%	0%	70%
2005-2010 Annual Average HR Total		**29%**	**71%**	**0%**	**100%**

Notes:
HR = hydrologic region, PA = planning area
[a]Percentage use is average annual groundwater use according to planning area and type of use, compared to the total groundwater use for the hydrologic region.
[b]Percentage of hydrologic region total groundwater use.

Groundwater Use by County Boundaries

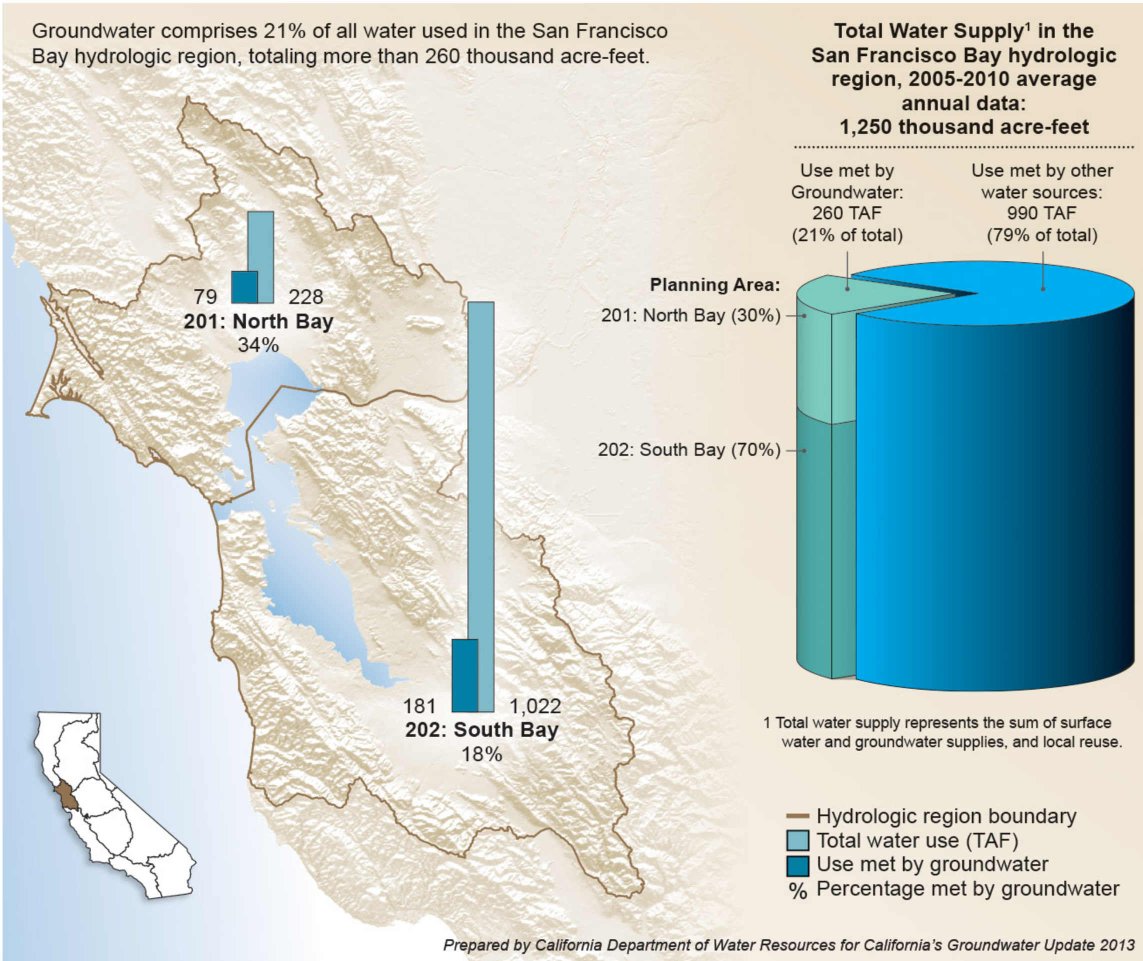
Groundwater supply and use was also calculated by county. County boundaries do not align with planning area or hydrologic region boundaries, so regional totals for groundwater, based on county area, will vary from the estimates based on planning areas shown in Table 4-4 and Figure 4-7.

San Francisco County is fully located within the San Francisco Bay region, while Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties are partially within the San Francisco Bay region. For the San Francisco Bay region, county groundwater use is only reported for Napa, Marin, Alameda, San Francisco, Santa Clara, and San Mateo counties. Groundwater use for Sonoma County, Solano County, and Contra Costa County are included in the statistics for the North Coast Hydrologic Region (Chapter 3), Sacramento River Hydrologic Region (Chapter 7) and San Joaquin River Hydrologic Region (Chapter 8), respectively. Tables showing groundwater use for all 58 California counties are included in Appendix C.

Table 4-6 lists the 2005-2010 average annual groundwater use according to county, type of use, and the percentage that groundwater contributes to the total water supply of the San Francisco Bay region. Overall, based on county boundaries, groundwater contributes 25 percent (268 taf) of the total water supply (estimated to be 1,055 taf, including approximately 9 taf of total reuse) for the six-county area in the San Francisco Bay region. Table 4-6 shows the groundwater contribution made to the total water supply of the six counties in the San Francisco Bay region ranges from almost 0 percent in San Francisco County to 59 percent in Napa County.

Groundwater supplies within the six-county area are used primarily to meet urban demands, with approximately 70 percent (186 taf) of total groundwater use going toward urban purposes.

Figure 4-7 Groundwater Use and Total Water Supply Met by Groundwater, by Planning Area, in the San Francisco Bay Hydrologic Region (2005-2010)



Change in Annual Groundwater Use

Changes in annual amount and type of groundwater use may be related to a number of factors, such as changes in surface water availability, urban and agricultural growth, economic fluctuations, and water use efficiency practices.

Figure 4-8 illustrates the 2002-2010 groundwater supply trend for the San Francisco Bay region. The right side of Figure 4-8 illustrates the total water supply volume by supply type (groundwater, surface water, and reused/recycled water), while the left side shows the percentage of the overall water supply that is met by those sources of water. The center column identifies the water year along with the corresponding amount of precipitation, as a percentage of the previous 30-year average for the hydrologic region.

Table 4-6 Groundwater Use and Percentage of Total Water Supply Met by Groundwater, According to County and Type of Use, for the San Francisco Bay Hydrologic Region (2005-2010)

San Francisco Bay Hydrologic Region	Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
County	**taf**	**%[a]**	**taf**	**%[a]**	**taf**	**%[a]**	**taf**	**%**
Alameda	5.8	51%	35.9	15%	0.0	0%	41.7	17%
Marin	3.1	63%	1.0	2%	0.0	0%	4.0	9%
Napa	36.6	77%	7.4	29%	0.0	0%	44.0	59%
San Francisco	0.0	0%	0.1	0%	0.0	0%	0.1	0%
San Mateo	2.0	67%	8.5	8%	0.0	0%	10.5	9%
Santa Clara	34.1	49%	135.7	32%	0.0	0%	169.8	34%
2005-2010 Annual Average HR Total	**81.5**	**60%**	**188.5**	**21%**	**0.0**	**0%**	**270.0**	**26%**

Notes:
HR = hydrologic region, taf = thousand acre-feet
[a]Percentage use is the percentage of the total water supply that is met by groundwater, according to type of use.
2005-2010 precipitation equals 93 percent of the 30-year average for the hydrologic region.

As shown in Figure 4-8, the annual total water supply for the San Francisco Bay region, assuming planning area boundaries, fluctuated between 1,101 taf (2010) and 1,382 taf (2002), while annual groundwater use has ranged between 239 taf (2010) and 281 taf (2008). The percentage that groundwater contributed toward the total water use during these years ranged from 18 percent to 23 percent, which is a relatively stable contribution from year-to-year, despite the water year type.

Figure 4-9 shows the 2002-2010 groundwater supply trend by urban, agricultural, and managed wetland uses in the San Francisco Bay region. The right side of Figure 4-9 illustrates the annual volume of groundwater extraction by type of use, while the left side shows the percent of groundwater extraction by type of use. For each of the water years represented in Figure 4-9, groundwater used for urban purposes was far greater than the amount of groundwater used for agricultural purposes. Groundwater for urban use ranged from 63 percent to 79 percent of the total groundwater used in the San Francisco Bay region, while agricultural activities accounted for 21 percent to 37 percent of the total groundwater used in the region.

Figure 4-8 Annual Surface Water and Groundwater Supply Trend for the San Francisco Bay Hydrologic Region (2002-2010)

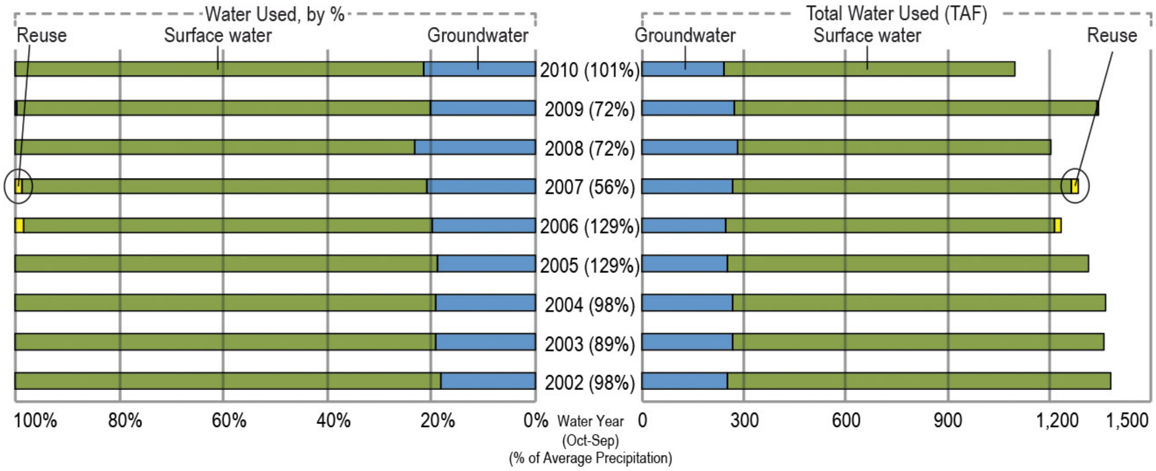


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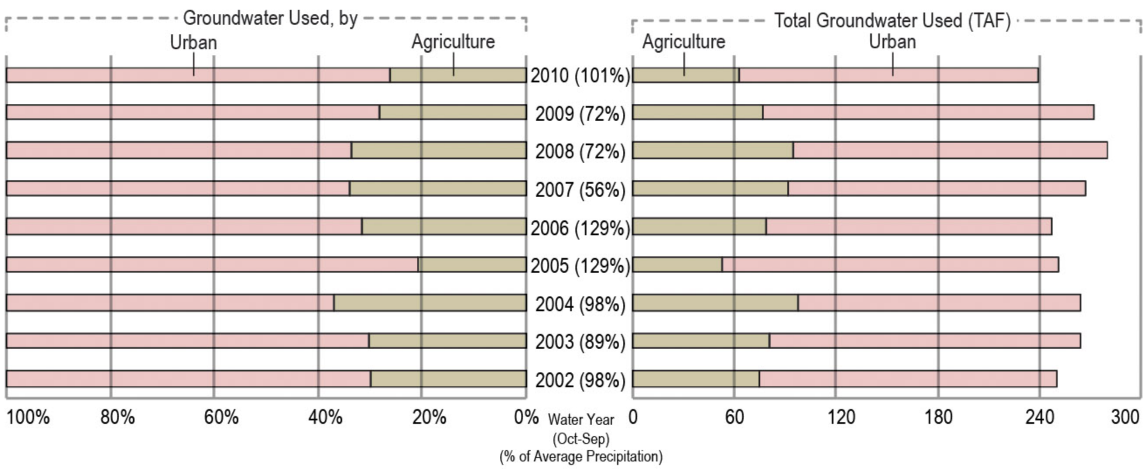
Figure 4-9 Annual Groundwater Supply Trend by Type of Use for the San Francisco Bay Hydrologic Region (2002-2010)



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Groundwater Monitoring Efforts

Groundwater resource monitoring and evaluation is a key aspect to understanding groundwater conditions, identifying effective resource management strategies, and implementing sustainable resource management practices. California Water Code Section10753.7 requires local agencies seeking state funds administered by DWR to prepare and implement GWMPs that include monitoring of groundwater levels, groundwater quality degradation, inelastic land subsidence, and changes in surface water flow and quality that directly affect groundwater levels or quality. The protocols associated with groundwater monitoring can vary greatly depending on the local conditions, but overall, monitoring protocols should be designed to generate information that promotes efficient and effective groundwater management.

This section summarizes some of the groundwater level, groundwater quality, and land subsidence monitoring activities in the San Francisco Bay region. The summary includes publically available groundwater data compiled by DWR, State Water Resources Control Board (SWRCB), California Department of Public Health (CDPH), and the U.S. Geological Survey (USGS). Information regarding the groundwater monitoring methods, assumptions, and data availability is provided in Appendix A.

Groundwater Level Monitoring

State and federal agencies with groundwater-level monitoring programs in the region include DWR and USGS. Groundwater-level monitoring is also performed by CASGEM-designated monitoring entities, as well as local cooperators that measure, or contract others to measure, groundwater levels. Groundwater-level information presented in this section represents data that is publically available through DWR or USGS online information systems. Privately collected and locally maintained groundwater-level information is not discussed in this section. The groundwater-level information in this section only includes active monitoring wells that have been measured since January 1, 2010, and monitoring groups that have entered data into the CASGEM or USGS online databases as of July 2012. Monitoring programs are frequently adjusted to meet changing demands and management actions. As a result, groundwater-level information presented for the San Francisco Bay region may not represent the most current information available. Updated groundwater-level information may be obtained online from the DWR CASGEM Program Web site (http://www.water.ca.gov/groundwater/casgem/), and through the USGS National Water Information System (http://maps.waterdata.usgs.gov/mapper/).

The number of groundwater-level monitoring wells in the San Francisco Bay region, according to monitoring agencies, cooperators, and CASGEM-designated monitoring entities, is provided in Table 4-7. The locations of these monitoring wells, according to monitoring entity and monitoring well type, are shown in Figure 4-10.

Table 4-7 shows that 117 wells in the San Francisco Bay region are actively monitored for groundwater-level information. That data is made available for public review. DWR’s North Central Region Office also collects groundwater-level data from additional monitoring wells in Napa, Sonoma, and San Mateo counties. Those data are not included in the monitoring well summary because of confidentiality agreements that limit public availability of the data. The hydrographs and historical data for wells monitored by DWR are available on DWR’s Water Data Library. The USGS monitoring network consists of six wells in the San Francisco Bay region. One cooperator and seven CASGEM monitoring entities monitor a combined 110 wells in the region. A comparison of Figure 4-6 and Figure 4-10 indicates that many of the CASGEM monitoring entities identified in Table 4-7 are monitoring the groundwater basins identified as having a high or medium priority under the CASGEM Basin Prioritization. It should be noted that additional CASGEM monitoring entities have been designated by DWR since these tables and figures were prepared. The CASGEM program Web site has a current list monitoring entities and groundwater elevation monitoring wells.

Table 4-7 Groundwater-Level Monitoring Wells by Monitoring Entity for the San Francisco Bay Hydrologic Region

State and Federal Agencies	Number of Wells
California Department of Water Resources	0
U.S. Geological Survey	6
U.S. Bureau of Reclamation	0
Total State and Federal Wells	**6**
Monitoring Cooperators	**Number of Wells**
Napa County Flood Control and Water Conservation District	13
Total Cooperator Wells	**13**
CASGEM Monitoring Entities[a]	**Number of Wells**
Alameda County Water District	26
City of Pittsburg	9
Coastside County Water District	1
Napa County	14
Montara Water and Sanitary District	6
San Francisco Public Utilities Commission	16
Sonoma County Water Agency	26
Total CASGEM Entity Wells	**98**
Total Hydrologic Region Monitoring Wells	**117**

Notes:
CASGEM = California Statewide Groundwater Elevation Monitoring Program
Table represents monitoring information as of July 2012.
[a]Additional CASGEM monitoring entities post July, 2012 include South Westside Basin Voluntary Cooperative Groundwater Monitoring Association, Sonoma County Permit and Resource Management District, Zone 7 Water Agency, and Santa Clara Valley Water District.
Table includes groundwater-level monitoring wells having publically available online data.

Most of the groundwater-level monitoring networks include a variety of well-use types. The groundwater-level monitoring wells are categorized by the type of well use and include irrigation, domestic, observation, public supply, and other. Groundwater-level monitoring wells identified as “other” include a combination of the less common well types, such as stock wells, test wells, industrial wells, or unidentified wells (no information listed on the well log). Wells listed as “observation” also include those wells described by drillers in the well logs as “monitoring” wells. Some of the domestic and irrigation wells used for groundwater-level monitoring include actively operated wells and older inactive or unused wells.

Domestic wells are typically relatively shallow and screened in the upper portion of the aquifer system, while irrigation wells tend to be constructed deeper within the aquifer system. As a result, groundwater-level data collected from domestic wells typically represent shallow aquifer conditions, while groundwater-level data from irrigation wells represent middle-to-deep aquifer conditions. Some observation wells are constructed as a nested or clustered set of dedicated monitoring wells, designed to characterize groundwater conditions at very specific and discrete production intervals throughout the aquifer system.

Figure 4-10 Monitoring Well Location According to Agency, Monitoring Cooperator, and CASGEM Monitoring Entity for the San Francisco Bay Hydrologic Region

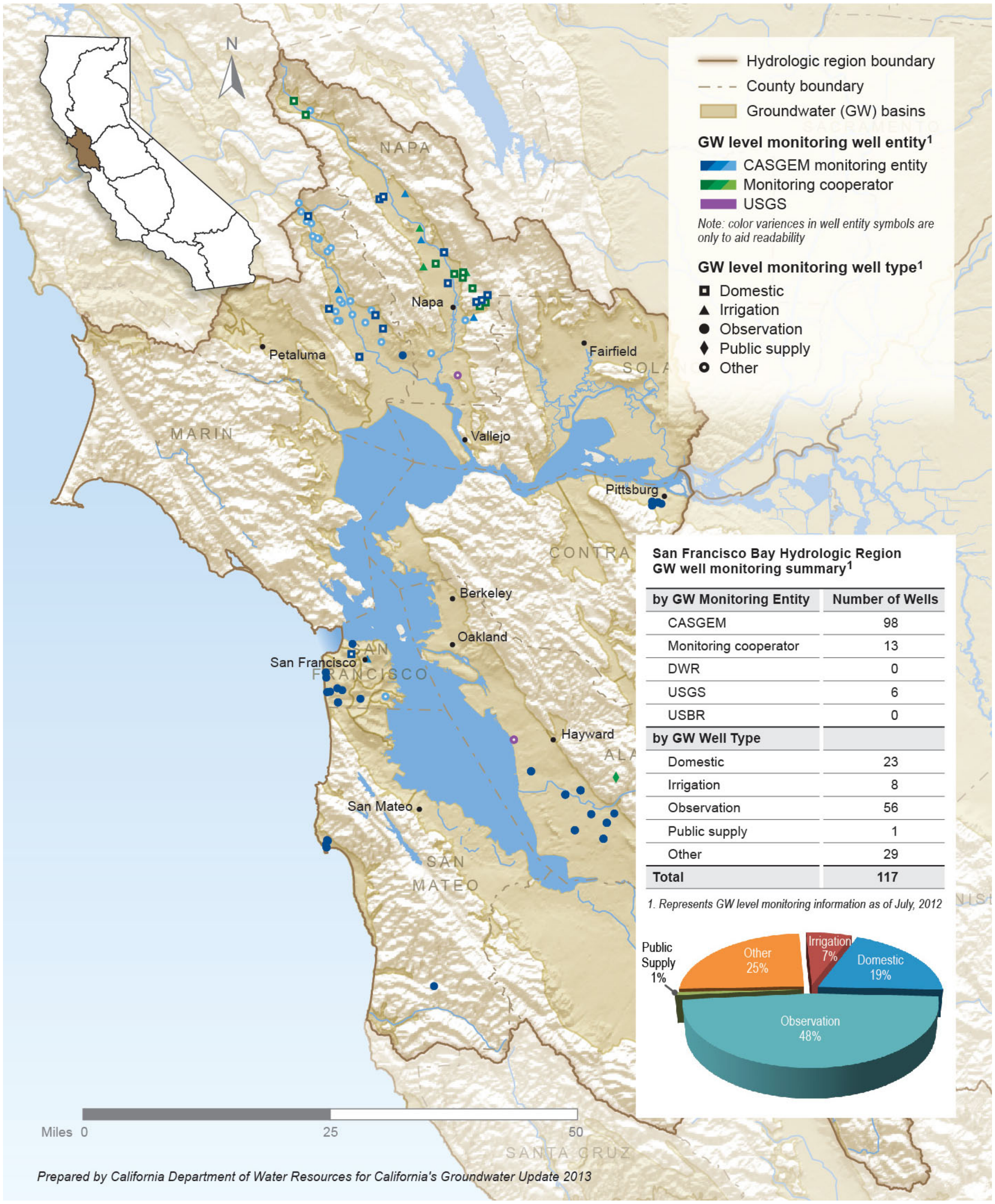


Figure 4-10 indicates which agency collects the groundwater-elevation data, and graphically displays groundwater-level monitoring wells, by use. A percentage breakdown of the groundwater-level monitoring wells by use (illustrated by the pie chart), indicates that wells identified by use as “other” account for more than 24 percent of the groundwater-level monitoring wells in the region. Observation wells comprise 48 percent of the monitoring wells, while irrigation and domestic wells account for 7 percent and 20 percent of the region’s monitoring wells, respectively. Less than 1 percent of the San Francisco Bay region’s monitoring wells are public supply wells.

Groundwater-Quality Monitoring

Groundwater-quality monitoring is an important aspect to effective groundwater basin management and is one of the required groundwater management planning components under California Water Code Section 10753.7. Groundwater quality monitoring and assessment evaluates current conditions, can be used to establish groundwater quality thresholds, and can help guide management decisions. Without sufficient groundwater quality monitoring, it is almost impossible to determine if groundwater problems exist or to forecast the potential for future problems that may warrant management actions. Many local, regional, and State agencies have statutory responsibility or authority to collect water quality and water use/level data and information; however, monitoring is inconsistent throughout the state, with significant regional variation in parameters monitored, monitoring frequency, and data availability. In spite of these inconsistencies, there are excellent examples of groundwater monitoring programs being implemented at the local, regional, and State levels.

Regional and statewide groundwater-quality monitoring information and data are available to the public on DWR’s Water Data Library (http://www.water.ca.gov/waterdatalibrary/), the SWRCB’s Groundwater Ambient Monitoring and Assessment (GAMA) Web site (http://www.waterboards.ca.gov/gama/geotracker_gama.shtml), and the GeoTracker GAMA Web site (http://geotracker.waterboards.ca.gov/). The GAMA Program was created in 2000 by the SWRCB to better understand California’s groundwater quality issues. The GAMA Program was later expanded, as part of the Groundwater Quality Monitoring Act of 2001, resulting in a publicly accepted plan to monitor and assess groundwater quality in basins that account for more than 95 percent of the state’s groundwater use. The GAMA Web site includes a description of the GAMA program and also provides links to all published GAMA and related reports.

GeoTracker GAMA is an online groundwater information system that provides the public with access to groundwater quality data. The data is geographically displayed and includes analytical tools and reporting features to assess groundwater quality conditions. GeoTracker GAMA allows users to search for more than 60 million standardized analytical test results from more than 200,000 wells and contains more than 125 million data records. These data records were obtained from different sources including the SWRCB, regional water quality control boards (RWQCBs), CDPH, California Department of Pesticide Regulation (DPR), USGS, and Lawrence Livermore National Laboratory (LLNL). In addition to groundwater quality data, GeoTracker GAMA contains more than 2.5 million depth-to-groundwater measurements from DWR and the RWQCBs. GeoTracker GAMA also contains hydraulically fractured oil and gas well information from the California Division of Oil, Gas, and Geothermal Resources. Groundwater quality data in

DWR's Water Data Library primarily includes primarily baseline minerals, metals, and nutrient data associated with regional monitoring.

Table 4-8 provides agency-specific groundwater quality information. Additional information regarding assessment and reporting of groundwater quality information is listed under the "Aquifer Conditions" section of this chapter.

Table 4-8 Sources of Groundwater Quality Information for the San Francisco Bay Hydrologic Region

Agency	Links to Information
State Water Resources Control Board http://www.waterboards.ca.gov/	**Groundwater** http://www.waterboards.ca.gov/water_issues/programs/#groundwater) • Communities that Rely on a Contaminated Groundwater Source for Drinking Water http://www.waterboards.ca.gov/water_issues/programs/gama/ab2222/index.shtml • Hydrogeologically Vulnerable Areas http://www.waterboards.ca.gov/gama/docs/hva_map_table.pdf • Aquifer Storage and Recovery http://www.waterboards.ca.gov/water_issues/programs/asr/index.shtml **Groundwater Ambient Monitoring and Assessment (GAMA)** http://www.waterboards.ca.gov/gama/index.shtml • GeoTracker GAMA (Monitoring Data) http://www.waterboards.ca.gov/gama/geotracker_gama.shtml • Domestic Well Project http://www.waterboards.ca.gov/gama/domestic_well.shtml • Priority Basin Project http://www.waterboards.ca.gov/water_issues/programs/gama/sw_basin_assesmt.shtml • Special Studies Project http://www.waterboards.ca.gov/water_issues/programs/gama/special_studies.shtml • California Aquifer Susceptibility Project http://www.waterboards.ca.gov/water_issues/programs/gama/cas.shtml **Contaminant Sites** • Land Disposal Program http://www.waterboards.ca.gov/water_issues/programs/land_disposal/ • Department of Defense Program http://www.waterboards.ca.gov/water_issues/programs/dept_of_defense/ • Underground Storage Tank Program http://www.waterboards.ca.gov/ust/index.shtml • Brownfields http://www.waterboards.ca.gov/water_issues/programs/brownfields/

Agency	Links to Information
California Department of Public Health http://www.cdph.ca.gov/Pages/DEFAULT.aspx	**Division of Drinking Water and Environmental Management** http://www.cdph.ca.gov/programs/Pages/DDWEM.aspx • Drinking Water Source Assessment and Protection (DWSAP) Program http://www.cdph.ca.gov/certlic/drinkingwater/Pages/DWSAP.aspx • Chemicals and Contaminants in Drinking Water http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Chemicalcontaminants.aspx • Chromium-IV http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Chromium6.aspx • Groundwater Replenishment with Recycled Water http://www.cdph.ca.gov/HealthInfo/environhealth/water/Pages/Waterrecycling.aspx
California Department of Water Resources http://www.water.ca.gov/	**Groundwater Information Center** http://www.water.ca.gov/groundwater/index.cfm • Bulletin 118 Groundwater Basins http://www.water.ca.gov/groundwater/bulletin118/gwbasins.cfm • California Statewide Groundwater Elevation Monitoring (CASGEM) http://www.water.ca.gov/groundwater/casgem/ • Groundwater Level Monitoring http://www.water.ca.gov/groundwater/data_and_monitoring/gw_level_monitoring.cfm • Groundwater Quality Monitoring http://www.water.ca.gov/groundwater/data_and_monitoring/gw_quality_monitoring.cfm • Well Construction Standards http://www.water.ca.gov/groundwater/wells/standards.cfm • Well Completion Reports http://www.water.ca.gov/groundwater/wells/well_completion_reports.cfm
California Department of Toxic Substance Control http://www.dtsc.ca.gov/	**EnviroStor** http://www.envirostor.dtsc.ca.gov/public/
California Department of Pesticide Regulation http://www.cdpr.ca.gov/	**Groundwater Protection Program** http://www.cdpr.ca.gov/docs/emon/grndwtr/index.htm • Well Sampling Database http://www.cdpr.ca.gov/docs/emon/grndwtr/gwp_sampling.htm • Groundwater Protection Area Maps http://www.cdpr.ca.gov/docs/emon/grndwtr/gwpa_maps.htm
U.S. Environmental Protection Agency http://www.epa.gov/safewater/	**Storage and Retrieval (STORET) Environmental Data System** http://www.epa.gov/storet/
U.S. Geological Survey http://ca.water.usgs.gov/	**Water Data for the Nation** http://waterdata.usgs.gov/nwis

Land Subsidence Monitoring

Land subsidence has been shown to occur in areas having a significant decline in groundwater levels. When groundwater is extracted from aquifers in sufficient quantity, the groundwater level is lowered and the water pressure, which supports the skeletal structure of the sediment grains, decreases. A decrease in water pressure causes more weight from the overlying sediments to be supported by the sediment grains within the aquifer. In unconsolidated deposits, the increased weight from overlying sediments may compact the fine-grained sediments and permanently decrease the porosity of the aquifer and the ability of the aquifer to store water. The partial collapse of the aquifer's skeletal structure results in the subsidence of the land surface overlying the aquifer. *Elastic land subsidence* is the reversible and temporary fluctuation of the Earth's surface in response to seasonal periods of groundwater extraction and recharge. *Inelastic land subsidence* is the irreversible and permanent decline in the earth's surface caused by the collapse or compaction of the pore structure within the fine-grained portions of an aquifer system (U.S. Geological Survey 1999).

In the San Francisco Bay region, land subsidence monitoring is conducted in Santa Clara County by SCVWD and in Alameda County by EBMUD. Additional information regarding land subsidence in California is provided in Appendix F.

SCVWD actively monitors land subsidence through benchmark surveying, groundwater elevation monitoring, and data from compaction wells. SCVWD surveys hundreds of benchmarks each year to determine if there has been any change in the land surface elevation. SCVWD also monitors groundwater levels to ensure that the amount of groundwater being pumped will not cause further subsidence, and it collects data from two compaction wells, which are 1,000-feet deep and are designed to measure changes in the land surface resulting from groundwater extraction (http://www.valleywater.org/Services/LandSubsidence.aspx).

EBMUD monitors land subsidence in the South East Bay Plain as part of its Bayside Groundwater Project. Direct measurement of ground elevation changes are being accomplished using high-resolution extensometers that were constructed and calibrated by the USGS (East Bay Municipal Utilities District 2013).

Aquifer Conditions

Aquifer conditions and groundwater levels change in response to varying supply, demand, and weather conditions. During years of normal or above normal precipitation, or during periods of low groundwater use, aquifer systems tend to recharge and respond with rising groundwater levels. As a result, if groundwater levels rise sufficiently, water table aquifers can reconnect to surface water systems, contributing to the overall base flow or directly discharging onto the ground surface via wetlands, seeps, and springs.

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

Lowering of groundwater levels can also impact the surface-water–groundwater interaction by inducing additional infiltration and recharge from nearby surface water systems, by reducing the groundwater contribution to the water base flow of surface water systems, and by reducing groundwater discharge to wetlands areas. Extensive lowering of groundwater levels can also result in land subsidence caused by the dewatering, compaction, and loss of storage within finer-grained aquifer systems.

Groundwater Occurrence and Movement

Groundwater comes from infiltration of precipitation and of water from streams, canals, and other surface water systems and moves from higher to lower elevations. Under predevelopment conditions, the occurrence and movement of groundwater was largely controlled by the surface and the subsurface geology, the size and distribution of the natural surface water systems, the average annual hydrology, and the regional topography. But, many decades of high-volume groundwater extraction can considerably affect the natural occurrence and movement of groundwater. Areas of high groundwater extraction tend to redirect and capture groundwater underflow that may otherwise have contributed to nearby surface water systems, leading to varying degrees of surface water depletion. High-capacity wells screened over multiple aquifer zones also lend themselves to vertical aquifer mixing, which can additionally alter natural groundwater flow conditions. Moreover, infiltration along unlined water conveyance canals, percolation of applied irrigation water, and direct recharge programs create significant groundwater recharge areas where none previously existed.

Depth to Groundwater

Understanding the local depth to groundwater provides a better awareness of these factors:

- Potential interaction between groundwater and surface water systems.
- Relationship between land use and groundwater levels.
- Potential for land subsidence.
- Groundwater contributions to the local ecosystems.
- Costs associated with well installation and groundwater extraction.

Under predevelopment aquifer conditions, changes in the depth to groundwater will generally correlate with ground surface elevation. For example, with increasing ground surface elevation, there is a corresponding increase in the depth to groundwater. In high-use basins or in conjunctively managed basins, the correlation between depth to water and ground surface elevation will eventually start to break down and show significant variability over areas having little change in ground surface elevation.

San Francisco Bay region depth-to-groundwater contours were not developed as part of *California's Groundwater Update 2013*. Depth-to-groundwater data for some of the groundwater basins in the San Francisco Bay region are available online via DWR's Water Data Library (http://www.water.ca.gov/waterdatalibrary/), DWR's CASGEM system (http://www.water.ca.gov/groundwater/casgem/), and the USGS National Water Information System (http://waterdata.usgs.gov/nwis/gw).

Numerous local water agencies in the San Francisco Bay region collect depth-to-groundwater information and make that data available to the public either online or in annual groundwater reports. Recent information for select groundwater basins in the San Francisco Bay region are collected by the following public agencies:

- Westside Groundwater Basin (2-35) — San Francisco Public Utilities Commission (http://www.sfwater.org/).
- Livermore Valley Groundwater Basin (2-10) — Zone 7 Water Agency (http://www.zone7water.com/).
- East Bay Plain Groundwater Subbasin (2-9.04) — East Bay Municipal Utilities District (http://www.ebmud.com).
- Santa Clara Groundwater Subbasin (2-9.02) — Santa Clara Valley Water District (http://www.valleywater.org/).
- Niles Cone Groundwater Subbasin (2-9.01) — Alameda County Water District (http://www.acwd.org/).
- Napa Valley Groundwater Subbasin (2-2.01) — Napa County (http://www.countyofnapa.org/).
- Sonoma Valley Groundwater Subbasin (2-2.02) — Sonoma County Water Agency (http://www.scwa.ca.gov/).

Groundwater Elevations

Depth-to-groundwater measurements can be converted to groundwater elevations if the elevation of the groundwater surface is known. Groundwater elevation contours provide a good regional estimate of the occurrence and movement of groundwater. Similar to topographic contours, the pattern and spacing of groundwater-elevation contours can be used to help estimate the direction of groundwater movement and the gradient and rate of groundwater flow. Groundwater-elevation contours for the San Francisco Bay region were not developed as part of *California's Groundwater Update 2013*. The local agencies that collect depth-to-water information should be contacted to determine if groundwater contour maps have been prepared for specific groundwater basins.

Groundwater Level Trends

Depth-to-water measurements collected from a particular well over time can be plotted to create a hydrograph. Hydrographs assist in the presentation of data and the analysis of seasonal and long-term groundwater-level variability and trends over a time. Because of the highly variable nature of the aquifer systems within each groundwater basin, and because of the variable nature of annual groundwater extraction, recharge, and surrounding land use practices, the hydrographs selected for discussion do not attempt to illustrate or depict average aquifer conditions over a broader region. Rather, the hydrographs in Figure 4-11 were selected to help tell a story of how the local aquifer systems respond to changing groundwater extractions and implementation of resource management practices.

The hydrographs are identified according to the State Well Number (SWN) system. The SWN identifies a well by its location, using the U.S. Public Lands Survey System of township, range, and section. More information on the SWN system is provided in DWR's information brochure, "*water facts*" No. 7 (http://www.water.ca.gov/pubs/conservation/waterfacts/numbering_water_wells_in_california__water_facts_7_/water_facts_7.pdf).

Figure 4-11 shows hydrograph examples for six selected groundwater-elevation monitoring wells in the San Francisco Bay region and provides a brief explanation of the hydrograph story. Detailed information about each hydrograph can be found in the paragraphs following Figure 4-11.

Figure 4-11 Groundwater Hydrographs for the San Francisco Bay Hydrologic Region, Page 1

Aquifer response to changing demand and management practices

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

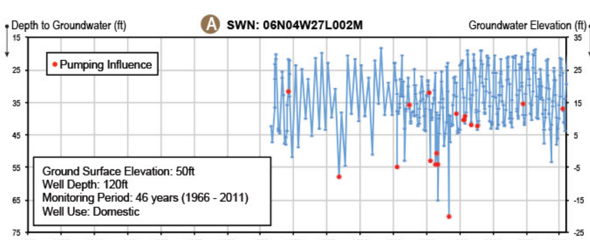
A, B Hydrograph 06N04W27L002M and 05N03W05M001M: illustrate the dramatically different aquifer conditions underlying the Napa Valley Subbasin. SWN 06N04W27L002M is completed in the upper Sonoma Volcanics where the alluvial deposits are young and unconsolidated, thus, more permeable and better connected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

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

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

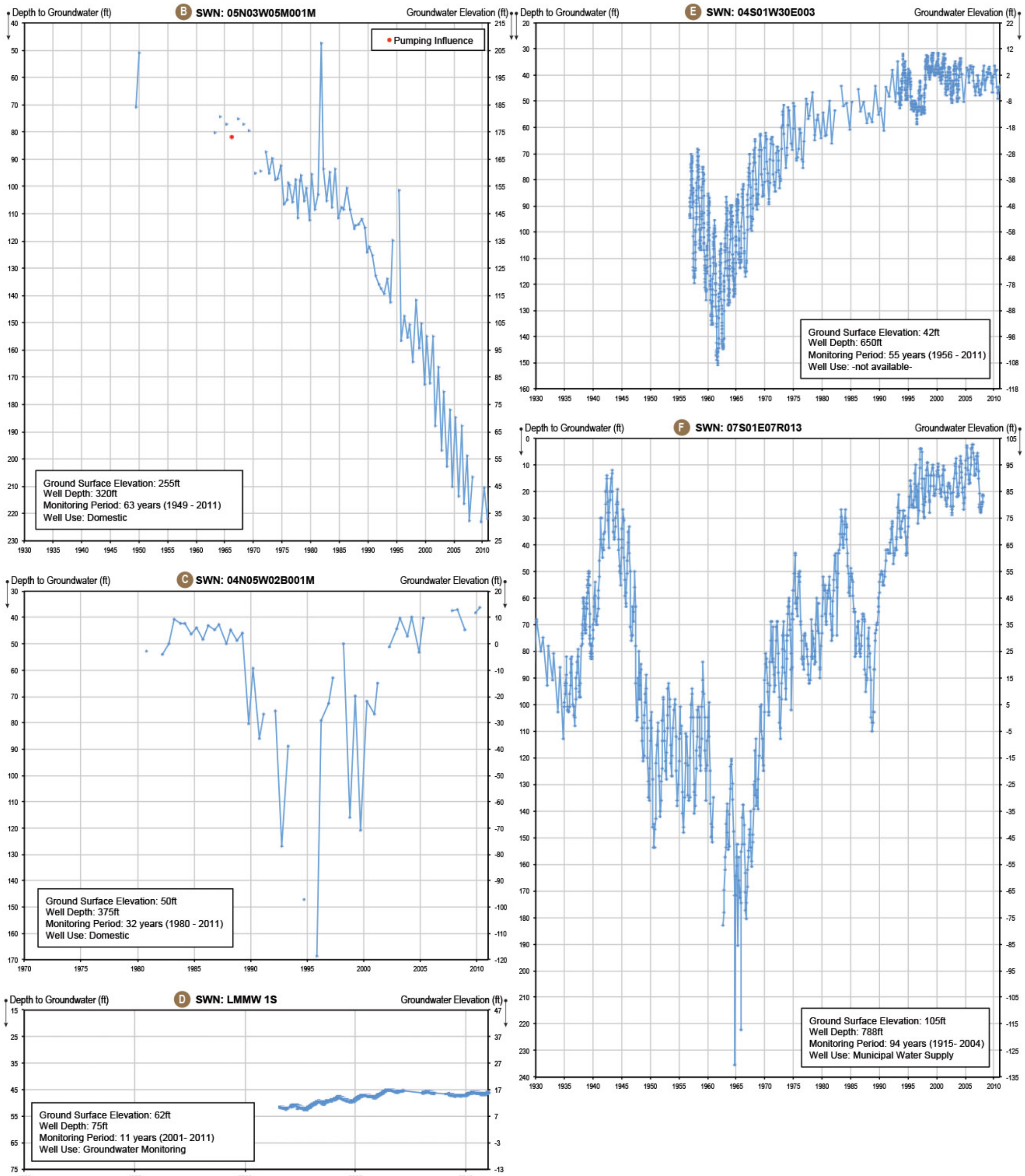
E, F Hydrograph 04S01W30E003M and 07S01E07R013M: illustrate the successful recovery of rapidly declining groundwater levels as a result of additional surface water deliveries, reduced groundwater pumping, and a local groundwater recharge program.

Regional locator map



Prepared by California Department of Water Resources for California's Groundwater Update 2013

Figure 4-11 Groundwater Hydrographs for the San Francisco Bay Hydrologic Region, Page 2



Hydrograph 06N04W27L002M and 05N03W05M001M

Figure 4-11a is a hydrograph for Well 06N04W27L002M and Figure 4-11b is a hydrograph for Well 05N03W05M001M. Both wells are located in Napa County, approximately 4 miles from each other, and reflect dramatically different groundwater-elevation conditions in the Napa Valley Groundwater Subbasin (2-2.01). The two wells are examples of the variability of groundwater conditions caused by complex hydrogeology, relative distance from major surface water systems, and surface recharge conditions.

Well 06N04W27L002M is a domestic well located directly north of the city of Napa within approximately 0.5 miles west of the Napa River. Well 05N03W05M001M is a domestic well located in the Lower Milliken-Sarco-Tulucay (MST) Creeks Area, just east and southeast of Napa along the west side of the Howell Mountains and approximately 2.5 miles east of the Napa River. Well 06N04W27L002M, which is completed in the upper Sonoma Volcanics and within younger, unconsolidated alluvial deposits, has historically shown a very stable groundwater elevation trend since the 1960s, likely because of its relative distance from and interaction with surface water from the Napa River. This stable trend is generally indicative of wells located within the Napa Valley area.

Well 05N03W05M001M is completed in the less-permeable portion of the Sonoma Volcanics and has shown a considerable groundwater elevation decline, approximately 3 feet per year, since it was first monitored in 1949 (U.S. Geological Survey 2003). Well 05N03W05M001M is considered by Napa County to be located in a “groundwater-deficient area” and is subject to a county-wide groundwater ordinance that was adopted in 1996. Napa County does not have a GWMP but is developing a county-wide groundwater monitoring program to compliment the CASGEM program and to better characterize its groundwater resources to ensure long-term sustainability. Approximately 61 percent of the wells located in Napa County are domestic wells. The Napa Valley Groundwater Subbasin is designated as a CASGEM medium-priority basin.

Hydrograph 04N05W02B001M

Figure 4-11c is a hydrograph for Well 04N05W02B001M located in the Sonoma Valley Groundwater Subbasin (2-2.02). The hydrograph shows how declining groundwater elevations responded when recycled water supplies were made available to the area around 1996. The well is located in the southern Sonoma Valley, which is an agricultural area that has experienced increased levels of salinity resulting from the northward (up-valley) migration of saline water caused by groundwater depressions near Sonoma. Groundwater-elevation levels prior to 1990 were generally stable at around 5 feet above mean sea level (msl) before they dropped to approximately 120 feet below msl in 1996 because of pumping for agricultural irrigation. In the mid 1990’s, the Sonoma County Sanitation District made recycled water available for irrigation, which offset the need for groundwater pumping for irrigation, and allowed groundwater elevations to rise. Between 1996 and 1998 the groundwater elevation recovered 120 feet and has been above sea level for more than 10 years. The hydrograph is an example of in-lieu recharge and saltwater intrusion control in a groundwater-dependent portion of Sonoma Valley. SCWA prepared a GWMP for the Sonoma Valley in 2007 and is proactively involved in a portfolio of water projects to ensure the sustainability of surface water and groundwater resources in Sonoma

Valley. The Sonoma Valley Groundwater Subbasin is designated as a CASGEM medium-priority basin.

Hydrograph LMMW-1S

Figure 4-11d is a hydrograph for Well LMMW-1S, a locally named well located in the highly urbanized Westside Groundwater Basin (2-35), and is monitored by San Bruno, Daly City, the California Water Service Company, and SFPUC. This hydrograph represents groundwater elevations in an urban environment where groundwater elevations have generally remained stable over time, primarily because of non-groundwater use for domestic consumption (the area is served by surface water supplies). Table 4-2 shows San Francisco County has the least number of well records of counties located in the San Francisco Bay region. Groundwater within the county is not widely used for domestic, irrigation, public supply, or industrial purposes. Of the 1,545 well records available for San Francisco County, 1,221 of the wells (79 percent) are monitoring wells likely associated with groundwater cleanup programs. Although Well LMMW-1S has only been monitored since 2001, there are few seasonal or long-term fluctuations observed in the hydrograph. Because San Francisco County relies heavily on surface water supplies, SFPUC is developing groundwater resources in the Westside Groundwater Basin for more reliable supplies. Approximately 85 percent of the SFPUC water supply is imported. SFPUC also monitors groundwater elevations in a portion of the Westside Groundwater Basin located in San Mateo County where groundwater is a significant source of the water supply. The Westside Groundwater Basin is designated as a CASGEM very-low-priority basin.

Hydrograph 04S01W30E003M

Figure 4-11e is a hydrograph for Well 04S01W30E003M located in an urban area of the Niles Cone Groundwater Subbasin (2-9.01). The hydrograph for Well 04S01W30E003M represents groundwater-elevation recovery resulting from imported surface water supplies becoming available to the area and groundwater recharge efforts being implemented. Salt water intrusion was first noticed in the Niles Cone Groundwater Subbasin in the 1920s, following decades of persistent pumping in the region. ACWD began purchasing imported water from the SWP in 1962 to supplement local water supplies and to increase the amount of water available for local groundwater recharge through percolation ponds constructed in former gravel quarry pits. The additional water supplies and the groundwater recharge efforts began to offset the amount of groundwater that was pumped and resulted in recovering groundwater elevations. In the 1970s, ACWD constructed inflatable dams in Alameda Creek to further increase recharge capabilities in the groundwater basin. The Niles Cone Groundwater Subbasin is designated as a CASGEM medium-priority basin.

Hydrograph 07S01E07R013M

Figure 4-11f is a hydrograph for Well 07S01E07R013M located in Santa Clara County in the Santa Clara Groundwater Subbasin (2-9.02). This hydrograph is a classic presentation of conjunctive water management that shows the effects of population increase, land use changes, and land subsidence on groundwater elevations. Because of groundwater withdrawal, the land subsided about 13 feet in San Jose between 1915 and 1970. Although the time scale for this hydrograph only goes back to 1930, the water elevation recorded in 1915 was approximately 100 feet above msl. In 1935 when the groundwater elevation was approximately 5 feet above msl, SCVWD constructed reservoirs to capture more local surface water. This process reversed the groundwater elevation decline that had been caused by pumping during the previous 20 years. As water demands increased because of an increase in population and a shift in land use, the groundwater elevation decreased to almost 135 feet below msl in 1964. In 1964, SCVWD received the first deliveries of imported water from the State, and in 1987 SCVWD increased its deliveries of imported water from the federal government. The groundwater elevation in Well 07S01E07R013M has been rising since 1988 and has been relatively stable since 1995. Because of the water management efforts initiated by SCVWD, along with technology changes and water conservation programs, SCVWD was able to halt land subsidence in the area. SCVWD prepared an updated GWMP in 2012 for the groundwater subbasins they manage in the Santa Clara Valley Groundwater Basin. The Santa Clara Groundwater Subbasin is designated as a CASGEM high-priority basin.

Change in Groundwater in Storage

Change in groundwater in storage is the difference in groundwater volume between two time periods. Change in groundwater in storage is calculated by multiplying the difference in groundwater elevation between two monitoring periods, by the overlying groundwater basin area, and by the estimated specific yield or volume of pore space from which water may be extracted.

Examining the annual change in groundwater in storage over a series of years helps identify aquifer response to changes in hydrology, land use, and groundwater management. If the volumetric change in storage is negligible over a period represented by average hydrologic and land use conditions, the basin is considered to be in equilibrium. Declining groundwater levels and reduction of groundwater in storage during years of average hydrology and land use does not always indicate basin overdraft or unsustainable management; typically, some additional investigation is required. Use of groundwater in storage during years of diminishing surface water supply, followed by active recharge of the aquifer when surface water or other alternative supplies become available, is a recognized and acceptable approach to conjunctively managing a groundwater basin. Additional information regarding risks and benefits of conjunctive management in California can be found in *California Water Plan Update 2013,* Volume 3, Chapter 9, "Conjunctive Management and Groundwater Storage."

Change-in-groundwater-in-storage estimates for the San Francisco Bay region were not developed for *California's Groundwater Update 2013*. Some local groundwater agencies within the San Francisco Bay region periodically develop change-in-groundwater-in-storage estimates for basins within their service area. Determining the change in volumetric storage allows the local groundwater managers to evaluate trends, land use patterns, responses to climate (weather), and sustainability. Examples of local agencies that monitor change in groundwater in storage as part of their groundwater management efforts include Zone 7 Water Agency, SFPUC, SCVWD, and SCWA.

Groundwater Quality

In general, groundwater quality throughout most of the San Francisco Bay region is suitable for most urban and agricultural uses with only local impairments. The primary chemical contaminants of concern in the region include high total dissolved solids (TDS), arsenic, nitrate, boron, and organic compounds.

The areas of high TDS (and chloride) concentrations are typically found in the region's groundwater basins situated close to San Francisco Bay. This includes the northern Santa Clara Valley, and southern Sonoma, Petaluma, and Napa valleys. The shallow aquifer zone within the Petaluma Valley shows persistent nitrate contamination. Groundwater with high TDS, iron, and boron levels is also present in the Calistoga area of the Napa Valley. Elevated boron levels in other parts of the Napa Valley make the water unfit for agricultural uses. Releases of fuel hydrocarbons from leaking underground storage tanks, and spills or leaks of organic solvents at industrial sites, have caused minor to significant groundwater impacts in many basins throughout the San Francisco Bay region. Methyl tertiary butyl ether (MTBE) and chlorinated solvent releases to soil and groundwater continue to be problematic. Environmental oversight for many of these sites is performed either by city and county enforcement agencies, the San Francisco Bay RWQCB, the California Department of Toxic Substances Control (DTSC), and/or the U.S. Environmental Protection Agency (EPA).

Several State and federal GAMA-related groundwater quality reports that help assess and outline the groundwater quality conditions for the San Francisco Bay region are listed in Table 4-9.

Table 4-9 GAMA Groundwater Quality Reports for the San Francisco Bay Hydrologic Region

Data Summary Reports
• North San Francisco Bay http://www.waterboards.ca.gov/gama/docs/nsfb_dsr_final.pdf • San Francisco Bay http://www.waterboards.ca.gov/gama/docs/sfbay_dsr.pdf • South Coast Interior http://pubs.usgs.gov/ds/463/pdf/DS_463.pdf
Assessment Reports
• Status and Understanding of Groundwater Quality in the North San Francisco Bay Groundwater Basins http://www.waterboards.ca.gov/gama/docs/nsfbay_sir.pdf • Status and Understanding of Groundwater Quality in the San Francisco Bay Groundwater Basins http://pubs.usgs.gov/sir/2012/5248/pdf/sir20125248.pdf
Fact Sheets
• Groundwater Quality in the North San Francisco Bay Groundwater Basins http://www.waterboards.ca.gov/gama/docs/nsfb_facts.pdf • Groundwater Quality in the San Francisco Bay Groundwater Basins http://pubs.usgs.gov/fs/2012/3111/pdf/fs20123111.pdf
Domestic Well Project
• No counties in this region have been sampled by this program.
Other Relevant Reports
• Communities that Rely on a Contaminated Groundwater Source for Drinking Water http://www.waterboards.ca.gov/water_issues/programs/gama/ab2222/index.shtml

Groundwater Quality at Community Drinking Water Wells

The SWRCB recently completed a report to the legislature titled *Communities that Rely on a Contaminated Groundwater Source for Drinking Water*. The report focused on chemical contaminants found in active groundwater wells used by CWSs. A CWS is defined under the California Health and Safety Code (Section 116275) as a "public water system that serves at least 15 service connections used by yearlong residents or regularly serve at least 25 yearlong residents of the area served by the system." A CWS serves the same group of people, year-round, from the same group of water sources. The findings of this report reflect raw untreated groundwater quality and do not necessarily reflect the final quality of groundwater delivered to these communities.

In the San Francisco Bay region there are an estimated 184 CWSs, with 421 active CWS wells. Table 4-10 shows that 28 wells (7 percent) are identified as being affected by one or more chemical contaminants that exceeds an MCL and require treatment. The affected wells are used by 18 CWSs in the region, with 12 of the 18 affected CWSs serving small communities that often need financial assistance to construct a water treatment plant or develop an alternate solution to meet drinking water standards (Table 4-11). The most prevalent groundwater contaminants in the region affecting CWS wells are arsenic and nitrate (Table 4-12).

While most large CWSs are able to construct, operate, and maintain a water treatment system to remove or reduce groundwater contaminants below drinking water standards, small CWSs often cannot afford the high cost to operate and maintain a treatment system. As a result, some are unable to provide drinking water that meets primary drinking water standards. As of February 2013, there was one small CWS in the San Francisco Bay region that violates the primary drinking water standard for arsenic (California Department of Public Health 2013).

Table 4-10 Community Drinking Water Wells that Exceed a Primary Maximum Contaminant Level Prior to Treatment in the San Francisco Bay Hydrologic Region

Well Information	Community Water System[a] Wells
Number of Affected Wells[b]	28
Total Wells in the Region	421
Percentage of Affected Wells[b]	7%

Source: State Water Resources Control Board's report to the Legislature, *Communities that Rely on a Contaminated Groundwater Source for Drinking Water* (2013)

Notes:
[a]Community water system means a public water system that serves at least 15 service connections used by year-long residents or regularly serves at least 25 year-long residents of the areas served by the system (Health and Safety Code Section 116275).
[b]Affected wells exceeded a primary maximum contaminant level prior to treatment at least twice from 2002 to 2010. Gross alpha levels were used as a screening assessment only and did not consider uranium correction.

Table 4-11 Community Drinking Water Systems that Rely on Contaminated Groundwater Wells in the San Francisco Bay Hydrologic Region

System Information	Community Water Systems[a]		
	Number of Affected Water Systems[b]	Total Water Systems in the Region	Percentage of Affected Water Systems[b]
Small Systems Population ≤ 3,300	12	123	10%
Medium Systems Population 3,301 – 10,000	1	7	14%
Large Systems Population > 10,000	5	54	9%
Total	**18**	**184**	**10%**

Source: State Water Resources Control Board's report to the Legislature, *Communities that Rely on a Contaminated Groundwater Source for Drinking Water* (2013)

Notes:
[a]Community water system means a public water system that serves at least 15 service connections used by year-long residents or regularly serves at least 25 year-long residents of the areas served by the system (Health and Safety Code Section 116275).
[b]Affected water systems are those with one or more wells that exceed a primary maximum contaminant level prior to treatment at least twice from 2002 to 2010. Gross alpha levels were used as a screening assessment only and did not consider uranium correction.
State small water systems are not included in the totals. These systems serve 5 to 14 service connections and do not regularly serve water to more than 25 people. In general, state small water systems are regulated by local county environmental health departments.

Table 4-12 Contaminants Affecting Community Drinking Water Systems in the San Francisco Bay Hydrologic Region

Principal Contaminant (PC)	Number of Affected Water Systems[b] (PC exceeds the Primary MCL)	Number of Affected Wells[c,d] (PC exceeds the Primary MCL)
Arsenic	9	10
Nitrate	4	10
Aluminum	2	2
Barium	1	1
Tetrachloroethylene (PCE)	1	2
Total Trihalomethanes	1	1
Trichloroethylene (TCE)	1	2

Source: State Water Resources Control Board's report to the Legislature, *Communities that Rely on a Contaminated Groundwater Source for Drinking Water* (2013)

Notes:
MCL = maximum contaminant level (State and/or federal)
[a]Community water system means a public water system that serves at least 15 service connections used by year-long residents or regularly serves at least 25 year-long residents of the areas served by the system (Health and Safety Code Section 116275).
[b]Affected water systems are those with one or more wells that exceed a primary maximum contaminant level prior to treatment at least twice from 2002 to 2010. Gross alpha levels were used as a screening assessment only and did not consider uranium correction.
[c]Affected wells exceeded a primary maximum contaminant level prior to treatment at least twice from 2002 to 2010. Gross alpha levels were used as a screening assessment only and did not consider uranium correction.
[d]No wells are affected by multiple contaminants.

Groundwater Quality at Domestic Wells

Private domestic wells are typically used by either single family homeowners or other groundwater-reliant systems which are not regulated by the State. Domestic wells generally tap shallower groundwater, making them more susceptible to contamination. Many domestic well owners are unaware of the quality of the well water because the State does not require well owners to test their water quality. Although private domestic well-water quality is not regulated by the State, it is a concern to local health and planning agencies and to State agencies in charge of maintaining water quality.

In an effort to assess domestic well-water quality, the SWRCB's GAMA Domestic Well Project samples domestic wells for commonly detected chemicals at no cost to well owners who voluntarily participate in the program. Results are shared with the well owners and used by the GAMA Program to evaluate the quality of groundwater used by private well owners. As of 2011, the GAMA Domestic Well Project had sampled 1,146 wells in six county focus areas (Monterey, San Diego, Tulare, Tehama, El Dorado, and Yuba.).

The GAMA Domestic Well Project tests for chemicals that are most commonly a concern in domestic well water. These constituents include:

- Bacteria (total and fecal coliform).
- General minerals (sodium, bicarbonate, calcium, others).
- General chemistry parameters (pH, TDS, others).
- Inorganics (lead, arsenic and other metals) and nutrients (nitrate, others).
- Organics (benzene, toluene, PCE, MTBE, and others).

The GAMA Domestic Well Project may also analyze for locally known chemicals of concern. Some of these chemicals include radionuclides, perchlorate, pesticides, and chromium VI.

The GAMA Domestic Well Project has not sampled private domestic wells in the counties that make up the San Francisco Bay region.

Groundwater Quality — GAMA Priority Basin Project

The GAMA Priority Basin Project was initiated to provide a comprehensive baseline of groundwater quality in the state, and assess deeper groundwater basins that account for more than 95 percent of all groundwater used for the public drinking water supply. The GAMA Priority Basin Project is grouped into 35 groundwater basin groups statewide called "study units," and it is being implemented by the SWRCB, the USGS, and LLNL.

The GAMA Priority Basin Project tests for constituents that are a concern in public supply wells. The list of constituents includes:

- Field parameters.
- Organic constituents.
- Pesticides.
- Constituents of special interest.
- Inorganic constituents.
- Radioactive constituents.

- Microbial constituents.

For the San Francisco Bay region, the USGS has completed data summary reports for three study units:

- North San Francisco Bay.
- San Francisco Bay.
- South Coast Interior.

The San Francisco Bay study unit resides entirely in the San Francisco Bay region. The other two study units cover multiple hydrologic regions. The North San Francisco Bay study unit includes wells in the San Francisco Bay and North Coast hydrologic regions. The South Coast Interior study unit includes wells in the San Francisco Bay, Central Coast, and Tulare Lake hydrologic regions.

For comparison purposes only, groundwater quality results from these data summary reports were compared against public drinking water standards established by CDPH and/or the EPA. These standards included MCLs, secondary maximum contaminant levels (SMCLs), notification levels (NLs), and lifetime health advisory levels (HALs). The summary of untreated groundwater quality results for these study units is shown in Table 4-13. In addition to these data summary reports, USGS has completed the assessment reports and fact sheets listed in Table 4-9.

Table 4-13 Groundwater Quality Results from GAMA Data Summary Reports for the San Francisco Bay Region

Constituent	Health Based Threshold	Number of Detections Greater Than Health Based Threshold			
		Valley and Highlands, Wilson Grove Formation, Volcanic Highlands Study Areas	Hydrothermal Wells and Spring Study Area	San Francisco Bay Study Unit[a]	South Coast Interior[b] Livermore Valley Study Area
Number of Wells		45	8	79	14
Inorganic Constituents					
Antimony	MCL	-	4	-	-
Arsenic	MCL	3	6	3	1
Boron	NL	1	8	2	5
Cadmium	MCL	-	6	1	-
Fluoride	MCL	-	-	-	-
Molybdenum	MCL	-	-	-	1
Nitrate	MCL	-	-	3	1
Selenium	MCL	-	-	-	-
Strontium	MCL	-	-	2	2
Uranium	MCL	-	-	-	2
Vanadium	NL	-	-	-	-

Constituent	Health Based Threshold	Number of Detections Greater Than Health Based Threshold			
		Valley and Highlands, Wilson Grove Formation, Volcanic Highlands Study Areas	Hydrothermal Wells and Spring Study Area	San Francisco Bay Study Unit[a]	South Coast Interior[b] Livermore Valley Study Area
Organic Constituents					
VOCs	MCL	-	-	-	-
Pesticides	MCL	-	-	-	-
Constituents of Special Interest					
Perchlorate	MCL	-	-	-	-
NDMA	NL	-	-	-	-
1,2,3 TCP	NL	-	-	-	-
Radioactive Constituents					
Gross Alpha	MCL	-	-	-	-
Secondary Standards					
Chloride	SMCL	-	2	5	2
Iron	SMCL	7	1	1	1
Manganese	SMCL	11	3	16	4
Sulfate[c]	SMCL	-	-	2	4
Total Dissolved Solids[c]	SMCL	3	8	15	10

Sources: U.S. Geological Survey report, *Ground-Water Quality Data in the North San Francisco Bay Hydrologic Provinces, 2004*; U.S. Geological Survey report, *Ground-Water Quality Data in the San Francisco Bay Study Unit, 2007*; U.S. Geological Survey report, *Ground-Water Quality Data for the South Coast Interior Basins Study Unit, 2008*

Notes:
HAL = lifetime health advisory level (U.S. Environmental Protection Agency), MCL = maximum contaminant level (State and/or federal), NL = notification level (State), SMCL = secondary maximum contaminant level (State), TDS = total dissolved solids, VOC = volatile organic compound

[a]The North San Francisco Bay Study Unit includes 89 wells in the San Francisco Bay and North Coast hydrologic regions. Forty-five wells are in the San Francisco Bay Region (U.S. Geological Survey report Figures 3, 4, 5, and 6. Well ID numbers NSFVP 21, 22, 27, 28, 32 through 41, 43 through 50, NSFVPFP 3, NSFVOL 3 through 8, 10 through 20, NSFWG 2, 6, 7, 10, 11). An additional 8 hydrothermal wells/spring were also sampled (well ID numbers NSFHOT 1 through 8).

[b]The South Coast Interior Basins Study Unit includes 54 wells in the San Francisco Bay, Central Coast, and Tulare Lake hydrologic regions. Fourteen wells are in the San Francisco Bay Region (U.S. Geological Survey report Figure 3. Well ID numbers LIV 01 through 06, LIVU 01 through 08).

[c]Wells that exceed secondary maximum contaminant levels for sulfate and total dissolved solids are greater than recommended levels.

Groundwater Quality Protection

A variety of historical and ongoing industrial, urban, and agricultural activities and their associated discharges have degraded groundwater quality. This includes 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. There are more than 800 groundwater cleanup cases in the San Francisco Bay region. About half are fuel cases. In many cases, the treated groundwater is discharged to surface waters via storm drains. The San Francisco Bay RWQCB has adopted general National Pollutant Discharge Elimination System (NPDES) permits for discharge of treated groundwater polluted by fuel leaks and other related wastes at service stations and similar sites and for groundwater polluted by volatile organic compounds (VOCs), as well as permits for aquifer protection and salinity barrier wells, reverse osmosis concentrate from aquifer protection wells, and high volume structure dewatering requiring treatment. As additional discharges are identified, source removal, pollution containment, and cleanup must be undertaken as quickly as possible, and activities that may potentially pollute groundwater must be managed to ensure that groundwater quality is protected.

Several high priorities for the San Francisco Bay RWQCB include cleanup of Department of Defense sites such as Hunter's Point, Point Molate, and Point Isabel; cleanup at "Brownfields" sites (in general, these are contaminated former industrial sites in urban areas that are suitable for redevelopment); increased enforcement against dischargers, technical input on cleanup, and working closely with DTSC.

Land Subsidence

Basin management objectives and monitoring protocols that relate to inelastic land subsidence and groundwater management are addressed in California Water Code Section10753.7. In the San Francisco Bay region, all of the active groundwater management plans adequately address the topic of land subsidence; however, historical land subsidence has only been observed in Santa Clara County. According to SCVWD's 2012 Groundwater Management Plan, the Santa Clara Subbasin experienced 13 feet of inelastic land subsidence between 1915 and 1970 because of groundwater overdraft. Serious problems developed as a result of subsidence, including flooding of lands adjacent to the San Francisco Bay, decreased ability of local streams to carry away winter flood waters, and damage to well casings, which necessitated the construction of additional dikes, levees, and flood control facilities to protect properties from flooding. Significant inelastic land subsidence was essentially halted about 1970 through the SCVWD's expanded conjunctive use programs, which allowed hydraulic heads to recover substantially.

Local water management efforts are utilizing conjunctive management and water conservation measures to reduce overdraft, but unless long-term groundwater decline can be halted, the potential for land subsidence remains. Additional information regarding land subsidence in California is provided in Appendix F.

Groundwater Management

In 1992, the California Legislature provided an opportunity for formal groundwater management with the passage of AB 3030, the Groundwater Management Act (California Water Code Section 10750 et seq.). Groundwater management, as defined in DWR Bulletin 118-2003, is "the planned and coordinated monitoring, operation, and administration of a groundwater basin, or portion of a basin, with the goal of long-term groundwater resource sustainability." Groundwater management needs are generally identified and addressed at the local level in the form of GWMPs. If disputes over how groundwater should be managed cannot be resolved at the local level, additional actions, such as enactment of ordinances by local entities with jurisdiction over groundwater, passage of laws by the Legislature, or decisions made by the courts (basin adjudications), may be necessary to resolve the conflict. Under current practice, DWR's role in groundwater management is to provide technical and financial assistance to support local agencies in their groundwater management efforts.

In addition to AB 3030, enacted legislation includes SB 1938, AB 359, and provisions of SB X7-6 and AB 1152. These significant pieces of legislation establish specific procedures on how GWMPs are to be developed and adopted by local agencies. They define the required and voluntary technical components that must be part of a GWMP and CASGEM groundwater-elevation monitoring plan. AB 359, introduced in 2011, made changes to the California Water Code that require local agencies to provide a copy of their GWMPs to DWR and requires DWR to provide public access to those plans. Prior to the passage of AB 359, which went into effect on January 1, 2013, local groundwater management planning agencies were not required to submit their GWMPs to DWR. As a result, the groundwater management information included in this report is based on documents that were readily available or submitted to DWR as of August 2012 and may not be all-inclusive, especially for those plans that were in the process of being finalized and adopted in 2012.

Groundwater management in California also occurs through other resource planning efforts. Urban water management plans (UWMPs) incorporate long-term resource planning to meet existing and future water demands. Agriculture water management plans (AWMPs) advance irrigation efficiency that benefits both farms and the environment. IRWM planning is a collaborative effort to regionally identify and align all aspects of water resource management and planning. Given California's reliance on groundwater to meet municipal, agricultural, and environmental needs, developing a thorough understanding of the planning, implementation, and effectiveness of existing groundwater management in California is an important first step toward sustainable management of this valuable resource.

DWR's Groundwater Web site (http://water.ca.gov/groundwater/) has the latest information on California's groundwater management planning efforts. It includes a summary of the Sustainable Groundwater Management Act, enacted in September 2014. The Sustainable Groundwater Management Act, a three-bill legislative package, includes the provisions of SB 1168 (Pavley), AB 1739 (Dickinson), and SB 1319 (Pavley). The act mandates formation of locally controlled groundwater sustainability agencies in high- and medium-priority groundwater basins, with the goal of sustainably managing local groundwater resources. Many of the newly established components of the act are based on the required, voluntary, and recommended groundwater management components assessed in the following sections.

The following sections provide an inventory and assessment of GWMPs, groundwater basin adjudications, county ordinances, and other groundwater planning activities in the San Francisco Bay region.

Groundwater Management Plan Inventory

Groundwater management information included in this chapter is based on GWMP documents that were readily available or submitted to DWR as of August 2012. The inventory of GWMPs identifies adopting and signatory agencies, the date of plan adoption, the location of plans by county, and the groundwater basins the plans cover. The inventory also provides the number of GWMPs that are based on AB 3030 (1992) legislation and the number developed or updated to meet the additional groundwater management requirements associated with SB 1938 (2002).

The San Francisco Bay region covers 4,500 square miles, including 1,400 square miles of alluvial groundwater basins. Figure 4-12 shows the location and distribution of the GWMPs within the San Francisco Bay region and distinguishes pre- and post-SB 1938 GWMPs. Table 4-14 lists the known San Francisco Bay region GWMPs (as of August 2012).

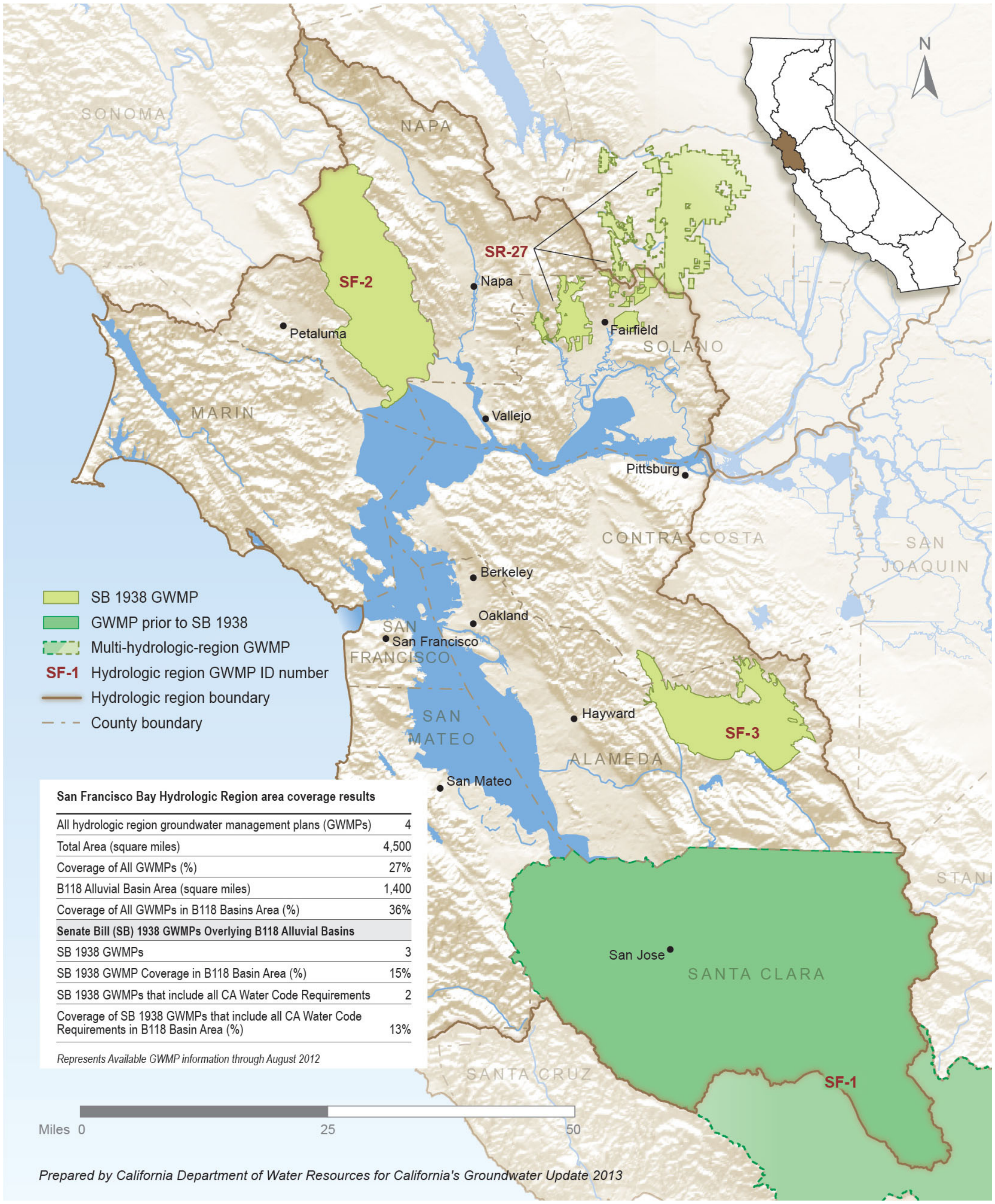
Four GWMPs exist within the San Francisco Bay region. Two of the four GWMPs are fully contained within the San Francisco Bay region, and two of the plans include portions of the adjacent Sacramento River and Central Coast regions. All four GWMPs cover areas overlying alluvial groundwater basins identified in Bulletin 118-2003. Two plans include areas not identified in Bulletin 118-2003 as alluvial basins; these two plans take a watershed approach, rather than a groundwater basin approach, with their GWMP boundaries.

Of the 1,400 square miles covered by the four GWMPs, about 600 square miles fall within Bulletin 118-2003 alluvial groundwater basins. The 600-square-mile area covered by GWMPs represents 43 percent of the alluvial groundwater basin area within the San Francisco Bay region.

Three of the four GWMPs have been developed or updated to include the requirements of SB 1938 and are considered active for the purposes of *California Water Plan Update 2013* GWMP assessment. Completed GWMPs that were not reviewed as part of *California Water Plan Update 2013*, because they were received after the initial assessment period, include City of San Bruno — South Westside Basin GWMP (2012), SCVWD GWMP (2012), and EBMUD — South East Bay Plain GWMP (2013).

One of the non-SB 1938 GWMPs covers the basin identified by the CASGEM Basin Prioritization Project as high priority, and two SB 1938-compliant GWMPs cover two of the six medium-priority basins. The seven high- and medium-priority basins account for about 63 percent of the population that overlies the basins and about 88 percent of groundwater use for the San Francisco Bay region.

Figure 4-12 Groundwater Management Plans in the San Francisco Bay Hydrologic Region



San Francisco Bay Hydrologic Region area coverage results

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

Represents Available GWMP information through August 2012

Table 4-14 Groundwater Management Plans in the San Francisco Bay Hydrologic Region

Map Label	Agency Name	Date	County	Basin Number	Basin Name
SF-1	**Santa Clara Valley Water District**	2001	Santa Clara	2-9.02	Santa Clara Subbasin
	No signatories required				
SF-2	**Sonoma County**	2007	Sonoma	2-2.02	Sonoma Valley
	City of Sonoma			2-19	Kenwood Valley
	Valley of the Moon Water District				
SF-3	**Zone 7 Water Agency**	2005	Alameda	2-10	Livermore Valley
	No signatories on file		Contra Costa	2-7	San Ramon Valley
SR-27	**Solano Irrigation District**	2006	Solano	5-21.66	Solano Subbasin
	No signatories on file			2-3	Suisun-Fairfield Valley
					Non-Bulletin-118 Basin

Notes:
Table reflects the plans that were received by August 2012.
Plans that were not reviewed as part of *California Water Plan Update 2013* because they were received after the initial assessment period include the City of San Bruno — South Westside Basin Groundwater Management Plan (2012), Santa Clara Valley Water District Groundwater Management Plan (2012), East Bay Municipal Utilities District — South East Bay Plain Groundwater Management Plan (2013).

Groundwater Management Plan Assessment

In 2011 and 2012, DWR partnered with the Association of California Water Agencies (ACWA) to survey local water agencies about their groundwater management, conjunctive management, and water-banking practices to build a better understanding of existing groundwater management efforts in California. In addition to the information gleaned from the DWR/ACWA groundwater management survey, DWR independently reviewed the GWMPs to assess:

- How many of the post-SB 1938 GWMPs meet the six required components included in SB 1938 and incorporated into California Water Code Section10753.7.
- How many of the post-SB 1938 GWMPs include the 12 voluntary components included in California Water Code Section10753.8.
- How many of the implementing or signatory GWMP agencies are actively implementing the seven recommended components listed in Bulletin 118-2003.

Groundwater management planning information collected through the DWR/ACWA survey and through DWR's assessment is not intended to be punitive in nature. It is widely understood that the application of effective groundwater management in California is rife with jurisdictional, institutional, technological, and fiscal challenges. DWR is committed to assisting local agencies develop and implement effective, locally planned, and locally controlled groundwater management programs. DWR is also committed to helping promote State and federal partnerships, and to coordinate with local agencies to expand groundwater data collection, management, and planning activities that promote effective local groundwater management. The overall intent of the GWMP assessment is to help identify groundwater- management challenges and successes, and provide recommendations for local and statewide improvement.

Information associated with the GWMP assessment is based on data that were readily available or received through August 2012. Requirements associated with the 2011 AB 359 (Huffman) legislation, related to groundwater recharge mapping and reporting, did not take effect until January 2013 and are not included in the GWMP assessment effort conducted as part of *California Water Plan Update 2013*. The following information will only address the active plans that were determined by DWR to meet some or all of the SB 1938 requirements.

Required GWMP Components

California Water Code Section10753.7 requires that six components be included in a GWMP for an agency to be eligible for State funding administered by DWR for groundwater projects, including projects that are part of an IRWM program or plan. The required components of a GWMP are:

1. **Basin Management Objectives**: Basin management objectives (BMOs) include components relating to the monitoring and management of groundwater levels within the groundwater basin, groundwater quality degradation, inelastic land surface subsidence, changes in surface flow and surface water quality that directly affect groundwater levels, or quality, or are caused by groundwater pumping in the basin. BMOs also include a description of how recharge areas identified in the plan substantially contribute to the replenishment of the groundwater basin.
2. **Agency Cooperation**: The plan will involve other agencies that enable the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin.
3. **Mapping**: The plan will include a map that details the area of the groundwater basin, as defined in DWR's Bulletin 118-2003, and the area of the local agency that is subject to the plan, as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a GWMP.
4. **Recharge Areas**: Commencing January 1, 2013, the GWMP shall include a map identifying the recharge areas for the groundwater basin, and provide the map to the appropriate local planning agencies and all interested persons, after adoption of the GWMP.
5. **Monitoring Protocols**: The local agency shall adopt monitoring protocols designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence (in basins for which subsidence has been identified as a potential problem), and flow and quality of surface water that directly affect groundwater levels, or quality, or are caused by groundwater pumping in the basin.
6. **GWMPs Located Outside Bulletin 118 Groundwater Basins**: Plans located outside the Bulletin 118-2003 alluvial groundwater basins will incorporate the above components and shall use geologic and hydrologic principles appropriate to those areas.

Three of the six components include subcomponents that were also evaluated. The requirement to develop a map of recharge areas was not required until January 1, 2013; consequently, the requirement was not evaluated. The requirement for local agencies located outside a Bulletin 118-2003 groundwater basin was not applicable for any of the GWMPs in the San Francisco Bay region.

Overall, the assessment of the required GWMP components for the San Francisco Bay region found that two out of three GWMPs incorporated all of the required components. Table 4-15 identifies the percentage of the three active plans that meet the required components and subcomponents (if applicable). The one plan that did not meet all of the required components did not address the surface-water–groundwater interaction subcomponents for BMO and monitoring protocols. A detailed description of the individual component assessment is provided in the following paragraphs.

Table 4-15 Assessment for GWMP Requirement Components in the San Francisco Bay Hydrologic Region

Senate Bill 1938 Required Components	Percentage of Plans that Meet Requirement
Basin Management Objectives	**67%**
BMO: Monitoring/Management Groundwater Levels	100%
BMO: Monitoring Groundwater Quality	100%
BMO: Subsidence	100%
BMO: SW/GW/GQ Interaction	67%
Agency Cooperation	**100%**
Map	**100%**
Map: Groundwater Basin Area	100%
Map: Area of Local Agency	100%
Map: Boundaries of other Local Agencies	100%
Recharge Areas (January 1, 2013)	**Not Assessed**
Monitoring Protocols	**67%**
MP: Changes in Groundwater Levels	100%
MP: Changes in Groundwater Quality	100%
MP: Subsidence	100%
MP: SW/GW/GQ Interaction	67%
Met All Required Components and Subcomponents	**67%**

Notes:
GW = groundwater, GQ = groundwater quality, SW = surface water
Table reflects assessment results of Senate Bill 1938 plans that were received by August 2012.

Basin Management Objectives

The BMO assessment consisted of each of the four required BMO subcomponents evaluated as part of the GWMP assessment. The subcomponents include: (1) the monitoring and management of groundwater levels, (2) groundwater quality, (3) inelastic land subsidence, and (4) surface-water–groundwater interaction. Two of the three GWMPs met the overall BMO requirement by providing measurable objectives and actions that will occur when specific conditions are met for each of the BMO subcomponents. One GWMP did not meet the overall BMO component, but did have the required information for three of the four BMO subcomponents; as a result, the GWMP was found to be in partial compliance.

The BMO subcomponents that were not addressed in the partially compliant GWMP were the planning requirements for addressing the interaction of surface water and groundwater levels and how they relate to water quality and groundwater pumping in the basin.

Mapping

The mapping requirement of SB 1938 has three subcomponents. The GWMPs are required to provide: (1) one or more maps which depict the GWMP area, (2) the associated Bulletin 118-2003 groundwater basin(s), and (3) all neighboring agencies located within the basin(s). The GWMP assessment determined that all three of the active GWMPs met the three mapping requirements.

Monitoring Protocols

The monitoring protocol component consists of four subcomponents. In accordance with SB 1938, GWMPs are required to establish monitoring protocols for assessing groundwater levels, groundwater quality, inelastic land subsidence, and surface water and groundwater interaction.

The overall results of the assessment for the monitoring protocols component are similar to the BMO component. The monitoring protocols assessment determined that two of the three GWMPs met each of the required monitoring protocol subcomponents. The GWMP that did not meet all of the BMO subcomponents also lacked monitoring protocols for the interaction of surface water and groundwater levels and how they relate to water quality and groundwater pumping in the basin.

Voluntary GWMP Components

As part of the GWMP review, 12 voluntary components included in California Water Code Section 10753.8 were assessed. During the GWMP review, some voluntary components were expanded to include subcomponents, which provided more opportunities to meet the various voluntary criteria, but the reporting and analysis were not done on a subcomponent level. In many cases during the review, if the GWMP included one or more of the subcomponents, full compliance credit was given for the GWMP assessment. Partial compliance was given when the plan left out key planning components including missing timelines, vagueness on the specifics of a plan, or vagueness on how a project met the GWMP's goals or objectives.

The voluntary components presented in California Water Code Section 10753.8 include:

1. The control of saline water intrusion.
2. Identification and management of wellhead protection areas and recharge areas.

3. Regulation of the migration of contaminated groundwater.
4. The administration of a well abandonment and well destruction program.
5. Mitigation of conditions of overdraft.
6. Replenishment of groundwater extracted by water producers.
7. Monitoring of groundwater levels and storage.
8. Facilitating conjunctive use operations.
9. Identification of well construction policies.
10. The construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
11. The development of relationships with State and federal regulatory agencies.
12. The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

The percentage of GWMPs in the San Francisco Bay region that included the voluntary components is shown in Table 4-16. The assessment of some voluntary components was expanded to include subcomponents, which aided in determining a level of inclusion, but reporting was not done on a subcomponent level. In many cases, if the GWMP included one of more of the subcomponents, the plan was considered to fully meet the voluntary component.

Table 4-16 shows that two of the three active GWMPs in the San Francisco Bay region included all 12 voluntary components. The third active GWMP in the region only included plans for four components — monitoring, conjunctive use operations, well construction policies, and involvement with regulatory agencies.

Table 4-16 Assessment for GWMP Voluntary Components in the San Francisco Bay Hydrologic Region

Voluntary Component	Percentage of Plans that Include Component
Saline Intrusion	67%
Wellhead Protection and Recharge	67%
Groundwater Contamination	67%
Well Abandonment and Destruction	67%
Overdraft	67%
Groundwater Extraction and Replenishment	67%
Monitoring	100%
Conjunctive Use Operations	100%
Well Construction Policies	100%
Construction and Operation	67%
Regulatory Agencies	100%
Land Use	67%

Notes:
GWMP = groundwater management plan
Table reflects assessment results of Senate Bill 1938 plans that were received by August 2012.

GWMP Components Recommended by Bulletin 118-2003

Bulletin 118-2003 contains suggestions on how GWMPs should be developed, and it provides details that should be included during development of a plan. Bulletin 118-2003, Appendix C provides a list of seven recommended components related to management development, implementation, and evaluation of a GWMP that should be considered to help ensure effective and sustainable groundwater management. The list includes:

- **Guidance:** Establish an advisory committee to assist in GWMP development and implementation.
- **Management Area:** Describe the physical setting, aquifer characteristics, and background data.
- **BMOs, Goals, and Actions:** Describe how the current or planned actions help to meet the overall management objectives and goals.
- **Monitoring Plan Description:** Describe groundwater monitoring type, location, frequency, and aquifer interval.
- **IRWM Planning:** Describe efforts to coordinate with other land use or water management planning.
- **Implementation:** Develop status reports with management actions, monitoring activities, basin conditions, and achievements.
- **Evaluation:** Develop periodic assessment of conditions in relation to management objectives.

Table 4-17 identifies the percentage of the three active GWMPs in the San Francisco Bay region that includes the seven recommended components outlined in Bulletin 118-2003. Results from the GWMP assessment determined that two of three GWMPs adequately addressed all seven groundwater management components outlined in Bulletin 118-2003, while the third active plan only met the management area component.

Table 4-17 Assessment of DWR Bulletin 118-2003 Recommended Components in the San Francisco Bay Hydrologic Region

Recommended Components	Percentage of Plans that Include Component
GWMP Guidance	67%
Management Area	100%
BMOs, Goals, and Actions	67%
Monitoring Plan Description	67%
IRWM Planning	67%
GWMP Implementation	67%
GWMP Evaluation	67%

Notes:
BMO = basin management objective, GWMP = groundwater management plan, IRWM = integrated regional water management
Table reflects assessment results of Senate Bill 1938 plans that were received by August 2012.

DWR/ACWA Survey — Key Factors for Successful GWMP Implementation

As noted in the previous section, DWR partnered with ACWA to survey its member agencies on various topics covering groundwater management. The survey respondents were asked to provide feedback on which components helped make their GWMP implementation successful. The participants were asked to provide additional insights and list additional components, but not to rank their responses in terms of importance.

Five agencies from the San Francisco Bay region participated in the survey; Table 4-18 is a summary of the responses. Survey participants were provided with ten options to use, plus the ability to add additional factors not listed. None of the responses were unanimous for any of the options presented in the survey. Four responding agencies identified all the options, with the exception of outreach and education, as important. Three of the responding agencies identified all the components as important to their success. One respondent supplied the additional important elements of State funding of their groundwater planning efforts, and coordination with land use agencies, as key components of groundwater management.

Table 4-18 Survey Results for Key Components Contributing to Successful GWMP Implementation in the San Francisco Bay Hydrologic Region

Key Component that Contributed to Success	Respondents
Sharing of Ideas and Information with other Water Resource Managers	4
Data Collection and Sharing	4
Adequate Surface Water Supplies	4
Adequate Regional and Local Surface Storage and Conveyance Systems	4
Outreach and Education	3
Developing an Understanding of Common Interest	4
Broad Stakeholder Participation	4
Water Budget	4
Funding	4
Time	4
Additional Component Supplied by Participating Agencies	
State Funding for Groundwater Management Programs	1
Stronger Coordination with Land Use Agencies	1

Notes:
GWMP = groundwater management plan
Results from an on-line survey sponsored by the California Department of Water Resources and conducted by the Association of California Water Agencies — 2011 and 2012.

DWR/ACWA Survey — Key Factors Limiting GWMP Success

Survey participants were also asked to identify key factors they felt impeded implementation of their GWMP. Table 4-19 shows the survey results. Respondents pointed to a lack of adequate funding as the greatest impediment to GWMP implementation. Funding is a challenging factor

Table 4-19 Survey Results for Factors that Limited the Successful GWMP Implementation in the San Francisco Bay Hydrologic Region

Limiting Factor	Respondents
Participation Across a Broad Distribution of Interests	1
Data Collection and Sharing	-
Funding for Groundwater Management Planning	2
Funding for Groundwater Management Projects	3
Funding to Assist in Stakeholder Participation	3
Understanding of the Local Issues	-
Outreach and Education	-
Groundwater Supply	-
Surface Storage and Conveyance Capacity	1
Access to Planning Tools	-
Unregulated Pumping	1
Lack of Governance	-

Notes:
GWMP = groundwater management plan
Results from an on-line survey sponsored by the California Department of Water Resources and conducted by the Association of California Water Agencies — 2011 and 2012.

for many agencies because the implementation and the operation of groundwater management projects are typically expensive, and because the sources of funding for projects are typically limited to either locally raised funds or to grants from State and federal agencies. The limited participation, limited surface storage and conveyance, and unregulated groundwater pumping were also identified as factors that impede the successful implementation of GWMPs.

DWR/ACWA Survey — Opinions of Groundwater Sustainability

Finally, the DWR/ACWA survey asked if the respondents were confident in the long-term sustainability of their current groundwater supply. All respondents felt long-term sustainability of their groundwater supply was possible.

Groundwater Ordinances

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

There are a number of groundwater ordinances that have been adopted by counties in the San Francisco Bay region. The most common ordinances regulate construction, abandonment, and destruction of groundwater wells. None of the ordinances adopted by counties in the San Francisco Bay region provide for comprehensive groundwater management. Table 4-20 lists the ordinances adopted in the San Francisco Bay region.

Table 4-20 County Groundwater Ordinances for the San Francisco Bay Hydrologic Region

County	Groundwater Management	Guidance Committees	Export Permits	Recharge	Well Abandonment and Destruction	Well Construction Policies
San Francisco	-	-	-	-	Yes	Yes
Sonoma	-	-	-	-	Yes	Yes
Marin	-	-	-	-	-	-
Napa	-	Yes	-	-	Yes	Yes
Solano	-	-	-	-	Yes	Yes
San Mateo	-	-	-	-	Yes	Yes
Alameda	-	-	-	-	Yes	Yes

Notes:
Table represents information as of August 2012.
The Santa Clara Valley Water District adopted Ordinances 89-1 (groundwater management) and 90-1 (well construction and destruction). These ordinances do not apply to a specific county.

Special Act Districts

Greater authority to manage groundwater has been granted to a few local agencies created through a special act of the Legislature. The specific authority of each agency varies, but the agencies can be grouped into two general categories: (1) agencies having authority to limit export and extraction (upon evidence of overdraft or threat of overdraft); or (2) agencies lacking authority to limit extraction, but having authority to require reporting of extraction and to levy replenishment fees.

Within the San Francisco Bay region, the SCVWD is considered a special act district with groundwater management authority. The SCVWD was formed in 1929 by an act of the California Legislature for the purpose of providing comprehensive management for all beneficial uses and protection from flooding within Santa Clara County. Under Sections 4 and 5 of the Santa Clara Valley Water District Act, SCVWD's objectives and authority related to groundwater management are to: recharge groundwater basins; conserve, manage, and store water for beneficial and useful purposes; increase water supply; protect surface water and groundwater from contamination; prevent waste or diminution of the SCVWD's water supply; and do any and every lawful act necessary to ensure sufficient water is available for present and beneficial uses (Santa Clara Valley Water District 2012).

Court Adjudication of Groundwater Rights

Another form of groundwater management in California is through the courts. When the groundwater resources do not meet water demands in an area, landowners may turn to the courts to determine how much groundwater can be rightfully extracted by each overlying landowner or appropriator. The court typically appoints a watermaster to administer the judgment and to periodically report to the court.

There are currently 24 groundwater adjudications in California. None of the 24 relate to groundwater basins in the San Francisco Bay region.

Other Groundwater Management Planning Efforts

Groundwater management is also occurring through other avenues. IRWM incorporates the physical, environmental, societal, economic, legal, and jurisdictional aspects of water management into regional solutions through open and collaborative stakeholder process to promote sustainable water use. UWMPs incorporate long-term resource planning to meet existing and future water demands. AWMPs advance irrigation efficiency that benefits both farms and the environment.

Integrated Regional Water Management Plans

IRWM improves water management and supports economic stability, environmental stewardship, and public safety. IRWM plans involve multiple agencies, stakeholders, individuals, and groups, and cross jurisdictional, watershed, and political boundaries. The methods used in IRWM planning include developing water management strategies that relate to water supply and water quality, water-use efficiency, operational flexibility, stewardship of land and natural resources, and groundwater resources. Statewide, the majority of IRWMPs address groundwater management in the form of goals, objectives, and strategies. They defer implementation of groundwater management and planning to local agencies through local GWMPs. A few IRWM plans actively manage groundwater. Efforts by these IRWM RWMGs include creating groundwater contour maps for basin operations criteria, monitoring groundwater elevations, and monitoring groundwater quality.

There is one IRWM region that covers the entire San Francisco Bay region, and one IRWM region that is located primarily within the San Joaquin River Hydrologic Region. The Bay Area IRWM Region (http://bairwmp.org/) was approved in 2009 through DWR's Region Acceptance Process to maximize opportunities to integrate local water management activities and promote partnerships and multi-objective projects that benefit local communities and the natural environment. The five overarching goals of the Bay Area IRWM Plan are to:

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

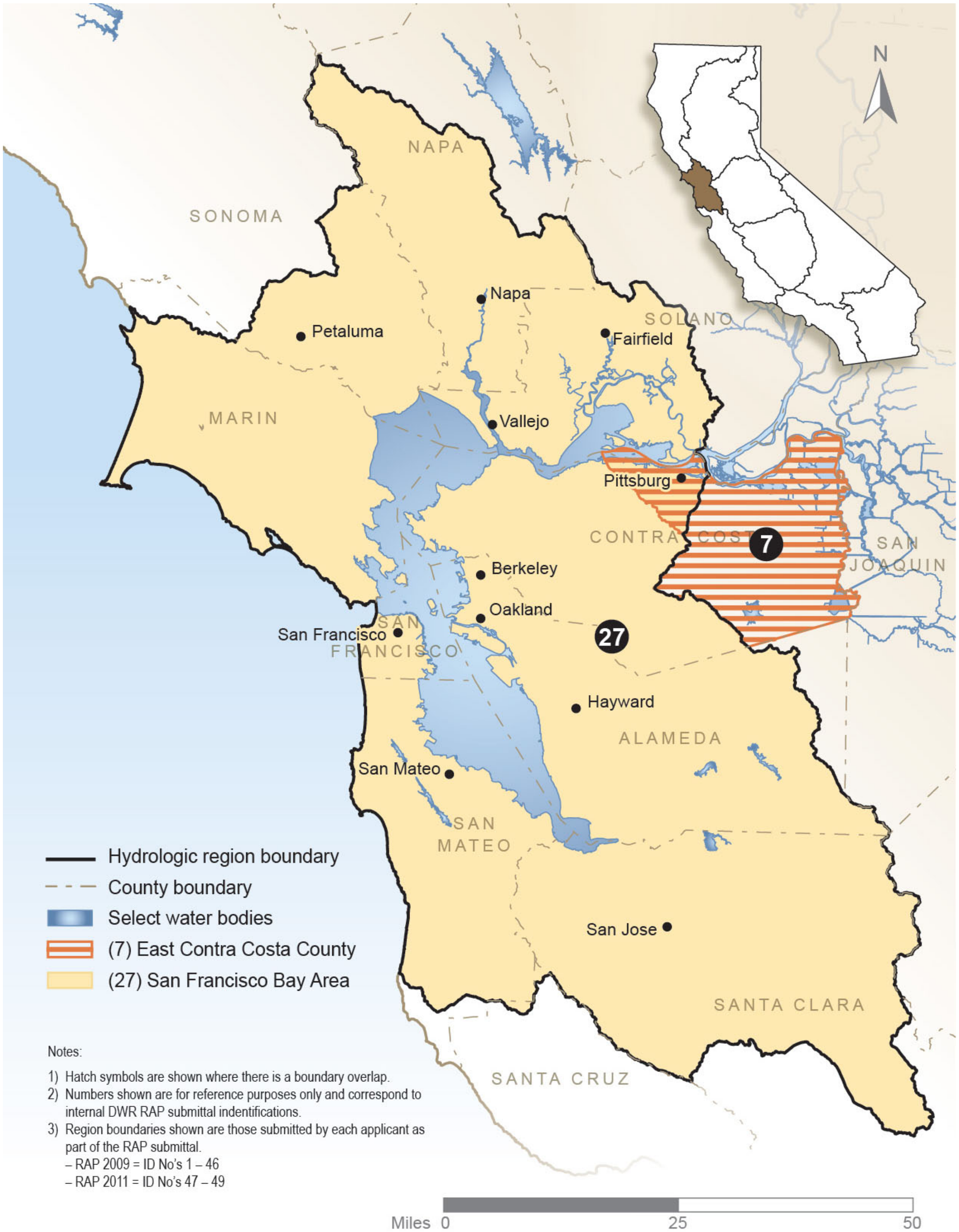
Figure 4-13 shows the area of the San Francisco Bay region that is covered by the single IRWM Plan as of September 2011. Table 4-21 lists the status of the IRWM planning areas by hydrologic region. More information about IRWM planning can be found at http://www.water.ca.gov/irwm/index.cfm.

Table 4-21 Status of Integrated Regional Water Management Plans in the San Francisco Bay Hydrologic Region

Hydrologic Region	IRWM Plan Name	Date	IRWM Plan Status	IRWM Map Number
San Francisco Bay	Bay Area Integrated Regional Water Management Plan	2007	Active	27
San Joaquin River/ San Francisco Bay	East Contra Costa County		In Progress	7
			IRWM Planning Regions:	2
			Active IRWM Plans:	1
			IRWM Plans In Development:	1
			IRWM Plans that Cross Hydrologic Boundaries:	1

Notes:
IRWM = integrated regional water management
Table represents information as of August 2012.

Figure 4-13 Integrated Regional Water Management Plans in the San Francisco Bay Hydrologic Region



Prepared by California Department of Water Resources for California's Groundwater Update 2013

Urban Water Management Plans

UWMPs are prepared by California's urban water suppliers to support their long-term resource planning and to ensure adequate water supplies are available to meet existing and future water demands. UWMPs include system descriptions, demands, and supplies, as well as water shortage reliability and water shortage contingency planning. In addition, the Water Conservation Bill of 2009 (SB X7-7) requires that urban water suppliers:

- Develop a single standardized water use reporting form for urban water suppliers.
- Develop method(s) by July 1, 2011, to identify per capita targets and update those methods in four years to meet the 20-percent reduction goal by 2020.
- Develop technical methodologies and criteria for calculating all urban water use.
- Convene a task force to develop alternative best management practices for commercial, industrial, and institutional water use.

Urban use of groundwater is one of the few uses that meter and report annual groundwater extraction volumes. The groundwater extraction data is currently submitted with the UWMP and then manually translated by DWR staff into a database. Online methods for urban water managers to directly enter their water use along with their UWMP updates are being evaluated. Additional information regarding urban water management and UWMPs can be found at http://www.water.ca.gov/urbanwatermanagement/.

Agricultural Water Management Plans

AWMPs are developed by water and irrigation districts to advance the efficiency of farm water management while benefitting the environment. The AWMPs provide another avenue for local groundwater management. Some of the efficient water management practices being implemented include controlling drainage problems through alternative use of lands, using recycled water that otherwise would not be used beneficially, improvement of on-farm irrigation systems, and lining or piping ditches and canals. In addition, SB X7-7 requires that agricultural water suppliers:

- Report the status of AWMPs and efficient water management practices, and evaluate their effectiveness.
- Adopt regulations to measure the volume of water delivered, and for adopting a pricing structure based on quantity delivered.
- Develop a method for quantifying efficiency of agriculture water use and a plan for implementation.
- Propose new statewide targets for regional water management practices for recycled water, brackish groundwater, and stormwater runoff.
- Promote implementation of regional water management practices through increased incentives and removal of barriers.

New and updated AWMPs addressing the SB X7-7 requirements were required to be submitted to DWR by December 31, 2012, for review and approval. More information about AWMPs can be found at http://www.water.ca.gov/wateruseefficiency/agricultural/agmgmt.cfm.

Conjunctive Management Inventory

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

As part of *California Water Plan Update 2013*, an inventory and assessment of conjunctive management programs in California was conducted. The overall intent of this effort was to provide a statewide summary of conjunctive water management program locations, operational methods, and capacities; and identify their challenges, successes, and opportunities for growth. The results of the inventory would be shared with policy-makers and other stakeholders to enable an informed decision-making process regarding groundwater and its management.

The statewide conjunctive management inventory and assessment consisted of literature research, an online survey, personal communication with local agencies, and a documented summary of the conjunctive management programs in California. Information from these efforts was compiled into a comprehensive spreadsheet of projects and historic operational information, which was updated and enhanced from a coordinated DWR/ACWA survey. The online survey administered by ACWA requested the following conjunctive management program information from its member agencies:

- Location of conjunctive management project.
- Year project was developed.
- Capital cost to develop the project.
- Annual operating cost of the project.
- Administrator/operator of the project.
- Capacity of the project in units of acre-feet.

Although initial response to the DWR/ACWA survey was encouraging, the number of survey participants and the completeness of those responses were limited. In an attempt to build on the survey and develop a greater understanding of the size and diversity of conjunctive management projects in California, staff from each of DWR's four region offices in the Division of Integrated Regional Water Management contacted, either by telephone or through e-mail, each of the entities identified as having a conjunctive water management program. DWR's follow-up information requested additional details regarding:

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

Statewide, 89 conjunctive management and groundwater recharge programs were identified. Because of confidentiality concerns expressed by some local agencies, information for some existing conjunctive management programs was not reported. Conjunctive management and groundwater recharge programs in the planning and feasibility stage were not included in the inventory.

A statewide map and series of tables listing the conjunctive management projects identified by DWR, grouped by hydrologic region and the questions noted in this section, are provided in Appendix D. The project locations shown on the map represent the implementing agency's office address and do not represent the project location. Additional information regarding conjunctive management in California can be found in *California Water Plan Update 2013*, Volume 3, Chapter 9, "Conjunctive Management and Groundwater Storage." The conjunctive management information in that chapter outlines some of the benefits, costs, and issues associated with this important resource management strategy.

Conjunctive Management Inventory Results

Of the 89 agencies or programs identified as operating a conjunctive management or groundwater recharge program in California, four programs are located in the San Francisco Bay region. The following information summarizes the details provided to DWR by Zone 7 Water Agency, SCVWD, ACWD, and EBMUD.

The earliest reported conjunctive use project in the San Francisco Bay region was in the 1920s by the SCVWD. Zone 7 Water Agency began its conjunctive management program in 1962. ACWD also initiated its conjunctive management efforts in 1962, while EBMUD began its recharge program in 2009. Based on the statewide data that was received in the conjunctive management survey, the majority of the programs in California were developed in the 1990s and 2000s, which coincides with the enactment of the Groundwater Management Act (AB 3030) in 1992, and the approval of Proposition 13 in 1999, which funded DWR's groundwater storage and conjunctive use grants and loans program.

The responses to the conjunctive management survey from agencies in the San Francisco Bay region were incomplete. The following paragraphs summarize the information provided by each of the four agencies.

SCVWD operates multiple spreading basins for direct percolation of surface water in the Santa Clara Valley Groundwater Basin. The sources of their recharge supplies include water from the SWP, CVP, and local surface water. Although no capital costs to develop the project were reported, SCVWD indicated that the annual operating costs of its conjunctive management program totaled approximately $3 million per year. In response to the conjunctive management survey, SCVWD reported data for a single year. In 2010, 104 taf of water was sent to local groundwater-recharge programs and 52 taf of water was banked with Semitropic Water Storage District in the Tulare Lake Hydrologic Region. According to the Bay Area IRWM Plan, SCVWD's integrated water system includes 10 reservoirs, 17 miles of canals, four water supply diversion dams, 300 acres of recharge ponds, and 91 miles of controlled in-stream recharge (Bay Area Integrated Regional Management Plan 2013).

Zone 7 Water Agency operates spreading basins for direct percolation into the Livermore Valley Groundwater Basin by using water from the South Bay Aqueduct and from local sources. The groundwater basin that Zone 7 Water Agency manages has a capacity of 126 taf. In addition to recharging local aquifers, Zone 7 Water Agency indicated it has additional project capacity with Semitropic Water Storage District (78 taf) and Cawelo Water District (120 taf) in Kern County.

ACWD reported its groundwater related programs in the Niles Cone Groundwater Subbasin have an annual operating cost of $278,000; no capital costs were provided. The Bay Area IRWM Plan indicated ACWD uses a series of former quarry pits to recharge groundwater. ACWD only reported that it has a secured capacity of 150 taf with Semitropic Water Storage District in Kern County.

EBMUD operates an ASR program in the East Bay Plain Groundwater Subbasin as part of its Bayside Groundwater Project. The current project capacity of EBMUD's ASR program is variable, but can directly inject as much as 1 million gallons per day into a confined aquifer.

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