San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix J: Groundwater Resources Affected Environment

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Appendix J
Groundwater Resources Affected Environment

This section presents the existing conditions of groundwater resources within the area of analysis for the San Luis Low Point Improvement Project (SLLPIP) alternatives.

J.1 Area of Analysis

The area of analysis for the groundwater resources section includes the South-of-Delta Central Valley Project (CVP) and State Water Project (SWP) Contractors Service areas as shown in Figure J-1. The area of analysis includes the following groundwater basins categorized by the hydrologic regions as defined by the California Department of Water Resources (DWR):

- San Joaquin Valley/Tulare Lake Hydrologic Region: San Joaquin Valley Groundwater Basin
- San Francisco Bay Hydrologic Region: Santa Clara Valley Groundwater Basin; and Gilroy-Hollister Valley Groundwater Basin
- South Lohantan Hydrologic Region: Fremont Valley Groundwater Basin; and Antelope Valley Groundwater Basin
- Colorado River Hydrologic Region: Ames Valley Groundwater Basin; Copper Mountain Valley Groundwater Basin; Warren Valley Groundwater Basin; and Coachella Valley Groundwater Basin
- South Coast Hydrologic Region: Northwest Metropolitan Area Groundwater Basins; San Fernando Valley Groundwater Basin; San Gabriel Valley Groundwater Basin; Coastal Plain of Los Angeles; Coastal Plains of Orange County; and Upper Santa Ana Valley Groundwater Basin

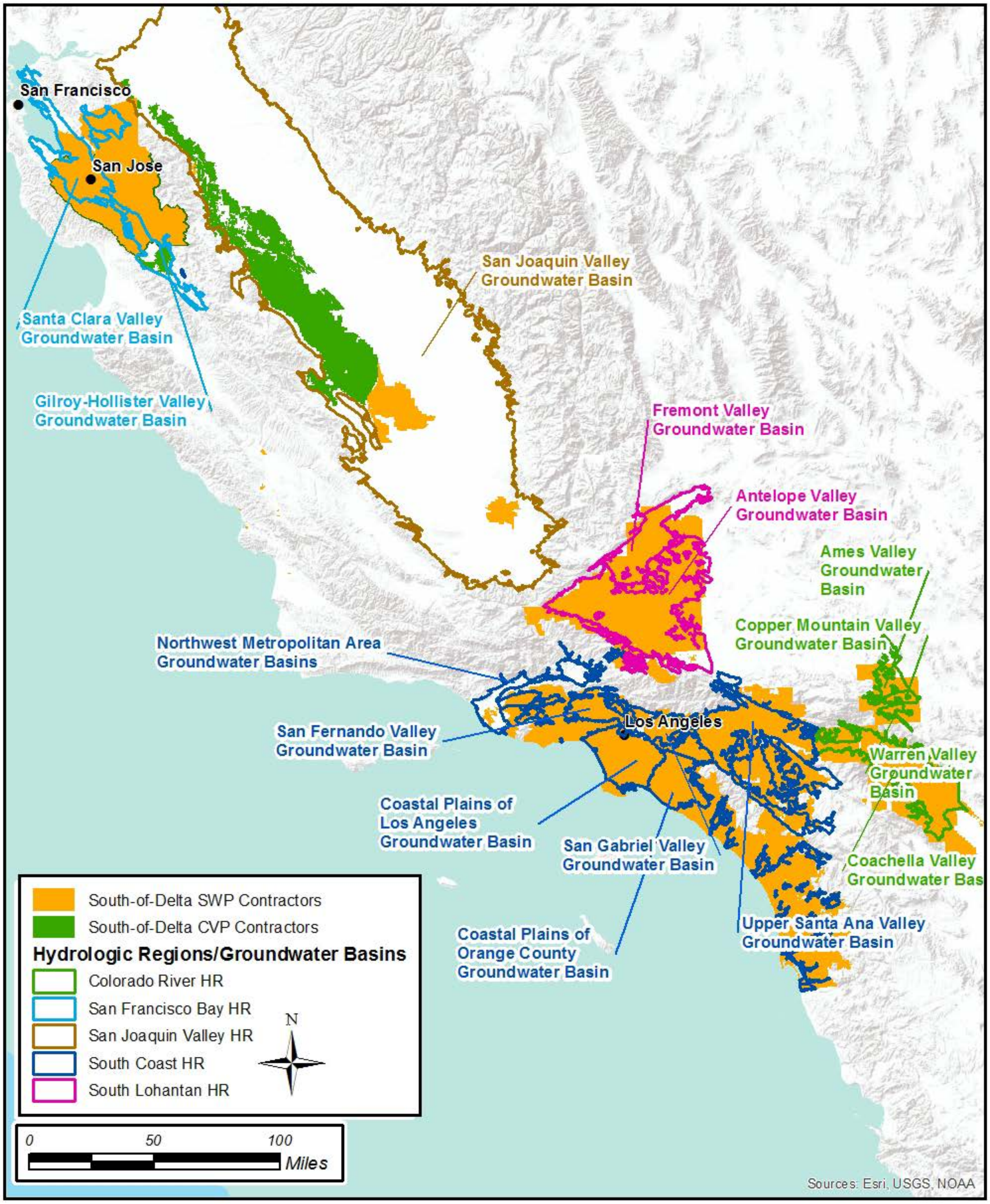


Figure J-1. Groundwater Resources Area of Analysis

There is no mapped groundwater basin underlying the San Luis Reservoir and the Pacheco Reservoir area (DWR 2016a) but the San Joaquin Valley Groundwater Basin (Delta-Mendota sub basin) underlies O'Neill Forebay. It should be noted that though there would be minimal to no direct recharge under the Pacheco Reservoir, the reservoir is currently operated for groundwater recharge through releases to Pacheco Creek. Pacheco Creek flows through the Gilroy-Hollister groundwater subbasin.

J.2 Affected Environment

J.2.1 San Joaquin Valley Hydrologic Region

J.2.1.1 San Joaquin Valley Groundwater Basin

The San Joaquin Valley Groundwater Basin extends over the southern two-thirds of the Central Valley regional aquifer system and has an area of approximately 13,500 square miles. The San Joaquin Valley Groundwater Basin, extends from just north of Stockton in San Joaquin County to Kern County.

Several requests for changes to subbasins boundaries within the San Joaquin Valley groundwater basins have been submitted to DWR in concurrence with the Basin Boundary Emergency Regulation, including changes to Tracy, Delta-Mendota and Westside subbasins. Requests for changes to Delta-Mendota and Westside subbasins have been approved, however, no changes have been incorporated into Bulletin 118 (DWR 2016b). Following section was written based on Bulletin 118 (DWR 2003) boundary.

DWR has prioritized Tracy subbasins as medium priority based on degraded water quality throughout the subbasin (DWR 2014a). Pursuant to Senate Bill (SB) 1168, West Stanislaus Irrigation District, City of Tracy, West Side Irrigation District, Banta-Carbona Irrigation District and County of San Joaquin have proposed to cooperatively manage the subbasin (DWR 2016c). The north western portion of the subbasin does not have designated Groundwater Sustainability Agency (GSA) at the time of writing this report.

DWR has prioritized the Delta-Mendota subbasin as high priority based on overdraft concerns in the subbasin (DWR 2014a). Farmers Water District, Aliso Water District, Patterson Irrigation District, West Stanislaus Irrigation District and San Joaquin River Exchange Contractors Water Authority have proposed to cooperatively manage the subbasin (DWR 2016c).

DWR has prioritized the Westside subbasin as high priority based on overdraft, land subsidence and water quality concerns in the subbasin (DWR 2018). A GSA has not been formed for Westside subbasin at the time of writing this report (DWR 2016c).

Geology, Hydrogeology, and Hydrology The aquifer system in the San Joaquin Valley Groundwater Basin is mostly comprised of unconsolidated alluvial and lacustrine sediments, Halocene to Jurassic in age, derived from parent materials of the Coast Ranges and the Sierra Nevada Mountains. The Valley fill reaches a thickness of about 28,000 feet in the southwestern corner (Page 1986). A significant hydrogeologic feature in the basin is the Corcoran Clay. This clay layer divides the aquifer system into two distinct zones, an upper unconfined to semi-confined aquifer and a lower confined aquifer. Both aquifers are composed of formations derived from the deposition of Coast Range sediments in the western portions of the basin. Overlying these formations are flood-plain deposits. The formations in the western portions of the basin are primarily marine formations that generally contain more silt and clay and also contain higher concentrations of salts. The lower confined aquifer system contains sediments of mixed origin.

The western portion of the San Joaquin Valley has major faults running parallel to the western boundary, along the east side of the Coast Range Mountains. The Greenville and Ortigalita faults lie within 6 to 13 miles of the western boundary (San Luis & Delt- Mendota Water Authority [SLDMWA] 2011).

The main surface water feature in the western portion of the San Joaquin Valley Groundwater Basin is the San Joaquin River and its tributaries, including Salt Slough, Mud Slough, and Los Banos Creek.

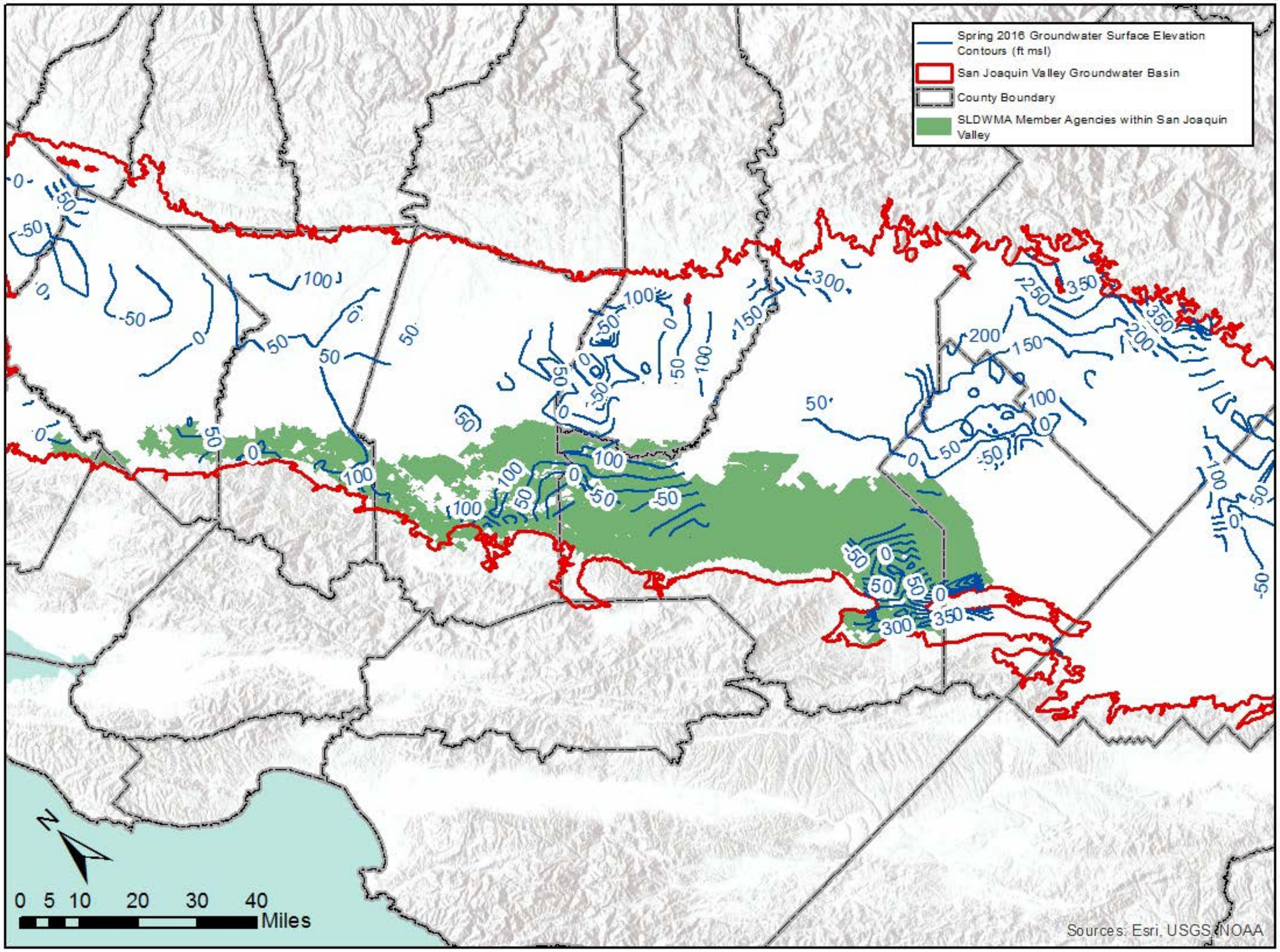
Groundwater Production, Levels, and Storage Prior to the large-scale development of irrigated agriculture, groundwater in the basin generally flowed from areas of higher elevation (i.e., the edges of the basin) toward the San Joaquin River and ultimately to the Delta. Most of the water in the San Joaquin Valley moved laterally, but a small amount leaked upward through the intervening confining unit (Planert and Williams 1995). Upward vertical flow to discharge areas from the deep confined part of the aquifer system was impeded partially by the confining clay beds, particularly the Corcoran Clay. Extensive groundwater pumping and irrigation (with imported surface water) have modified local groundwater flow patterns and in some areas, groundwater depressions are evident. Groundwater flow has become more rapid and complex. Groundwater pumping and percolation of excess irrigation water has resulted in steeper hydraulic gradients as well as shortened flow paths between sources and sinks (Faunt 2009).

Irrigated agriculture in the northern portion of the San Joaquin Valley Groundwater Basin increased from about one million acres in the 1920s to more than 2.2 million acres by the early 1980s (United States Department of the Interior, Bureau of Reclamation [Reclamation] 1997). Subregion 10 (Delta Mendota Basin) in the United States Geological Survey's (USGS's) Central Valley Hydrologic Model (CVHM), show average groundwater pumping to be 60,000 acre-feet (AF) per year from 1962 through 2003 (Faunt 2009).

Figure J-2 shows Spring 2016 groundwater elevation contours for the San Joaquin Valley Groundwater Basin. According to CVHM, the cumulative change in groundwater storage for the entire San Joaquin Valley Groundwater Basin was relatively constant from 1962 through 2003, storage dropped during dry periods and increased during wetter years. However according to C2VSim, storage within the San Joaquin Valley has been showing a steady decline since the 1940s. Annual average groundwater production in the basin was estimated to be 0.9 million AF in the CVHM model (Faunt 2009).

Groundwater-Related Land Subsidence From the 1920s until the mid-1960s, the use of groundwater for irrigation of crops in the San Joaquin Valley increased rapidly, causing land subsidence throughout the west and southern portions of the valley. DWR has prioritized the western portion of the San Joaquin Valley (Tracy, Delta-Mendota and Westside subbasins) as having a high potential for subsidence (DWR 2014b). USGS's extensometer near the city of Dos Palos has recorded approximately 0.1 feet of subsidence in 2015 (USGS 2015). In addition to the extensometers, DWR is also analyzing and recording subsidence trends from 319 continuous global positional system (cPGS) stations across the central valley. cPGS station Patterson_CN2005 located between the City of Patterson and Crows Landing along CA-33 has recorded a little over 0.13 feet of subsidence since 2005 (DWR 2016d).

Groundwater Quality Groundwater quality varies throughout the San Joaquin Valley Groundwater Basin. The Groundwater Ambient Monitoring and Assessment (GAMA) Program's Priority Basin Project evaluates statewide groundwater quality and sampled 58 wells in the western San Joaquin Valley region between March and June 2010 (USGS 2013). Water quality data was analyzed for inorganic constituents (e.g., nutrients, radioactive constituents, TDS, and iron/manganese); special interest constituents (e.g., perchlorate) and organic constituents (e.g., solvents, gasoline additives, and pesticides).



Source: DWR 2016e

Figure J-2. San Joaquin Valley Spring 2016 Groundwater Elevation Contours

Inorganic constituents were detected at concentrations less than health-based benchmarks at most of the 39 grid wells sampled. Exceptions included two detections of arsenic greater than the United States Environmental Protection Agency (USEPA) maximum contamination level of 10 micrograms per liter (μg/L); 20 detections of boron greater than the California Department of Public Health (CDPH) notification level of 1,000 μg/L, 2 detections of molybdenum greater than the USEPA lifetime health advisory level of 40 μg/L, 1 detection of selenium greater than the USEPA maximum contamination level (MCL) of 50 μg/L, 2 detections of strontium greater than the USEPA lifetime health advisory level of 4,000 μg/L, and 3 detections of nitrate greater than the MCL-US of 10 μg/L. Results of inorganic constituents with non-health-based benchmarks like iron, manganese, chloride, sulfate, and total dissolved solids (TDS) were also detected at levels greater than CDPH secondary maximum contamination levels at some of the wells (USGS 2013).

Organic and special-interest constituents from the 39 sampled grid wells were also less than health-based benchmarks. Volatile Organic Compounds were detected in approximately 31 percent of the sampled wells, pesticides and pesticide degradates were detected in approximately 23 percent of the sampled wells, and perchlorate was detected in approximately 38 percent of the sampled wells (USGS 2013).

J.2.1.2 San Francisco Bay Hydrologic Region

The Santa Clara Valley Water District (SCVWD) is the primary water contractor within the South Coast Hydrologic Region. SCVWD is a CVP and SWP contactor. The SCVWD was formed in 1929 for the purpose of providing conjunctive management of surface and groundwater for all beneficial uses, which was later expanded to include stream stewardship and protection from flooding within Santa Clara County. Groundwater is an important water supply source for Santa Clara County and its preservation was the goal that spurred the formation of the SCVWD. SCVWD manages two groundwater subbasins: the Santa Clara subbasin (DWR Basin 2-9.02) and the Llagas subbasin (DWR Basin 3-3.01). SCVWD further subdivides the Santa Clara subbasin into two groundwater management areas: the Santa Clara Plain and the Coyote Valley (SCVWD 2016).

DWR has prioritized the Santa Clara subbasin as high priority based primarily on high population, groundwater use, and documented historical impacts (DWR 2018). The Llagas subbasin was prioritized as high priority based primarily on groundwater use/reliance and irrigated acreage (DWR 2018). Pursuant to the Sustainable Groundwater Management Act (SGMA) requirements, SCVWD declared their intent to exclusively manage Santa Clara and Llagas subbasins as the GSA on June 16, 2016 (DWR 2016c), prior to the June 30, 2017 statutory deadline. In December 2016, SCVWD submitted the 2016 Groundwater Management Plan for the Santa Clara and Llagas Subbasins to DWR as an Alternative to a GSP as allowed by SGMA.

J.2.1.3 Santa Clara Groundwater Subbasin (DWR Basin 2-9.02)

The Santa Clara subbasin is a 297 square mile groundwater basin that borders the southern San Francisco Bay and principally drains parts of Santa Clara and San Mateo Counties. The Santa Clara subbasin occupies a structural trough parallel to the northwest trending Coast Ranges. The Diablo Range bounds it on the east and the Santa Cruz Mountains form the basin boundary on the west. It extends from the northern border of Santa Clara County to the groundwater divide near the town of Morgan Hill. The dominant hydrogeologic feature is a large inland valley (USGS 1995). The valley is drained to the north by tributaries to San Francisco Bay including Coyote Creek, the Guadalupe River, and Los Gatos Creek. Annual average precipitation for the Santa Clara subbasin ranges from less than 15 inches in the valley to more than 28 inches in the upland areas.

Geology, Hydrogeology, and Hydrology Most of the basin is characterized by gently sloping topography of coalescing alluvial fans that combine to form the valley floor and coastal tidal lowlands. The sloping offshore plain and underlying aquifers extend beneath the Bay. The location of the northwest boundary and the extent of the groundwater basin offshore beneath the Bay and its connection with adjacent areas such as the Niles Cone or Fremont groundwater areas remain uncertain. In general, groundwater flow in the Santa Clara subbasin can be characterized as a convergent regional flow system within a basin bounded by mountains and hills on three sides (USGS 2004). Recharge to the groundwater flow system starts along the mountain fronts and flows toward the center of the basin and toward the southern San Francisco Bay (USGS 2004). Much of the predevelopment flow paths have been modified by pumping centers characterized by groups of wells that have resulted in sub-regional cones of depression and related flow paths (SCVWD 2001). Discharge from the groundwater flow system occurs as pumpage, underflow, base flow to streams, and evapotranspiration.

The Santa Clara subbasin is a regional groundwater basin that can be divided into two onshore subregions that represent the confined and unconfined parts of the aquifer systems as shown in Figure J-3. The confined zone in the northern portion of the subbasin is overlain by a clay layer of low permeability (SCVWD 2016). The southern portion of the subbasin is generally unconfined and contains no thick clay layers (SCVWD 2001). The basin contains extensive alluvial-aquifer systems that are bounded by faults and Bedrock Mountains.

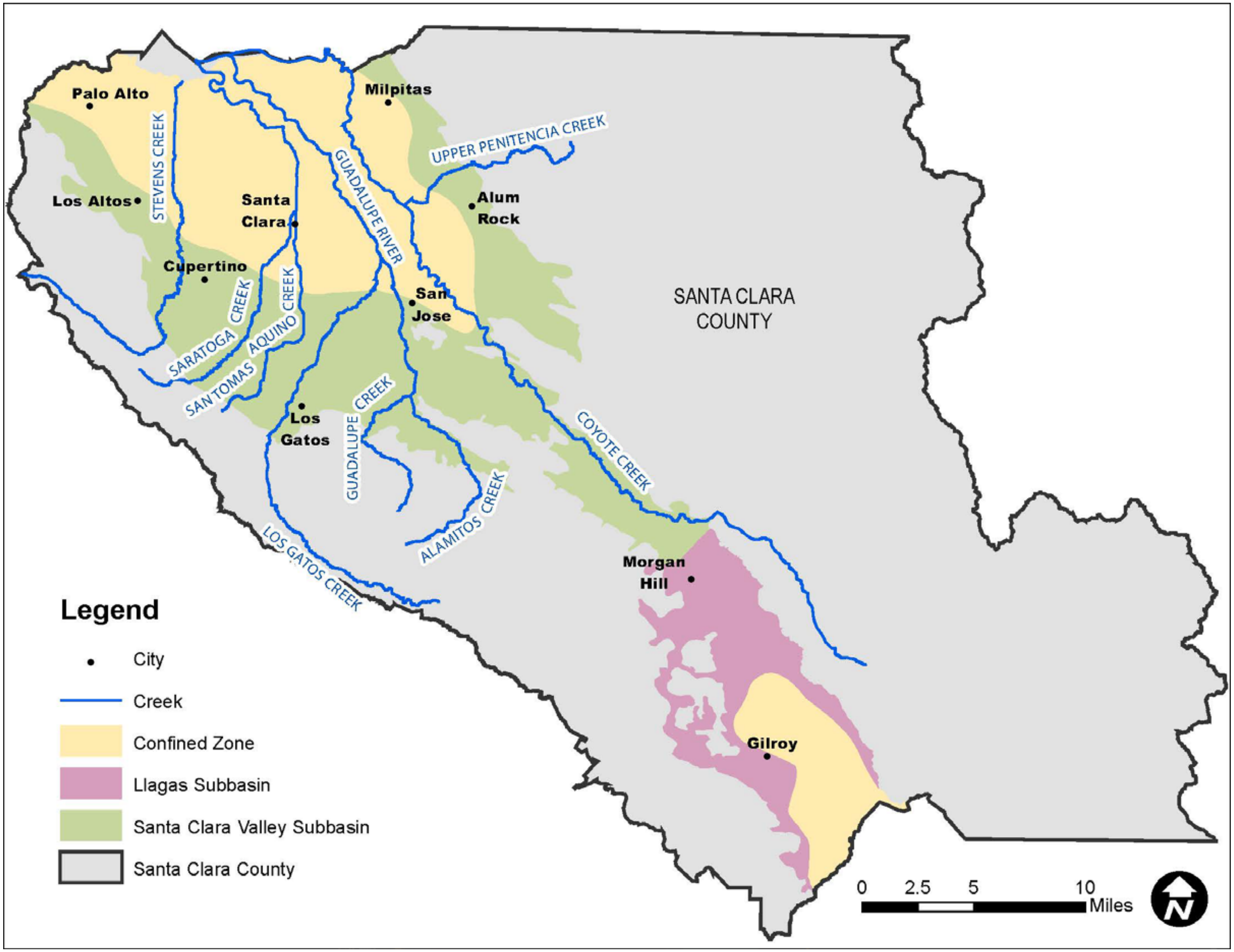


Figure J-3. Santa Clara County Groundwater basins

There is extensive groundwater development in the deeper, or lower, aquifer system of the Pleistocene and Pliocene-age alluvial deposits (USGS 2004). Shallow parts of the upper aquifer are artificially recharged with some of the groundwater in the system dating back less than 60 years and some dating back as much as 2,500 years. Groundwater in lower aquifer generally ranges in age from 16,700 to 39,900 years (Hanson 2015). The Santa Clara subbasin includes continental deposits of unconsolidated to semi-consolidated gravel, sand, silt, and clay. Two members form this group, the Santa Clara Formation of Plio-Pleistocene age and the younger alluvium of Pleistocene to Holocene age (DWR 2003). The combined thickness of these two units probably exceeds 1,500 feet (DWR 2003). The alluvial deposits that form the regional aquifer systems are unconformably underlain by Pliocene-age deposits of the Santa Clara Formation, Tertiary-age sediments that include the Miocene-age parts of the Monterey Formation, and Tertiary-age serpentinites as shown in Figure J-4 (USGS 2004). These underlying deposits form the relatively impermeable base of the regional aquifer systems. The alluvial aquifer systems are composed of a complex sequence of layers of fluvial sand and gravel and fluvial fine-grained silt and clay (USGS 2004). It becomes progressively finer-grained at the central portions of the valley. The Santa Clara Formation is exposed only on the west and east sides of the Santa Clara subbasin. The exposed portions are composed of poorly sorted deposits ranging in grain size from boulders to silt (DWR 2003).

Groundwater in the Santa Clara subbasin is primarily present in the Pleistocene to Holocene alluvium deposits. The permeability of the valley alluvium is generally high and principally all large production wells derive their water from it (DWR 2003). Well logs indicate that permeability increases from west to east and that in the central part of the valley permeability and grain size decrease with depth (DWR 2003).

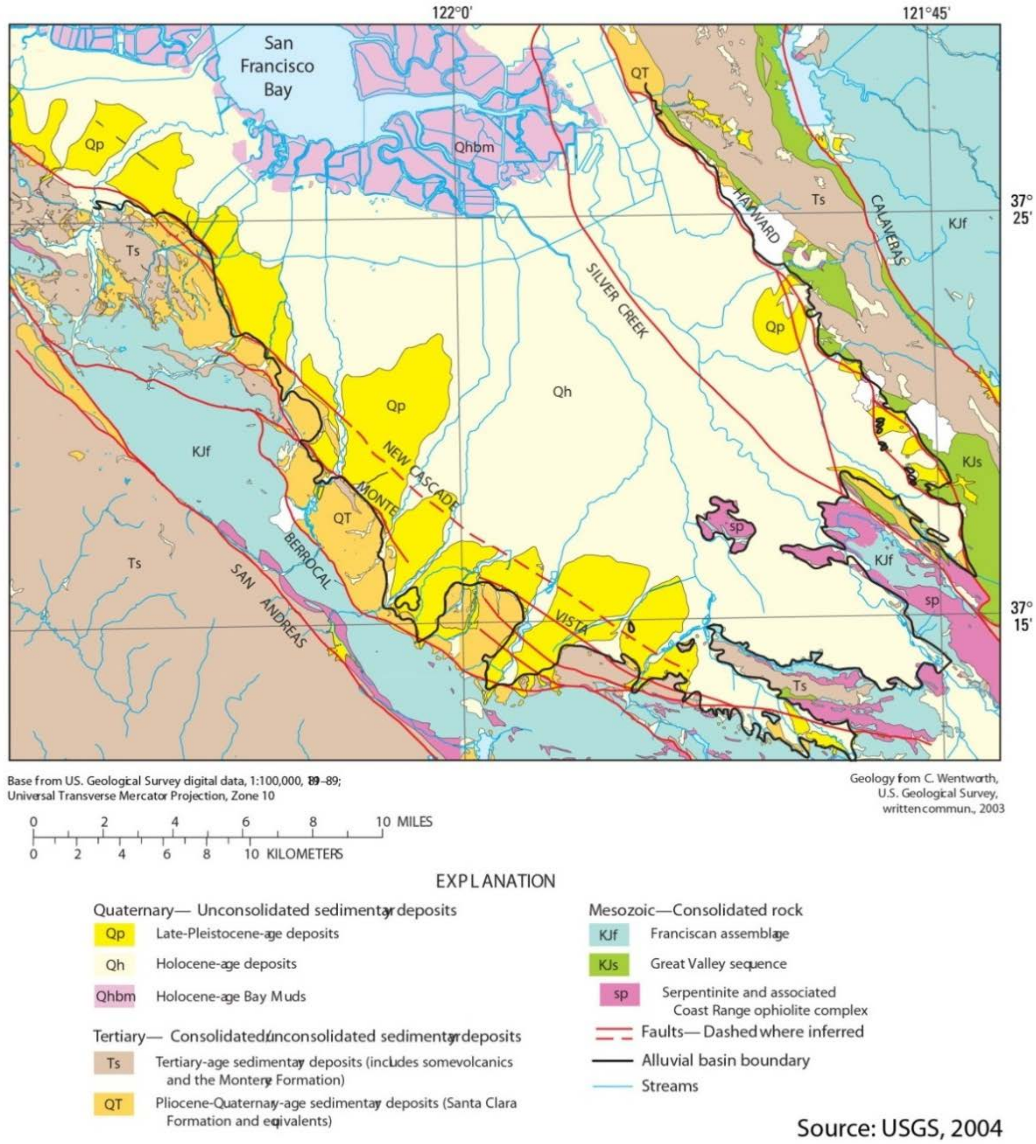


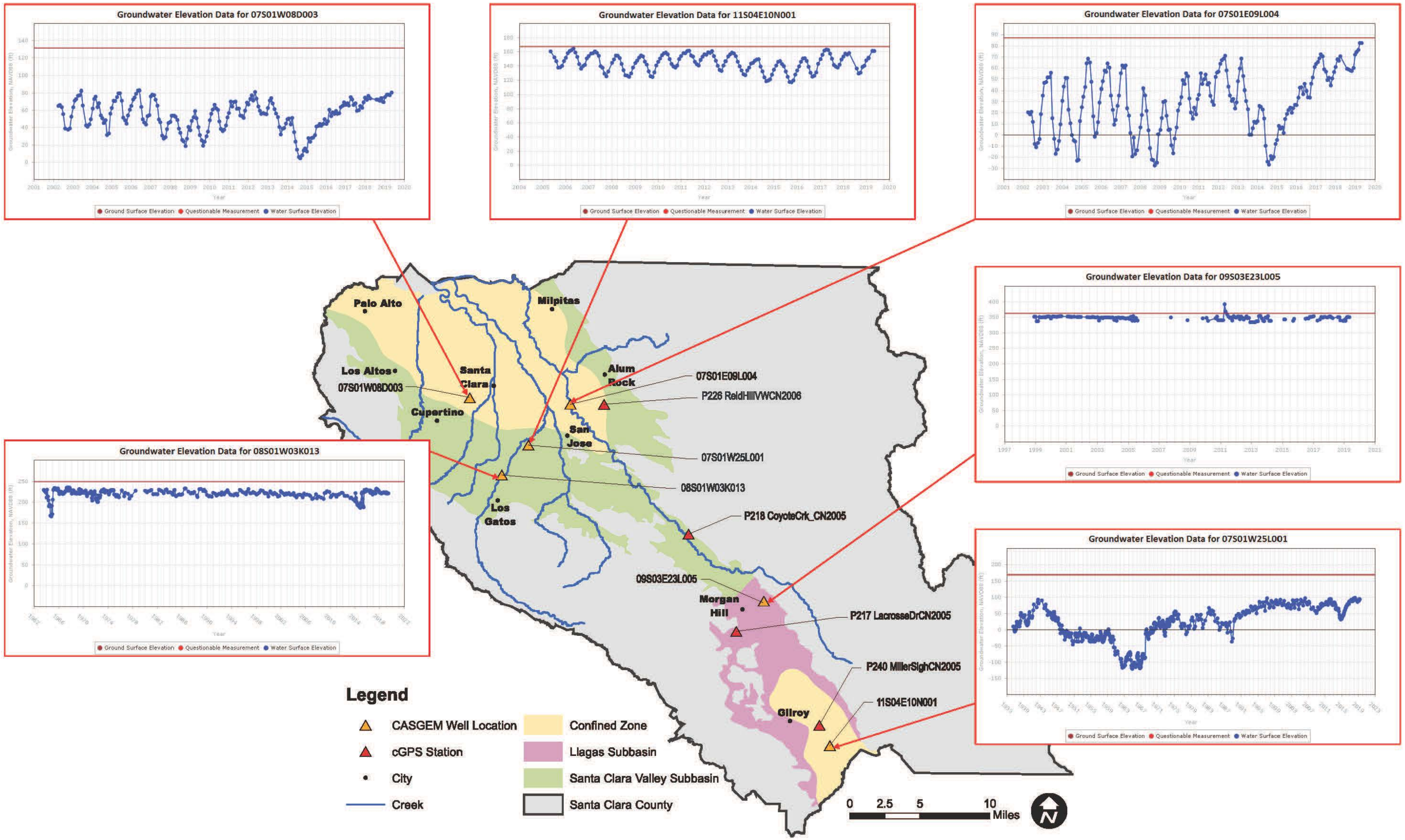
Figure J-4. Santa Clara Valley Geology

The surface water system in the Santa Clara County includes the natural streamflow network, groundwater recharge percolation ponds, in-stream recharge facilities, ten reservoirs, and a system of channels or canals, pipelines, and storm drains. The main surface water features in the Santa Clara groundwater subbasin are the tributaries to San Francisco Bay including Coyote Creek, Guadalupe River, and Los Gatos Creek. The major streams discharge directly to the San Francisco Bay through the tidal lowlands along the southern end of San Francisco Bay. Other creeks, such as San Francisquito Creek that forms the northwestern boundary of the Santa Clara subbasin, drain directly into the San Francisco Bay. The reservoirs discharge directly into several of the major tributaries and creeks. Different networks of pipelines are used to transport imported water directly to treatment plants where the water is treated and then delivered to local water retailers. The storm drain channels drain additional runoff from the valley floor to the San Francisco Bay.

SCVWD classifies groundwater recharge into two categories: natural and managed recharges. Natural groundwater recharge occurs principally as infiltration from streambeds that exit the upland areas within the drainage basin and from direct percolation of precipitation that falls on the basin floor. Annual average precipitation for the Santa Clara subbasin ranges from 14 inches in the valley to 45 inches in the upland areas (SCVWD 2015). Other sources classified as natural recharge include net leakage from pipelines, percolation from upland areas, ungauged creeks, and net irrigation return flows to the basin.

Managed recharge refers to the active and intentional recharge of the basin by groundwater recharge ponds and in-stream recharge facilities with releases of local and imported water from reservoirs or the distribution system to the managed recharge facilities. In-stream recharge occurs along stream channels in the alluvial apron upstream from the confined zone. The groundwater recharge ponds include abandoned gravel pits and areas specifically excavated for recharge purposes. In-stream and off-stream facilities provide approximately equal recharge capacity (SCVWD 2016). The District operates off-stream groundwater recharge ponds systems with a cumulative surface area of about 390 acres in 7 major recharge systems countywide. Within the Santa Clara Subbasin, average managed recharge is about 73,500 AF per year (SCVWD 2016).

Groundwater Production, Levels, and Storage SCVWD manages the Santa Clara subbasin. Groundwater is pumped within Santa Clara subbasin by major water retailers, well owners, and agricultural users. Historically, from the early 1900s through the mid-1960s, groundwater level declines from groundwater pumping have induced land subsidence in the Santa Clara subbasin and caused degradation of the aquifer adjacent to the bay from saltwater intrusion. Prior to construction of reservoirs that supply recharge water and the import of surface water via the Hetch Hetchy and South Bay Aqueducts, water levels declined more than 200 feet in the Santa Clara subbasin (USGS 1988). Groundwater levels have generally increased since 1965 as a result of increased recharge and decreased pumping (USGS 1995). Figure J-5 shows the location of the monitoring wells within Santa Clara subbasin and the recent (2011-2015) groundwater elevation at the wells.



Source: DWR 2019

Figure J-5. Santa Clara County Historic Groundwater Elevations

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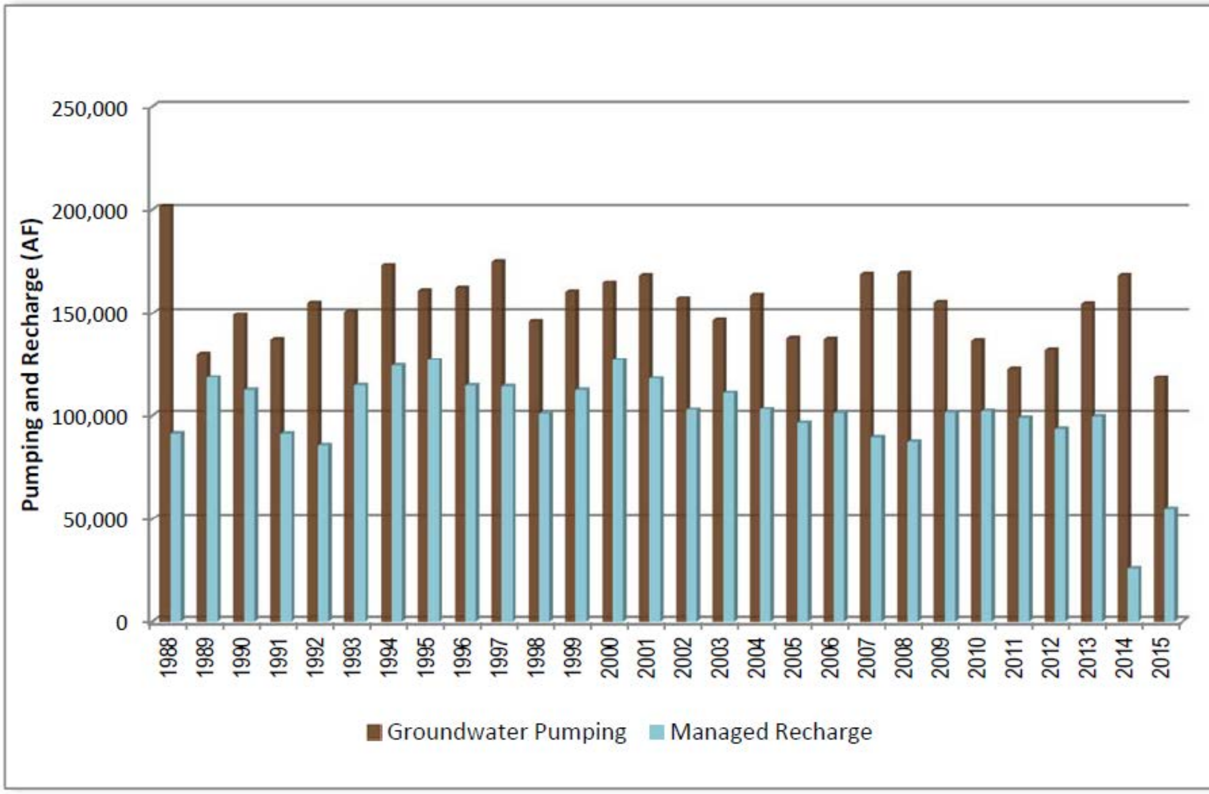
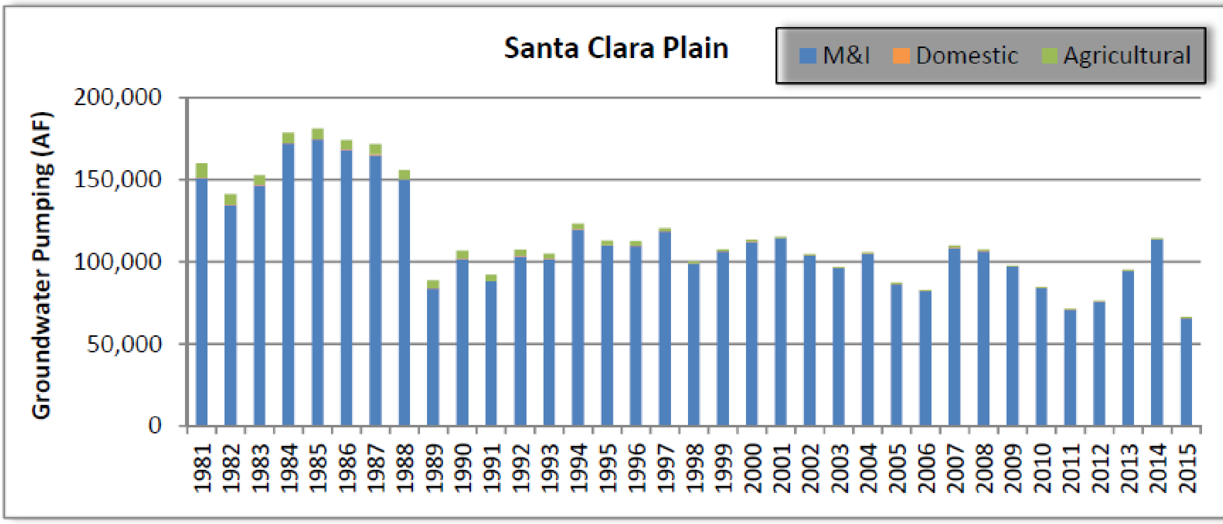
About 40% of the water used in Santa Clara County water comes from groundwater; North County (Santa Clara Plain area of the Santa Clara Subbasin) meets 31 percent of its water demand through groundwater pumping and South County (Coyote Valley of the Santa Clara subbasin and Llagas subbasin) meets 94 percent of its demand through groundwater (SCVWD 2016). Figures J-6 through J-9 show historical groundwater pumping within Santa Clara County.



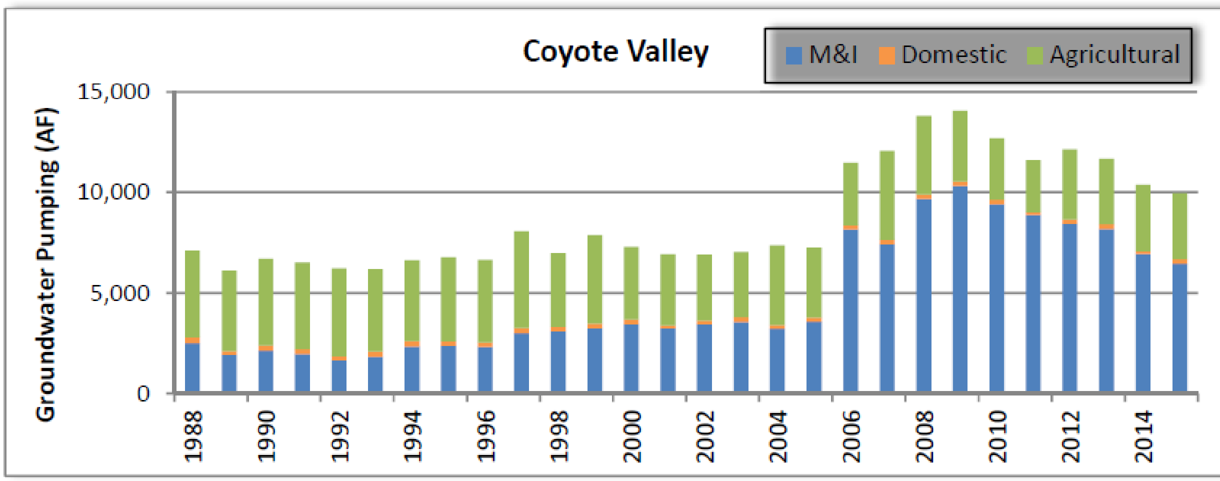
Source: SCVWD 2016

Figure J-6. Santa Clara County Groundwater Pumping and Managed Recharge



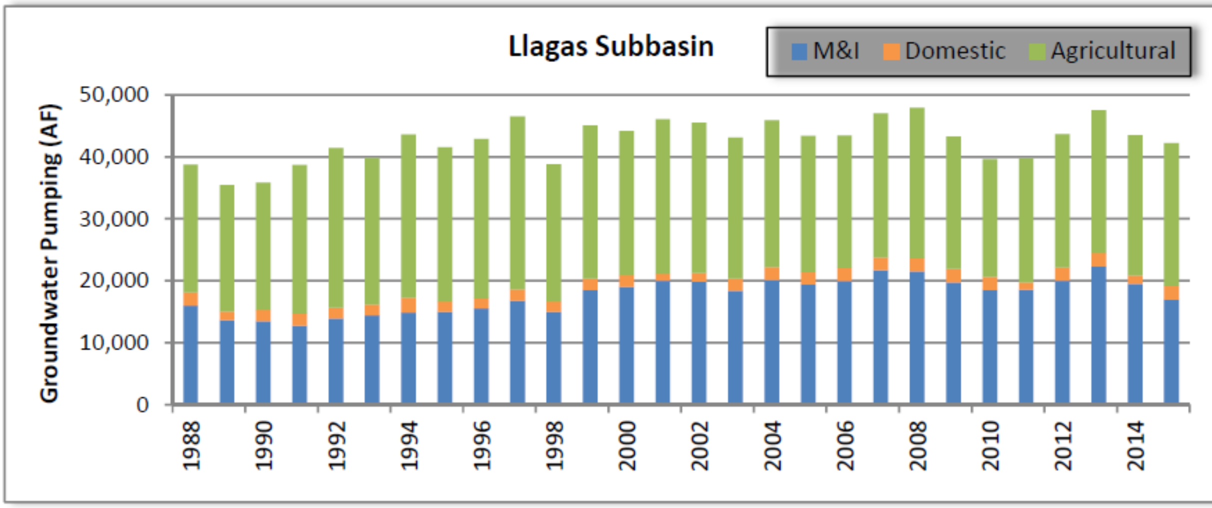
Source: SCVWD 2016

Figure J-7. Santa Clara Plain Groundwater Pumping by Use



Source: SCVWD 2016

Figure J-8. Coyote Valley Groundwater Pumping by Use



Source: SCVWD 2016

Figure J-9. Llagas Subbasin Groundwater Pumping by Use

The operational storage capacity of the Santa Clara subbasin is estimated to be between 373,000 to 383,000 AF (SCVWD 2016). The operational storage capacity is less than the total storage capacity of the basin and accounts for available pumping capacity and the avoidance of land subsidence and problems associated with high groundwater levels.

Groundwater-Related Land Subsidence Historically, Santa Clara County has experienced as much as 13 feet of subsidence caused by excessive pumping of groundwater. One serious consequence of subsidence in the Santa Clara County was that lands near San Francisco Bay sank below sea level between 1940 and 1970, enabling salt water to intrude upstream through the mouths of rivers dramatically affecting the riparian habitat of the rivers. Land subsidence also increased potential for tidal flooding (SCVWD 2000). Land subsidence since 1980's has primarily been elastic with most of this minimal compaction occurring in the upper aquifer (upper 250 feet of sediments) and trending over seasonal and climatic cycles (Hanson 2015). Figure J-10 reflects the elevation of groundwater at the downtown San Jose index well (well ID 7S01E07R013) and the land subsidence measured at First and St. James Streets in San Jose. In addition to the index well, DWR is also analyzing and recording subsidence from cGPS stations across the state (operated by University NAVSTAR Consortium [UNAVCO]). cGPS station Reid Hill_P226 located near Hillview Park in San Jose (see Figure J-5 for location of cGPS stations) has recorded a little over 0.01 feet of subsidence since 2006 (DWR 2016d). cGPS station Coyote Creek P218 located in Coyote Valley near the Coyote Creek Golf Club has recorded approximately 0.02 feet of subsidence since 2005 (DWR 2016d).

SCVWD uses Predictions Relating Effective Stress and Subsidence (PRESS)[1] numerical modeling to simulate current conditions and predict future subsidence under various groundwater conditions. SCVWD has calibrated the model at ten index wells within the subbasin, and has established subsidence thresholds equal to the current acceptable rate of 0.01 feet per year (SCVWD 2001, SCVWD 2012, SCVWD 2016). DWR has categorized Santa Clara subbasin as having a low potential for future land subsidence (DWR 2014b).

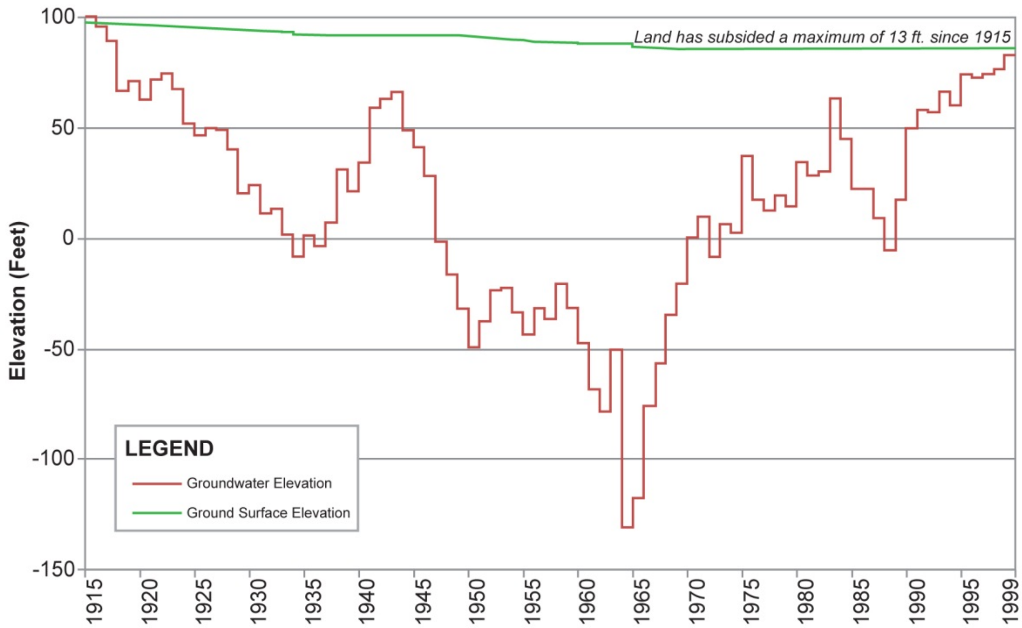


Figure J-10. Land Subsidence at San Jose Index Well (Source SCVWD 2000)

Groundwater Quality DWR has prioritized the Santa Clara subbasin as high priority based on high population, groundwater use, and documented historical impacts (DWR 2018). Though groundwater in the Santa Clara subbasin is typically considered "hard", the groundwater is suitable for most uses and meets drinking water standards at public supply wells without the use of treatment methods (SCVWD 2001). Groundwater alkalinity in the Santa Clara subbasin is generally bicarbonate type with sodium and calcium being the principal cations (DWR 2003).

Groundwater in the northern portion of the basin has elevated mineral levels which could be associated with the historical saltwater intrusion due to land subsidence (SCVWD 2001). Some wells with elevated nitrate concentration have been identified in the southern portion of the basin (SCVWD 2001).

[1] Predictions Relating Effective Stress and Subsidence (PRESS) is a two-dimensional model that relates the stress associated with groundwater extraction to the resulting strain in fine-grained materials such as clays.

J.2.2.2 Llagas Subbasin (DWR Basin 3-03.01)

The Llagas subbasin is part of the Gilroy-Hollister Groundwater Basin DWR Basin 3-03 (DWR 2003). A request for the basin boundary modification was submitted to DWR in concurrence with the Basin Boundary Emergency Regulation (DWR 2016b). At the time of writing this report modification to the basin boundary has been approved, however, no changes have been incorporated into Bulletin 118 (DWR 2016b). Following section was written based on Bulletin 118 (DWR 2003) boundary.

The Llagas subbasin occupies a northwest trending structural depression. The Diablo Range bounds it on the east and the Santa Cruz Mountains form the basin boundary on the west. The subbasin extends from the groundwater divide at Cochran Road near the town of Morgan Hill in the north to the Pájaro River in the south (SCVWD 2016).

Geology, Hydrogeology, and Hydrology The Llagas subbasin similar to the Santa Clara subbasin was formed by continental deposits of unconsolidated to semi-consolidated gravel, sand, silt and clay (DWR 1981). The water bearing formation of the subbasin includes the Santa Clara Formation and the valley fill material (alluvial and alluvial fan deposits) (DWR 1981).

The Santa Clara Formation is of Plio-Pleistocene age. This formation underlies much of the valley and unconformably overlies older non-water bearing sediments (DWR 1981). It consists of fairly well consolidated clay, silt, and sand with lenses of gravel. These sediments are generally of fluvial origin with an estimated maximum thickness of 1,800 feet (DWR 1981). The lower portions of deeper wells within the subbasin likely intersect the Santa Clara Formation. Alluvial fan deposits of Holocene age occur at the margin of the valley basin. The alluvial fan deposits are composed of a heterogeneous mixture of unconsolidated to semi-consolidated clay, silt, sand, and gravel usually locally partially confined (DWR 1981). The alluvial fan deposits range in thickness from 3 feet to 125 feet and overlie the Santa Clara Formation and other older non water bearing deposits (DWR 1981). A number of these wells supply water of excellent quality for irrigation and municipal purposes (DWR 1981). A series of interbedded clay layers, which extends north from the Pajaro River, divides the Llagas subbasin into confined and forebay zones as shown in Figure J-2.

Older alluvium of the Plio-Pleistocene age is distributed in the central portion of the valley from the northern boundary of the subbasin to Gilroy. It consists of unconsolidated clay, silt, and sand formed as floodplain deposits. It characteristically is identified by a dense clayey subsoil that acts as an aquitard to vertical movement of water and limits recharge potential (DWR 1981). It provides adequate yields to wells up to 100 feet in depth and water obtained from this formation is generally suitable for most uses (DWR 1981). Younger alluvium of the Holocene age occurs in the flat lying areas from Gilroy south to the basin's southern boundary. Similarly to the older alluvium, the younger alluvium has been formed principally as a flood plain deposit but it does not have a well-defined clay subsoil. The younger alluvium has a maximum thickness of about 100 feet and generally overlies the older alluvium and alluvial fan deposits (DWR 1981). Groundwater in the younger alluvium is generally unconfined and the quality of water is acceptable for domestic purposes (DWR 1981).

The dominant geohydrologic feature in the subbasin is an inland valley that is drained to the south by tributaries of the Pájaro River, including Uvas and Llagas creeks. Annual average precipitation for the Llagas subbasin ranges from less than 16 inches in the south to more than 24 inches in the north (DWR 2003).

Groundwater Production, Levels and Storage Figure J-5 shows the recent (2011-2015) groundwater elevation in the Llagas subbasin wells (09S03E23L005M, 11S04E10N001M). While groundwater elevations in the well are not indicative of elevations in all wells within the subbasin, these groundwater levels are suggestive of relative changes in groundwater levels within the subbasin.

SCVWD manages the Llagas subbasin, and groundwater is pumped from the subbasin by major water retailers, well owners and agricultural users. Annual average groundwater pumping within the Llagas subbasin has remained fairly constant over the years. Figure J-5 shows historic groundwater pumping from 2000 to 2015 within Santa Clara and Llagas subbasins.

Natural groundwater recharge based on the 10 years average (2003-2012) average for the Llagas subbasin is estimated to be 22,000 AF per year (SCVWD 2016). In addition to natural groundwater recharge, SCVWD operates an managed recharge program in the Llagas subbasin with about 24,000 AF recharged annually, approximately 52% of total recharge (SCVWD 2016). The operational storage capacity of the Llagas subbasin is estimated to be between 150,000 and 165,000 AF (SCVWD 2016). The operational storage capacity is less than the total storage capacity of the basin and accounts for available pumping capacity and the avoidance of problems associated with high groundwater levels.

Groundwater-Related Land Subsidence Most of the subsidence within Santa Clara County has occurred in the Santa Clara subbasin (SCVWD 2000). UNAVCO’s cPGS stations Lacrosse Drive P217 and Miller Slough P240 (see Figure J-5 for location of cGPS stations) are showing a not subsiding trend since 2006 (DWR 2016d).

Groundwater Quality DWR has prioritized the Llagas subbasin as high priority based primarily on groundwater use/reliance and irrigated acreage (DWR 2018). Groundwater alkalinity in the Llagas subbasin is generally high similar to the Santa Clara subbasin. Though the water is hard, it is suitable for most uses and drinking water standards are met at public supply wells without the use of treatment methods (SCVWD 2001).

The SCVWD continues to engage with land use and regulatory agencies to address nitrate loading to monitor and address elevate nitrate concentrations in the Llagas subbasin (SCVWD 2016). Nitrate concentrations in most wells appear stable or decreasing but elevated concentrations of nitrate still exist in certain portions of the Llagas subbasin (SCVWD 2017). Since 1997, more than 600 wells in south Santa Clara County including the Llagas Subbasin and Coyote Valley have been tested for nitrate. SCVWD offers free basic nitrate testing for domestic well owners as well as rebates for point-of-use nitrate treatment systems (SCVWD 2016). The 2017 median nitrate concentration for the principal aquifer zone of the Llagas subbasin was 5.2 mg/L Nitrate as N, with a maximum value of 24 mg/L (SCVWD 2017).

J.2.3 South Lohantan Hydrologic Region

J.2.3.1 Fremont Valley Groundwater Basin

Fremont Valley Groundwater Basin underlies Antelope Valley-East Kern Water Agency in eastern Kern County and northwestern San Bernardino County. Alluvium is primary water-bearing formation in this basin and is about 1,190 feet thick along the margin of the basin and thins towards the middle of the basin (DWR 2003). Total storage capacity of the basin is estimated to be approximately 4,800,000 AF (DWR 2003).

DWR has prioritized the Fremont Valley Groundwater Basin as a low priority basin with declining groundwater levels and some groundwater quality concerns. The basin has naturally high TDS and other constituents like fluoride and sodium (DWR 2018). DWR has also categorized the subbasin to have a medium to high potential for subsidence (DWR 2014b). cGPS station CalCity_CS2005 located in California City Airport in California City has recorded a little under 0.02 feet of subsidence since 2005 (DWR 2016d).

J.2.3.2 Antelope Valley Groundwater Basin

Antelope Valley Groundwater Basin also underlies Antelope Valley-East Kern Water Agency in the western Mojave Desert. Primary water-bearing formation in this basin are unconsolidated alluvial and lacustrine deposits. The basin is divided into three large structural basins separated by faults and folds along the San Andreas and Garlock fault zones. Groundwater flow in the basin is impeded by several other faults in addition to the San Andreas and Garlock faults. Groundwater storage capacity is estimated to be 70,000,000 AF (DWR 2003).

DWR has prioritized the Antelope Valley Groundwater Basin as a very low priority basin despite declining groundwater levels (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR

2018). DWR has also categorized the subbasin as having a high potential for subsidence (DWR 2014b). cGPS station BarnardPro_CS2005 located in the northern end of the basin has recorded a little under 0.03 feet of subsidence since 2005 (DWR 2016d). Station LakeLosAnge SCIGN located in southern end of the basin has recorded a little over 0.01 feet of subsidence since 2000 (DWR 2016d).

J.2.4 Colorado River Hydrologic Region

J.2.4.1 Ames Valley Groundwater Basin

The Ames Valley Groundwater Basin underlies Ames Valley, Homestead Valley, and Pipes Wash in the southcentral San Bernardino County. The primary water-bearing formation in this basin consists of unconsolidated to partly consolidated continental deposits (DWR 2003). Several northwest trending faults within the basin form partial barriers to groundwater flow. Total storage capacity of the basin is estimated to be approximately 1.2 million AF (DWR 2003).

J.2.4.2 Copper Mountain Valley Groundwater Basin

The Copper Mountain Valley Groundwater Basin is approximately one mile north of the town of Joshua Tree and underlies an alluvial valley below and adjacent to Coyote Lake. The primary water-bearing formation in this basin consists of unconsolidated to partly consolidated continental deposits (DWR 2003). The Pinto Mountain fault zone along the southern end of the basin acts as a barrier to groundwater flow (DWR 2003).

J.2.4.3 Warren Valley Groundwater Basin

The Warren Valley Basin is located in located south of the Copper Mountain Valley Groundwater Basin. The Warren Valley Groundwater Basin has been adjudicated since 1977 and is managed by Warren Valley Basin Watermaster. DWR has prioritized the groundwater basin as very low priority despite groundwater supply concerns (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018).

J.2.4.4 Coachella Valley Groundwater Basin

The Coachella Valley Groundwater Basin is located in the northwestern portion of the Salton Trough. The primary water-bearing formation in the basin is made of unconsolidated Pleistocene-Holocene valley fill. The basin includes the Indio, Mission Creek, Desert Hot Spring and San Gorgonio Pass subbasins as defined by Bulletin 118. Total storage capacity of the basin is estimated to be approximately 38.7 million AF (DWR 2003). DWR has prioritized the Indio, San Gorgonio and Mission Creek subbasins as medium priority due to groundwater quality concerns (DWR 2018). DWR has also prioritized the Indio subbasin as having a high potential for subsidence (DWR 2014b).

J.2.5 South Coast Hydrologic Region

Metropolitan Water District of Southern California (MWD) is the largest CVP contractors within the South Coast Hydrologic Region. All the groundwater basins discussed in this section are managed by MWD.

J.2.5.1 Northwest Metropolitan Area Groundwater Basins

The Northwest Metropolitan Area Groundwater Basins include Oxnard Plain, Oxnard Forebay, Pleasant Valley, Santa Rosa and West, East, and South Las Posas subbasins as defined by Bulletin 118. All listed basins are typically east-west trending basins that drain into the Pacific Ocean to their west by the Santa Clara River, Calleguas Creek and Conejo Creek. Total storage capacity of the basins is estimated to be between 3 to 5 million AF (MWD 2007). Natural Safe Yield and Operation Safe Yields are estimated to be approximately 45,000 AF and 100,000 AF respectively (MWD 2007).

J.2.5.2 San Fernando Valley Groundwater Basin

The San Fernando Valley Groundwater Basins is located within Los Angeles River Watershed in Los Angeles County. Total storage capacity of the groundwater basin is estimated to be approximately 3.2 million AF (MWD 2007). Natural Safe Yield and Operation Safe Yields are estimated to be approximately 43,600 AF and 96,800 AF respectively (MWD 2007). DWR has prioritized the groundwater basin as very low priority despite groundwater contamination issues in the basin (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018). The basin has been adjudicated since 1979 (DWR 2014c).

J.2.5.3 San Gabriel Valley Groundwater Basin

The San Gabriel Valley Groundwater Basin is located in eastern Los Angeles County. Total storage capacity of the groundwater basin is estimated to be approximately 8.6 million AF (MWD 2007). Natural Safe Yield is estimated to be approximately 152,700 AF (MWD 2007). DWR has prioritized the groundwater basin as very low priority despite the presence of superfund sites within the basin (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018). The priority for this basin has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018). The basin has been adjudicated since 1971 (DWR 2014c). DWR has also categorized the basin to have a high potential for subsidence (DWR 2014b).

J.2.5.4 Coastal Plains of Los Angeles Groundwater Basin

The Coastal Plain of Los Angeles Groundwater Basin lies within central Los Angeles County. The basin includes the Santa Monica, Hollywood, West Coast, and Central subbasins as defined by Bulletin 118. Total storage capacity of the groundwater basin is estimated to be approximately 13.8 million AF

(MWD 2007). Natural Safe Yield and Operation Safe Yields are estimated to be approximately 125,800 AF and 217,300 AF respectively (MWD 2007).

DWR has prioritized the Santa Monica subbasin as medium priority for groundwater contamination and overdraft concerns. The Central and West Coast subbasins were prioritized as very low priority despite overdraft concerns (DWR 2018). The priority for these basins has been set to very low as a result of conditions with adjudication and non-adjudicated groundwater use of less than 9,500 AF being met (DWR 2018). The Central and West Coast basins are adjudicated basins since 1965 and 1961 respectively (DWR 2014c). DWR has also categorized the Central subbasin to have a medium to high potential for subsidence (DWR 2014b).

J.2.5.5 Coastal Plains of Orange County Groundwater Basin

The Coastal Plain of Orange County Groundwater Basin lies in north and central Orange County within the lower Santa Ana River watershed. Total storage capacity of the groundwater basin is estimated to be approximately 66 million AF (MWD 2007). Natural Safe Yield is estimated to be approximately 70,500 AF (MWD 2007). DWR has prioritized the groundwater basin as medium priority due to sea water intrusion concerns (DWR 2018). DWR has also categorized the basin as having a high potential for subsidence (DWR 2014b).

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